Estimating the Effect of Participating in Eureka on Firm Performance

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1. Introduction

This paper is part of a broader research program undertaken by the Eureka Secretariat (ES), under the Israeli chairmanship, to strengthen the methodological basis for the assessment of Eureka's impact on firm performance. There are two main objectives to this program: (1) to establish a comprehensive methodological framework for estimation of the economic effect of participating in Eureka, and (2) to provide the ES with the appropriate policy-shaping tools to evaluate and improve Eureka's economic impact.

A key ingredient in achieving these objectives has been the four professional workshops on the subject that took place in the ES headquarters in Brussels with the participation of expert teams from Denmark, France Israel and Spain, and national Eureka representatives (NPCs) from The Netherlands, Portugal, Slovakia, Sweden and Turkey.

In Sections 2 and 3 of the paper we describe the methodology for the estimation of the economic effect that stems from participating in Eureka. This methodological approach was presented and adopted at the workshops mentioned above. In Sections 4 and 5 we describe the procedure, data and results of our empirical application of the proposed methodology. Overall our results show positive, strong and statistically significant Eureka effects in terms of sales and employment. The results are found to be robust across several model specifications. In Section 6 we summarize and bring forth our recommendations.

The research summarized here was carried out by E.G.P. Applied Economics Ltd., a private research-based consulting firm hired by the Office of the Chief Scientist in the Israeli Ministry of Industry trade and Labor to evaluate R&D programs.

2. What is the Eureka Effect?

Before we address this question it is useful to review the current methodology used to evaluate the effect of Eureka.

2.1. Using market impact report data to evaluate Eureka

Eureka evaluates its performance by analyzing the final and market impact reports (MIR) submitted by participating firms at the end of the project, and 2 and 4 years after completion.

The submission of these reports is voluntary and response rates are generally low. This low response rate is problematic since the samples are not large enough to get reliable estimates of effects and, even more problematic, the set of firms that choose to respond may not be representative of the population of firms participating in Eureka.

More specifically, the set of responding firms could plausibly be representative of the more satisfied firms; these may be firms that foresee participating in Eureka in the future and then have an interest in keeping a working relationship with Eureka authorities. This creates a selection bias in the inference drawn from such a sample. Namely, the inference would be valid for the set of more satisfied firms but it would not be valid for the population of participating firms as a whole.

Thus, it seems reasonable to request mandatory compliance in the provision of firm and project level information from firms receiving Eureka's support. This would increase response rates and attenuate selection bias.

The market impact reports contain information about characteristics of the participants as well as their evaluations of the technological and commercial achievements of the project. This information is very detailed and of great interest. For our purposes, the questions asking for a qualitative ranking of overall commercial achievements as a result of the project, as well as for the monetary value of the estimated additional turnover resulting from the project are of great relevance. These responses are widely cited as being an outcome of the Eureka program. This, however, would be a correct interpretation of the data only under very strict assumptions. The firms' responses reflect the commercial impact of the joint R&D project being carried out by the firms and its partners. This commercial impact can either be the realized impact at the time of answering the survey or an expected impact. If we assume that the joint R&D project would not have been carried out at all without participation in Eureka, and that the firm does not invest in alternative R&D projects then, and only then, would firms' responses represent the effect of participating in the Eureka program.

In any other scenario, the estimated effect would overestimate the true effect of participating in Eureka. To see this, suppose that indeed the joint R&D project would not have been carried out without Eureka but that the firm invests some (or all) of the resources intended for the cooperative project in an alternative R&D project, or even in the same project but without cooperating with other firms. In this situation, in order to obtain the effect of participating in Eureka we would need to subtract the benefits (realized or expected) accrued to the alternative project from the firm's response to the MIR questionnaire. Or, to take a more extreme example, suppose now that the firm would carry on the joint project even without Eureka's support. Then, if the R&D project is exactly the same with and without Eureka's participation, then Eureka's effect is, of course, nil.

In other words, using the MIR figures, without adjusting for alternative R&D investments in the event the firm does not participate in Eureka, overestimates the true effect of participating in Eureka since it implicitly assumes that the participating firm would generate zero benefits if it were not to receive Eureka status.

2.2. The Eureka effect

What is the Eureka effect? Is there a real effect of participating in Eureka? There are good reasons to believe that potentially there is such an effect. Eureka facilitates cooperation among firms by helping to identify potential partners and by offering a framework where IP (and other) frictions among partners can be harmoniously resolved. Since the target firms are SMEs working in different countries, Eureka's seal of approval may also serve as a signal to private investors about the project's quality. In some cases, Eureka can potentially turn a single-firm R&D project into a joint R&D project. Thus, getting Eureka status may change the nature of the R&D project as well as the extent to which the firm invests in R&D activities.

In general, Eureka's effect is to facilitate cooperation in R&D projects across countries. Naturally, we should then ask whether this is a desirable goal. From a social point of view, cooperative R&D is in general preferred to noncooperative R&D because it avoids wasteful duplication of scarce R&D resources. R&D cooperation may also be preferred by private firms (as well as socially) since it internalizes spillovers among them. Indeed, there is ample empirical evidence suggesting that cooperation in R&D, not necessarily across different countries, has positive effects on firm performance.[1]

In sum, participating in Eureka can have real effects on R&D activity and consequently on firm performance. This is the effect we would like to estimate.

More formally, the Eureka effect is defined as the *difference between an observed outcome of the participating firm and its counterfactual outcome in the case it would not have participated in Eureka*. This difference answers the question of what would have a participating firm done (in terms of the outcome measure) if it were not to receive Eureka's support. The difference between the observed performance of the participating firm and its counterfactual is what is known in the literature as the treatment effect on the treated. The treatment in this context is to participate in Eureka.

Of course, we never observe the counterfactual outcome so that it has to be estimated if we want to know something about the effect of Eureka. Before we address the estimation issue in Section 3 we want to discuss the possible choices regarding the outcomes or indicators of participating in Eureka.

[1] See Caloghirou et al (2003) for a survey on research joint ventures and Belderbos et al (2004) for evidence on the positive effect of R&D cooperation on productivity among Dutch innovating firms. Brenstetter and Sakakibara (2002) find that patent outcomes are positively associated with the degree of potential R&D spillovers among participants within Japanese R&D consortia.

2.3. Outcome measures

Given that Eureka's stated goal is to promote R&D cooperation among SMEs across countries, a natural choice for outcomes would be the incidence or extent of transnational R&D cooperation among SMEs. If the participating firm would not have engaged in R&D cooperation without obtaining Eureka's seal of approval then the Eureka effect would indeed be positive in the sense that the program induced firms to cooperate in R&D whereas, in its absence, they would not have cooperated.

This choice of outcome, however, ignores the possibility that the counterfactual for the participating may be to carry on with the same (or very similar) R&D project, perhaps without cooperating with a foreign firm, or to invest in alternative R&D projects. Limiting the analysis to transnational R&D cooperation is then likely to overestimate the effect of Eureka on *overall R&D activity* since it ignores alternative R&D activity undertaken by the firm in the case it did not participate in Eureka.

This argument suggests choosing total R&D expenditures of the firm (i.e., total R&D outlays in all research activities of the firm) as the outcome, as this will account for alternative R&D activity in the counterfactual situation. This choice, however, also has its problems. Suppose that a participating firm, were it not to participate in Eureka, would undertake by itself the same research project it intended to undertake in cooperation with a foreign partner under Eureka's tutelage. The firm would then have to spend more resources on R&D since it is doing the project alone, or it would have to cut down other research projects in order to maintain the same overall R&D budget. In any case, we will conclude that Eureka had a negative or a nil effect if we measure outcomes by total R&D expenditures of the firm. Under the chosen outcome measure, this would be the correct conclusion since the same research project is being performed with or without Eureka's participation, and the firm may have scaled down other R&D activities in order to fund this particular project.

Yet this does not sound totally correct because the *nature* of the R&D project itself changes when the research is done cooperatively with other firms rather that solely by a single firm. And this change in the nature of the project cannot be (fully) captured in the R&D expenditures figures. In fact, the problem with measuring R&D activity via its input side, i.e., using expenditures, is that it implicitly assumes that all research projects are equally valuable to the firm. Arguably, cooperative R&D allows firms to benefit from each other's knowledge base and this should be manifested in improved research outcomes. Cooperating with firms located in different countries enlarges the set of potential partners allowing for a better choice of partners and, consequently, for enhanced synergy effects. Furthermore, transnational R&D allows for the possibility of opening new national markets with direct effects on future sales performance which is particularly important in our context since the R&D projects funded through Eureka are near-to-market projects. Thus, a given research project will evolve differently and will have different performance outcomes if undertaken in cooperation with another firm. Furthermore, its performance will also depend on whether the R&D partner is local or from another country. Importantly, these differences will not be (fully) manifested in the amount of R&D expenditures spent on the project, but should be reflected in research outcomes and in the monetary benefits they generate.

This reasoning suggests that one way of measuring the outcomes of Eureka in the presence of heterogeneity across R&D projects, would be to use indicators of research outcomes. Patents applied for or granted is an example of such indicators.[2] Using patents, preferably accounting for their quality through citations, would allow us to compare R&D projects which are different in nature (i.e., apples and oranges) thereby solving many of the problems mentioned above.

Differences in research outcomes should ultimately lead to differences in profits. We can then use profit data as an outcome of R&D activities, even though profits depend

[2] By their very nature, however, patent counts do not differentiate between more or less valuable patents. Economists have used citations to patents to account for this heterogeneity in patents. The number of times a patent is cited by other patents is used as a measure of the patent's quality. The finding is that more cited patents are also more valuable.

on many factors, many of them unrelated to R&D (e.g., taxes). Profit data, however, are seldom available. Data on sales, on the other hand, are available and correlated with profits. Note that sales should be measured at the firm level and not at the project level which, even if available, will, again, ignore other counterfactual activities of the firm that may affect sales through other channels. A similar argument could be used for justifying the use of employment figures as an outcome of R&D.[3]

In this report we use sales and employment data as observable outcomes of participation in Eureka.

3. Estimation of the Eureka effect

Estimation of counterfactuals is not easy. The only available source of data for estimating the counterfactuals is the outcome data of non-participating firms, and the question is how to use these data. A naive approach would suggest using the mean outcome of R&D-doing firms which did not receive Eureka support. The problem with this naive approach is that firms receiving Eureka support are probably different from those not receiving it along dimensions that may matter for performance. Comparing differences in outcomes between participants and non-participants will reflect the effect of these differences on outcome, in addition to the effect of participating in Eureka. For example, more innovative firms may be more likely to participate in Eureka and may also have better outcomes. In this case, the naive estimator will overestimate the Eureka effect.

There are various approaches in the literature to cope with this problem. The regression approach usually assumes a parametric model (e.g., linear) of outcomes as a function of covariates and estimates the parameters of this model. For example, firm's sales are posited to be a linear function of capital stock, employment, R&D expenditures

[3] An interesting hypothesis -- not explored in this report -- about a possible effect of Eureka is that R&D cooperation allows partners to evaluate each other and to gain a better understanding of the potential value that could be generated from joint operations. Thus, firms participating in Eureka should be more prone to acquire or merge with other firms (maybe, but not necessarily, with their Eureka partner) or being the target of an acquisition or takeover process. This suggests that an additional relevant outcome by which to measure the Eureka effect is the occurrence of an M&A.

and, for our purposes, participation in Eureka. Using data on these variables for firms that did and did not participate in Eureka would allow us to estimate the parameters of this relationship using statistical (regressions) techniques. The coefficient of the Eureka variable measures the difference in expected sales between a firm that participated in Eureka and the expected sales of the same firm had it not participated in Eureka. Thus, in effect we use the estimated parameters to predict the counterfactual, i.e., what a participating firm would have done were it not to participate in Eureka.

The alternative approach we propose here does not require parametric assumptions and is also more intuitive than the regression approach. It is called the matching approach (Abadie and Imbens, 2006, 2007, 2009). In this approach we look for a twin, or group of twins, to a participating firm and use the outcome of this twin (or twins) as an estimate of the counterfactual outcome. For clarity of exposition, we will proceed as if there is only one twin; later we will return to the case of several twins. We say that we match a twin firm to each firm participating in Eureka.

This twin is a firm that is very similar to the participating firm in terms of its pre-Eureka participation characteristics, except for the fact that it did not participate. Suppose we find a firm which is identical in every aspect to the firm that received Eureka support during the period before the Eureka support decision was made. The fact that one firm, and not the other one, received Eureka status can be viewed as random since both firms are ex-ante identical. Moreover, the outcome of the twin firm would accurately represent the counterfactual outcome of the treated firm because, again, both firms are identical at the time of the treatment, except for one of them receiving the treatment. The difference in outcomes (after the Eureka project is completed) between the treated firm and its twin is attributed to the effect of participating in Eureka. In other words, if we can find such a twin firm we can then recreate the conditions of a random experiment and the difference in outcome between the treated and non-treated, or control, firm consistently estimates the effect of the treatment. Indeed, borrowing from the jargon of experiments, the twin firm is the control firm for the participating firm.

Implementing this simple yet powerful idea is not easy since we usually do not observe all the characteristics that make up a firm. Suppose we observe a vector of characteristics denoted by x. x may include the firm's size, as measured by sales, R&D intensity (R&D as a share of sales), past investments in R&D, patent history, the technological area in which the firm operates, etc. Importantly, these characteristics are measured before the treatment occurs, i.e., before the firm receives Eureka's support. There are still many things that make up a firm, in the sense that they affect the firm's performance, that are not included in x either because they are not observed, such as liquidity or other financial constraints faced by the firm, or because they are intrinsically not measurable, such as the degree of innovativeness of the manager.

The important point is that x *includes enough characteristics to validate the assumption that the assignment of Eureka status between two firms having the same* x *is essentially random*. To be clear, this is the critical assumption underlying the matching approach. This assumption is sometimes called the selection on observables assumption since, essentially, we are assuming that the Eureka selection committee selects which firms to support only on the basis of the vector x of characteristics.[4] Thus, which of various firms with the same x actually gets Eureka status can be viewed as random. No other unobserved factors enter the committee's decision making because if these factors differ among the firms having the same x they could affect both the decision to give Eureka support and the performance of the firm thereby confounding the effect of Eureka with the effect of these unobserved factors.

An example can clarify this issue. Suppose that the unobserved manager's innovativeness increases outcome performance and is also viewed favorably by the selection committee. In this case there is (positive) selection based on an unobserved

[4] The selection of projects is probabilistic in the sense that x determines the probability of being approved for Eureka. The actual decision, conditional on x, is random. In fact, we need to assume that selection is not deterministic or, more precisely, that the probability of being approved for Eureka conditional on x is strictly less than one. Otherwise, there will not be non-participating firms for a given x. This assumption is known as the common support assumption.

variable which is ignored in our choice of the twin firm (since innovativeness is not observed in the data, i.e., it is not included in x). As a result, the treated firm is likely to be more innovative than its twin and will therefore have a higher observed outcome due, in part, to being more innovative to start with and not only due to its participation in Eureka. This will bias (upward) our estimation of the Eureka effect. This bias could be avoided if x were to include a measure of innovativeness. This example makes clear how crucial it is to specify the vector x in such a way that the assumption of selection into treatment based only on x is believable.

As a technical matter it is very difficult to match firms on a multidimensional vector of characteristics. Recall that we want the vector x to include as many variables as necessary to make the *selection on observables* assumption plausible. It may well be the case that we will not be able to find a non-participating firm with exactly the same characteristics x as the participating firm. This problem was solved by Rosenbaum and Rubin (1983) who showed that if the selection on observables assumption holds for x then it also holds for a one-dimensional function of x, namely the probability of receiving Eureka support conditional on x,

$$p(x) \equiv \Pr\left(Eureka = 1 \mid x\right)$$

This probability is called the *propensity score* and it is a function of x. Thus, instead of matching on the multidimensional vector x we match on the one-dimensional propensity score function which is easier. By matching on the propensity score we compare a firm that received Eureka status with another firm that was not supported by Eureka but that was ex-ante equally likely to receive Eureka support. Of course, $p(x)$ is not known and we will therefore have to estimate it using standard statistical methods (e.g., a probit regression).

A simple estimator of the Eureka effect could then be

$$\frac{1}{N}\sum_i \left(y_{it} - y_{twin(i),t}\right)$$

where y denotes the outcome measure (sales or employment) in a post-participation year t, and the indexes i and $twin(i)$ denote treated firm i and its twin, respectively. N is the number of firms participating in Eureka.

For each Eureka firm i the twin firm is chosen such that

$$\left| p(x_i) - p(x_{twin(i)}) \right| \text{ is smallest}$$

and the outcome data on the twin firm is chosen to correspond to the same calendar period for which we observe the outcome data of the Eureka firm. This avoids comparing firms operating in different time periods and facing different macroeconomic conditions.

As mentioned above, for this estimator to work well it requires x to include enough characteristics so that that the assignment of Eureka status between two firms having the same x can be considered essentially random. This is a very strong requirement on x which can be difficult to meet with the available data. Instead we propose to use a variation of this estimator, namely

$$Eureka\ Effect = \frac{1}{N}\sum_i \left(\Delta y_i - \Delta y_{twin(i)}\right) \tag{1}$$

where Δy denotes the change in y between a post-participation year and a pre-participation year.

This estimator is called the *matched difference-in-difference* estimator since it is based on the change in outcome changes between the treated firm and its control. The advantage of using changes in outcome is that by using the *changes* in the firm's outcome we control for the effect of additive, time-invariant, factors affecting outcome y that are not included in x because they are unobserved. As in the previous example, suppose that unobserved innovativeness does not change over time and that it increases the probability of receiving Eureka, $p(x)$, and it increases sales (y) in an additive fashion. Since the twin firm was not matched on the basis of innovativeness, but only on the basis of $p(x)$, and innovativeness increases the chances of receiving Eureka support, the outcome of the treated firms will be higher than the non-treated firms because they are more innovative and not because they participated in Eureka. This will confound the Eureka effect and, in this example, it will bias the estimated effect upwards. Using changes in y solves this problem because Δy does not depend on unobserved, time-invariant, additive factors affecting outcomes.

To see this point more formally we assume that potential outcomes are any function of observed, possibly time-varying factors, x_{it}, and of the participation indicator E_i, and a linear function of unobserved, time-invariant factors denoted by z_i, and of unobserved but time-varying factors u_{it} as follows,

$$y_{it} = \mu(x_{it}, E_i) + z_i + u_{it}$$

The Eureka effect is then

$$\mu(x_{it}, 1) - \mu(x_{it}, 0)$$

since this answers the counterfactual question of how would the outcome of a firm change had it not participated in Eureka.

Clearly, in this model, the simple difference

$$y_{it} - y_{twin(i),t} = \mu(x_{it}, 1) - \mu(x_{twin(i),t}, 0) + z_i + u_{it} - z_{twin(i)} - u_{twin(i),t}$$

will be picking up differences in the unobserved factors between i and its twin. The underlying idea is that, when averaging over i, these differences wash out. Thus, we estimate an *average* Eureka effect and not an Eureka effect for each individual firm.

We treat the term u_{it} as a zero-mean random factor affecting outcome which is uncorrelated with x_{it} and E_i (e.g., an unexpected increase in demand for the firm's product). The zero-mean assumption is a normalization without loss of generality. The average of $u_{it} - u_{twin(i)t}$ will converge to zero when N is large. The problem is that when the unobserved factors in z_i are correlated with receiving Eureka support, averaging these simple differences across i will not eliminate the term $z_i - z_{twin(i)}$. Since we cannot rule-out the possibility that z_i is correlated with E_i, the estimator $\frac{1}{N}\sum_i \left(y_i - y_{twin(i)}\right)$ will be biased.

The solution is to eliminate z_i by examining changes between a pre- and post-Eureka year, t_0 and t_1, in y_{it} since $\Delta y_i - \Delta y_{twin(i)}$ does not depend on the $z'_i\,s$,

$$\begin{aligned}\Delta y_i - \Delta y_{twin(i)} &= \left(\mu\left(x_{it_1},1\right) - \mu\left(x_{it_0},0\right)\right) - \left(\mu\left(x_{twin(i)t_1},0\right) - \mu\left(x_{twin(i)t_0},0\right)\right)\\ &\quad + \left(u_{it_1} - u_{it_0}\right) - \left(u_{twin(i)t_1} - u_{twin(i)t_0}\right)\\ &= \mu\left(x_{it_1},1\right) - \mu\left(x_{it_1,}\,0\right) + \left(u_{it_1} - u_{it_0}\right) - \left(u_{twin(i)t_1} - u_{twin(i)t_0}\right)\end{aligned}$$

since, by the definition of matching, the observed component of the mean outcome is the same for participating firms and their twins in the pre-participation year, $\mu\left(x_{it_0},0\right) = \mu\left(x_{twin(i)t_0},0\right)$, and the twin's outcome after Eureka should be the same as the counterfactual outcome, i.e., $\mu\left(x_{it1},0\right) = \mu\left(x_{twin(i)t_1},0\right)$.

An important remark is that even though we use changes in outcome the Eureka effect we estimate is still interpreted as representing the *average difference between the observed outcome of the participating firm and its counterfactual outcome in the case it would not have participated in Eureka*. That is, it measures the change in sales or employment due to participation in Eureka. In particular, it should *not* be interpreted as the change in the *change* in sales or employment due to participation in Eureka. This occurs because the matching ensures that pre-treatment differences in y between Eureka firm i and its twin are nil except for unobserved time-invariant factors which are removed by the time-differencing.

The advantage of this difference in difference estimator is that by using changes in outcomes we do not need data on the time-invariant, additive factors z since these do not affect Δy. This reduces our data requirements. On the other hand, the matched difference-in-difference estimator is feasible only if there are outcome data for a period before and for a period after participation in Eureka.

So far, the exposition of the matching estimator proceeded by matching only one twin to each treated firm. Note also that this twin has been chosen by requiring that its propensity score be closest to the propensity score of the treated firm (ideally, the scores should be the same but this does not usually occur in practice). This raises the question of using more than one twin for each firm. In fact, in practice we sometimes use k twins, the closest k non-participating firms to the treated firm in terms of their propensity scores. The choice between a single twin and many twins involves a trade-off between bias and variance of the estimator. By using the closest match to a treated firm we reduce the bias of the estimator since we are using the best match. Including additional matches increases the bias since we use inferior matches, but reduces the variance of the estimator since we are averaging over many firms to estimate the counterfactual.

An additional issue is whether to allow non-treated firms to serve as twins of more than one treated firm. Allowing for this improves the quality of the matching since for each treated firm we have more potential twins (Abadie and Imbens, 2006).

In equation (1) we may want to restrict the set of non-treated firms to firms that belong to the same group as the treated firm. That is, suppose we are looking for a match for a small firm in biotech. We can search for twins among all non-treated firms or we can restrict the search to the set of small firms in biotech. That is, we match on the propensity score within a subset of the non-treated firms defined by some characteristics (such as industry, size, etc.).

The Eureka effect can be estimated for different subgroups of the data, i.e., by industry, size group, etc. provided we have enough treated and non-treated firms in each group. This allows us to test for differences in the Eureka effect across these groups. We report estimates of the Eureka effect for SMEs and large firms separately.

A related exercise is to restrict the choice of twins to firms that received support from the local R&D Authority (e.g., the OCS in Israel) through its regular R&D support programs. By doing this we are choosing a particular counterfactual where the treated firm would have received public R&D funding if it would not have participated in Eureka. The Eureka effect estimated in this manner would represent the additional value conferred by Eureka above and beyond the contribution of the regular R&D support programs.

4. Description of the data

The empirical analysis uses data on European and Israeli firms. We need data on pre-Eureka participation characteristics x to estimate the propensity score and on outcomes y to estimate the Eureka effect. Moreover, we need these data for the participating firms as well as for their non-participating twins.

The Eureka Secretariat provided a list of firms that participated in Eureka individual projects since 1985.[5] Using this list and various sources of data we constructed a sample of 381 European and 31 Israeli firms that participated in Eureka projects that started during the period 1996-2004, for the European firms, and that started during the period 2000-2008, for the Israeli firms. In the remaining of this Section we describe the construction of this sample; we start with the European firms.

Our main source of data on both x and y is the Amadeus database. Amadeus is a pan-European database compiled and constantly updated by Bureau van Dijk from local information providers: it includes financial and business firm-level data for 43 European

[5] That is, we do not include projects funded by Eureka's other programs such as Eurostars, Clusters, etc.

countries -- including standardized annual accounts (consolidated and unconsolidated), national industry codes (NACE, US SIC, and NAICS), financial ratios, sectorial activities and ownership information. This report is based on the Amadeus database updated up to 2007 that contains data of companies up to 2006 and complemented with data from firms that appeared earlier in the database but that were dropped from the 2007 version (because of having missing data for 4 consecutive years).[6]

Notice that a firm can participate in more than one Eureka project, although usually not during the same time period.[7] Thus, the unit of analysis will not be the firm per se but the combination of a project and a firm. That is, we base our analysis on the *participations* of firms in Eureka projects. By definition, there are more firms than Eureka projects (since projects involve at least 2 firms) and there are more participations than firms (since firms can participate in more than one project). Table 1 shows the actual number of Eureka projects, firms and participations by SME status.[8]

In order to identify the Eureka firms in the Amadeus database we searched the Amadeus database for the name and country of each of the firms in the Eureka list. We also tried a more refined search by adding the city where the firm is located to the matching criteria (in addition to name and country) but this resulted in significantly fewer matches. We decided to use the name-country criteria after conducting satisfactory representativity checks and verifying that our estimation results did not change when we used the more stringent criteria. Table 2 indicates that we locate 42 percent $\left(\frac{1082}{2597}\right)$ of the participations in the Eureka list in Amadeus.

As discussed in Section 3, estimation of the effect of participating in Eureka requires us to compare the outcomes of participants to that of their controls. Recall that

[6] The data were processed by a third party, with legal access to the relevant Amadeus data, under the methodological guidance of Applied Economics Ltd.
[7] However, 92.5 percent of the firms participate in only 1 project, while 6.5 percent participate in exactly 2 projects.
[8] SME status as reported in Eureka's list of firms.

we use sales and employment as outcomes.[9] These outcomes correspond to the post-Eureka participation period. We also need data on pre-participation outcomes for two reasons: first, the matched difference-in-difference estimator is based on changes in outcomes over time and, second, we want to use pre-Eureka outcomes as a matching variable to identify the twins. Eureka projects usually last for 2-3 years and it is likely that the impact of Eureka on outcomes is spread over a few years after completion of the project. It follows that if we want to measure performance up to, say, 3 years after completion of the project, we would need at least 6 years of data for the participating firms and their controls. The number of Eureka firms with 6 or more consecutive years of data in Amadeus is very small and we would be forced to use only a small fraction of the 1082 participations identified in the data.

To overcome this limitation, we proceed as follows. For the pre-treatment outcome, we average the non-missing outcome measures during the 4 year period starting, and including, the first year of the project and up to 3 years before the project starts.[10] This way of computing the pre-treatment outcome requires at least one year of data among the 4 years as opposed to requiring data for precisely the year before the project starts. In addition, it smoothes out unrelated fluctuations in sales and employment. Similarly, for the post-treatment outcome, we average the outcomes of up to 3 years after completion of the project. Using this approach, we are able to find data for about 15 percent $\left(\frac{381}{2597}\right)$ of the Eureka participations (Table 2). That is, our empirical analysis will be based on 381 participations corresponding to 359 firms and 306 projects.

Amadeus does not cover Israeli firms. For these firms we utilized data collected by the Office of the Chief Scientist (OCS) in the Israeli Ministry of Industry, Trade and Labor, the Eureka Secretariat's database, firms' public financial statements and from Dun & Bradstreet, Israel. The Israeli data covers projects that started between 2000 and 2008 (and finished by 2009). We identified 69 Israeli participations (61firms) that appeared

[9] Sales are measured in 2005 prices.
[10] Assuming that the outcome during the first year is mostly determined by pre-participation factors.

both in the Eureka Secretariat and in the Israeli OCS data bases. Table 2 indicates that we have data on about 45 percent $\left(\frac{31}{69}\right)$ of them.[11]

The control firms used to estimate the counterfactual outcomes are taken from the pool of firms that did not participate in Eureka. The controls for the European Eureka firms are taken from Amadeus, while the controls for the Israeli Eureka firms are taken from the OCS database. An important difference between the two sets of controls is that firms in the OCS database are firms that were active in R&D and received government support through one of the OCS programs, while those in Amadeus do not necessarily engage in R&D.[12] This difference affects the interpretation of the estimated effects. Unfortunately, because of the small number of observations in each country, it is not possible to analyze each country separately and learn therefore about country differences in the estimated effects**.**

Another issue of concern is that the selection of firms into the sample may be non-random. Since the inclusion of firms in the sample is driven by the availability of data in Amadeus, the issue is the criteria by which firms are included in Amadeus and, once included, the reasons for their lack of data. The concern is that Eureka firms that did no succeed in their business left Amadeus (or were not included to begin with) and the sample therefore includes disproportionately the most successful firms. Our estimation methodology can cope with such as concern as long as the factors determining success for each firm are constant over time. However, if the reasons for remaining in the sample are related to the success or failure of the Eureka project itself we will then be sampling disproportionately from the successful firms and our inference will be correct for this selected group of firms only. There is not much we can do at this stage about this. Note, however, that the selection could also work in the opposite direction: more successful firms are bought by larger firms and therefore disappear from the sample.

[11] Note that there are less firms than projects in the Israeli case since some of the firms participate in 2 projects, and the partners are European firms. In fact, 87 percent of the Israeli firms participated in 1 project, while 13 percent participated in exactly 2 projects.
[12] Amadeus has a an R&D expenses variable which is missing for most firms.

Tables 3-8 present descriptive statistics for the 412 Eureka participations (381 European and 31 Israeli). Most of the projects started between 1997 and 2003. Slightly more than a fifth of the participations in the sample are Spanish which is overrepresented (as is Israel), while about 2/3 are SMEs. When computing our final estimates of the Eureka effect we therefore weight the individual effects so that the country's share in the sample average is the same as its weight in the population.

Not surprisingly, most of the projects -- about 22 percent -- are in the IT area. The sample distribution of SMEs and technology areas is very similar to the population distribution so that the sample is representative of the population of Eureka participations in these two dimensions. The size distribution of participations, in terms of pre-Eureka sales and employment, is quite spread out with about 14 percent of the participants selling under 1 million euros per year (and employing 7 workers on average), and 9 percent of the participants selling above 1 billion euros per year (and employing 79,000 workers on average).

At this stage, we have data on 412 participants with outcome information on two points in time corresponding to a pre-Eureka and a post-Eureka period. For all other firms in Amadeus and the OCS database -- firms that did not participate in Eureka -- we compute a 4-year moving average of sales (in 2005 prices) and employment using the non-missing available data for each such firm. Thus, the data for both treated and non-treated firms are averaged over time.

5. Results

5.1. Estimation of the propensity score

We mentioned above that the variables in x used to estimate the propensity score should be such that the selection on observables assumption is deemed believable. That is, conditioning on $p(x)$, receiving Eureka status is as good as random from the point of view of the potential outcomes. Thus x would need to include all the factors affecting the probability of receiving Eureka that could also affect potential outcomes.[13] This is a very stringent requirement which is difficult to comply in practice. Amadeus offers some information on the firm's pre-Eureka characteristics such as its sales and employment but is missing information on its R&D activity, funding sources, etc. Fortunately, the availability of longitudinal data -- data over time for the same firm -- allows us to account for time-invariant unobserved factors in our estimation of the Eureka effect as described in Section 3. Thus, the availability of outcome data on at least two points in time (before and after Eureka) compensates in part for the lack of a rich list of factors.

For the European participants we estimated a probit model to estimate the probability of receiving Eureka support, i.e., $p(x) = F(x\beta)$ where $F(\cdot)$ is the normal cumulative distribution and x are pre-Eureka characteristics. We estimate $p(x)$ using the firms that start Eureka in a given year and firms in Amadeus that are not in Eureka (at any point during the sample period). The explanatory variables in this regression are sales and employment as well as 2 digit industry and country dummies. We also included a set of size class dummies to capture non-linearities.[14] Sales and employment for the Eureka participants are measured in the pre-Eureka period (as defined in Section 4). We pooled the observations over all years -- and added year dummies -- resulting in 2,751,503 observations. The estimated coefficients β are presented in Table 9.

We observe in Table 9 that size class is significant and that within each class, larger firms have a higher probability of receiving Eureka approval, although this effect is not significant. There are significant differences across countries, years and industries.

[13] Note that because it is very likely that the potential twins among the firms in Amadeus did not apply to Eureka, $p(x)$ reflects both the probability of receiving Eureka status, given that the firm applied, as well as the probability of applying to Eureka. x should then include factors that affect the probability of applying as well as the probability of obtaining Eureka status once the firm has applied. If we could focus on firms that applied to Eureka but did not receive Eureka support, i.e., their projects were rejected, then we would be conditioning on having applied to Eureka and this would reduce the data requirements on x .

[14] Seven size classes defined by sales, as in Tables 7 and 8: 0 sales, sales between 0 and 1 million euros, between 1 million and 10 million, between 10 millions and 50 million, between 50 million and 1 billion, between 1 billion and 5 billion, and more than 5 billion euros in sales.

The propensity score for the Israeli firms was estimated separately using size class dummies and a technology area indicator available in the OCS data (instead of the 2 digit SIC variable used with the European sample).

5.2. Propensity score matching

We use the predicted probability $\hat{p}(x) = F\left(x\hat{\beta}\right)$ to compute the log odds-ratio

$$\hat{q}(x) = \log\left[\frac{1-\hat{p}(x)}{\hat{p}(x)}\right]$$

and use the log odds ratio to check the common support assumption, i.e., that for each treated firm there is at least one control firm with the same propensity score. $\hat{q}(x)$ is easier to use than $\hat{p}(x)$ since the latter is a very small number.[15]

For each Eureka participant i we looked for a non-treated firm whose value of $\hat{q}(x)$ is closest to $\hat{q}(x)$ This is called *nearest neighbor* matching. In addition, we require that the twin firm belong to the same industry and country as the treated firm as well as to the same size class. That is, for each Eureka participant i, a twin firm satisfies the following criteria:

1) Their value of $\hat{q}$ is closest to $\hat{q}_i$ and less than $0.25 \text{ x } \mathrm{STD}(\hat{q}(x))$ away from $\hat{q}_i$
2) They belong to the same country as i.
3) They belong to the same 3 digit SIC industry as i.
4) They belong to the same size class as i.
5) Their data is for the pre-Eureka year of i.

The standard deviation of $\hat{q}(x)$ is 1.87 so that we require that a twin's log odds ratio be no more than 0.47 away from the Eureka firm's log odds ratio. Because the mean of

[15] The mean of $\hat{p}(x)$ is 0.0001356, while that of $\hat{q}(x)$ is 10.73.

$\hat{q}(x)$ is 10.7, the radius requirement 1 ensures that the nearest neighbors are indeed close (in an absolute sense) to the treated firms.

The same procedure was used for the 31 Israeli participations.

We started with a total of 381 European participations but, for some of these participations, we could not find an appropriate twin. We could not compute $\hat{p}(x)$ for 6 firms since they were missing their industry affiliation (2 digit SIC) variable. Two of the firms got $\hat{p}(x)=1$ and were also dropped. 42 participations were dropped because even though we found controls with similar $\hat{q}(x)'s$ they did not satisfy (at least) one of the remaining four requirements (i.e., these controls were not within the same country or industry or size class or year). Finally, we also had to drop another 12 Eureka participations which were successfully matched to twins but their twins did not have post-Eureka outcome data. Altogether, we discarded 62 treated observations. A similar analysis of the Israeli firms forced us to discard 6 participants (out of the initial 31 observations).

The performance evaluation is therefore conducted on 344 Eureka participations for whom we could find an appropriate twin firm from among the non-participants according to the five requirements presented above.[16] Table 10 presents the distribution of the log odd ratio for the treated firm and for their twins. Note that there are 359 control firms instead of 344. The reason is that in some cases we found two or more controls that qualified as twins and had identical log odds ratio. Instead of selecting only one such twin we average the outcomes of all the tied twins. As expected, the treated and controls groups are well balanced in terms of $\hat{q}$. Due to the presence of very large Eureka firms, the mean pre-Eureka sales and employment for the treated are larger than for the control firms. These differences in mean, however, are not significantly different from zero. We also observe that the differences between treated and control firms appear only in the

[16] In the robustness checks in Section 5.3.1, we use 4 twins instead of one by choosing the four controls firms with the closest log odds ratio to $\hat{q}_i$ in addition to the other four requirements.

higher quantiles of the distribution. Thus, balancing on the propensity score also balances pre-Eureka sales and employment between treated and control groups.

5.3. The Eureka effect

We measure the outcomes in natural logs and therefore the Eureka effect reflects the percentage change in sales or employment due to participation in Eureka. This is the effect that occurs after participation in Eureka taking into account that firms were in Eureka during different lengths of time.[17]

Table 11 presents our results for the estimated Eureka effect according to equation (1). These estimates are based on the nearest neighbor match, the matching done according to the five requirements in Section 5.2. This is our baseline scenario and, later, we will examine the robustness of the estimated results to variations in this scenario. We show the estimated effects of participation in Eureka for all 344 Eureka participations taken together and for those corresponding to SMEs and large firms, 237 and 107 participations, respectively.[18]

We find that participation in Eureka increased post-participation sales and employment by 28 percent. That is, sales and employment for Eureka participants are, on average, 28 percent higher relative to the sales and employment that would have resulted if the firm had not participated in Eureka. These increments are annual increases as well as the increment for the 3-year post-Eureka period as a whole.[19] In particular, they should

[17] That is, the effect is not normalized on a per-year basis. A natural normalization would be by the extent of the investment in R&D but these data are not available.

[18] We use the EU definition of SME status: less than 250 employees and annual sales under 50 million euros.

[19] Recall that we measure average annual sales for up to 3 years after the project is completed. If sales are larger by 28 percent relative to the counterfactual in every year then total sales over the 3 year period are also 28 percent higher than the total counterfactual sales.

More formally, let y_{it}^1 be the outcome in the t^{th} year after the project is finished for the participating firm and let y_{it}^0 be its counterfactual outcome. The estimates we report correspond to $\ln\left(\frac{1}{3}\sum_{t=1}^{3} y_{it}^1\right) - \ln\left(\frac{1}{3}\sum_{t=1}^{3} y_{it}^0\right)$ which is identical to $\ln\left(\sum_{t=1}^{3} y_{it}^1\right) - \ln\left(\sum_{t=1}^{3} y_{it}^0\right)$. This presupposes that we not be understood as meaning that sales and employment are increasing 28 percent per year. To make valid inference on the effect of Eureka over longer time horizons requires longer time series of post-participation outcomes.

These are large and precisely estimated Eureka effects.[20] It is possible, however, that they overstate the Eureka effect because, except for the Israeli firms, we have no guarantee that the twin firms are involved in R&D projects. As a consequence, our estimated Eureka effect may be picking up part of the positive effect of the R&D projects themselves. The best way to avoid this possible bias is to get additional data on the R&D activity of the control firms. Lacking these data we deal with this issue in two ways. First, our matching procedure ensures that Eureka firms and their twins belong to the same three digit industry branch. Second, as described in Section 5, we estimate the propensity score using productivity and the firm's wage bill as additional characteristics. These two variables are usually higher for R&D performing firms and we therefore use them to partially identify R&D doers. As shown in Section 5, the estimated effects are still large and significant.

It should be emphasized that we estimate an average effect and that there is dispersion around these averages, as can be seen in the last five columns of table 11, showing the percentiles of the distribution of $\Delta y_i - \Delta y_{twin(i)}$. In fact, about 2/3 of the individual effects are positive, and thus 1/3 of the firms participating in Eureka exhibit a decrease in sales relative to the alternative. This is clearly seen in Figures 1 and 2 showing the distribution of the individual difference-in-difference effects, $\Delta y_i - \Delta y_{twin(i)}$.

The large firms exhibit larger effects than the SMEs: sales for larger firms are 29 percent higher while sales for SMEs are 27 percent higher. However, the effects are significant for both types of firms. The difference is even stronger for employment:

have non-missing data for all the 3 years.

[20] As shown in Abadie and Imbens (2009), the usual standard errors overestimate the true standard errors when matching is on the estimated propensity score. The results are therefore even more significant than what they appear.

participation in Eureka causes large firms to increase their employment by 43 percent while smaller firms increase theirs by only 18 percent.

We use the estimates of the Eureka effect to compute the increase in sales and employment that can be attributed to overall participation in Eureka projects that started between 1996-2003 and finished by 2005 (the period covered by our sample). We did this in two steps. First, we multiply the estimated Eureka effect (given in percentage terms) from Table 11 by the average pre-Eureka outcomes (sales and employment) of the participating firms in our sample to obtain an average absolute effect for the sample firms. We then multiply this average absolute effect by an *annual* number of participations to give a total annual Eureka effect. The annual number of Eureka participations is the population average number of projects that started during the 1996-2003 period (and ended by 2005). All the steps of these computations appear in Table 12.

We computed the absolute effects separately for SMEs and for the large firms in order to avoid outlier effects due to the presence of very large firms. As an additional measure of precaution we limit the set of large firms to those having less than 1,000 workers.

The annual total increment in sales that can be attributed to overall participation in Eureka projects that started between 1996-2003 and finished by 2005, is about 526 million euros for the SMEs and 3.6 billion euros for the large firms. The corresponding total figures for employment are 2,164 and 24,110. Thus, the bottom line is that the *additional* annual sales and employment due to the participation of firms in Eureka during the mentioned period amount to approximately 4 billion euros and 26,000 employees.

6. Robustness checks

In this Subsection we modify the baseline specification in two ways and analyze the impact of these changes on the estimated Eureka effect. Results are presented in Table 13. The top two panels - A and B -- consider matching on 4 nearest neighbors instead of one neighbor as done in the baseline specifications in Table 11. The estimated effects are robust to the use of more twins.

We estimated an alternative specification for the propensity score $p(x)$ where we added two additional explanatory variables: pre-Eureka value added per worker and pre-Eureka share of wage costs in value added. The idea is to use these two variables to help us select R&D performers among the non-participating firms since value-added and wages tend to be significantly higher among R&D performing firms (recall that R&D data is not widely available in Amadeus). The number of treated observations is reduced by about 25 percent because of missing data on these two variables. The bottom two panels -- C and D -- match on one twin firm but use this alternative specification of the propensity score. As observed, this does not change the general nature of our findings, even though they reduce somewhat the Eureka effect for both sales and employment. This reduction in the estimated effect could suggest that the Eureka effect might be lower vis-à-vis firms that did not participate in Eureka but are involved in R&D activities. However, the difference in estimated effects might also be due to selection issues regarding the sub-sample of firms with available value added and wage bill variables.

Table 14 examines the effect of outliers on the mean Eureka effect. We do this by trimming the top and bottom 1 and 5 percent observations on $\Delta y_i - \Delta y_{twin(i)}$ and recomputing the mean for the trimmed distributions. We observe that the estimated effects do not change much when we discard the extreme 2 and 10 percent of the observations. Thus, the large Eureka effects are not driven by outliers.

7. Concluding remarks

7.1. Summary of results

- It is important to compare observed outcomes of Eureka participants to the potential outcomes they would have obtained had they not participated in Eureka; the counterfactual outcomes.

- We use a matching methodology to estimate these counterfactuals.

- We find positive and statistically significant Eureka effects in terms of sales and employment:
  - On average, sales and employment of participating firms are 28 percent higher than the sales and employment they would have experienced had they not participated in Eureka.
  - The Eureka effects are larger for large firms than for SMEs firms, particularly the employment effects.
  - These estimates are robust to changes in the model specifications and removal of outliers.

- The additional annual sales and employment due to firm participation in Eureka projects that started during 1996-2003 and finished by 2005 amount to almost 4 billion euros and 26,300 employees.

7.2. Recommendations

- Eureka Permanent Assessment Task Force
  - Eureka's assessment should be conducted on a regular basis.
  - Assessment planned and overseen by a permanent expert task force.

- Data Collection from Applying Firms
  - Mandatory: participating firms should be required to fill in a questionnaire at application time and up to 3 years after completion of the project.
  - Data collection should be a systematic real time accumulation of quantitative data uniformly and coordinated by Eureka headquarters.
  - Subjective/qualitative data can be very meaningful as a complementary layer but cannot substitute for objective/quantitative data.

- Obtaining Data on Potential Twins
    - We recommend the acquisition of full access to the Amadeus data base, the only source of comparable and updated data across countries.
    - Use the updated Amadeus data to estimate the Eureka effect for firms that participated in Eureka up to 2008 (our estimation covers projects completed by 2005).
    - We recommend to match Amadeus data to Patent Data sources in order to improve pre-participation matching and also as an alternative outcome measure.

References

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Figures

Figure 1: Distribution of firm difference-in-difference Eureka effects - sales

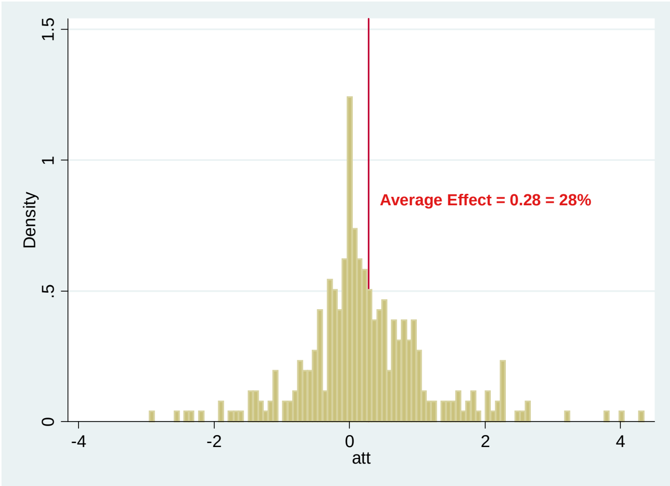
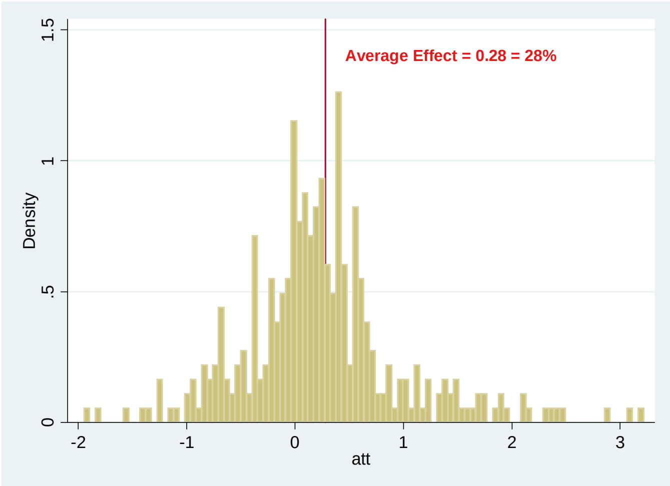


Figure 2: Distribution of firm difference-in-difference Eureka effects – employment



Tables

Table 1: Projects, firms and participations in population

European (1996-2004)	Total	SMEs	Large firms
Projects	932		
Firms	2378	1537	841
Participations	2597	1654	943
Israeli (2000-2008)			
Projects	63		
Firms	61	50	11
Participations	69	56	13

Table 2: Projects, firms and participations in sample

European (1996-2004)	Identified	With data
Projects	638	306
Firms	978	359
Participations	1082	**381**
Israeli (2000-2008)		
Projects	34	30
Firms	30	26
Participations	35	**31**

Notes: "Identified" means European firms found in Amadeus and Israeli firms found in the OCS data. "With data" means with non-missing pre- and post-Eureka data on sales and employment

Table 3: Timing of the participations

Year	Started	Finished
1996	21	
1997	43	1
1998	55	6
1999	66	30
2000	67	46
2001	76	68
2002	36	61
2003	31	81
2004	3	74
2005	5	24
2006	6	7
2007	2	6
2008	1	7
2009		1
Total	412	412

Table 4: Distribution by country

Country	Participations	Percentage in sample	Percentage in population
SPAIN	88	21.40%	9.20%
FRANCE	50	12.10%	10.00%
GERMANY	38	9.20%	12.00%
ISRAEL	31	7.50%	2.60%
ITALY	31	7.50%	5.30%
UNITED KINGDOM	30	7.30%	7.40%
NORWAY	28	6.80%	2.90%
BELGIUM	24	5.80%	4.70%
FINLAND	24	5.80%	3.10%
THE NETHERLANDS	19	4.60%	8.60%
CZECH REPUBLIC	18	4.40%	4.20%
SWEDEN	15	3.60%	4.50%
SWITZERLAND	7	1.70%	5.40%
GREECE	6	1.50%	0.70%
AUSTRIA	1	0.20%	2.90%
DENMARK	1	0.20%	2.70%
POLAND	1	0.20%	1.40%
TOTAL	412	100.00%	87.40%

Notes: population percentages computed for the relevant period

Table 5: Distribution by Size

	Participations	Percentage In sample	Percentage in population
SME	263	64%	64%
Large Company	149	36%	36%
Total	412	100%	100%

Notes: population percentages computed for the relevant period

Table 6: Distribution by technology area

Technology Area (Eureka Definition)	Participations	Percentage in sample	Percentage in population
Information	93	22.60%	21.10%
Medical & Biotechnology	70	17.00%	15.00%
Robotics-Production automation	66	16.00%	16.10%
New Materials	63	15.30%	15.20%
Environment	44	10.70%	11.80%
Transport	29	7.00%	8.00%
Energy	22	5.30%	5.80%
Communications	20	4.90%	4.60%
Lasers	5	1.20%	2.40%
Total	412	100.00%	100.00%

Notes: population percentages computed for the relevant period

Table 7: Pre-Eureka sales by size class

Size class by sales	N	Mean	SD	Median
0	2	0	0	0
0 – 1M	57	431	290	442
1M – 10M	117	4,195	2,783	3,167
10M – 50M	100	24,093	11,242	21,332
50M – 1B	101	265,853	256,501	134,705
1B – 5B	23	2,413,919	1,165,185	1,957,927
5B+	12	54,666,604	68,659,880	22,791,584
Total	412	1,799,260	14,512,442	15,182

Notes: M-million, B=billion. Sales in 2005 prices, in thousand euros.

Table 8: Pre-Eureka employment by size class

Size class by sales	N	Mean	SD	Median
0	2	4	2	4
0 – 1M	57	7	6	6
1M – 10M	117	54	81	30
10M – 50M	100	161	137	126
50M – 1B	101	1,338	1,670	606
1B – 5B	23	6,343	5,381	5,566
5B+	12	151,960	173,798	99,209
Total	412	5,164	38,221	109

Notes: M-million, B=billion.

Table 9: Propensity score estimation

Explained variable: Participation in Eureka (eureka) – binary dummy variable
Explanatory variables: pre-Eureka sales (avgsalesbefore) and workers (emp_before), dummy varaibles for country (cc), 2 digit SIC codes (ss) , size group (by sales - ww) and year (yy).

Probit regression

Number of obs	=	2751503
LR chi2(68)	=	1455.37
Prob > chi2	=	0.0000
Pseudo R2	=	0.1969

Log likelihood = -2967.2567

eureka	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ww2	-2.302782	.1596523	-14.42	0.000	-2.615695	-1.98987
ww3	-1.96698	.1556151	-12.64	0.000	-2.27198	-1.66198
ww4	-1.575091	.1557592	-10.11	0.000	-1.880374	-1.269809
ww5	-1.184717	.1552297	-7.63	0.000	-1.488961	-.880472
ww6	-.5246788	.1716743	-3.06	0.002	-.8611542	-.1882033
yy2	-.3603551	.0940591	-3.83	0.000	-.5447076	-.1760026
yy3	-.2961136	.0813222	-3.64	0.000	-.4555022	-.1367249
yy4	-.3100635	.0783959	-3.96	0.000	-.4637167	-.1564102
yy5	-.3017846	.0762386	-3.96	0.000	-.4512095	-.1523598
yy6	-.35233	.0749174	-4.70	0.000	-.4991654	-.2054946
yy7	-.3529944	.0741347	-4.76	0.000	-.4982957	-.2076931
yy8	-.6263193	.0842881	-7.43	0.000	-.7915211	-.4611176
ss2	-.1094981	.442142	-0.25	0.804	-.9760805	.7570843
ss4	-.9384891	.4256362	-2.20	0.027	-1.772721	-.1042576
ss5	-.4370687	.4431878	-0.99	0.324	-1.305701	.4315634
ss6	-.8658355	.4323059	-2.00	0.045	-1.71314	-.0185315
ss7	-.1985819	.4892626	-0.41	0.685	-1.157519	.7603551
ss8	-.4838689	.4135739	-1.17	0.242	-1.294459	.326721
ss10	-.1975458	.4259154	-0.46	0.643	-1.032325	.637233
ss11	-.2050604	.5122635	-0.40	0.689	-1.209078	.7989576
ss12	-.226435	.4335282	-0.52	0.601	-1.076135	.6232646
ss13	-.5777084	.4555299	-1.27	0.205	-1.470531	.3151138
ss14	-.5527761	.4532152	-1.22	0.223	-1.441062	.3355094
ss15	-.52963	.4946377	-1.07	0.284	-1.499102	.4398421
ss16	-.2685008	.4112094	-0.65	0.514	-1.074456	.5374549
ss18	-.6153637	.423571	-1.45	0.146	-1.445548	.2148202
ss20	-.3683776	.4234264	-0.87	0.384	-1.198278	.4615228
ss21	-.4640312	.4272026	-1.09	0.277	-1.301333	.3732705
ss22	-.6537917	.4155728	-1.57	0.116	-1.468299	.160716
ss23	-.3718083	.4104957	-0.91	0.365	-1.176365	.4327485
ss24	-.2452836	.4108658	-0.60	0.551	-1.050566	.5599985
ss25	-.3814506	.4136501	-0.92	0.356	-1.19219	.4292887
ss26	-.1558531	.4137836	-0.38	0.706	-.9668542	.6551479
ss27	-.4430749	.4544266	-0.98	0.330	-1.333735	.447585
ss29	-.3485933	.4576271	-0.76	0.446	-1.245526	.5483395
ss31	-.6070562	.465117	-1.31	0.192	-1.518669	.3045563
ss32	-.6905131	.4454301	-1.55	0.121	-1.56354	.1825139
ss33	-.5367828	.4604016	-1.17	0.244	-1.439153	.3655878
ss34	-.6317419	.42735	-1.48	0.139	-1.469332	.2058488
ss35	-.9809486	.4122427	-2.38	0.017	-1.788929	-.1729678
ss36	-.8497731	.415811	-2.04	0.041	-1.664748	-.0347985
ss41	-.5239475	.5027335	-1.04	0.297	-1.509287	.4613921
ss42	-.914885	.4736129	-1.93	0.053	-1.843149	.0133791
ss43	-.4813181	.5087329	-0.95	0.344	-1.478416	.5157801
ss44	-1.258565	.4684351	-2.69	0.007	-2.176681	-.340449
ss45	-.7302615	.42875	-1.70	0.089	-1.570596	.1100731
ss46	-.7685934	.4914121	-1.56	0.118	-1.731743	.1945566

ss49	-.4472436	.4093984	-1.09	0.275	-1.24965	.3551625
ss50	.1950876	.4749933	0.41	0.681	-.7358821	1.126057
ss54	-.235859	.4544277	-0.52	0.604	-1.126521	.6548031
ss56	-.2748092	.4517979	-0.61	0.543	-1.160317	.6106985
ss58	-.4111145	.4105551	-1.00	0.317	-1.215788	.3935588
ss59	.5223764	.4742057	1.10	0.271	-.4070496	1.451802
cc1	-.9417105	.3137748	-3.00	0.003	-1.556698	-.3267232
cc2	-.4513981	.1134731	-3.98	0.000	-.6738013	-.2289949
cc3	.0823066	.1245952	0.66	0.509	-.1618956	.3265087
cc4	-.7982134	.2977378	-2.68	0.007	-1.381769	-.2146581
cc6	-.1604168	.1166643	-1.38	0.169	-.3890746	.068241
cc7	-.7217115	.1027607	-7.02	0.000	-.9231188	-.5203042
cc8	-.8248055	.1066142	-7.74	0.000	-1.033765	-.6158456
cc11	-.7944723	.1081074	-7.35	0.000	-1.006359	-.5825857
cc12	-.2587063	.1120135	-2.31	0.021	-.4782489	-.0391638
cc14	-.5420308	.1010966	-5.36	0.000	-.7401765	-.3438851
cc15	-.5030538	.1216944	-4.13	0.000	-.7415705	-.2645372
cc16	-.4106267	.1708275	-2.40	0.016	-.7454424	-.0758111
cc18	-.8300434	.110169	-7.53	0.000	-1.045971	-.6141162
avgsalesbe~e	1.40e-09	1.16e-09	1.21	0.225	-8.65e-10	3.67e-09
emp_before	1.35e-07	1.16e-07	1.17	0.243	-9.17e-08	3.63e-07
_cons	-.2047243	.4400582	-0.47	0.642	-1.067223	.6577739

Reference values for dummies: ww7 (sales 5B+), yy9 (2003), ss17 (sic 29), cc9 (Greece), cc13 (Poland), cc17 (The Netherlands).

Table 10: Balancing

	N	Mean	SD	Percentile 10%	Percentile 25%	Percentile 50%	Percentile 75%	Percentile 90%
q treated	344	7.088	1.933	4.307	5.752	7.193	8.421	9.483
q control	359	7.065	1.935	4.307	5.755	7.144	8.419	9.506
Pre-Eureka Sales treated	344	288,339	2,202,561	521	1,959	11,914	67,153	411,314
Pre-Eureka Sales control	359	199,064	1,064,523	523	2,119	11,495	68,043	457,591
Pre-Eureka Employment treated	344	1,025	6,095	7	19	77	366	2,000
Pre-Eureka Employment control	359	515	2,373	5	15	70	343	942

Sales in 2005 prices, in thousand euros.

Table 11: Eureka effect on Sales and Employment (baseline scenario)

	Eureka Effect	Standard Deviation	T-value	95% lower bound	95% upper bound	Number of Eureka Participations	Percentile 25%	Percentile 50%	Percentile 75%	Percentile 90%	Percentile 95%
			All Firms								
Sales	0.281	0.051	5.510	0.181	0.381	344	-0.231	0.119	0.687	1.488	4.344
Employment	0.280	0.048	5.830	0.186	0.374	344	-0.161	0.193	0.557	1.246	3.219
			SMEs								
Sales	0.273	0.063	4.320	0.149	0.397	237	-0.261	0.091	0.713	1.527	4.040
Employment	0.178	0.055	3.210	0.069	0.286	237	-0.223	0.130	0.544	1.219	2.872
			Large firms								
Sales	0.290	0.078	3.690	0.136	0.443	107	-0.171	0.125	0.634	1.093	4.344
Employment	0.433	0.087	4.970	0.262	0.604	107	-0.005	0.264	0.569	1.246	4.739

Notes: 1 firm nearest neighbor matching by pre-Eureka sales and workers, country, 3 digit SIC code, size group (by sales) and year.

Table 12: Eureka total effects in absolute terms

	Pre-Eureka mean outcome		Eureka effect		Mean absolute Eureka effect in sample		Annual No of participations	Total annual increment due to Eureka	
	Sales	Employment	Sales	Employment	Sales	Employment		Sales	Employment
SMEs	9.3	58.9	27.3%	17.8%	2.5	10.5	206.8	526.1	2,164
Large	104.4	472.3	29.0%	43.3%	30.3	204.5	117.9	3,566.5	24,110
Total							324.6	4,092.6	26,274

Notes: Sales in 2005 prices, in **millions**.

Large firms include only firms with up to 1000 workers. Eureka effects are from Table 11.

Annual number of participations is the population average number of projects starting during the period 1996-2003 (and finished by 2005).

Table 13: Eureka effect - robustness checks

All Firms

Trimming	Eureka Effect	Standard Deviation	T-value	95% lower bound	95% upper bound	Number of Eureka Participations
Panel A: Sales - 4 firms matching						
None	0.262	0.051	5.150	0.162	0.362	344
1%	0.266	0.049	5.460	0.171	0.362	338
5%	0.266	0.043	6.180	0.182	0.351	313
Panel B: Employment - 4 firms matching						
None	0.262	0.051	5.150	0.162	0.362	344
1%	0.266	0.049	5.460	0.171	0.362	338
5%	0.266	0.043	6.180	0.182	0.351	310
Panel C: Sales - matching on pre-Eureka value added per worker & share of wages in value added						
None	0.192	0.072	2.650	0.050	0.334	255
1%	0.194	0.062	3.120	0.072	0.317	251
5%	0.185	0.055	3.360	0.077	0.292	232
Panel D: Employment - matching on pre-Eureka value added per worker & share of wages in value added						
None	0.244	0.061	4.030	0.126	0.363	255
1%	0.244	0.054	4.510	0.138	0.350	251
5%	0.251	0.051	4.970	0.152	0.350	229

Table 14: Eureka effect -- removing outliers (baseline scenario)

	Trimming	Eureka Effect	Standard Deviation	T-value	95% lower bound	95% upper bound	Number of Eureka Participations
				SALES			
All firms	1%	0.283	0.046	6.100	0.192	0.373	338
All firms	5%	0.280	0.042	6.600	0.197	0.364	313
SMEs	1%	0.274	0.056	4.860	0.164	0.385	233
SMEs	5%	0.230	0.053	4.340	0.126	0.335	214
Large firms	1%	0.294	0.070	4.210	0.157	0.431	105
Large firms	5%	0.326	0.062	5.270	0.205	0.447	99
				EMPLOYMENT			
All firms	1%	0.245	0.041	5.960	0.164	0.325	338
All firms	5%	0.229	0.037	6.220	0.157	0.301	310
SMEs	1%	0.181	0.053	3.450	0.078	0.284	233
SMEs	5%	0.179	0.048	3.720	0.085	0.274	213
Large firms	1%	0.436	0.081	5.360	0.276	0.595	105
Large firms	5%	0.354	0.075	4.730	0.207	0.501	97

Notes: 1 firm nearest neighbor matching by pre-Eureka sales and workers, country, 3 digit SIC code, size group (by sales) and year.