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Long-run effects of public–private research joint ventures: The case of the Danish Innovation Consortia support scheme☆

Ulrich Kaiser[a,b,c,d], Johan M. Kuhn[b,e,*]

[a] University of Zurich, Department of Business Administration, Plattenstr. 14, 8032 Zurich, Switzerland
[b] Center for Corporate Performance, Aarhus University, Denmark
[c] Center for European Economic Research, Mannheim, Germany
[d] Institute for the Study of Labor, Bonn, Germany
[e] Centre for Economic and Business Research (CEBR), Department of Economics, Copenhagen Business School, Porcelænshaven 16 A, 2000 Frederiksberg, Denmark

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ABSTRACT

Subsidized research joint ventures (RJVs) between public research institutions and industry have become increasingly popular in Europe and the US. We study the long-run effects of such a support scheme that has been maintained by the Danish government since 1995. To cope with identification problems we apply nearest neighbor matching and conditional difference-in-difference estimation methods. Our main findings are that (i) program participation effects are instant for annual patent applications and last for three years, (ii) employment effects materialize first after one year and (iii) there are no statistically significant effects on value added or labor productivity. We further show that these overall results are primarily driven by firms that were patent active prior to joining the RJV and that there are no statistically significant effects for large firms. The insignificant results we document for large firms coupled with the fact that these type of firms are over-represented in many support programs, including the one considered here, leads us to suggest a rethinking of support policies that often aim at large firms.

1. Introduction

Governments all over the world try to stimulate industrial research expenditures through research subsidies. The economic rationale behind such efforts is that the social value of R&D, mainly due to the existence of research spillovers, lies above its private return — firms are unable to fully appropriate the benefits from their R&D efforts. This external effect leads to under-investment in R&D from a social point of view and thereby justifies governmental intervention (D'Aspremont and Jacquemin, 1988; Kaiser, 2002a; Kamien et al., 1992; Kamien and Zang, 2000; Katz, 1986; Leahy and Neary, 1997; Spence, 1984; Suzumura, 1992).

Research subsidies come in two main forms, tax breaks and direct subsidies for specific research projects.[1] Research subsidies are, however, not the only measure to stimulate innovation. In the mid-1980s policy makers in the EU and the US started to permit Research Joint Ventures (RJVs), where RJV members pool their research resources to generate inventions (Kaiser, 2002b). Spillovers are partly internalized within a joint venture so that private and social returns to R&D are realigned.

Such cooperations were hitherto deemed anti-competitive. After they had been legalized, RJVs became increasingly popular (Caloghirou et al., 2003a) and constitute the dominant form of research cooperation today (Hagedoorn, 2002).

An additional means of research stimulation that has received much attention by policy makers and economists alike is the technology transfer between public sector research institutions and industry. These may take on the form of formal and informal

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* Corresponding author.
E-mail addresses: jmk.cebr@cbs.dk, jmk@asb.dk (J.M. Kuhn).

[1] The economic efficiency of such schedules in terms of their effects on private R&D has been extensively discussed in a special issue on technology policy in *Research Policy* in 2000 with a positive verdict about tax incentives and with somewhat inconclusive results with respect to research subsidies.

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public–private R&D collaborations as well as of university spinoffs and licensing.[2]

While the literature has so far well studied RJVs, research subsidies and public–private R&D cooperation, comparatively little is known about the effects of subsidized public–private research cooperations where the partners involved in the RJV receive subsidies on their R&D expenditures that accrue within the RJV. These "hybrid" forms of RJV and subsidies have spread substantially both in the US (Vonortas, 1999, 2000) and in Europe (Caloghirou et al., 2003a) where e.g. the "Cooperation" program within the 7th EU Framework Programme requires participation of both public and private institutions.

In this paper we study a particular subsidized public/private RJV program, the "Danish Innovation Consortia" (DIC), and its effects on the performance of the participating private sector firms. The DIC program was started in 1995 with the intention to strengthen the technology transfer between public research institutions and industry. It includes private sector entities and public research institutions. Our data trace the period 1990–2007. Until 2002, which is the year the last DIC in our data started, the program program covered 80 DICs and included 220 unique firms with a total grant volume of 766 mio. DKK (about 100 mio. Euros).

A unique feature of our data is that they trace a comparably long time period which enables us to investigate the *long-term* effects of subsidized RJV participation on firm performance. In particular, we study both contemporaneous effects as well as the effect of DIC membership with a five years lag. We account for contemporaneous effects since Hall et al. (1986) demonstrate that R&D effects on patent counts appear to be contemporaneous and we consider lags of up to five years since Peterson (1993), using business survey data for the European EUREKA publicly sponsored joint research program, finds that up to five years lapse until EUREKA effects materialize. Related studies by Bayona-Sáez and García-Marco (2010), Benfratello and Sembenelli (2002) as well as Branstetter and Sakakibara (2002) have considered two year lags. Bayona-Sáez and García-Marco (2010) study the EUREKA program using dynamic panel data technique and find a positive effect of program participation on return on assets that, however, materializes only one year after project completion. Benfratello and Sembenelli (2002) apply differences in means tests to show that participation in the EUREKA program has positive effects on labor productivity and price cost margins while participation in the less market oriented EU framework program FPST is not significantly related to either variable. Branstetter and Sakakibara (2002) study Japanese research consortia and find that program participation has more positive effects if it is geared towards more basic research and that they appear first one year after project completion.

We link the instance of program participants to firm-level data, essentially balance sheet information before and after DIC participation, to control for a wide range of variables that affect program participation choice and/or firm performance. We use multi-dimensional measures of firm performance, namely growth in patent stock (i.e. the number of patent applications) as a "direct" measure – the DICs are geared towards "high quality research" – as well as two more indirect and frequently used measures, namely employment growth and growth in value added (which we deflate to account for inflation).

What performance measure to use is a debated issue in the literature (Caloghirou et al., 2003a). Most studies investigate innovative *inputs* to investigate whether public subsidies or RJVs crowd in or crowd out private R&D. With the exception of Wallsten (2000), who provides evidence for crowing out for research subsidies, the existing literature tends to either find insignificant or positive effects for such support schemes (Almus and Czarnitzki, 2003; Girma et al., 2007; González and Pazó, 2008; Klette et al., 2000; Lach, 2002). Branstetter and Sakakibara (1998), Irwin and Klenow (1996) as well as Kaiser (2002b) find positive effects of RJV participation on private R&D spending.

Existing research has also studied the relationship between subsidization and innovative *outputs* (Archibald and Finifter, 2003; Branstetter and Sakakibara, 1998; George et al., 2002; Huggins, 2001; Kogut, 1988; Larédo, 1998; Klette and Møen, 1999), finding positive or statistically insignificant effects. In this paper we consider the number of patent applications per year as a measure of innovative output. We do not, however, observe any measure of innovative input.

Yet another strand of the literature has studied firm *performance* effect of subsidies and research joint ventures. We follow that strand by considering value added and employment growth as our more indirect measures of performance effects of DIC membership. Profit-related variables have previously been considered by Bayona-Sáez and García-Marco (2010), Benfratello and Sembenelli (2002), Berg et al. (1982), Hagedoorn and Schakenraad (1994) as well as Siebert (1996). These studies tend to find positive effects of governmental intervention. Employment growth has been analyzed by Wallsten (2000) who does not find any significant effects.[3]

The measurement of program participation effects is complicated by the fact that participation is non-random and participation choice may well be correlated with firm performance and innovative output. Since firms are either observed as program participants or non-participants, we are faced with an identification problem. Our attempt to getting around that issue is to apply "conditional differences in differences" (cDID) estimation methods (Heckman et al., 1998, 1999) where we first match participating and non-participating firms with respect to observed firm-specific characteristics before joining a DIC and then run firm performance regression models on the matched data set (hence the term "conditional difference-in-difference"). The idea behind running parametric regression's on the matched treatment/control data is to remove any remaining differences in the observable characteristics between both groups. Such an approach has been previously applied for research subsidization programs by Almus and Czarnitzki (2003) as well as by Branstetter and Sakakibara (1998). The latter do, however, not apply formal matching models but compare what they term "roughly similar" firms instead. Our approach identifies causal effects of treatment conditional on observables (i.e. the explanatory variables we do control for) and on unobserved time-invariant firm-specific effects and time trends. That is to say, we do not identify causal effects if we omitted time-variant variables that affect both selection into treatment and our outcome measures, at least to the extent that these are not highly correlated with the variables we do control for.

Our main results are as follows. In the specifications that allow for contemporaneous effects only we find statistically and economically significant effects of DIC participation on annual patent applications: DIC membership increases the number of annual patents by 39 percent, a figure that needs to be related to a mean number of annual patent application of 0.59. This finding is primarily driven by firms that applied for a patent prior to joining a DIC. We do not find any statistically significant contemporaneous

[2] Another relevant but more indirect form of research partnership, technology transfer offices, has been established in the wake of the Bayh-Dole act of 1980. A special issue of *Research Policy* had been devoted to economic analyzes of that change in legislature (Grimaldi et al., 2011).

[3] Other author have analyzed productivity (Benfratello and Sembenelli, 2002; Sissoko, 2011), R&D efficiency (Link, 1998a,b) as well as subjective performance measures (Caloghirou et al., 2003b; Caloghirou and Vonortas, 2000).