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Preface

Innovation Norway (IN) is a government agency that aims to promote firm growth through innovation programs, regional support and other industrial policies. In this report we analyse effects of government support to firms from Innovation Norway. The indicators and results presented here are used by IN as a tool in their process of goal setting and decision making. The project is financed by Innovation Norway.

We would like to thank Pål Aslak Hungnes and Sigrid Gåseidnes, in particular, for a wealth of detailed information about IN and many valuable suggestions for improving our analyses. We also acknowledege many useful comments from Kjetil Telle and Øivind Anti Nilsen.

Statistisk sentralbyrå, 13. august 2015.

Torbjørn Hægeland

Abstract

In this report we study possible effects of government support to firms from Innovation Norway (IN) – a government agency that aims to promote firm growth through innovation programs, regional support and other industrial policies. We document a tool for management by objectives/management by results (MBO/MBR) for IN, intended for repeated use in the process of goal setting and decision making.

We compare firms that received support from IN during 2001-2012 (the "treated" firms) with a comparison group of non-treated firms that we have matched according to a set of individual firm characteristics. We estimate average treatment effects of participation (average treatment effects on the treated) in four types of IN-programs (assignments): innovation, regional, lending and innovation cluster. Our evaluation context is not an experimental one and one should therefore not conclude that our findings necessarily represent causal effects. Nonetheless, we have taken into account selection effects due to fixed firm effects, which are eliminated through differencing, and observable firm characteristics, which are controlled for through propensity score matching. Average treatment effects on the treated firms are measured as differences in average annual growth rates between treated and matching firms (matched difference-in-differences) in the first 3-year period following the year of assignment to treatment by IN.

For the innovation and regional development assignments we find significant positive effects with regard to the performance indicator variables number of employees, sales revenues and value added, but much smaller effects with regard to labor productivity and returns to total assets. On the other hand, we find no evidence that the commercial and low-risk lending assignment enhances firm performance. Moreover, we find no evidence that financial support to start-up firms improves survival probabilities of the client firms compared to the matching firms, measured five and ten years after start-up. Participation in IN-supported clusters leads to higher sales and employment in firms during the immediate period after enrollment.

Sammendrag

I denne rapporten studerer vi potensielle virkninger av offentlig støtte til enkeltbedrifter gjennom Innovasjon Norge (IN) - en offentlig etat som har som mål å bidra til vekst i bedrifter gjennom innovasjonsprogrammer, regional støtte og annen næringsutviklingspolitikk. Vi dokumenterer vårt verktøy for mål- og resultatstyring (MRS) for IN, ment for gjentatt bruk innen deres målstyringsprosesser.

Vi sammenligner foretak som fikk støtte fra IN i løpet av 2001-2012 («behandlingsgruppen») med en sammenligningsgruppe av foretak som ikke fikk slik støtte, og som vi har matchet i henhold til et sett av individuelle kjennetegn målt i det første hele driftsåret vi observerer foretaket. Vi beregner gjennomsnittlige effekter av deltakelse i IN-programmer basert på fast-effekt modellering (faste bedriftsspesifikke effekter) og propensity-score matching. Gjennomsnittlig effekt er målt som forskjeller i gjennomsnittlig årlig vekstrater mellom behandlede og matchende foretak i den første tre-års perioden etter tildelingsdato for IN-støtte (årlig mervekst i forhold til kontrollgruppen).

Mht. støtte fra innovasjonsprogrammet og det regionale utviklingsprogrammet finner vi signifikante positive effekter på indikatorene antall ansatte, omsetning og verdiskaping, men mye svakere effekter på arbeidsproduktivitet og totalkapitalrentabilitet. For programmet for kommersielle, ikke-subsidierte lavrisikolån finner vi generelt små effekter, og ingen av de estimerte effektene er robuste overfor fjerning av ekstreme datapunkter eller endring i matching-prosedyre. Vi finner ingen støtte for hypotesen at programmene rettet mot nyetablerte foretak/gründere øker overlevelsessannsynlighetene for IN klienter som får slik støtte sammenlignet med kontrollgruppen, målt fem og ti år etter etablering. For cluster-programmet finner vi positive effekter på vekst i omsetning og antall ansatte i den første perioden etter at foretaket er blitt med i clusteret.

Contents

1. Introduction

In 2013 Statistics Norway´s Research Department received a commission from the public agency Innovation Norway (IN) to develop a tool for management by objectives/management by results (MBO/MBR), intended for repeated use in the current process of goal setting and decision making in their organization. This report documents the procedures we have developed and provides some empirical results.

IN´s primary task is to promote industrial development. Our commission includes the operationalization of effect indicators, choice of empirical methodology, establishing datasets and carrying out empirical effect analyses. The new MBO/MBR system includes estimation of public benefit effects, which shall serve as a basis for owners and clients in the management of IN. Our task involves some degree of research and innovation.

1.1. Innovation Norway – policy areas and activities

IN is a government agency that aims at promoting innovation and profitable business development in Norway. The Ministry of Trade, Industry and Fisheries owns 51 per cent of IN and the 19 counties own the remaining 49 per cent. IN is the Norwegian government's official trade representative abroad. Besides having an office in every county in Norway, the organization also runs 35 offices abroad. IN provides Norwegian firms with an extensive set of business support systems. IN offers loans, grants, guarantees and equity to firms. IN also provides advisory services, promotional services and network services that stimulate interaction between enterprises and various knowledge institutions. The marketing of Norway as a tourist destination is also considered an important task. After a reorganization of several government entities more than a decade ago, IN also has the task of securing development in rural areas using funds from (mainly) the Ministry of Local Government and Modernisation.

IN has a wide variety of policy instruments at its disposal. They include grants and advisory services to entrepreneurs. More established firms may also receive advisory services from IN regarding market orientation, for example in order to improve their export performance. IN operates business networks where enterprises that wish to enter into strategic cooperation with other firms can receive support to establish and administer meeting places and other collaborative measures. Three different cluster programs are supported by IN: The ARENA program, the Norwegian Centres of Expertise (NCE), and the Global Centres of Expertise (GCE). IN has a number of innovation programs where firms may apply for grants or loans for business developments. These programs can be of a fairly general nature, or can be designed for a specific industry or branch but may also have a specific regional focus.

IN-financed activities totaled nearly seven billion NOK in 2013.[1] A little more than half of this amount consisted of low risk loans mainly going to agriculture and fisheries, of which the Ministry of Trade, Industry and Fisheries financed 2.5 billion NOK. Funds financing innovation activities including high risk loans financed by the Ministry of Trade, Industry and Fisheries (NFD) amounted to 1.2 billion NOK in 2013. The Ministry of Local Government and Modernisation (KMD) finances a number of policy instruments targeting regional development administered by IN. In 2013 these policy instruments amounted to around one billion NOK. IN also handles some innovation programs relating to forestry financed by the Ministry of Agriculture and Food, which amounted to nearly 40 million NOK in 2013. All in all the policies administered by IN that we will study in this report amounted to 4.7 billion NOK in 2013. These policy areas are

[1] 1 USD $\approx$ 8.2 NOK (August 2015).

specified as four separate policy assignments from the government to IN. These are the following:

- The innovation assignment (NFD)
- The regional assignment (KMD)
- The lending assignment (NFD, including low-risk loans to the agricultural sector)
- The agricultural assignment (Ministry of Agriculture and Food)

The agricultural assignment is not included in this study because few of the recipients are limited liability companies with publicly available accounts. In addition we study effects of three *industry cluster programs*, financed by both NFD and KMD. The cluster programs are defined as a fifth assignment and analyzed in a similar way as the other assignments.

1.2. MBO/MBR in Innovation Norway

All public agencies are required by law to implement some form of MBO/MBR. An MBO/MBR process involves definition of objectives, monitoring of results and evaluating performance. Our work deals with the latter two, as the objectives of IN are predefined by the organization itself and its owners (NHD, 2013). IN and its owners have also considered relevant effect indicators for each IN objective. Our operationalization of effect indicators is based on these suggested indicators, with some necessary modifications.

Innovation Norway's mission is to be the National and the Regional Governments' policy instrument for value-creating business development across Norway. The main goal is that IN shall *trigger off industrial and commercial development that is profitable from both a private and socioeconomic perspective, and to release the business opportunities of all regions of Norway.*
The secondary goals are:

1. *More successful entrepreneurs*
2. *More enterprises with a capacity for growth*
3. *More innovative business clusters.*

The suggested *effect indicators* for each of the secondary goals are, respectively:

1. Survival rates for new firms and turnover growth (share of new firms with growth in turnover)
2. Turnover growth, productivity growth (share of firms with productivity growth) and growth in profitability (share of profitable firms)
3. Turnover growth and growth in profitability.

Since identical indicators are assigned to different objectives, the suggested indicators cannot identify each specific goal. Of course, this may also reflect that the distinction between the three secondary goals is difficult: What do we mean by successful entrepreneurs? Shouldn't successful entrepreneurship mean "more enterprises with a capacity for growth"? And wouldn't more innovative business clusters help entrepreneurs and stimulate growth?

The three secondary goals reflect three target groups, which may be treated somewhat differently. Different theoretically approaches, such as theories of entrepreneurial behavior, market failure due to asymmetric information between the business and the financer and new innovation theories and system failure, are all relevant. Different needs for resources such as finance, knowledge and networks, require different instruments and proportioning to release different behavior.

Our framework implies testing of the estimated treatment effects of three different assignments listed above*,* and the innovation cluster program as the fourth using the same set of indicators as measures of success for all assignments and program. These assignments are defined by their source of financing (which is collected from the owners and principals of IN – the government and the 19 county authorities with their own objectives) and are therefore classified according to the principal objective of the policy assignment. Our analysis is restricted to *participation* in a scheme or a program (means); we do not consider the amount of grants or loans given. Corresponding to the policy assignments mentioned above, we study the effects of four assignments with different but overlapping objectives and selection criteria:

The innovation assignment (henceforth I-assignment)
The innovation assignment comprises means such as grants, innovation loans/venture capital loans/risk loans and advisory services intended to release innovation, internationalization and profiling as tools for an increase in competitiveness and growth. The expected effects in the MBO-system are higher turnover, profitability and productivity. These are the direct effects in the treated businesses. In a socio-economic perspective, there is more to it. In addition we must add externalities, both pecuniary and technological spillovers and external effects such as learning and technology transfer and adoptions from the innovation and internationalization processes. These important effects are not measured in the MBO-system, and must be evaluated separately. The innovation task involves a substantial degree of risk-taking and thus resembles the role of investors.

Selection criteria: Projects should contain a new product or new technology, a new combination of existing technologies not yet present in the market in production processes, or organizational changes/innovating their business model. The innovation assignment is considered to be demanding and intended for competent applicants.

The lending assignment (henceforth L-assignments)
IN's lending assignment resembles ordinary bank activities like provision of low-risk loans. The main task is to encourage growth by supplementing the private banks where they do not perform adequately well. This might be both in some rural areas and in specific industries where local banks need some risk sharing, for instance due to the size of the loans (for example fishing boats). The lending assignment is a non-profit activity where costs of operation and losses are covered by the interest margin. Similar to the I-assignment, the expected effects are higher turnover, profitability and productivity in the firms.

Selection criteria by IN: The lending assignment includes low risk loans to enterprises all over Norway and across all industries. In order to qualify, projects should have growth potential in national or international markets and have profitable prospects, and the loans require collateral. Financial support is granted to projects within a broad scope, such as investments in buildings, machinery and information and communications technology (ICT), restructuring and readjustment to changing market conditions, innovation and internationalization, renewal and modernization, business establishment, generational change etc.

The regional development assignment (henceforth R-assignment)
The regional development assignment is an additional effort to increase growth and durable employment in rural areas. The means includes business development grants, investment grants and venture capital/risk loans as "top financing" tool, being lent on conditions without full security (collateral) and at a higher interest rate. Here, the success criteria might involve some trade-off between higher turnover, profitability and productivity against employment and value added in the regions of Norway. The trade off between multiple goals is expected to reduce the performance on each goal.

Selection criteria by IN: Similar criteria as the innovation assignment, but directed towards development in the regions as an additional effort. The investment grant is earmarked investment in non-mobile investments in rural areas, to compensate for low second hand values. Some of the venture capital loans are used as top financing of the same investments. Business development grants are often used to finance soft investments such as knowledge building and technology adoption.

Norwegian Innovation Clusters (henceforth C-assignment)
In addition to the innovation, lending and regional development assignments, we have defined a forth assignment; the Innovation Cluster program. Norwegian Innovation Clusters is jointly owned by IN, the Industrial Development Corporation of Norway (SIVA) and the Research Council of Norway. The cluster program operates on three levels: Arena, Norwegian Centres of Expertise (NCE) and Global Centres of Expertise (GCE). The C-assignment may comprise firms that belong to one of the three main policy assignments mentioned above. However, we consider participation in the C-assignment as a separate treatment in our analysis.

Participation in the industry cluster program involves no direct subsidy to each single participating firm, only that the organizer of the industry cluster receives a grant to cover the administration costs and possibly some advisory services. In our analyses, a cluster “treatment” starts with the date of entry for each single participating enterprise.

Selection criteria by IN: Applications are evaluated according to the cluster’s resources, established relations between the cluster participants and relations with external partners, growth potential in the cluster’s market or technology, ownership and management of the project, the project’s effect and performance potential and the quality of, and resource base for the implementation of the project.

1.3. How does IN affect firms?

A firm may obtain direct public funding of a project from IN only by application. IN decides whether to fund the project after a screening process. The criteria used in the screening process will differ depending on the specific support scheme the firm has applied to. There may be industry specific criteria, regional criteria and innovation content issues that to a varying degree are emphasized. Thus the actual projects undertaken will reflect both firm- and IN-preferences. There are costs for the firm related to the application process and there are of course costs incurred by IN-screening. IN finances a range of projects, not only innovation projects, that we emphasize in our discussion below.

While there are many theoretical models regarding the impact of direct subsidies and tax credits on firms’ R&D and innovation activities (typically extensions of the user cost of capital or Tobin’s q-literature), there are fewer theoretical models of firms’ behavior regarding grants, with Takalo et al. (2013) being one exception. The most commonly used framework for studying the effects of innovation activities by firms is the so-called CDM model of Crepon et al. (1998) (see the special issue of Economics of Innovation and New Technology (2006), which is devoted to various studies using this framework). This framework is also used by Cappelen et al. (2012) on Norwegian data.

The basic structure of the CDM approach is to model heuristically the firm’s decision to undertake an innovation activity that can be classified as (investments in) knowledge capital. This intangible capital stock is then assumed to affect output along with other inputs in a standard production function. In their original paper, Crepon et al. (1998), proposed a three-stage model. First they specified a probit model of the decision to undertake an innovation activity. Conditional on a positive outcome of this binary choice, they estimated a linear model of the innovation intensity and then finally a linear outcome equation using a standard regression framework.

Compared to the three-stage CDM framework, we focus on a more reduced form framework, where we do not use (or even have access to) data on innovation activities by firms. On the other hand, we have detailed accounts data for each firm during 2000-2013 and can address issues like how quickly do innovation projects lead to outcomes? The causal mechanisms we rely on are those of the CDM approach: The firm decides to apply for a grant; if it is accepted by IN, the firm undertakes the project and may thereby increase its knowledge stock, which again may have positive effects on several outcome indicators, such as output and productivity.

Support of industry clusters by IN differs from support of innovation projects, but the operating mechanisms can be quite similar. Participation in a cluster may (or may not) increase access to intangible capital or external resources that will boost firm productivity. A firm that receives support through regional IN support schemes may then increase its inputs (and output) compared to a situation without. It may not stimulate productivity since the aim of regional support is mainly to reallocate resources. Innovation schemes are usually thought of as having positive productivity effects since they enable firms to increase their (tangible and intangible) capital stock and this latter effect may also apply to firms which receive financial support.

1.4. Measuring effects: Limitations and challenges

The MBO/ MBR evaluation tool we have developed for Innovation Norway is essentially a micro econometric evaluation method. We meet in our task the same standard evaluation problem as all other analyses of policy interventions based on non-experimental data: the enterprises we observe may either be *treated* or *nontreated* and we do not observe the counterfactual outcomes for any of the firms. Our procedure falls in the category "natural experiments," with the main problems being that (1) firms self-select into the programs by application and (2) IN selects firms from the applicants based on particular criteria (an assignment rule). Some of the characteristics that affect participation may be observable, others not, meaning that it is difficult to identify causal effects of treatment vs effects that are related to characteristics of the firms. For example, if a growth opportunity appears to a specific firm, for reasons not observable for the evaluator, we may observe that the firm applies for and receives a grant or loan from IN. This may later affect growth in turnover or employment. However, we do not observe what the outcome would have been without the financial support from IN. Such evaluation problems are reviewed in Blundell and Costas Dias (2009) and will be discussed in Section 3 where we present our evaluation method.

In addition to the general difficulties often faced in evaluation, we have considered carefully some other difficulties that we face in our evaluation and which may be of relevance to other researchers:

- How long does it take before participation in a program has any effect?
- How long does the effect last?
- How should we treat repeated support and support that lasts more than one accounting period?
- When does one treatment stop and another start?
- How do we classify the type of treatment if we observe multiple treatments in subsequent years?

In our analysis we use a matched difference-in-differences procedure to identify treatment effects. In order to interpret our estimated treatment effects as causal effects, the most important assumption is that in the sample of *matched* firms (but not necessarily *all* firms), firm-specific shocks are uncorrelated with assignment to treatment. We elaborate on and discuss these issues and our operationalizations in Section 3.

2. Data

In this section we present data that characterize the firms involved in programs financed by IN as well as data for firms that have been selected or matched as belonging to the control group. We present data for firms included in the main assignments of IN as presented earlier. All our analyses are limited to limited liability (AS) enterprises.

We start by presenting the number of firms included in the analyses from 2001 to 2013. Table 2.1 shows the number of IN-firms included in our analysis as well as the number of firms matched to the IN-firms (the control group). The control group is selected from the total population of limited liability enterprises using nearest neighbor propensity score matching (see Section 3). The total population numbered roughly 84 000 in 2001, increasing to 124 000 in 2013. IN-firms' share of the total population of enterprises is stable around 5-6 percent. Notice that the growth in the number of matching IN-firms has been larger than that of all IN-firms. In this sense the reliability of our estimates may increase over time since we are able to match a larger share of IN-firms to other firms (around 78 percent in 2013 against 75 percent in 2001).

Distinguishing between IN-firms and firms in the control groups, Table 2.2 shows the mean and median values of number of employees, labor productivity (value added per employee) and the rate of return on total assets during 2001-2013. The median is 6 employees for all three IN-assignments compared to 3–4 employees in the control group. The mean values are higher, in particular among IN-firms, which on average are about twice as large in terms of empoloyment as the firms in the control group. In general IN-firms have lower mean and median productivity than the matching firms, except for the lending (L) assignment, where the median is higher and the mean is lower among the IN-firms. The median rate of return on total assets (the ratio of ordinary profits before taxes plus financial expenses to total assets) is always positive, whereas mean profitability is negative across the various assignments and control groups, except in the control group of the lending assignment. With regard to both mean and median values, IN-firms are less profitable than the firms in the control group across all assignments. The least profitable firms are those belonging to the IN innovation assignment (I).

Table 2.1. Number of firms included in the analysis vs. the population

Year	IN before matching[1]	IN after matching[2]	Control group	Population
2001	4 980	3 746	15 031	84 147
2002	5 492	4 164	14 971	83 642
2003	5 864	4 469	15 823	86 486
2004	6 227	4 780	17 176	92 312
2005	6 565	5 073	18 158	105 131
2006	6 961	5 412	19 247	121 729
2007	7 140	5 528	20 098	130 235
2008	6 704	5 254	20 526	135 771
2009	6 952	5 409	20 312	133 359
2010	7 474	5 827	20 823	137 340
2011	7 383	5 782	20 313	132 913
2012	7 092	5 542	19 610	129 285
2013	6 690	5 245	18 741	124 404

[1] The table shows the number of IN-firms in the sample each year they are operative regardless of their first year of participation.
[2] The number of IN firms that were matched to at least one firm in the control group.

Table 2.2. Effect indicators. Mean and median values over the period 2001-2013

	IN				Control group			
Indicator	R	I	L	All	R	I	L	All
Firm size (number of employees per firm)								
Mean	23.24	21.42	18.95	22.26	9.14	9.72	12.15	9.55
Median	6	6	6	6	4	3	4	4
Labor productivity (value added in 1000 NOK per employee)								
Mean	331.57	349.62	608.22	398.45	477.08	519.49	634.20	514.36
Median	294.45	353.22	380.54	317.18	336.53	411.48	323.80	358.78
Rates of return on total assets (in percent)								
Mean	-22.93	-54.30	-3.87	-29.84	-18.50	-30.01	12.48	-19.32
Median	2.67	1.76	3.04	2.54	4.87	5.92	4.82	5.13

Note: The IN-population consists of all matched IN firms in all years they are observed, according to the first type of IN-support received.

Looking at the spread of productivity between IN-firms and matching firms in the control group in 2001 and 2013, Figure 2.1 reveals that the control group distributions are more skewed towards high positive values with heavier right tails than the corresponding distributions for the IN firms, who appear to be more symmetric with a higher share of observations with negative values.

Figure 2.1. Distribution of labor productivity in 2001 (upper panel) and 2013 (lower panel) for IN-firms and firms in the control group. The lower and upper 5 percentiles are excluded from the figures

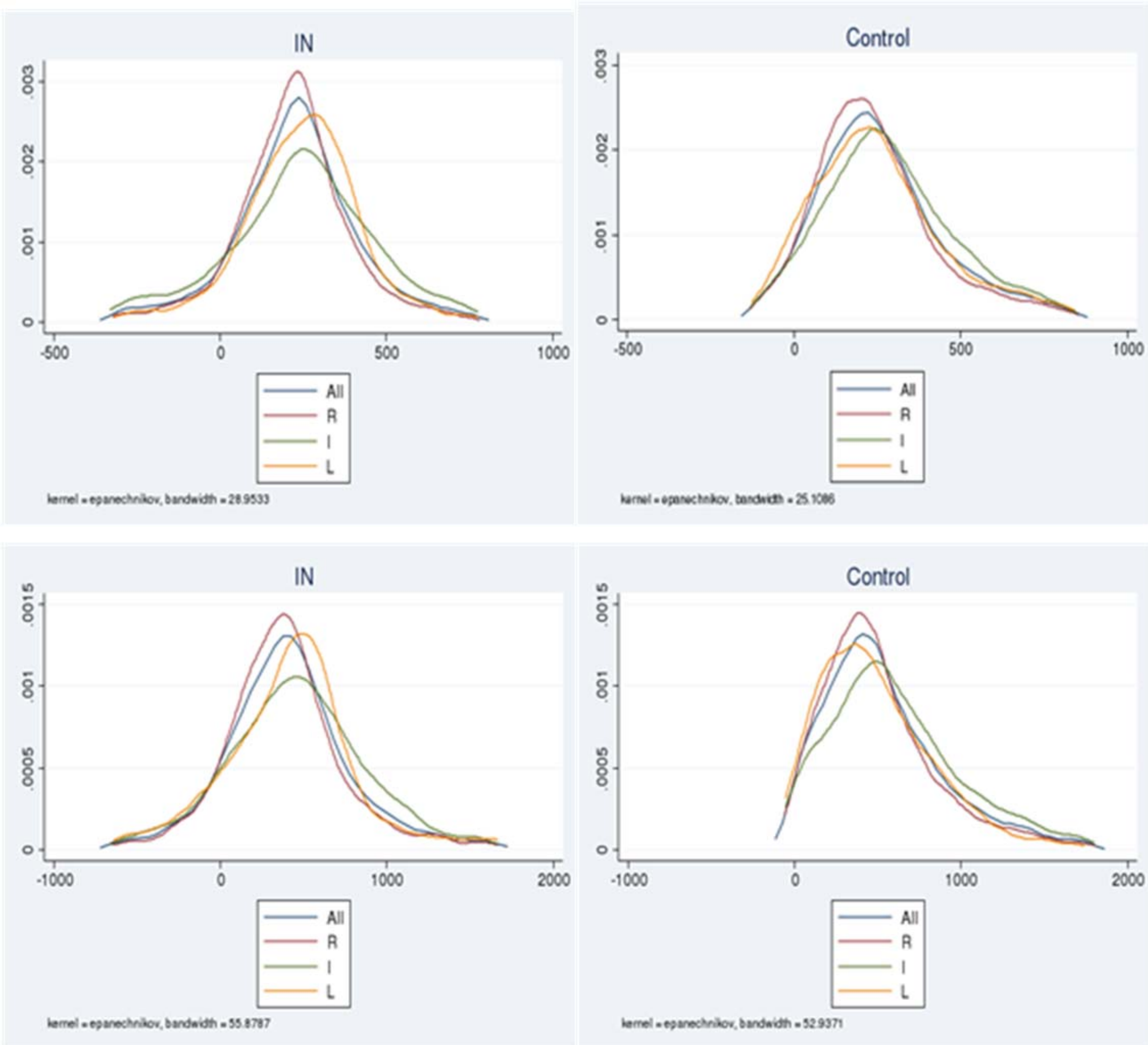


Figure 2.2. Distribution of rate of return on total assets in 2001 (upper panel) and 2013 (lower panel) for IN-firms and for firms in the control group. The lower and upper 5 percentiles are excluded from the figures

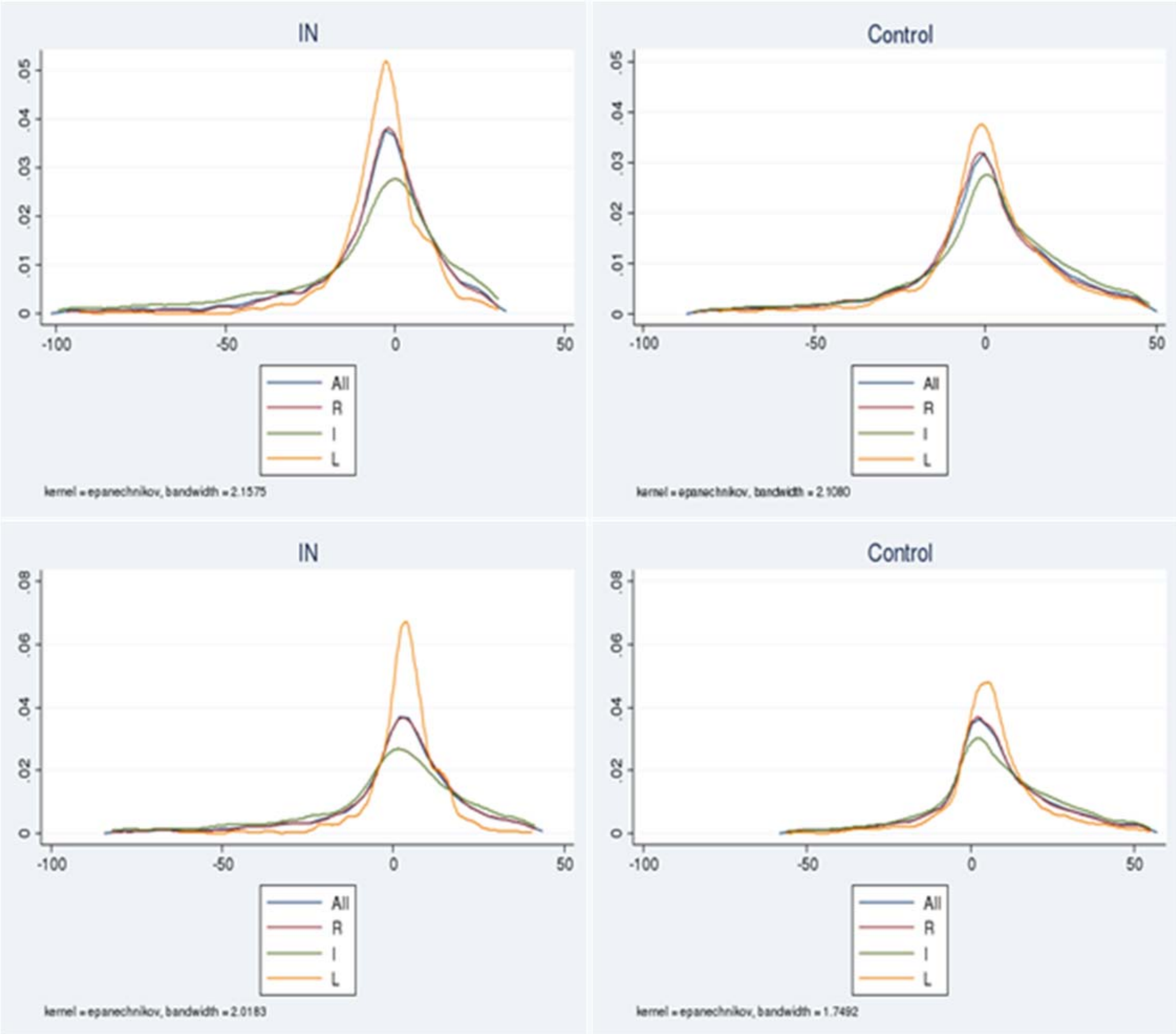


Figure 2.2 shows the distributions of rates of return in 2001 and 2013. All distributions are characterized by heavy left tails (towards high negative values), which explain the large negative mean values. However, the dispersion in profitability is large, with most observations located outside what is usually considered a normal rate of return. From the figure it looks like the IN-firms are less profitable than firms in the control group with regard to *any* quantile, not just the median.

Our matching procedure is based on the characteristics of firms in the first full accounting year they are observed during 2001-2013 (more about this in Section 3). Of course, this does not guarantee that IN-firms and matching firms are equal at the time of comparison (age at treatment).

It may be of interest to know if IN-firms are selected among enterprises that have higher growth *prior* to participation than the firms in the control group. To illuminate this issue, Tables 2.3 – 2.5 show the growth ratio from age one (i.e., the first year after establishment) to the age of first assignment for different representative IN-firms. The growth ratios are computed by age category at first assignment and depicted in the tables for turnover (sales revenues), employment and value added. Thus we compare the growth ratios of IN-firms with corresponding measures for firms in the control groups of similar age (and over the same age-interval). The representative firms are “aggregate firms” obtained by summing the value of the variable in question over the firms in each age group. The tables give no clear indication of *systematic* differences between the IN-firms and the control groups with respect to pre-assignment growth.

Table 2.3. Ratio of turnover at treatment age to turnover at age one

Age at first assignment	IN				Control			
	R	I	L	All	R	I	L	All
3-5 years	1,19	1,40	1,07	1,25	1,10	1,16	1,24	1,13
6-8 years	1,24	2,51	1,08	1,62	1,30	1,35	1,24	1,31
9+ years	1,31	1,80	1,28	1,45	1,47	1,57	1,30	1,48

Table 2.4. Ratio of employees at treatment age to employees at age one

Age at first assignment	IN				Control			
	R	I	L	All	R	I	L	All
3-5 years	0,99	1,09	0,94	1,02	1,18	1,12	1,1	1,16
6-8 years	0,99	1,22	1,11	1,07	1,33	1,27	1,24	1,30
9+ years	0,96	1,21	0,89	1,02	1,18	1,24	0,87	1,17

Table 2.5. Ratio of value added at treatment age to value added at age one

Age at first assignment	IN				Control			
	R	I	L	All	R	I	L	All
3-5 years	1,07	1,14	1,04	1,09	1,48	1,89	0,53	1,55
6-8 years	1,44	2,95	0,97	1,87	1,56	1,56	1,11	1,52
9+ years	1,39	1,99	1,35	1,56	1,60	1,77	2,74	1,78

Table 2.6 shows the total sum of grants and loans per year for each IN-program. In 2009, there was a sharp increase in lending and grants from the innovation assignment, as a part of the government efforts to counteract the financial crisis. IN-lending was gradually reduced from 2010. However, as seen from Table 2.7, total loans as well as loans per enterprise remained much higher after 2009 than before 2009, indicating a change in demand patterns or a change in IN's lending policy, whereas total grants from the innovation assignment quickly returned to pre-2009 levels. The number of firms that have received support is depicted in Table 2.8.

Table 2.6. Total grants and loans from IN during 2000-2012, total disbursements (in NOK)

Assignment year	Lending	Regional	Innovation
2000	448 000 000	199 000 000	51 900 000
2001	840 000 000	176 000 000	97 600 000
2002	477 000 000	353 000 000	123 000 000
2003	363 000 000	203 000 000	84 600 000
2004	543 000 000	177 000 000	106 000 000
2005	443 000 000	213 000 000	70 300 000
2006	496 000 000	200 000 000	126 000 000
2007	691 000 000	246 000 000	161 000 000
2008	421 000 000	382 000 000	237 000 000
2009	1 500 000 000	354 000 000	846 000 000
2010	743 000 000	271 000 000	445 000 000
2011	806 000 000	265 000 000	186 000 000
2012	843 000 000	162 000 000	190 000 000

Note: The IN-population consists of all matched IN firms.

Table 2.7. Average grants and loans from IN (per firm) during 2000-2012 (in NOK)

Assignment year	Lending	Regional	Innovation
2000	5 823 371	501 910	494 610
2001	7 175 556	414 425	625 724
2002	6 282 116	700 805	785 102
2003	5 769 421	532 962	626 389
2004	7 535 279	447 021	638 104
2005	6 821 772	455 968	621 714
2006	7 300 228	469 539	774 954
2007	9 602 251	607 597	1 061 455
2008	6 787 684	989 251	1 169 041
2009	14 000 000	948 593	2 191 641
2010	11 800 000	703 894	1 595 566
2011	15 800 000	759 133	982 140
2012	19 200 000	768 915	1 406 919

Note: The IN-population consists of all matched IN firms.

Table 2.8. Number of firms that received support during 2000-2012

Assignment year	Lending	Regional	Innovation
2000	77	396	105
2001	117	425	156
2002	76	504	157
2003	63	381	135
2004	72	396	166
2005	65	467	113
2006	68	426	163
2007	72	405	152
2008	62	386	203
2009	107	373	386
2010	63	385	279
2011	51	349	189
2012	44	211	135

Note: The IN-population consists of all matched IN firms.

As mentioned earlier, IN supports three cluster programs, the ARENA program, NCE, and GCE. There are clearly some differences in terms of members of the various clusters. In recent years the number of firms in new ARENA-clusters is quite high compared to that in the NCE clusters and more and more firms in Norway now belong to a cluster (see Table 2.9).

Firms that belong to a cluster are on average larger than the typical IN-firm. Table 2.10 shows the size of firms in clusters in the enrollment year. If we compare with the firm sizes in Table 2.2, we see that cluster firms are much larger than IN-firms in general.

Table 2.9. Number of firms per cluster according to enrollment year

Enrollment year	Arena	GCE	NCE	All
2004	3			3
2005		21		21
2006		12	26	38
2007	1	4	13	18
2008			8	8
2009	1	6	16	23
2010	29	9	21	59
2011	91	3	18	112
2012	56	2	28	86
2013	90	1	31	122

Note: All matched IN firms in the enrollment year. Firms with missing enrollment year are not included.

Table 2.10. Mean and median number of employees for cluster members in the enrollment year

Enrollment year	<=3 years old		>3 years old		All	
	Mean	Median	Mean	Median	Mean	Median
2004			6,67	7,00	6,67	7,00
2005	39,00	6,00	99,17	6,00	79,11	6,00
2006	46,50	46,50	93,92	43,50	87,14	43,50
2007	43,00	43,00	41,25	25,50	41,83	31,50
2008			380,33	325,00	380,33	325,00
2009	6,00	6,00	74,43	65,00	65,88	58,50
2010	106,00	106,00	63,50	26,00	67,04	26,00
2011	71,75	15,50	56,62	17,00	59,89	17,00
2012	168,50	6,50	102,31	29,00	109,53	24,00
2013	21,69	8,00	78,77	18,00	68,17	15,50

3. Choice of evaluation method

The two most popular methods for estimating treatment effects from panel data are difference-in-differences (DID) and matching-estimators. We will now review these methods in some detail and then, at the end of the section, present our preferred method which is a version of Matched DID (MDID) originally proposed by Heckman, Ichimura and Todd (1997), and described in a more general evaluation context in Blundell and Costa Dias (2009).

3.1. The classical methods: DID and matching

In the classical version, the DID estimator uses a policy reform taking place at some given point in time and treats it as a "natural" experiment. Formally, treatment or non-treatment of a unit (*i*) is the outcome of a stochastic assignment indicator, N_i. That is, $N_i = n$ with *n* equal to 0 or 1. DID then compares the change (difference) in the outcome variable before and after the reform between the treated units (with $N_i = 1$) and the non-treated firms (with $N_i = 0$).

While this method allows treatment effects to be heterogeneous among the units, it enables identification of average treatment effects of the treated (ATT) under very restrictive assumptions. The most important of these is that transitory shocks that are specific to an individual unit (e.g., firm-specific shocks) are uncorrelated with treatment assignment. This requirement is often referred to as the common trend assumption. As noticed by Blundell and MaCurdy (1999), the DID estimator is identical to the familiar first-difference panel data estimator when only macro-variables (such as time dummies) are allowed in the regression.

In the case of assignment to treament from IN, there is no natural experiment that excludes a subgroup of firms from treatment. The control group has to be defined through non-assignment to treatment, which occurs either because a firm decides not to apply for support, or it applies but fails in the competition for funding. This assignment process may clearly violate the requirements of DID.

The second common estimator is the matching estimator. This estimator seeks to establish a control group that represents the counterfactual (non-treated) outcomes of the treated firms taking *observed* firm heterogeneity into account. Under certain (strict) conditions a treated firm and the corresponding matching firms (to which the treated firm is paired) are identical in all respects, except a random term that is independent of treatment assignment. The most important condition is that there must exist a vector of matching variables (*S*) such that the untreated outcome (the counterfactual outcome of a treated unit) is independent of treatment assignment *conditional on S*. This is called the Conditional Independence Assumption (CIA). In our context, this means that if a firm is assigned to treatment by IN, this assignment *per se* is uninformative about the counterfactual outcome of the dependent variable (given *S*).

In practice it is impossible to find matching units with identical (or similar) *S* when *S* is of a high dimension. However, Rosenbaum and Rubin (1983) effectively reduced the multi-dimensional matching problem to a univariate one, by instead matching on the probability of treatment given S: $P(S) = \Pr(N = 1 | S)$. This probability is called the propensity score. Under the additional assumption of common support: $0 < P(S) < 1$, they showed that the non-treated outcome is independent of N given $P(S)$. The common support assumption is crucial, because if the propensity score is one there are no matching units (if it is zero there are no treated firms, which is not a problem regarding the estimation of ATT). Their result facilitates estimation of ATT in the following way:

1. Choose a treated unit *i* from the population of all units (with $N_i = 1$)
2. Pair it with a non-treated unit *j* with the same propensity score, $P(S_i) = \mathrm{P}(\mathrm{S}_j)$, but possibly a different value of S.

A simple matching estimator is the average of differences of the outcome variable between matched pairs of units with the same propensisty score. However, one-to-one matching is not the most efficient way of implementing the propsensity score estimator on a finite sample. One-to-many matching (such as 1 to many nearest neighbor matching) and kernel-matching is more efficient, but involves weighting of the observations. We refer to Caliendo and Kopeinig (2008) for discussions and practical details.

A main problem with matching is the choice of matching variables. If *S* is too high-dimensional the common support assumption will fail, but if *S* contains too few variables, CIA will fail (i.e., conditional independence is not achieved if the information set is too small). As demonstrated by Kvitastein (2014) on Norwegian firm-level data, the balancing properties of the propensisty score may be poor in finite samples even when *S* only contains a few continuous variables. Another limitation is that P(S) is unknown and therefore must be estimated, which either requires auxiliary assumptions about functional form (typically logit or probit) or the application of non-parametric methods which are subject to the same curse of dimensionality as covariate matching. In any case, as stressed by Blundell and Costa Dias (2009), the matching variables must be determined before a unit potentially *can* be assigned to treatment (not just before it actually *is)*. This is a large problem when the time of treatment is not a fixed date, as in the case of support from IN. Then a firm may be assigned to treatment early, or late, in the lifetime and even several times (sequential treatment). In any case, assignement may depend on an increasing or changing information set over time. The appropriate information set will then be difficult to determine. Thus either the CIA assumption is likely to be violated (because *S* does not contain sufficient information), or observations may not be matched, in which case only the average treatment effect over some subgroup of the treated units is estimated by the method. The estimated parameter will then be difficult to interpret. See Heckman and Lozano (2004) for a demonstration of how difficult – and critical – it is to choose the right information set.

3.2. Implementing Matched DID (MDID) to analyze the effect of support from IN

Blundell and Costa Dias (2009), based on Heckman, Ichimura and Todd (1997), combine DID and matching to weaken the assumptions of both methods. In their implementation the outcome equation is decomposed into a unit-specific fixed effect (ω_i), macro-effects and idiosyncratic shocks. The fixed effect will be eliminated by differencing. They still define the propenisty score as $P(S_i) = \Pr(N_i = 1 \mid S_i)$, but N_i is now allowed to depend on the fixed effect ω_i. A fundamental assumption is still that the time of treatment is exogenous. Thus the selection problem is a static one, as in the classical matching model.

We will now formally outline our version of MDID which we use to analyse whether assignment of treatment by IN changes the performance of firms as measured by a performance indicator, X. Depending on the application, X will either denote log-employment (number of employees), log-sales (turnover), log-labor productivity (value added per employee), or return on total capital. X_{ijrst} refers to the value of the performance indicator (dependent variable) for the *i*'th firm in the industry–region–cohort category (*j,r,s*) – which we denote *cell* $C(j,r,s)$ – at time *t*. Our industry classification (*j*) follows 2-digit NACE, the regional classification (*r*) the five zones of payroll taxes, and cohort (s) refers to the year of establishment.

As discussed in Sections 1 and 2, we separate between four main types of assignments: support obtained through the innovation assignment (I), the regional development assignment (R), the lending assignment (L) and the innovation cluster assignment (C). We estimate separate models and average treatment effects for all four assignments. To simplify, we only record the type of assignment the first time a firm obtains support. Subsequent treatments are treated as sequential treatments, not a qualitatively new category of treatment.

The data from IN cover the period 2000-2012 containing information about type, timing and amount of support given to each IN-supported firm, hereafter referred to as *treated* firms. A firm may obtain repeated treatments. Each cell of treated firms are matched to a control group of non-treated firms through propensity score matching. The firm's (initial) characteristics at start-up, or in 2001 for firms established before 2001, are used as matching variables, as we will describe below. We implement two types of matching: matching with stratification (treated firms can be matched only with non-treated firms in the same cell) and matching without stratification (allowing matching across cells). A general discussion of the pros and cons of matching with stratification are discussed in Caliendo and Kopeinig (2008). The specific motivation for stratification in our case is that cell characteristics are key determinants both of the probability of obtaining support, e.g. through regional programs and programs targeting young firms, and of the dependent variables, e.g. through industry-specific market conditions or local labor market conditions.

Our matching variables, *S*, are measured at start-up, or in 2001 for firms established before 2001, and include the 3-digit NACE *sub-industry* (within 2-digit industry *j*)[2], size (total assets) and owner concentration measured by the Herfindahl index. The matching procedure used is the STATA routine *psmatch2* with 1 to 5 nearest neighbor matching with trimming.[3]

To describe matching with stratification formally, we define the treatment group N_{jrs}^T as the group of firms that obtain a given type of treatment (a particular type of support) in the industry–region–cohort cell $C(j,r,s)$. The corresponding control group is denoted N_{jrs}^C and is obtained by matching firms in the treatment group N_{jrs}^T to non-treated firms in the same cell. Let N_{it} be the number of treatments given to firm *i* at *t*: $N_{it} = n$ with $n = 0,1,2,...$. and define $N_i = \max_t N_{it} > 0$.

The matching is done w.r.t. cell-specific propensity scores

$$P_{jrs}(S_i) \equiv \Pr(N_i \geq 1 \mid S_i, i \in C(j,r,s)) .$$

Since a firm may get repeated (sequential) treatments, N_i is a *counting* variable and CIA is not sufficient for $P_{jrs}(S_i)$ to be a balancing score (see Lechner, 2001). We need the additional assumption that how many treatments a firm gets – given that it obtains at least one – does not depend on S_i. We will turn to this complicating issue below.

In the case of matching without stratification, $P_{jrs}(S_i)$ can be defined in the same way as above, except that $i \in C(j,r,s)$ are included as ordinary matching variables in addition to S_i (a dummy variable for each cell – which is one if $i \in C(j,r,s)$). In this case, a treated firm can be matched with firms belonging to another cell.

The matching with stratification approach outlined above (matching within the cell only), has the practical drawback that fewer treated firms will be matched as the potential control group is much small for any treated firm. In our experience, the number of IN-firms that can be matched is reduced with more than 50 percent. When we present the results in the next section, we therefore present estimates for matching both with and without stratification.

[2] This will exclude firms from 3-digit NACE industries without treated firms from the matched sample through the common support condition.
[3] The option specification we used is: *neighbor(5) common trim(10)*. See Leuven and Sianesi (2003) for practical guidelines and technical details regarding the algorithm.

3.3. Econometric model

Let $X_{ijrst}(n)$ denote the dependent variable of firm *i* (belonging to cell $C\left(j,r,s\right)$) if it has been assigned the treatment *n* times at *t,* let $\tau_i^{(n)}$ be the (long-term) treatment effect of the *n*'th treatment and let $T_i^{(\mathrm{n})}$ denote the year of the *n*'th assignment, with $\tau_i^0 = T_i^0 = 0$. The average treatment effects of the treated (ATT) are: $\tau^{(n)} \equiv E(\tau_i^{(\mathrm{n})} \mid N_i \geq n)$. To estimate $\tau^{(n)}$ by MDID, we assume

$$X_{ijrst}(n) = m_{jrst}(S_i) + \omega_i + \sum_{k=0}^{\max(0,n-1)} \tau_i^{(k)} + \frac{\tau_i^{(n)}}{m} \times min\left(t - T_i^{(\mathrm{n})}, m\right) + \varepsilon_{ijrst},\ n \geq 0,$$

where $m_{jrst}(S_i)$ is the predictable, but unknown (non-parametric), part of X_{ijrst} given S_i and ε_{ijrst} is the error term. The term $(\tau_i^{(n)} / m) \times min(t - T_i^{(n)}, m)$ reflects our assumption that the *n*'th treatment incurs an *annual* increase in *X* equal to $\tau_i^{(n)} / m$ in the *treatment interval* $(T_i^{(n)}, T_i^{(n)} + m]$ – and zero increase thereafter. The choice of *m* is crucial and we test in our empirical analyses whether the last condition is violated for our chosen *m* (see below). A treatment effect is identified as a *persistent* effect on the *level* of *X*. The long-term change in *X* caused by *n* treatments equals $\sum_{k=1}^{n} \tau_i^{(k)}$ and this effect is realized *m* years after the last assignment year $T_i^{(n)}$:

$$X_{ijrst}(n) - X_{ijrst}(0) = \sum_{k=1}^{n} \tau_i^{(k)},\ t \geq T_i^{(\mathrm{n})} + m.$$

The crucial assumption for consistent estimation of treatment effects is the CIA assumption:

$$\Delta X_{ijrst}(0) \perp N_i \mid S_i$$

where $\perp$ denotes stochastic independence (no selection on the non-treated outcome), or equivalently

$\varepsilon_{ijrst} \perp N_i$ for all *t*.

It follows from Lechner (2001) that $P_{jrs}(S_i)$ will be a balancing score for N_i if the following condition holds:

$$P(N_i = n \mid \mathrm{S}_i, N_i \geq 1, i \in C(j,r,s)) = P(N_i = n \mid N_i \geq 1, i \in C(j,r,s)).$$

That is, how many treatments a firm gets – given that it obtains at least one – does not depend on S_i. However, it may depend on the effect of the treatments (since $\Delta X_{ijrst}(0)$ is independent of $\tau_i^{(n)}$ by assumption). As shown by Lechner (2001), given the common support assumption $0 < P_{jrs}(S_i) < 1$,

$$\Delta X_{ijrst}(0) \perp N_i \mid \mathrm{P}_{jrs}(S_i).$$

Note that this is a non-trivial extension of the classsical matching result, as N_i is a count variable, not a binary treatment indicator.

Define

$$m_{jrst} = E_{P_{jrs|1}}\left[E(m_{jrst}(S)) \mid \mathrm{P}_{jrs}(\mathrm{S})\right]$$

where $P_{jrs|1}$ is the distribution of S in the sub-population of treated firms in the cell $C(j,r,s)$ satisfying $0 < P_{jrs}(S) < 1$. By construction of the matching algorithm, $P_{jrs|1}$ is also the distribution of S in the *matched subpopulation* (defined by repeating steps 1-2 of the matching algorithm for each treated firm in the population, rather than in the sample). Thus m_{jrst} is the mean value of $m_{jrst}(S)$ in the sub-population of *all* matched firms. MDID collapses to (ordinary) DID if *either* $m_{jrst}(S_i)$ does not depend on S_i (there is a common trend for all firms in the same cell), *or* S_i has the same distribution among the treated and the non-treated firms within each cell. In either case, there is no need to perform matching.

Let $X_{ijrst} = X_{ijrst}(N_{it})$ be the realized value of the dependent variable. By differencing, we obtain

$$\Delta X_{ijrst} = \Delta m_{jrst} + \sum_{j=1}^{m} \frac{\tau_i^{(N_{it})}}{m} \times I(t = T_i^{(N_{it})} + \mathrm{j}) + \Delta e_{ijrst} \,,$$

where $e_{ijrst} = m_{jrst}(S_i) - m_{jrst} + \varepsilon_{ijrst}$ and $\mathrm{I(A)}$ is the indicator function which is one if the statement A is true and zero else. In the matched subpopulation, the error term e_{ijrst} has mean equal to zero given N_i for all *t*, since

$$E_{P_{jrs|1}}\left[E(m_{jrst}(S_i) - m_{jrst} + \varepsilon_{ijrst}) \mid \mathrm{N}_i, \mathrm{P}_{jrs}(\mathrm{S}_i)\right] = E_{P_{jrs|1}}\left[E(m_{jrst}(S_i) - m_{jrst}) \mid \mathrm{N}_i, \mathrm{P}_{jrs}(\mathrm{S}_i)\right]$$
$$E_{P_{jrs|1}}\left[E(m_{jrst}(S_i) - m_{jrst}) \mid \mathrm{P}_{jrs}(\mathrm{S}_i)\right] = 0.$$

.

The first equality follows from $\varepsilon_{ijrst} \perp N_i$ and the second from the balancing property of the propensity score, demonstrated by Rosenbaum and Rubin (1983):

$$S_i \perp N_i \mid P(S_i) \,.$$

The last equality follows from the definition of m_{jrst}. Thus we conclude that Δe_{ijrst} satisfies all the conditions of a regression error term in the matched subpopulation.

3.4. Estimation of ATT

Contrary to standard DID-based estimators, we utilize panel data to estimate the autocorrelation structure of the error term. We do so by assuming that Δe_{ijrst} is a moving average process of order q (MA(q)):

$$\Delta e_{ijrst} = \theta_q(L)\eta_{ijrst}, \;\; \eta_{ijrst} \sim i.i.d.(0,\sigma^2) \,,$$

where $\theta_q(L) = 1 + \theta_1 L + ... + \theta_q L^q$ and L is the lag operator (by definition $L^k e_t = e_{t-k}$). Explicitly incorporating autocorrelated error terms improves the efficiency of the estimator (increases the signal-to-noise ratio), as we will see below. Bertrand, Duflo and Mullainathan (2004) point out that standard errors of estimation may be seriously underestimated by DID-methods when applied to panels with many repeated observations per unit.[4] Inserting into the equation for ΔX_{ijrst}, we obtain

$$\Delta X_{ijrst} = \Delta m_{jrst} + \sum_{j=1}^{m} \frac{(\tau^{(\mathrm{N}_{it})} + \delta_i^{(N_{it})})}{m} \times I(t = T_i^{(N_{it})} + \mathrm{j}) + \theta_q(L)\eta_{ijrst}$$

with fixed parameters $\tau^{(n)} \equiv E(\tau_i^{(\mathrm{n})} \mid N_i \geq n)$ and firm-specific (random) parameters $\delta_i^{(n)} = \tau_i^{(n)} - \tau^{(n)}$.

The above equation is a mixed model, which can be consistently estimated by standard mixed models methods. The following assumptions are then assumed to hold:

Assumption 1: $E(\tau_i^{(n)} \mid T_i^{(n)}, N_i \geq n) = E(\tau_i^{(n)} \mid N_i \geq n)$ $(\equiv \tau^{(n)})$
Assumption 2: $E(\delta_i^{(n)} I(T_i^{(n)} = t)) = 0$ for all t
Assumption 3: $E(\delta_i^{(n)} \eta_{ijrst}) = 0$ for all t
Assumption 4: $E(\eta_{ijrst} \mid T_i^{(n)}) = 0$ for all t

Assumption 1 says that *when* a firm gets the *n*'th treatment ($T_i^{(n)}$) – given that it does so – is not informative about the effect of that treatment. This assumption is implicitly assumed in all standard treatment effects models (where it is usually considered fixed). Assumption 2 is satisfied because from Assumption 1, $E(\tau_i^{(n)} - \tau^{(n)} \mid T_i^{(n)}, N_i \geq n) = 0$. Moreover,

$$E(\tau_i^{(n)} - \tau^{(n)} \mid T_i^{(n)}, N_i \geq n) = 0 \Leftrightarrow E(\delta_i^{(n)} \mid T_i^{(n)}, N_i \geq n) = 0 \Leftrightarrow E(\delta_i^{(n)} \mid \mathrm{I}(\mathrm{T}_i^{(n)} = \mathrm{t}), N_i \geq n) = 0$$
$$\Rightarrow E(\delta_i^{(n)}\, \mathrm{I}(\mathrm{T}_i^{(n)} = \mathrm{t})) = 0$$

Assumption 3 says that the firm-specific effect of the treatment (measured as a deviation from ATT) does not depend on the genuine error term. This assumption says that the treatment effect (if the firm is treated) should not depend on the non-treated outcomes.

Assumption 4 is the CIA assumption, implying that if i'' is a firm in the treatment group, $i'' \in N_{jrs}^T$, and i' is a firm in the control group matched to i'', $i' \in N_{jrs}^C$, and $I_{i,t-1} = \{\eta_{i,t-1}, \eta_{i,t-2}, ...\eta_{i,s}\}$ (with $\eta_{it} = 0$ for *t<s*), then for *k=1,..,m*,

$$E(\Delta X_{i''jrst} \mid I_{i'',t-1}, T_{i''}^{(n)} = t - k) - E(\Delta X_{i'jrst} \mid I_{i',t-1}, \mathrm{N}_{i'} = 0) = \tau^{(n)} / m + \tilde{\theta}_{q-1}(L)(\eta_{i''jrs,t-1} - \eta_{i'jrs,t-1})$$

where
$\tilde{\theta}_{q-1}(L) = \theta_1 + \theta_2 L + ... + \theta_q L^{q-1}$.

[4] A new contribution to this discussion is Cameron and Miller (2015), who advocate the use of cluster-robust standard errors in regression based inference (such as DID).

In the special case where $\theta_q(L)=1$, i.e., $\Delta e_{ijrst}=\eta_{ijrst}$, inference about $\tau^{(\mathrm{n})}=E(\tau_i^{(\mathrm{n})}\mid N_i \geq n)$ can be made without loss of information from the difference-in-differences $\Delta X_{i''jrst}-\Delta X_{i'jrst}$ for $t=T_{i''}^{(n)}+1,\ldots,T_{i''}^{(n)}+m$. However, if the growth rates Δe_{ijrst} are dependent over time, there is a loss of efficiency by ignoring the information contained in lagged values of the dependent variable, i.e. ignoring $\tilde{\theta}_{q-1}(L)(\eta_{i''jrs,t-1}-\eta_{i'jrs,t-1})$. In our analysis, the MA-polynomial $\theta(L)$ is unknown, and will be estimated. The order, *q*, is determined using the Akaike information criterion. In all our applications *q=2* or *3*. The first MA-coefficient is typically estimated to lie between –0.6 and –0.5 and is highly significant with a standard error between 0.01 and 0.02. All our models are estimated using the mixed command in STATA[5]. In particular, this command gives consistent estimates of the average treatment effects parameters $\tau^{(\mathrm{n})}$.

Our model assumes that the effect of the treatment is realized within an *m*-year interval after the assignment of treatment. There is uncertainty about what *m* should be in practice. In our analyses we use *m*=3, based on discussions with IN, but we have also estimated a more general version where we incorporate a "post-treatment" (or "placebo") effect equal to $g_i^{(k)}/m$ per year in a second *m*-year interval, $(T_i^{(k)}+m, T_i^{(k)}+2m]$. This was also done also to check whether the initial effect of the treatment is followed by a mean-reversion effect (partly) nullifying the initial effect. In this case

$$X_{ijrst}(n)-X_{ijrst}(0)=\sum_{k=1}^{n}(\tau_i^{(k)}+g_i^{(k)}),\ t \geq T_i^{(\mathrm{n})}+2m,$$

and the average (long-run) treatment effect of the *n*'th treatment is $\tau^{(n)}+g^{(n)}$, where

$$\tau^{(n)} \equiv E(\tau_i^{(n)}\mid N_{it}\geq n)$$
$$g^{(n)} \equiv E(g_i^{(n)}\mid N_{it}\geq n)$$

With one exception, we do not report estimates of $g^{(n)}$ in the results section as the estimated "post-treatment" effects are generally small and insignificant, supporting our choice of $m=3$.

4. Results

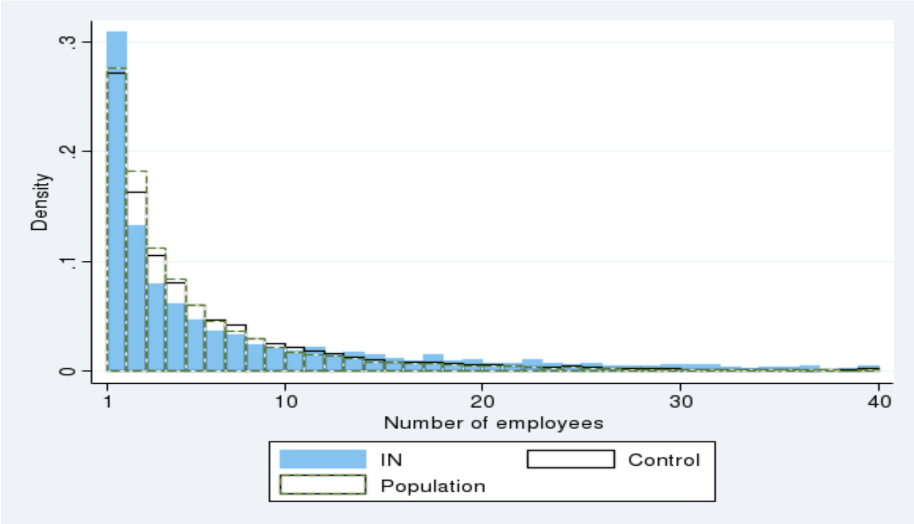
4.1. The balancing properties of matching

Figures 4.1-4.3 depict the balancing properties of the matching with respect to number of employees, total assets and the Herfindahl index of owner concentration (all variables measured at the time of matching). The overall impression is that the IN-firms, the control group and the total population have similar distributions with regard to these variables. Table 4.1 does reveal, however, that there is a lower share of IN-firms with less than 40 employees (91 percent) than in both the control group and in the total population (97 percent). The only vfariable for which there is a clear distinction between the three groups of firms is the Herfindahl index (Figure 4.3), where there is a larger share (13 %) of firms with index value equal to one in the entire population (these are the firms owned 100% by one person) than among both the IN-firms and in the control group (5 %).

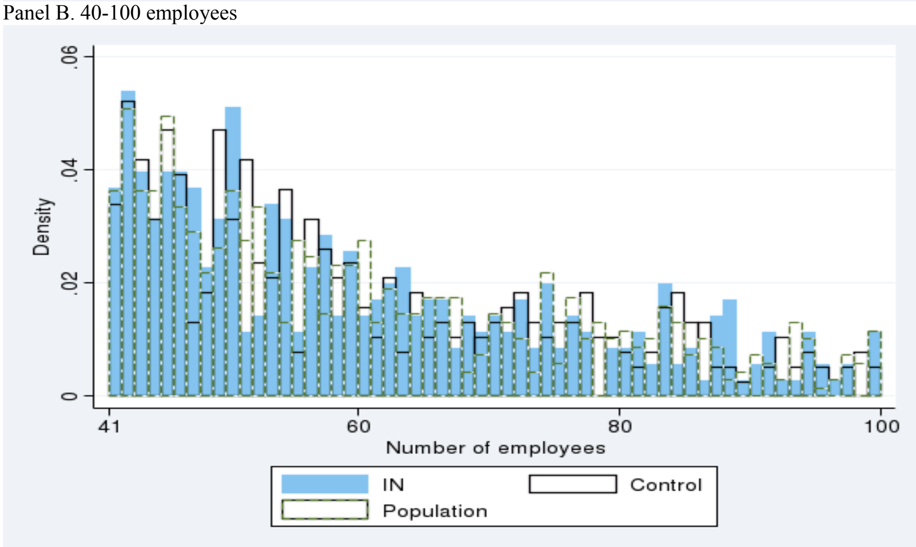
[5] See http://www.stata.com/bookstore/stata12/pdf/xt_xtmixed.pdf

Figure 4.1. Distribution of employees among new and incumbent IN firms, firms in the control group and firms in the entire population

Panel A. 1-40 employees



Panel B. 40-100 employees



Panel C. More than 100 employees

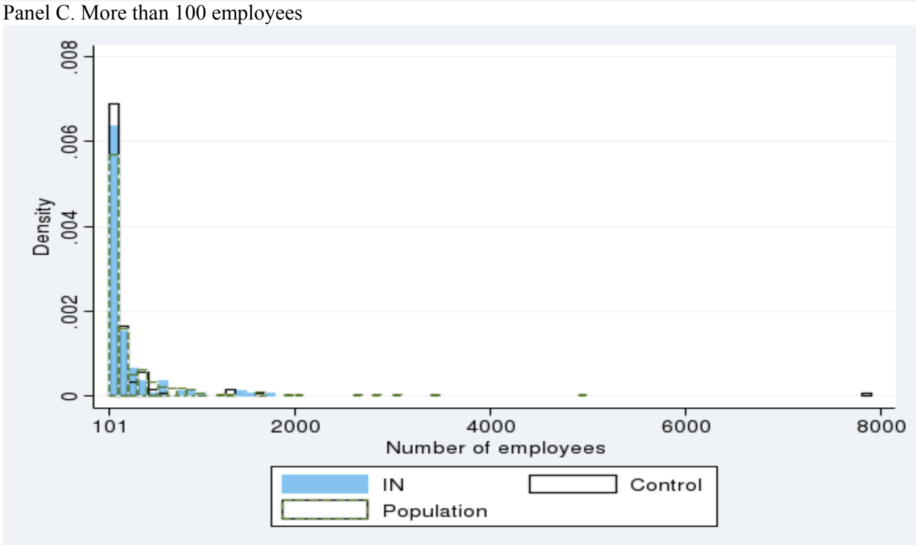
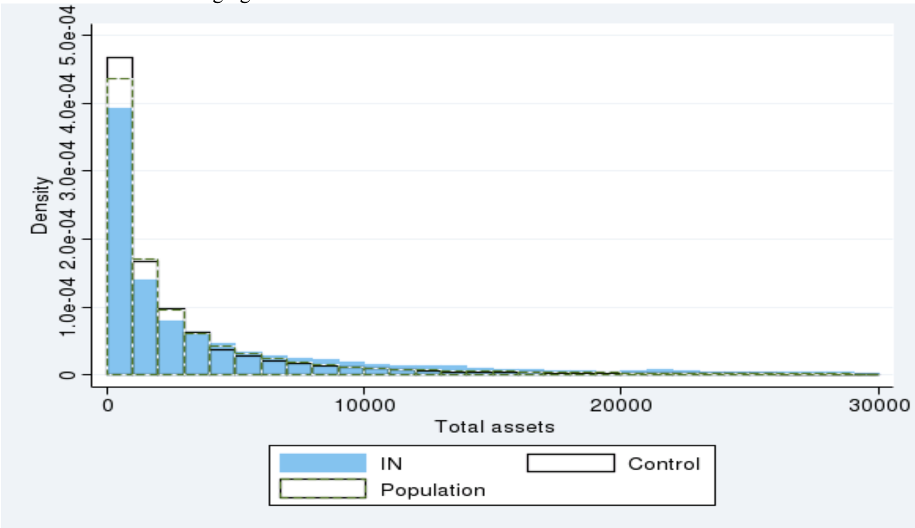
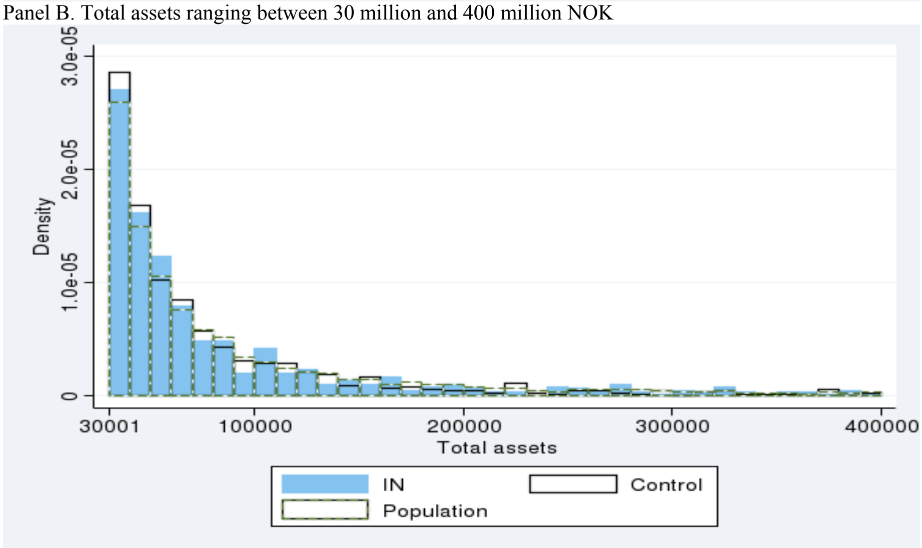


Figure 4.2. Distribution of total assets among new and incumbent IN firms, firms in the control group and firms in the entire population

Panel A. Total assets ranging between 0 and 30 million NOK



Panel B. Total assets ranging between 30 million and 400 million NOK



Panel C. Total assets above 400 million NOK

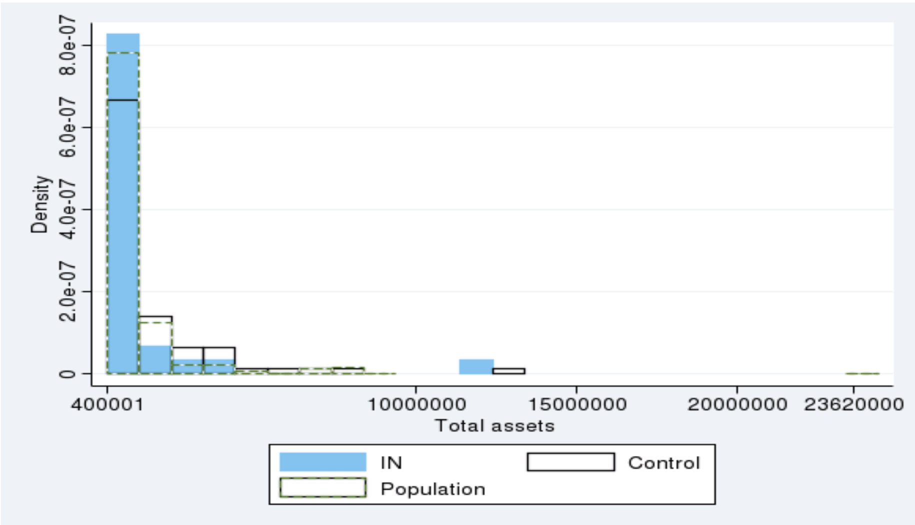


Figure 4.3. Distribution of the Herfindahl index among new and incumbent IN firms, firms in the control group and firms in the entire population

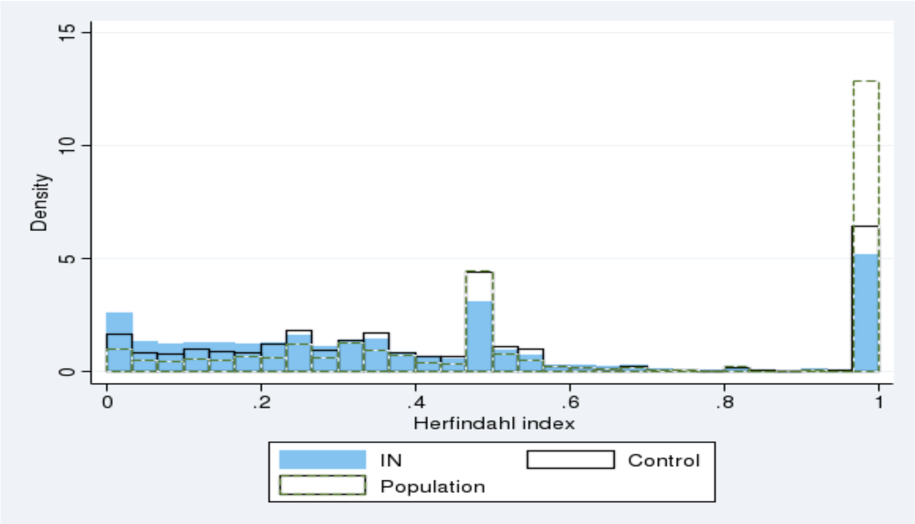


Table 4.1. Share of observations for each histogram

	IN	Control	Population
Number of employees			
0-40	90.91 %	97.02 %	97.36 %
41-100	6.55 %	2.26 %	1.89 %
>100	2.54 %	0.72 %	0.75 %
Total assets in mill. NOK			
0-30	90.91 %	96.54 %	94.87 %
30-400	8.67 %	3.20 %	4.76 %
>400	0.42 %	0.26 %	0.37 %

4.2. Estimation results

Tables 4.2-4.5 present estimated treatment effects (ATT) for all the financial assignments – either separately (Tables 4.3-4.5) or across all assignments (Table 4.2). We distinguish between start-up firms (≤ 3 years when assigned to treatment) and support given to firms older than 3 years. In the latter group, we distinguish between first-time support and later support. (See Table A.10 for supplementary results for first-time support when firms of all ages are lumped together). To investigate the robustness of our results we separate between results obtained from the full sample and a trimmed sample where the 2.5 percent highest and lowest observations of ΔX are removed.

The dependent variable X is either the logarithm of a (positive) variable: $X = \ln Y$, or a ratio: the return on total assets or value added per employee. The estimated treatment effect (ATT) corresponds to the parameter $100 \times \tau^{(1)} / 3$ in the case of first-time support and a common estimate of $100 \times \tau^{(n)} / 3$ for all $n > 1$ in the case of later support. Multiplying by 100 means that ATT can be interpreted as a percentage points effect, whereas dividing by 3 means that we present the effect as an average *annual* effect over a 3-year interval after the assignment year.

The results in Table 4.2 exhibit a distinct difference between the size variables (log of) *number of employees*, *sales revenues* and *value added* on the one side, and the ratio variables *value added per employee* (labor productivity) and *return on total assets* on the other, with generally higher and more significant estimates of ATT in the former group. For start-up firms (“entrepreneurs”), the estimated ATT for the size variables on the full sample lies in the range of 10-20 percentage points. Thus start-up firms with IN-support increase employment, sales revenues and value added by 10 to 20 percentage points more per year than the matching firms during the 3-year interval after assignment. For older firms that receive IN-support for the first time, the estimated effects are lower (3-9 percentage points increased growth), but still highly statistically significant.

Table 4.2 also depicts the consequences of trimming: the 2.5 percent highest and lowest observations of ΔX (after lumping all the assignments together) were removed from the sample. Trimming reduces the highest estimates considerably: for start-up firms, the estimated effects are more than halfed by trimming. Still most of the effects remain strongly significant, because standard errors are also reduced substantially when outliers are removed.

The effects on start-up firms and older firms that obtain first-time support become much more similar with trimming: the estimated ATT for number of employees lies in the range of 2-4 pecentage points, for sales revenues 6-11 percentage points and for value added 3-5 percentage points. The coefficients are mostly highly significant (p-value below 0.01 and even below 0.001). For firms that obtain repeated treatments, the effect of later assignments is generally lowered by 1-2 percentage points compared to first-time assignment, but these estimates are also higly significant.

In terms of the ratio variables, we do not find any significant effects for start-up firms, but we do find modest significant effects for older firms. For example, labor productivity is estimated to increase 2.6 percentage points more per year in the group of treated firms than in the control group, but this effect vanishes when trimming the sample. On the other hand, the effect on return on total assets is robust, and in fact higher and more significant in the trimmed sample, where the estimated ATT for the return on total assets lies in the range of 0.3-0.6 percentage points.

When we examine the results at the level of the three financial assignments (I, R and L), we find that the innovation assignment and the regional assignment have results that are similar to all assignements, except that only the R-assignment exhibits a positive effect on returns on total assets. Hence the regional assignment seems to be successful on a broader set of indicators (not just scale input and output indicators) than the innovation assignment. On the other hand, the lending assignment does not appear to be particularly successful with regard to any indicator. There are a few significant estimates in Table 4.4, but they are not robust towards trimming and some significant estimates are even negative (productivity).

Table 4.2. Assignments I, R and L. Estimated average treatment effects (ATT) in the first 3-year interval after assignment (in percentage points).[1] Average annual difference in ΔX between IN-firms and matching firms ("matched difference-in-difference")

Dependent variable (X_t)	Firm age in assignment year	Full sample				Trimmed sample			
		ATT	z	[95% CI]		ATT	z	[95% CI]	
Number of employees									
First-time support[2)]	<= 3 years	10.2***	6.4	7.1	13.3	3.4**	2.8	1.0	5.8
	> 3 years	3.0***	6.0	2.0	4.0	2.1***	5.9	1.4	2.8
Later support[3)]	>= 3 years	1.2*	2.5	0.3	2.0	1.7***	5.4	1.5	2.9
Sales revenues									
First-time support[2)]	<= 3 years	21.0***	6.8	15.0	27.0	10.9***	5.7	7.2	14.7
	> 3 years	8.6***	8.6	6.6	10.5	5.7***	9.4	4.5	6.8
Later support[3)]	>= 3 years	2.3**	2.8	0.7	4.0	3.3***	6.7	4.9	7.2
Value added									
First-time support[2)]	<= 3 years	9.9**	3.2	3.9	15.9	3.5	1.5	-1.2	8.3
	> 3 years	5.0***	5.8	3.3	6.6	4.3***	6.4	3.0	5.6
Later support[3)]	>= 3 years	0.8	1.1	-0.6	2.2	1.3*	2.4	3.0	5.5
Value added per employee									
First-time support[2)]	<= 3 years	1.0	0.3	-5.1	7.0	2.0	0.8	-2.9	7.0
	> 3 years	2.6**	3.2	1.0	4.2	0.2	0.3	-1.0	1.3
Later support[3)]	>= 3 years	0.6	1.2	-0.4	1.6	-0.2	-0.6	-0.8	1.4
Return on total assets									
First-time support[2)]	<= 3 years	0.1	0.2	-0.8	1.0	0.2	0.5	-0.7	1.1
	> 3 years	0.4**	2.8	0.1	0.6	0.6***	4.1	0.3	0.8
Later support[3)]	>= 3 years	0.3*	2.3	0.1	0.7	0.3*	2.3	0.3	0.8
Firms with IN-assignments									
First-time support[2)]	<= 3 years	1 334							
	> 3 years	5 934							
Later support[3)]	>= 3 years	2 674							

Notes: 1:5 nearest neighbor matching without stratification. In the trimmed sample, 2.5% of the lowest and highest ΔX were removed. *** p< 0.001, ** p< 0.01, * p< 0.05.
[1] If a firm obtains new support during the interval, this is considered as (a continuation of) the same treatment. [2)] Estimated parameter is $ATT = 100 \times \tau^{(1)} / 3$. [3)] Average effect of second and later treatments for firms obtaining repeated support (common estimate of $ATT = 100 \times \tau^{(n)} / 3$ for all $n > 1$).

Table 4.3. Innovation assignment (I). Estimated average treatment effects (ATT) in the first 3-year interval after assignment (in percentage points).[1] Average annual difference in ΔX between IN-firms and matching firms ("matched difference-in-difference").

Dependent variable (X_t)	Firm age in assignment year	Full sample				Trimmed sample			
		ATT	z	[95% CI]		ATT	z	[95% CI]	
Number of employees									
First-time support[2)]	<= 3 years	14.7***	5.0	8.9	20.5	5.3	1.9	-0.1	10.7
	> 3 years	3.3***	3.9	1.7	5.1	2.4***	4.0	1.2	3.6
Later support[3)]	>= 3 years	1.8*	2.2	0.2	3.5	1.7**	2.7	1.4	3.8
Sales revenues									
First-time support[2)]	<= 3 years	22.9**	3.5	10.1	35.6	7.3	1.8	-0.9	15.6
	> 3 years	11.8***	6.7	8.4	15.3	7.8***	7.1	5.6	9.9
Later support[3)]	>= 3 years	4.7**	2.8	1.5	7.9	3.0**	3.0	5.5	9.7
Value added									
First-time support[2)]	<= 3 years	15.6*	2.0	0.4	30.9	5.8	1.1	-4.7	16.3
	> 3 years	4.4**	2.8	1.3	7.4	4.2**	3.8	2.0	6.4
Later support[3)]	>= 3 years	1.3	0.9	-1.6	4.3	0.3	0.2	2.1	6.4
Value added per employee									
First-time support[2)]	<= 3 years	-0.5	-0.1	-16.7	15.7	2.5	0.4	-10.1	15.1
	> 3 years	2.3	1.7	-0.4	4.9	0.4	0.4	-1.6	2.4
Later support[3)]	>= 3 years	1.5	1.4	-0.5	3.5	-0.5	-0.6	-1.5	2.4
Return on total assets									
First-time support[2)]	<= 3 years	-1.4	-1.0	-1.4	0.4	-0.8	-0.6	-3.5	1.8
	> 3 years	0.2	0.6	-0.1	0.2	0.1	0.4	-0.4	0.6
Later support[3)]	>= 3 years	0.3	1.0	-0.3	0.8	0.2	0.8	-0.5	0.6
Firms with IN-assignments									
First-time support[2)]	<= 3 years	371							
	> 3 years	1 784							
Later support[3)]	>= 3 years	629							

Notes: 1:5 nearest neighbor matching without stratification. In the trimmed sample, 2.5% of the lowest and highest ΔX were removed. *** p< 0.001, ** p< 0.01, * p< 0.05.

[1] If a firm obtains new support during the interval, this is considered as (a continuation of) the same treatment. [2)] Estimated parameter is $ATT = 100 \times \tau^{(1)} / 3$. [3)] Average effect of second and later treatments for firms obtaining repeated support (common estimate of $ATT = 100 \times \tau^{(n)} / 3$ for all $n > 1$).

Table 4.4. Lending assignment (L). Estimated average treatment effects (ATT) in the first 3-year interval after assignment (in percentage points).[1] Average annual difference in ΔX between IN-firms and matching firms ("matched difference-in-difference").

Dependent variable (X_t)	Firm age in assignment year	Full sample				Trimmed sample			
		ATT	z	[95% CI]		ATT	z	[95% CI]	
Number of employees									
First-time support[2)]	<= 3 years	15.2**	3.1	5.5	24.9	-1.6	-0.3	-11.0	7.7
	> 3 years	1.8	1.2	-1.2	4.9	2.1	1.8	-0.1	4.3
Later support[3)]	>= 3 years	0.4	0.3	-1.9	2.6	1.0	1.4	-0.3	4.0
Sales revenues									
First-time support[2)]	<= 3 years	24.8**	3.3	10.2	39.3	3.1	0.6	-7.8	13.9
	> 3 years	7.9**	2.9	2.6	13.2	3.0	1.9	-0.1	6.1
Later support[3)]	>= 3 years	0.3	0.1	-3.9	4.4	2.2*	2.1	0.0	6.0
Value added									
First-time support[2)]	<= 3 years	10.4	1.3	-5.1	26.0	14.9	1.9	-0.4	30.1
	> 3 years	3.5	1.6	-0.9	7.9	5.4**	2.7	1.5	9.3
Later support[3)]	>= 3 years	-1.3	-0.8	-4.6	1.9	0.1	0.1	9.5	0.0
Value added per employee									
First-time support[2)]	<= 3 years	-8.7	-1.1	-24.9	7.4	7.6	1.1	-5.6	20.9
	> 3 years	2.3	1.0	-2.3	7.0	-1.8	-1.1	-4.9	1.4
Later support[3)]	>= 3 years	-0.9	-0.8	-3.3	1.5	-2.2*	-2.1	-4.5	1.7
Return on total assets									
First-time support[2)]	<= 3 years	0.4	0.4	-1.5	2.2	0.0	0.0	-2.1	2.0
	> 3 years	0.3	1.0	-0.3	0.8	0.4	1.4	-0.1	0.9
Later support[3)]	>= 3 years	0.0	0.2	-0.4	0.5	0.1	0.3	-0.2	0.9
Firms with IN-assignments									
First-time support[2)]	<= 3 years	118							
	> 3 years	626							
Later support[3)]	>= 3 years	476							

Notes: 1:5 nearest neighbor matching without stratification. In the trimmed sample, 2.5% of the lowest and highest ΔX were removed. *** p< 0.001, ** p< 0.01, * p< 0.05.

[1] If a firm obtains new support during the interval, this is considered as (a continuation of) the same treatment. [2)] Estimated parameter is $ATT = 100 \times \tau^{(1)} / 3$.

[3)] Average effect of second and later treatments for firms obtaining repeated support (common estimate of $ATT = 100 \times \tau^{(n)} / 3$ for all $n > 1$).

Table 4.5. Regional assignment (R). Estimated average treatment effects (ATT) in the first 3-year interval after assignment (in percentage points).[1] Average annual difference in ΔX between IN-firms and matching firms ("matched difference-in-difference").

Dependent variable (X_t)	Firm age in assignment year	Full sample				Trimmed sample			
		ATT	z	[95% CI]		ATT	z	[95% CI]	
Number of employees									
First-time support[2)]	<= 3 years	6.9**	3.5	3.1	10.7	2.1	1.5	-0.6	4.8
	> 3 years	3.0***	4.7	1.8	4.3	1.3**	2.9	0.4	2.1
Later support[3)]	>= 3 years	1.0	1.8	-0.1	2.0	1.8***	4.7	0.5	2.2
Sales revenues									
First-time support[2)]	<= 3 years	18.8***	5.0	11.4	26.2	12.7***	5.6	8.3	17.2
	> 3 years	7.6***	6.0	5.1	10.0	4.6***	6.0	3.1	6.0
Later support[3)]	>= 3 years	2.3*	2.5	0.5	4.2	3.0**	5.4	3.9	6.7
Value added									
First-time support[2)]	<= 3 years	7.7*	2.1	0.6	14.9	1.6	0.6	-4.0	7.3
	> 3 years	5.0***	4.5	2.9	7.2	3.4***	3.9	1.7	5.1
Later support[3)]	>= 3 years	0.2	0.3	-1.3	1.8	1.2*	2.1	1.6	4.8
Value added per employee									
First-time support[2)]	<= 3 years	1.8	0.5	-5.3	8.9	1.2	0.5	-4.0	6.5
	> 3 years	2.3*	2.1	0.2	4.4	-0.5	-0.7	-2.0	0.9
Later support[3)]	>= 3 years	0.2	0.3	-0.9	1.3	-0.4	-0.8	-1.8	1.0
Return on total assets									
First-time support[2)]	<= 3 years	0.2	0.3	-0.9	1.2	0.0	0.0	-1.1	1.0
	> 3 years	0.4*	2.3	0.1	0.7	0.4*	2.5	0.1	0.7
Later support[3)]	>= 3 years	0.2	1.3	-0.1	0.4	0.2	1.8	0.1	0.7
Firms with IN-assignments									
First-time support[2)]	<= 3 years	845							
	> 3 years	3 524							
Later support[3)]	>= 3 years	1 569							

Notes: 1:5 nearest neighbor matching without stratification. In the trimmed sample, 2.5% of the lowest and highest ΔX were removed. *** p< 0.001, ** p< 0.01, * p< 0.05.

[1)] If a firm obtains new support during the interval, this is considered as (a continuation of) the same treatment. [2)] Estimated parameter is $ATT = 100 \times \tau^{(1)} / 3$. [3)] Average effect of second and later treatments for firms obtaining repeated support (common estimate of $ATT = 100 \times \tau^{(n)} / 3$ for all $n > 1$).

Some supplementary results are provided in Tables A.1-A.4 in the Appendix. These tables correspond to Tables 4.2-4.5, but the matching is now done *with* stratification (firms are matched only to firms in the same industry-region-cohort cell). Matching with stratification reduces the sample of IN-firms that can be matched to almost 50 percent compared to matching without stratification, and the control group to only 1/3 (see Table A.5). Thus the results in Tables A.1-A.4 come with the caveat that they may not be representative for the population of IN-firms as a whole. Still the majority of the results support our previous conclusions. Both the innovation and regional program appear highly successful in terms of the scale input and output indiators, with generally robust and significant estimates of similar magnitude as in Tables 4.2-4.5. The innovation assignment now also exhibits a positive effect on labor productivity, which is significant at the 1 percent level. Regarding the lending assignment, the estimated effects without trimming remain mixed with sometimes negative estimates, and there are no significant effects after trimming.

To sum up: our results suggest that the lending program is not particularly successful with regard to any performance indicator, whereas the two other assignments are successful in reaching goals with regard to input and output growth. Finally, the evidence with regard to the productivity and profitability indicators is inconclusive, as the results are highly dependent on whether the data are trimmed or not, or whether the matching is done with or without stratification.

Even further results are provided in Tables A.6-A.9, which depict separate ATT estimates according to assignment period: 2000-2007 or 2008-2012. For start-up firms the results are quite similar between the two periods and close to the common estimates of Tables 4.2-4.5. However, with regard to older firms there is a marked difference between the two periods: when all programs are lumped together (in Table A.6) the scale variables remain significant for first-time support, but the estimated ATT are much lower in the later period – typically 1/3 or less – albeit still significant at the 0.1 percent level in both periods. Moreover, the ATT for labor productivity is significant at the 1 percent level in the first period and at the 5 percent level in the second. The magnitude of the estimated ATT also drops: from 5.6 to 2.0 percentage points. Looking at the different programs (Tables A.7-A.9), the same pattern is found. One can only speculate about the reasons for the sharp drop in the estimated ATT. It could be related to the drop in private venture capital markets during the financial crisis, when many new projects got funding from IN as a part of the government measures to compensate for the crisis. The increase IN-spending was particularly strong for the innovation and lending assignments (c.f. Tables 2.6-2.8). Still, the drop in estimated ATT is also very distinct for the regional assignment which did not increase its spending. Thus, the adverse business conditions seem to have hit the IN-firms harder than firms in the control group, or possibly the increase in support (both scope and scale) has lowered the returns of IN-support.

Table 4.6 presents results for the cluster assignment (C). Enrollment into a cluster happened in most cases after 2008, so these estimates should be compared to the estimates for assignments during 2008-2012 for the financial programs. We find significant effects at the 0.1 percent level of assignment to the cluster with regard to sales revenues and number of employees during the first 3 years after assignment – but no additional effect in the second 3-year period. For the other variables there are no significant effects. Thus any growth potential seems to be realized shortly after enrollment, but there is no addition effect (nor evidence of mean reversion) later on.

Figure 4.4 shows survival probabilities 5 and 10 years after start-up for firms established between 2001 and 2007 for two groups of firms: i) IN-firms assigned to any program targeting start-up firms (firms ≤ 3 years old when given support) and ii) matching firms. Interestingly, the survival probabilities of the IN and matching firms are almost identical. Thus we may safely conclude that the programs targeting start-up firms do nothing to improve the survival probabilities of the client firms.

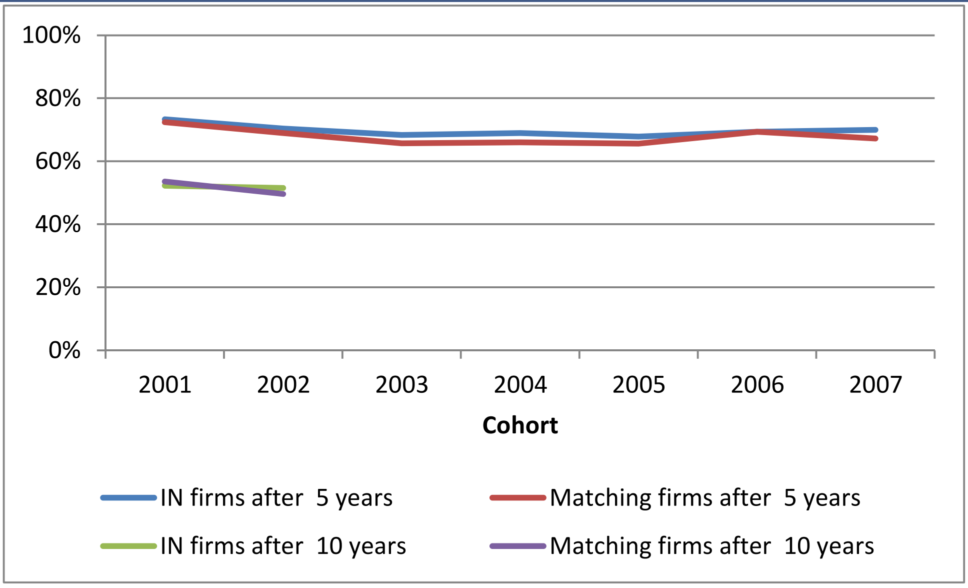
Table 4.6. The cluster assignment (C). Estimated average treatment effects (ATT) in the first and second 3-year interval after assignment (in percentage points). Average annual difference in ΔX between IN-firms and matching firms ("matched difference-in-difference")

Dependent variable (X_t)	First 3-year interval [1]				Second 3-year interval [2]			
	ATT	z	[95% CI]		ATT	z	[95% CI]	
Number of employees	12.93***	3.42	5.51	20.34	-1.92	-0.33	-13.51	9.66
Sales revenues	8.32***	4.46	4.66	11.97	-0.23	-0.08	-6.03	5.57
Value added	4.41	1.23	-2.60	11.42	0.59	0.12	-9.12	10.30
Value added per employee	2.60***	3.20	1.00	4.20	6.52	1.48	-2.13	15.17
Return on total assets	-1.22	-1.92	-2.47	0.03	-0.43	-0.48	-2.20	1.33
Firms with IN-assignments	365				100			

Notes: 1:5 nearest neighbor matching without stratification. *** p< 0.001, ** p< 0.01, * p< 0.05.

[1] Estimate of $ATT = 100 \times \tau^{(1)} / 3$. [2] Estimate of $ATT = 100 \times g^{(1)} / 3$.

Figure 4.4. Survival probabilities 5 and 10 years after start-up, by cohort



5. Conclusion

In this paper we have studied possible impacts of government support to individual firms from Innovation Norway (IN) – a government agency that aims to promote firm growth through innovation programs, regional support and other industrial policies. We have documented key characteristics of firms that received support from IN during 2001-2013 (the treated firms). We have compared these features with a control group of non-treated firms that we have matched according to a set of individual firm characteristics measured in the first full year of operation. The matching variables include industry classification (3-digit NACE), start-up size (total assets), geographic location and owner concentration. We have estimated average treatment effects of participation in the IN-programs based on a matched DID approach. Our evaluation context is not an experimental situation and one should therefore not conclude that our findings necessarily represent causal effects. Nonetheless, we have taken into account selection effects due to fixed firm effects through first-differencing and some *observable* firm characteristics through statistical matching. Average treatment effects on the treated are estimated as differences in average annual growth rates between treated and matching firms in the first 3-year period following the date of assignment to treatment by IN. For the innovation and regional assignment, our estimates of the average treatment effects are highly significant and robust as regards number of employees, sales revenues and value added, but much weaker for labor productivity (value added per worker) and returns to total assets. In the latter case, the results are highly dependent on the handling of outliers in the data, or whether matching is done with or without stratification.

The lending program does not appear to be particularly successful. Only few of the estimated effects are significant, and neither of these are robust towards the treatment of outliers or choice of matching method. Finally, we find no evidence that the programs targeting start-up firms improve survival probabilities compared to the matching firms (the control group).

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Appendix: Supplementary results

Table A.1. Matching with stratification: Assignments I, R and L. Estimated average treatment effects (ATT) in the first 3-year interval after assignment (in percentage points).[1] Average annual difference in ΔX between IN-firms and matching firms ("matched difference-in-difference")

Dependent variable (X_t)	Firm age in assignment year	Full sample				Trimmed sample			
		ATT	z	[95% CI]		ATT	z	[95% CI]	
Number of employees									
First-time support[2)]	<= 3 years	8.2**	3.8	4.0	12.4	2.7	1.5	-0.7	6.1
	> 3 years	3.7***	5.4	2.3	5.0	2.5***	4.9	1.5	3.5
Later support[3)]	>= 3 years	1.2	1.9	0.0	2.5	1.7	3.6	1.5	3.5
Sales revenues									
First-time support[2)]	<= 3 years	21.4***	4.8	12.6	30.1	13.2***	4.4	7.4	19.0
	> 3 years	10.2***	7.7	7.6	12.7	5.9***	6.9	4.3	7.6
Later support[3)]	>= 3 years	4.3**	3.4	1.8	6.7	2.3*	3.1	4.8	8.1
Value added									
First-time support[2)]	<= 3 years	8.8*	2.2	0.8	16.8	5.7	1.6	-1.2	12.6
	> 3 years	6.1***	4.9	3.6	8.5	4.8***	4.8	2.9	6.8
Later support[3)]	>= 3 years	1.5	1.3	-0.7	3.7	0.7	0.8	3.0	6.8
Value added per employee									
First-time support[2)]	<= 3 years	-1.3	-0.3	-10.3	7.6	-9.7	-1.0	-28.1	8.7
	> 3 years	2.3*	1.9	0.0	4.6	-0.4	-0.1	-5.5	4.8
Later support[3)]	>= 3 years	0.6	0.8	-1.0	2.3	-1.3	-0.6	-5.9	3.8
Return on total assets									
First-time support[2)]	<= 3 years	-0.6	-0.8	-1.9	0.8	-0.6	-0.5	-3.0	1.7
	> 3 years	0.4*	2.2	0.1	0.8	-0.5	-1.2	-1.2	0.3
Later support[3)]	>= 3 years	0.3	1.3	-0.1	0.6	-0.5	-1.3	-1.2	0.2
Firms with IN-assignments									
First-time support[2)]	<= 3 years	739							
	> 3 years	3 194							
Later support[3)]	>= 3 years	1 203							

Notes: 1:5 nearest neighbor matching *with* stratification. In the trimmed sample, 2.5% of the lowest and highest ΔX were removed. *** p< 0.001, ** p< 0.01, * p< 0.05.
[1)] If a firm obtains new support during the interval, this is considered as (a continuation of) the same treatment. [2)] Estimated parameter is $ATT = 100 \times \tau^{(1)} / 3$. [3)] Average effect of second and later treatments for firms obtaining repeated support (common estimate of $ATT = 100 \times \tau^{(n)} / 3$ for all $n > 1$).

Table A.2. Matching with stratification: Innovation assignment (I). Estimated average treatment effects (ATT) in the first 3-year interval after assignment (in percentage points).[1] Average annual difference in ΔX between IN-firms and matching firms ("matched difference-in-difference").

Dependent variable (X_t)	Firm age in assignment year	Full sample				Trimmed sample			
		ATT	z	[95% CI]		ATT	z	[95% CI]	
Number of employees									
First-time support[2)]	<= 3 years	13.8**	3.8	6.7	21.0	8.2*	2.4	1.4	15.0
	> 3 years	3.4**	2.9	1.1	5.7	3.5**	4.1	1.8	5.2
Later support[3)]	>= 3 years	1.6	1.3	-0.8	4.1	0.8	0.8	2.2	5.4
Sales revenues									
First-time support[2)]	<= 3 years	28.0**	3.4	11.8	44.2	13.2*	2.3	2.1	24.2
	> 3 years	13.5***	5.9	9.0	17.9	8.4***	5.2	5.2	11.6
Later support[3)]	>= 3 years	4.1	1.8	-0.5	8.7	1.1	0.7	5.2	11.4
Value added									
First-time support[2)]	<= 3 years	11.7	1.2	-7.6	31.0	3.5	0.5	-9.9	17.0
	> 3 years	8.3***	3.9	4.2	12.5	7.3***	4.4	4.1	10.6
Later support[3)]	>= 3 years	1.5	0.7	-2.9	5.8	0.3	0.1	3.9	10.2
Value added per employee									
First-time support[2)]	<= 3 years	2.2	0.2	-24.3	28.6	6.9	0.8	-10.8	24.6
	> 3 years	8.2**	3.3	3.4	13.1	4.7**	2.8	1.5	7.9
Later support[3)]	>= 3 years	1.5	0.9	-1.8	4.9	1.1	0.7	1.1	6.5
Return on total assets									
First-time support[2)]	<= 3 years	-2.4	-1.2	-6.3	1.4	-2.4	-1.2	-6.3	1.4
	> 3 years	0.5	1.1	-0.4	1.3	0.5	1.1	-0.4	1.3
Later support[3)]	>= 3 years	0.4	0.8	-0.6	1.3	0.4	0.8	-0.6	1.3
Firms with IN-assignments									
First-time support[2)]	<= 3 years	242							
	> 3 years	1 037							
Later support[3)]	>= 3 years	301							

Notes: 1:5 nearest neighbor matching *with* stratification. In the trimmed sample, 2.5% of the lowest and highest ΔX were removed. *** p< 0.001, ** p< 0.01, * p< 0.05.
[1] If a firm obtains new support during the interval, this is considered as (a continuation of) the same treatment. [2)] Estimated parameter is $ATT = 100 \times \tau^{(1)} / 3$. [3)] Average effect of second and later treatments for firms obtaining repeated support (common estimate of $ATT = 100 \times \tau^{(n)} / 3$ for all $n > 1$).

Table A.3. Matching with stratification: Lending assignment (L). Estimated average treatment effects (ATT) in the first 3-year interval after assignment (in percentage points).[1] Average annual difference in ΔX between IN-firms and matching firms ("matched difference-in-difference")

Dependent variable (X_t)	Firm age in assignment year	Full sample				Trimmed sample			
		ATT	z	[95% CI]		ATT	z	[95% CI]	
Number of employees									
First-time support[2)]	<= 3 years	24.6*	2.4	4.3	45.0	4.1	0.5	-10.6	18.8
	> 3 years	4.2	1.8	-0.4	8.8	2.2	1.6	-0.5	5.0
Later support[3)]	>= 3 years	3.3	1.7	-0.5	7.0	1.6	1.4	-0.3	5.0
Sales revenues									
First-time support[2)]	<= 3 years	24.5	1.5	-7.6	56.7	9.6	0.5	12.7	0.0
	> 3 years	9.1*	2.1	0.6	17.5	2.8	1.3	-1.5	7.1
Later support[3)]	>= 3 years	3.3	0.9	-4.0	10.7	2.7	1.4	-1.6	6.6
Value added									
First-time support[2)]	<= 3 years	18.9	0.8	-30.7	68.5	21.8	1.5	-6.0	49.6
	> 3 years	3.3	1.0	-3.1	9.7	2.0	0.7	-3.2	7.2
Later support[3)]	>= 3 years	5.8	1.9	-0.2	11.8	2.0	0.9	-2.6	7.7
Value added per employee									
First-time support[2)]	<= 3 years	-71.7**	-2.7	-124.4	-19.0	-2.3	-0.2	-26.8	22.1
	> 3 years	1.1	0.3	-5.7	8.0	-4.3	-1.9	-8.8	0.2
Later support[3)]	>= 3 years	-0.2	-0.1	-5.1	4.7	-2.9	-1.4	-8.7	0.2
Return on total assets									
First-time support[2)]	<= 3 years	0.2	0.6	-0.4	0.8	1.6	0.8	-2.4	5.6
	> 3 years	-0.3	-0.9	-0.9	0.3	0.2	0.5	-0.5	0.8
Later support[3)]	>= 3 years	-0.3	-0.9	-0.9	0.3	-0.3	-0.9	-0.4	0.8
Firms with IN-assignments									
First-time support[2)]	<= 3 years	35							
	> 3 years	298							
Later support[3)]	>= 3 years	187							

Notes: 1:5 nearest neighbor matching *with* stratification. In the trimmed sample, 2.5% of the lowest and highest ΔX were removed. *** p< 0.001, ** p< 0.01, * p< 0.05.
[1)] If a firm obtains new support during the interval, this is considered as (a continuation of) the same treatment. [2)] Estimated parameter is $ATT = 100\times\tau^{(1)}/3$. [3)] Average effect of second and later treatments for firms obtaining repeated support (common estimate of $ATT = 100\times\tau^{(n)}/3$ for all $n > 1$).

Table A.4. Matching with stratification: Regional assignment (R). Estimated average treatment effects (ATT) in the first 3-year interval after assignment (in percentage points).[1] Average annual difference in ΔX between IN-firms and matching firms ("matched difference-in-difference")

Dependent variable (X_t)	Firm age in assignment year	Full sample				Trimmed sample			
		ATT	z	[95% CI]		ATT	z	[95% CI]	
Number of employees									
First-time support[2)]	<= 3 years	3.0	1.1	-2.3	8.4	-0.3	-0.2	-4.4	3.7
	> 3 years	4.1***	4.5	2.3	5.9	2.1**	2.9	0.7	3.4
Later support[3)]	>= 3 years	0.7	0.9	-0.8	2.3	2.2**	3.7	0.5	3.2
Sales revenues									
First-time support[2)]	<= 3 years	16.3**	2.9	5.4	27.2	13.0**	3.6	5.9	20.1
	> 3 years	8.9***	5.0	5.4	12.3	5.0***	4.4	2.8	7.2
Later support[3)]	>= 3 years	5.7**	3.8	2.8	8.6	4.4***	4.8	3.7	8.0
Value added									
First-time support[2)]	<= 3 years	3.4	0.7	-6.2	13.1	3.0	0.7	-5.2	11.2
	> 3 years	5.9**	3.3	2.3	9.4	4.2**	2.9	1.3	7.0
Later support[3)]	>= 3 years	1.9	1.5	-0.6	4.4	2.1*	2.1	1.4	6.8
Value added per employee									
First-time support[2)]	<= 3 years	1.7	0.4	-6.4	9.7	-0.2	-0.1	-8.1	7.6
	> 3 years	1.7	1.0	-1.7	5.1	-1.7	-1.3	-4.3	0.9
Later support[3)]	>= 3 years	1.7	1.7	-0.3	3.6	0.1	0.2	-4.0	1.0
Return on total assets									
First-time support[2)]	<= 3 years	-0.5	-0.6	-2.0	1.1	-0.5	-0.6	-2.0	1.1
	> 3 years	0.3	1.2	-0.2	0.8	0.3	1.2	-0.2	0.8
Later support[3)]	>= 3 years	0.2	0.8	-0.3	0.7	0.2	0.8	-0.2	0.7
Firms with IN-assignments									
First-time support[2)]	<= 3 years	462							
	> 3 years	1 859							
Later support[3)]	>= 3 years	715							

Notes: 1:5 nearest neighbor matching *with* stratification. In the trimmed sample, 2.5% of the lowest and highest ΔX were removed. *** p< 0.001, ** p< 0.01, * p< 0.05.
[1] If a firm obtains new support during the interval, this is considered as (a continuation of) the same treatment. [2)] Estimated parameter is $ATT = 100\times\tau^{(1)}/3$. [3)] Average effect of second and later treatments for firms obtaining repeated support (common estimate of $ATT = 100\times\tau^{(n)}/3$ for all $n > 1$).

Table A.5. Sample size for matching with and without stratification

Cohort	Matching without stratification		Matching with stratification	
	IN firms	Control group	IN firms	Control group
<=2001	3,409	13,474	1,346	2,478
2002	350	1,494	241	801
2003	334	1,535	215	746
2004	333	1,568	214	775
2005	342	1,597	214	715
2006	370	2,107	278	992
2007	350	1,996	248	925
2008	334	1,652	218	764
2009	279	1,402	196	697
2010	266	1,242	202	639
2011	243	1,284	187	660
2012	221	1,125	149	556
All	6,831	30,476	3,708	10,748

Table A.6. Assignments I, R and L. Estimated average treatment effects (ATT) in the first 3-year interval after assignment (in percentage points).[1] Average annual difference in ΔX between IN-firms and matching firms ("matched difference-in-difference").

Dependent variable (X_t)	Firm age in assignment year	Assignments during 2000-2007				Assignments during 2008-2012			
		ATT	z	[95% CI]		ATT	z	[95% CI]	
Number of employees									
First-time support[2)]	<= 3 years	13.3***	5.1	8.2	18.4	8.3***	4.3	4.5	12.2
	> 3 years	10.1***	7.7	7.5	12.6	1.9**	3.6	0.9	3.0
Later support[3)]	>= 3 years	4.6***	5.2	2.9	6.4	0.1	0.2	-0.9	1.1
Sales revenues									
First-time support[2)]	<= 3 years	20.1***	8.7	15.5	24.6	22.1***	5.9	14.7	29.4
	> 3 years	20.5***	7.7	15.2	25.7	6.8***	6.4	4.7	8.9
Later support[3)]	>= 3 years	9.4***	5.7	6.2	12.6	0.1	0.1	-1.8	1.9
Value added									
First-time support[2)]	<= 3 years	11.5*	2.4	1.9	21.1	8.2*	2.0	0.3	16
	> 3 years	11.4***	5.3	7.2	15.7	3.9***	4.2	2.1	5.7
Later support[3)]	>= 3 years	3.3*	2.5	0.7	5.9	-0.3	-0.4	-2.0	1.3
Value added per employee									
First-time support[2)]	<= 3 years	1.4	0.3	-8.1	10.9	0.2	0.1	-7.6	8.1
	> 3 years	5.6**	2.8	1.6	9.6	2.0*	2.4	0.3	3.8
Later support[3)]	>= 3 years	0.7	0.7	-1.1	2.4	0.5	0.8	-0.7	1.7
Return on total assets									
First-time support[2)]	<= 3 years	1.0	1.3	-0.5	2.5	-0.5	-0.9	-1.7	0.7
	> 3 years	0.6	1.7	-0.1	1.2	0.3*	2.4	0.1	0.6
Later support[3)]	>= 3 years	0.1	0.5	-0.3	0.6	0.2	1.6	0.0	0.5
Firms with IN-assignments	<= 3 years	1 475				1 167			
	> 3 years	2 856				2 191			
	>= 3 years	4 331				3 358			

Notes: 1:5 nearest neighbor matching without stratification. In the trimmed sample, 2.5% of the lowest and highest ΔX were removed. *** p< 0.001, ** p< 0.01, * p< 0.05.

[1)] If a firm obtains new support during the interval, this is considered as (a continuation of) the same treatment. [2)] Estimated parameter is $ATT = 100 \times \tau^{(1)} / 3$. [3)] Average effect of second and later treatments for firms obtaining repeated support (common estimate of $ATT = 100 \times \tau^{(n)} / 3$ for all $n > 1$).

Table A.7. Innovation assignment (I). Estimated average treatment effects (ATT) in the first 3-year interval after assignment (in percentage points).[1] Average annual difference in ΔX between IN-firms and matching firms ("matched difference-in-difference")

Dependent variable (X_t)	Firm age in assignment year	Assignments during 2000-2007				Assignments during 2008-2012			
		ATT	z	[95% CI]		ATT	z	[95% CI]	
Number of employees									
First-time support[2)]	<= 3 years	14.8**	3.0	5.1	24.6	14.4***	4.0	7.4	21.4
	> 3 years	11.1***	4.6	6.4	15.9	1.8*	2.0	0.0	3.6
Later support[3)]	>= 3 years	7.4***	4.0	3.8	11.0	-0.2	-0.2	-2.0	1.6
Sales revenues									
First-time support[2)]	<= 3 years	19.9	1.8	-2.4	42.2	23.7**	3.1	8.5	39.0
	> 3 years	23.6***	4.7	13.7	33.4	8.7***	4.7	5.1	12.4
Later support[3)]	>= 3 years	13.0**	3.6	6.0	20.1	0.8	0.4	-2.8	4.4
Value added									
First-time support[2)]	<= 3 years	29.1*	2.3	4.2	54.0	7.2	0.7	-12.0	26.4
	> 3 years	9.8*	2.3	1.3	18.3	3.6*	2.2	0.4	6.9
Later support[3)]	>= 3 years	4.5	1.4	-1.7	10.7	0.2	0.1	-3.2	3.6
Value added per employee									
First-time support[2)]	<= 3 years	13.9	1.0	-12.5	40.3	-9.2	-0.9	-29.5	11.1
	> 3 years	4.5	1.2	-2.8	11.7	1.9	1.3	-0.9	4.7
Later support[3)]	>= 3 years	0.0	0.0	-4.2	4.1	2.0	1.6	-0.5	4.4
Return on total assets									
First-time support[2)]	<= 3 years	-1.3	-0.6	-5.9	3.2	-1.4	-0.8	-4.9	2.0
	> 3 years	-0.8	-1.0	-2.3	0.7	0.3	1.0	-0.3	0.9
Later support[3)]	>= 3 years	-0.5	-0.9	-1.6	0.6	0.5	1.7	-0.1	1.1
Firms with IN-assignments	<= 3 years	424				283			
	> 3 years	793				461			
	>= 3 years	1 217				744			

Notes: 1:5 nearest neighbor matching without stratification. In the trimmed sample, 2.5% of the lowest and highest ΔX were removed. *** p< 0.001, ** p< 0.01, * p< 0.05.

1) If a firm obtains new support during the interval, this is considered as (a continuation of) the same treatment. 2) Estimated parameter is $ATT = 100 \times \tau^{(1)} / 3$. 3) Average effect of second and later treatments for firms obtaining repeated support (common estimate of $ATT = 100 \times \tau^{(n)} / 3$ for all $n > 1$).

Table A.8. Lending assignment (L). Estimated average treatment effects (ATT) in the first 3-year interval after assignment (in percentage points).[1)] Average annual difference in ΔX between IN-firms and matching firms ("matched difference-in-difference").

Dependent variable (X_t)	Firm age in assignment year	Assignments during 2000-2007				Assignments during 2008-2012			
		ATT	z	[95% CI]		ATT	z	[95% CI]	
Number of employees									
First-time support[2)]	<= 3 years	13.7	1.6	-2.9	30.3	15.7**	2.6	4.0	27.5
	> 3 years	2.3	0.7	-3.8	8.4	1.5	0.9	-1.8	4.9
Later support[3)]	>= 3 years	4.7*	2.2	0.6	8.9	-1.1	-0.9	-3.6	1.3
Sales revenues									
First-time support[2)]	<= 3 years	6.7	0.5	-20.5	34.0	31.5**	3.6	14.4	48.7
	> 3 years	15.4**	2.9	5.0	25.8	5.5	1.9	-0.3	11.2
Later support[3)]	>= 3 years	8.3*	2.1	0.6	16.0	-3.0	-1.3	-7.7	1.7
Value added									
First-time support[2)]	<= 3 years	-12.2	-0.9	-39.1	14.7	22.1*	2.3	3.0	41.1
	> 3 years	0.1	0.0	-7.8	7.9	4.6	1.8	-0.3	9.5
Later support[3)]	>= 3 years	1.2	0.4	-4.4	6.8	-2.4	-1.2	-6.2	1.4
Value added per employee									
First-time support[2)]	<= 3 years	-17.3	-1.2	-44.5	10.0	-4.0	-0.4	-23.9	15.9
	> 3 years	-1.0	-0.2	-9.4	7.4	3.6	1.3	-1.7	8.8
Later support[3)]	>= 3 years	-1.8	-0.9	-5.7	2.1	-0.4	-0.3	-3.4	2.6
Return on total assets									
First-time support[2)]	<= 3 years	-0.4	-0.2	-3.6	2.9	0.7	0.6	-1.6	3.0
	> 3 years	1.0	1.9	0.0	2.0	0.1	0.3	-0.5	0.7
Later support[3)]	>= 3 years	0.4	1.1	-0.3	1.1	-0.1	-0.4	-0.6	0.4
Firms with IN-assignments	<= 3 years	135				93			
	> 3 years	382				283			
	>= 3 years	517				376			

Notes: 1:5 nearest neighbor matching without stratification. In the trimmed sample, 2.5% of the lowest and highest ΔX were removed. *** p< 0.001, ** p< 0.01, * p< 0.05.

1 If a firm obtains new support during the interval, this is considered as (a continuation of) the same treatment. 2) Estimated parameter is $ATT = 100 \times \tau^{(1)} / 3$. 3) Average effect of second and later treatments for firms obtaining repeated support (common estimate of $ATT = 100 \times \tau^{(n)} / 3$ for all $n > 1$).

Table A.9. Regional assignment (R). Estimated average treatment effects (ATT) in the first 3-year interval after assignment (in percentage points).[1)] Average annual difference in ΔX between IN-firms and matching firms ("matched difference-in-difference").

Dependent variable (X_t)	Firm age in assignment year	Assignments during 2000-2007				Assignments during 2008-2012			
		ATT	z	[95% CI]		ATT	z	[95% CI]	
Number of employees									
First-time support[2)]	<= 3 years	11.2**	3.6	5.1	17.3	3.9	1.6	-0.9	8.8
	> 3 years	11.3***	6.9	8.1	14.5	1.6*	2.3	0.2	2.9
Later support[3)]	>= 3 years	3.3**	3.3	1.4	5.3	0.0	0.0	-1.2	1.2
Sales revenues									
First-time support[2)]	<= 3 years	17.0**	2.8	5.0	29.1	19.2***	4.1	10.0	28.3
	> 3 years	18.6***	5.6	12.1	25.0	5.3***	4.0	2.7	7.9
Later support[3)]	>= 3 years	7.7***	4.3	4.2	11.2	-0.1	-0.1	-2.3	2.0
Value added									
First-time support[2)]	<= 3 years	9.5	1.7	-1.5	20.5	5.3	1.1	-4.2	14.8
	> 3 years	14.8***	5.4	9.4	20.2	3.3**	2.8	1.0	5.7
Later support[3)]	>= 3 years	3.2*	2.3	0.4	6.0	-1.1	-1.2	-3.0	0.7
Value added per employee									
First-time support[2)]	<= 3 years	-0.2	0.0	-11.0	10.7	2.9	0.6	-6.5	12.3
	> 3 years	6.1*	2.3	0.9	11.3	1.6	1.4	-0.7	3.9
Later support[3)]	>= 3 years	1.0	1.1	-0.8	2.9	-0.3	-0.4	-1.7	1.1
Return on total assets									
First-time support[2)]	<= 3 years	1.4	1.6	-0.3	3.0	-0.8	-1.1	-2.3	0.6
	> 3 years	1.0*	2.4	0.2	1.7	0.3	1.6	-0.1	0.6
Later support[3)]	>= 3 years	0.2	0.9	-0.2	0.7	0.1	0.9	-0.2	0.5
Firms with IN-assignments	<= 3 years	893				784			
	> 3 years	1 599				1 421			
	>= 3 years	2 492				2 205			

Notes: 1:5 nearest neighbor matching without stratification. In the trimmed sample, 2.5% of the lowest and highest ΔX were removed. *** p< 0.001, ** p< 0.01, * p< 0.05.

[1] If a firm obtains new support during the interval, this is considered as (a continuation of) the same treatment. [2)] Estimated parameter is $ATT = 100 \times \tau^{(1)} / 3$. [3)] Average effect of second and later treatments for firms obtaining repeated support (common estimate of $ATT = 100 \times \tau^{(n)} / 3$ for all $n > 1$).

Table A.10. Estimated average treatment effects (ATT) of first-time support by type of assignment. Average annual difference in ΔX between IN-firms and matching firms ("matched difference-in-difference")

Dependent variable (X_t)	Assignment	ATT	z	[95% CI]	
Number of employees					
	I	4.2***	5.0	2.6	5.8
	L	2.9	2.0	0.0	5.9
	R	3.4***	5.6	2.2	4.6
	All	4.6***	5.2	2.9	6.4
Sales revenues					
	I	12.4***	7.4	9.1	15.7
	L	9.3***	3.6	4.3	14.4
	R	8.7***	7.4	6.4	11.0
	All	9.4***	5.7	6.2	12.6
Value added					
	I	5.1***	3.4	2.1	8.1
	L	4.0	1.8	-0.3	8.3
	R	5.3***	5.1	3.2	7.3
	All	3.3*	2.5	0.7	5.9
Value added per employee					
	I	2.2	1.7	-0.4	4.8
	L	1.8	0.8	-2.7	6.3
	R	2.2*	2.3	0.3	4.2
	All	0.7	0.7	-1.1	2.4
Return on total assets					
	I	0.1	0.2	-0.5	0.6
	L	0.3	1.1	-0.2	0.8
	R	0.4*	2.3	0.1	0.7
	All	0.1	0.5	-0.3	0.6

Notes: Firms of all ages included, 1:5 nearest neighbor matching without stratification.

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