
Paper to be presented at the DRUID Academy conference in Rebild, Aalborg, Denmark on January

15-17, 2014

# Fostering export by subsiding innovation : empirical analysis on the `French CIS Survey

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## Abstract

This paper examines the impact of financial schemes supporting innovation (tax credits and direct subsidies) on French industrial firms. Unlike previous work, we also consider their indirect effects on firm?s export behaviour.

Since the seminal contribution of Melitz (2003), a large theoretical literature has considered firm?s innovation and export decisions (Constantini and Melitz, 2007 Atkeson and Burstein, 2010). One of the main result of these models shows that an external intervention such as trade liberalization has a major impact on overcoming fixed cost to start both activities. The relationship between innovation and export has been widely empirically demonstrated (Damijan & Kostevc, 2010 ; Golovko & Valentini, 2011). In the meantime, another strand of literature has assessed the efficiency of innovation subsidies (see Cerulli, 2010). Most of studies conclude to an heterogeneous effect, depending both on targeted firm?s and grants characteristics.

Our approach consists in combining these complementary literatures. To the best of our knowledge, there has been very little research on the impact of discrete external intervention on the innovation-export link. We build an original model where public support for innovation may directly enhance firm?s R&D investment and indirectly affect export decisions. A positive impact on both innovation and export would mean a complementarity between these two activities. This effect could however be over-compensated by firms? opportunistic behaviour. Firms can modulate their strategic priorities independently from public policy-makers aims. For instance, decision makers may be willing to use a larger part of their own limited resources on the subsided activity (R&D) and reduce their investment intensity in non-financed ones (such as export).

Our empirical analysis is based on the French CIS 2006 survey, referring to the years 2004 to 2006. This dataset is then merged with variables from the EAE (French Annual Firm Survey), covering the period from 2002 until 2007. The final sample contains 2043 industrial firms with more than 10 employees. We use the propensity score matching methodology, that is well-adapted for public policies evaluation. It allows to compare subsided firms and not granted ones, controlling for endogeneity and selection bias.

Our results show a positive effect of innovation subsidies on firm?s R&D spending, but also on its export intensity. In a second step we focus on the specific effects of tax credits whose characteristics are more easily observable by the researcher. We integrate the attribution of direct grants by sample differentiation. We first observe the effects of

receiving only fiscal subsidies (compared to no public support). Then we estimate the impact of receiving fiscal and direct subsidies (compared to receiving only direct ones). Tax credits, by themselves, are effective measures to foster firms R&D investment as well as their share of export turnover. Being granted by tax credits while also getting direct subsidies does not lead to such behavioural change. This can be explained by a threshold effect. Public policies positively impact the innovation-export link, but only to a limited extent. We assess the robustness of our estimation by running a simulation-based test.
These results have important implications for the design of public policies. First of all, allocating public schemes to foster innovation have higher impacts than expected by policy makers. They can be considered as starters of virtuous complementarity effect between innovation and export. Such conclusion is also true when we focus on tax credits. Receiving tax credits in addition of direct financing positively increase firm?s innovation investment, but does not imply a specific behavioural change, which may limit its impact on firm growth.

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Jelcodes:O38,C14

# Fostering export activity by subsidizing innovation: an empirical analysis on the french CIS survey

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December 16, 2013

**preliminary and incomplete draft, please do not cite.**

**Abstract**

To be done

**JEL classification :** *C14; F13; H23; O31; O38*
**Keywords :** public policies; innovation; exports; externalities; matching.

## 1 Introduction

The 9th barometer of innovation[1] (2013) observe that 73% of surveyed firms consider innovation as essential to remain competitive. Among them, 64% uses the CIR (Credit impot recherche[2]), and 48% benefits from French end European direct subsidies. In 2010, OSEO and UBIFRANCE conducted a survey on the relationship between innovation and export. They surveyed 701 firms where 94% of them were innovative in the broad sense. 30% of firms realise more than half of their turnover abroad, and half of them began exporting as they started their activity.
Since the seminal contribution of Melitz (2003 [35]), a large theoretical literature has considered firm's innovation and export decisions. One of the main result of these models shows that an external intervention such as trade liberalization has a major impact on overcoming fixed cost to start both activities. The relationship between innovation and export has been widely empirically demonstrated . In the meantime, another strand of literature has assessed the efficiency of innovation subsidies . Most of studies conclude to an heterogeneous effect, depending both on targeted firm's and grants characteristics.

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[1]Survey conducted by the french CSA institute for Alma consulting group, on the basis of 693 firms

[2]Tax credit for research

This paper examines the impact of financial schemes supporting innovation (tax credits and direct subsidies) on French industrial firms. Unlike previous work, we also consider their indirect effects on firm's export behaviour. To the best of our knowledge, there has been very little research on the impact of discrete external intervention on the innovation-export link.

We build an original model where public support for innovation may directly enhance firm's R&D investment and indirectly affect export decisions. A positive impact on both innovation and export decisions would mean a complementarity between these two activities. This effect could however be over-compensated by firms' opportunistic behaviour (Roper & Love, 2002). Firms can modulate their strategic priorities independently from public policy-makers aims. For instance, decision makers may be willing to use a larger part of their own limited resources on the subsided activity (R&D) and reduce their investment intensity in non-financed ones (such as export). Our empirical analysis is based on the French CIS 2006 survey, referring to the years 2004 to 2006. This rich dataset provides information about firm's R&D and innovation activities as well as access to public support innovation programs. The CIS dataset is then merged with variables from the EAE (French Annual Firm Survey). We use the propensity score matching methodology that is well-adapted for public policies evaluation. It allows to compare subsided firms and not granted ones, controlling for endogeneity and selection bias. Our results show a positive effect of innovation subsidies on firm's R&D spending, but also on its export intensity. The baseline model does not differentiate between the scheme type of public intervention. In a second step we focus on the specific effects of tax credits whose characteristics are more easily observable by the researcher. We integrate the attribution of direct grants by sample differentiation. We first observe the effects of receiving only fiscal subsidies (compared to no public support). Then we estimate the impact of receiving fiscal and direct subsidies (compared to receiving only direct ones). Tax credits, by themselves, are effective measures to foster firms R&D investment as well as their share of export turnover. Being granted by the mean of tax credits while also getting direct subsidies does not lead to such behavioural change. This can be explained by a threshold effect. Public policies positively impact the innovation-export link, but only to a limited extent. We assess the robustness of our estimation by running the simulation-based test developed by Ichino et al. (2008 [28]). These results have important implications for the design of public policies. First of all, allocating public schemes to foster innovation have higher impacts than expected by policy makers. They can be considered as starters of virtuous complementarity effect between innovation and export. Such conclusion is also true when we focus on tax credits. Receiving tax credits in addition of direct financing positively increase firm's innovation investment, but does not imply a specific behavioural change, which may limit its impact on firm growth. The reminder of this paper is organised as follows : section 2 review the main literature on public policies for innovation and their relationship with export activity. Section 3 presents our estimation strategy and the data is described in section 4. The results are discussed in section 5. Finally, section 6 conclude.

# 2 Literature

## 2.1 Decision making and the innovation - export link

This study is related to the literature on trade and firm heterogeneity. Since the seminal study of Melitz (Melitz, 2003 [35]), a wide literature have shown the impact of heterogeneous firm productivity on foreign market participation ( Melitz and Ottaviano; 2005 [36] Bernard and al., 2003 [5] ). All of them reach to the conclusion that more productive firms self-select into international markets. They earn more profits than less productive ones. More recently, some contributions have argued that self-selection effect also holds for firms' decision to start investing in R&D. (Notably , Bustos (2011) [9] Aw *et al.* (2011) [4] at a macroeconomic level, and Van Long et al. , 2011 at an industry level). All these studies theoretically demonstrate a positive relationship between innovation and export and conclude that innovative and exporting firms are more productive than others. Atkeson and Burstein (2010 [2]), particularly, study the interdependence between the choices of exporting and investing, both depending of the firm's productivity level. The model thus features both product (i.e introduction of new varieties) and cost reducing process innovation. Constantini and Melitz (2008, [12]), at a micro level show that innovating firm productivity is always greater than non-innovating companies whether it exports or not. in the meantime exporting firm productivity is always higher than for non exporting ones whether it innovates or not. One of the key feature of these models is the consideration of immediate firm's decisions to export and innovate. Firms compare expected profits in both activities (form $t$ to $t+1$) to the cost of undertaking them (in period $t$). Innovation and export are considered as simultaneous investment decisions.
Constantini and Melitz (2008 [12]) focus on liberalization's "non-technological" factors such as announcement timing and speed of setting up. They show that such parameters are crucial for innovation and export decisions. Firms are strategic priorities. Extending these results provides some insights into firm reactions following changes in their environment. These, whether expected or unexpected, will impact both component of the broad firm's investment strategy.

This relationship between innovation (both product and process) and export has been also widely demonstrated empirically. The main issue of these analyses is endogeneity of innovation and export. Cassiman and Martinez-Ros (2010 [**?**]) observe from a panel of Spanish firms that product innovation increases the probability that firms will enter foreign markets , particularly small firms. However process innovation does not generate such effects. Van Beveren & Vandenbussche (2010 [7]) control for innovation endogeneity on a sample of Belgium firms over two periods. They also conclude only firms with high probability to start exporting kick off innovation activity before joining international market. Harris and Li (2009 [23]) show an absence of innovation impact on export intensity on United Kingdom-based firms. Finally Damijan et al. (2010 [15]) investigate the causal link driving innovation to export or export to innovation. They find no empirical evidence that either product or process innovation increases the probability of starting export activity.

Golovko and Valentini (2011 [20] ) go further by analysing an hypothesis of complementarity between innovation and export. Both activities are then part of a virtuous circle, which significantly impacts firm's growth. On the contrary innovation and export may be considered as rival if the firm does not have enough resources to conduct both activities at the same time (Roper and Love 2002 a,b [38] [34])

## 2.2 Evaluating public policies

Over the last years, a very extensive literature has shown the importance of public intervention on private R&D investment. Fostering private investment effort is the explicit goal of public intervention for innovation, and therefore constitutes its main efficiency criterion. In 2000, David et al. ([16]) and Klette et al. ([30]) survey the previous literature on the macroeconomic and microeconomic level. The majority of the considered studies support the complementarity between public schemes and private R&D (also named "additionnality effect"), even if they found mixed results when studies are conducted at the firm-level. Furthermore, they express methodological issues on the existence of a potential selection bias. Until then, most studies assumed a random-allocation process of public subsidies. Two distinct effects may be highlighted : First, participation in public programs is subjected to government's decisions and priorities. In particular policy maker can adopt a "picking the winner strategy" (Wallsten, 2000), granting only the most innovative and fast-growing firms. Firms may also self-select themselves into the the application process of subsidies programs. Since, analyses address the selection bias. Some estimates Heckman's selection model (Busom, 2000 [8] ; Hussinger 2008 [27]) or IV[3] regressions (Wallsten, 2000 Al Yrroko 2005, Koga 2005 [31] Clausen, 2009 [11]), but most studies uses quasi-experimental methodologies (Differences in Differences and Matching)[4]. Recently, Cerulli (2010 [10] ) reviews the main econometric methods used to measure public support effects on R&D investment. The author offers a comprehensive overview on the subject by presenting a taxonomy, classifying papers according to their estimation methods and data features[5]. The author conclude, among other recommendation, that *"The relationship between firm R&D and non R&D strategies* [...] *still need more in-depth investigation"*. . Zuniga-Vicente et al. (2014 [42]) examines 118 public R&D schemes evaluation from 1966 to 2011. This exhaustive literature review shows mixed results concerning public policies efficiency.

Public policy makers may also aim at supporting global firm's growth strategy. Publicly financed firms are then believed to switch to more ambitious growth patterns, based on their expectations about future benefits (Atkeson Burstein, 2012 [3] ). Very few empirical studies focus on such potential behaviour. Some authors shows an effect of public R&D support on firm's productivity (

[3]instrumental variables

[4]An extensive review of theses papers may be found in Zuniga-Vicente et al., 2014

[5]Cross sectional or longitudinal data and type of policy variable

Piekkola 2007 [37]), other on employment (Link and Scott, 2013 [33]). Combining the occurrence of a behavioural change with the concept of complementarity exposed earlier lead to the hypothesis 1 :

**Hypothesis 1 :** *Innovation and export decisions are complementary (within the same period). Subsiding innovation will induce an increase in both R&D investment (additionnality) and export intensity (complementarity effect).*

On the contrary, If the two activities are concurrent, firms may prefer focus their resources on the subsided activity. Following the idea of Constantini and Melitz( 2007 [12]) firms may increase their R&D investment at the expense of export as they need to focus on the subsidized activity.

**Hypothesis 2 :** *Public support for innovation foster R&D activity at the expense of export. (priority effect).*

This hypothesis is particularly credible in a situation of limited financial resources, and access to external sources of credit (Hall, 2002). In this case, firms will have to make constrained strategic choices. It is furthermore common knowledge public intervention schemes usually include a clause of "obligation of mean" suggesting firms should invest at least a given amount from their private funds in order to demonstrate their willingness to innovate. They can sometimes be completed by an "obligation of results". Such conditions may be determinant for firm's decision-making.
Studying behavioral change implies that effect on R&D to be positive. Some authors show an absence of additionnality (Lach 2002 [32] , Kaiser 2006 [29]). Following the conceptual framework exposed before, a crowding out effect should be explained by expected benefits of R&D lower than fixed costs of undertaking them. Gonzalez et al. (2005 [21]) explain a potential crowding out effect by the amount of barriers to innovation faced by the firm. A minimal grant is therefore needed to be efficient. The evaluation literature define the crowding out as an opportunistic behaviour (David and al. 2000 [16], Cerulli 2010 [10]). Firms act as freeriders (Heijs 2003 [25]), leading to an adverse selection problem. (Akerlof 1970[1]). In the latter case, the complementarity and priority effects could still exist, but would be masked by firm's strategy.
In absence of R&D additionnality, granted funds may be used in another context when companies crowd them out. It might thus mean that companies use allocated subsidies to invest into non-targeted activity, notably exports.

**Hypothesis 3 :** *Public support for innovation does not foster R&D activity (crowding out effect), but the allocated funds are used by the firm to develop its export activity (Inverted priority effect).*

Most econometric analyses considers export activity as a key driver of Subsidies allocation. First, fostering export may constitute a priority for public policy makers. Past export may also represent

a quality signal (Blanes and Busom ). Exporting firms may therefore benefits of more opportunities to diffuse their innovations, and therefore have higher incentives to invest in R&D. . Current evaluation of public intervention effect on export activity only focus on global policy mix and not specifically on innovation schemes. (Girma, Görg and Strobl (2009, [18] Girma, Görg and Wagner (2009, [19]). Görg, Henry and Strobl, particularly (2008 [22]) analyse the impact of Public support intensity on a sample of Irish firms. The authors conclude a minimal amount of grant is necessary to encourage exporters to increase their presence on international markets. However there is little evidence showing grants encourage non-exporters to start exporting.
Only few studies differentiate between discretionary subventions and fiscal incentives. This represents a limitation as some authors, such as Dagenais et al. (2004 [14]) Berube & Mohnen (2009 [6]) ). However this distinction may be considered as a major source of heterogeneity when evaluating impact of public policies. French government regularly evaluates the efficiency of the main fiscal incentives used at a national level, the "credit impôt recherche" (Duguet (2004 [17] notably). These results show that french CIR efficiently increase firms R&D investment.

## 2.3 Methodology

In the next section we empirically test the propositions described in the literature review. This analysis aims at understanding the external effects induced by public intervention at the firm level on the export activity. All effects displayed in this paper are indirect and conditional to subsidy efficiency on R&D investment.
Therefore it seems relevant to set up an empirical methodology in two stages :

**Step 1** Analysis of public intervention's impact on R&D intensity

**Step 2** Analysis on export intensity.

First step of this analysis consists of studying public intervention's effects on product R&D investment. It constitutes a prerequisite to observe potential occurrence of the propositions formulated above. If subsidies does not impact firm's investment for the targeted activity, it would mean that complementarity and priority effects cannot hold. Only the inverted priority effect might be observed. In a second phase we estimate impact of awarding of public support on the export activity. Same model will be used for both steps of the analysis to get comparable results.
With an experimental dataset, the methodology of evaluation relies on comparing a "treated" and a "control" samples. It is critical in order to assure inferability of the results that both samples are randomly assigned. This experiment cannot be set up in a public policy situation because of obvious technical and moral reasons. As we mentioned in the literature review the matching methodology have been used in most of public policies evaluations over the last years. It consists

of a comparison between the variable of interest (i.e. dependent variable) and a "counterfactual" situation, which is elaborated from the control sample.
Evaluation methods aim at determining the true effect of public policies by evaluating performance differentials between subsided firms and non-supported ones (Rubin 1974 [40]). The main challenge is to overcome both selection and endogeneity bias induced by R&D subsidies non-random attribution. The problem may be stated as follows. Firms are denoted $i$.
$T$ is a binary variable representing whether the firm receive a grant ( the treatment group, $T = 1$) or not (the reference group $T = 0$). $Y$, the outcome variable, may be divided in two mutually exclusives *"latent variables"* $Y_0$ if $T = 0$ and $Y_1$ if $T = 1$. Without interference between firms, potential outcomes depend on the treatment received, and not on what treatments other firms obtain[6](Rubin 1986). Then $Y_1$ and $Y_0$ cannot be observed at the same time for the same firm. We have instead :

$$Y = TY_1 + (1 - T)Y_0$$

For each firm causal treatment effect can be determined by differenciating the actual performance and the one it would have reached in the *Counterfactual situation* : $\Delta = Y_1 - Y_0$
Since observing directly $\Delta$ is not possible, the Average Treatment Effect ("ATE") will be measured by comparing the outcome earned and the one they would have achieved without obtaining the grant. Therefore the average effect on treated individuals ($TT$) will be : $\Delta^{TT} = E(Y_1 - Y_0|T = 1)$
If we consider that the variable measuring access to treatment is independent from the "result variables" ($(Y_0, Y_1) \coprod T$) , we will obtain :

$$\Delta^{TT} == E(Y|T = 1) - E(Y|T = 0)$$

This means that it would be sufficient to estimate the average difference between the treated and non-treated individuals in order to obtain real efficiency of public policy.
If we focus on each treated firm with a vector of characteristics $x$ and as we observe $Y_1$, we estimate :

$$g(x) = E(Y|X = x, T = 0)$$

On the basis of this model, we will resort to matching estimator methodology (Rubin, 1977 [41]). Each firm $i$ (treated) is matched with a firm $i'$ (non treated), which has the same identical characteristics vector $X_{i'} = X_i$. If public decisions are based on several variables, match two firms with similar characteristics may not be feasible.

Rosenbaum and Rubin (1983 [39]) solve this problem by introducing the notion of "propensity score". This unique value aggregates the heterogeneous firm's characteristics and measures its probability to receive a grant. To be efficient, this method must respect the conditional indepen-

[6]"Stable Unit Treatment value assumption"

dence assumption (CIA). The attribution of public support must depend only on characteristics observable by the researcher. If the grant decision and the outcome variable were conditionally independent, it would also be the case for propensity score. The actual matching can be defined as : $P(xi) = P(x\tilde{i})$

Based on this method, several kind of estimators have been developed in order to increase accuracy of analysis. Kernel's estimator, as developed by Heckman, Ichimura and Todd (1998, [24]), is the best suited to be used in this article. It provides most robust estimates in the presence of various sample sizes and treated per non-treated firm ratio.

The subsided firm is compared with all non supported ones and weighted in function of their distance in term of propensity score. It can be formulated as follow :

$$\Delta^{TT} = \frac{1}{N} \sum_{j \in I_0} \left( \frac{K((P(x_j) - P(x_i))/h}{\sum_{j \in I_0} K((P(x_j) - (x_i))/h} y_j \right)$$

With $N$, the number of treated individuals and $h$, the estimation window (bandwith function) K is a kernel function with $\int_{-\infty}^{+\infty} K(u)du = 1$

# 3 Description of the data

## 3.1 Dataset

We base our analysis on the french CIS 2006 survey, referring the years 2004 to 2006. This rich dataset provides informations about firm's R&D and innovation activities and access to public support programs. It also contains a wide range of firm characteristics like number of employees, sales or industry. The CIS dataset is then merged with variables from the EAE (enquêtes annuelles d'entreprises[7], covering the period from 2002 until 2007. This base is a widespread source of informations on the firms' financial accounts. Due to the specificity of service firms' innovation and export activities ,we focus our empirical study on manufacturing ventures only. We obtain a balanced dataset of 2043 industrial firms of more than 10 employees. To account for each specific policy instrument, we consider three distinct situations :

We estimate a baseline model which does not differentiate between direct subsidies and tax credits. Treated firms have obtained either one kind of public intervention or both of them. Then, we deepen our analysis by focussing especially on the effect of fiscal subsidies.

We integrate the attribution of direct grants by sample differentiation.

[7]Annual Firm Survey

| Access to treatment variable | sample size | subsided firms | sample size | control group | sample size |
|---|---|---|---|---|---|
| Baseline estimate *(model 1)* | 2043 | Any public intervention | (1139) | No subsidy | (904) |
| Only fiscal credits *(model 2)* | 1490 | Only tax credit | (586) | No subsidy | (904) |
| Both kind of subsidies *(model 3)* | 554 | Fiscal credits and direct subsidies | (275) | Only a direct subsidies | (278) |

Table 1: description of the two samples

We first observe the effects of receiving only fiscal subsidies (compared to no public support). Then we estimate the impact of receiving fiscal and direct subsidies (compared to receiving only direct ones The rationale is to avoiding the simultaneity problem between fiscal credits and direct subsidies. The following endogenous variables are used in this study. We distinguish two binary treatment variables : $SUBVTOT$ indicates if the firm obtained public R&D funding between 2004 and 2006. It covers subsidies from the local policy makers, the French Government as well as the EU.
These variables covers a three year period, we use lagged values of the covariates measured before 1998 whenever possible, in order to avoid endogeneity problems in the selection equation

**Section to be completed**

## 3.2 Main variables

**Variable description to be written**

The variables used in the empirical model are summarized in table 4.

## 3.3 Descriptive statistics

In the next part of this article, we present main characteristics of dependant and indendant variables considered in the empirical estimation.

**to be written**

In order to efficiently estimates of the impact of the aids to innovation, we will implement the matching procedure exposed in the previous section.

| *Name of the variable* | *description* |
|---|---|
| **Dependent variables** | |
| SUBV | Dummy = 1 if the firm received public support between 2004 and 2006 |
| RDINT | % of turnover dedicated to internal investment into innovation (2006) |
| RDTOT | % of turnover dedicated to total investment into innovation (2006) |
| EXPINT | % of turnover earned on international markets (2006) |
| **Lagged export dummies** | |
| EXPTURN1 | Dummy = 1 if the firm exports and earn less than 50% of its turnover on international markets (*lagged*, 2003) |
| EXPTURN2 | Dummy = 1 if the firm export and earn more than 50% of its turnover on international markets (*lagged*, 2003) |
| **Independent variables** | |
| LSIZE03 | Number of employees (logarithm, *lagged*, 2003) |
| GROUP | Dummy = 1 if the firm belong to a group |
| FOREIGN | Dummy = 1 if the if firm belong to a group with a foreign parent company |
| FINEMP03 | Amount of financial charges per employee (*lagged*, 2003) |
| CASHTURN03 | Firm's operational cash-flow per unit of turnover (*lagged*, 2003) |
| SECTOR2 - SECTOR12 | dummy = 1 if the firm belong to the corresponding sector (list in appendix) |

Table 2: Variables used in the estimation

# 4 Matching estimation

**Section incomplete : results to be written**

## 4.1 Baseline model

We start with the estimation of the propensity score for the global sample. Table X display the likelihood to receive at least one kind of public intervention[8]. As already shown by the descriptive statistics, several parameters explain the distribution of public schemes.

First, larger firms have higher probability to receive support for R&D activity. . Larger firms often have their own R&D laboratories, have more financial capabilities and have more abilities to bring together the administrative expertise to meet the policy makers requirements. (Hall (2002b [?], Czarnitzki & Fier, 2004 [13]). Most exporting firm's acheive a higher probability to obtain public funds. More surprisingly, belonging to a domestic group strongly decrease the probability of being granted, such as firms with a foreign parent company. This result differs from the previous literature. Most previous studies indicates that firms belonging to a group have an higher probability of beeing granted (which is not the case for foreign owned firms). French public R&D policies are primarily targeted on independent companies. In the case of large groups, subsidies may also be more often distributed to parent companies than subsidiaries.

[8] i.e direct subsidies or fiscal credits

| Treatment variable : | *substot* | |
|---|---|---|
| nb of obs : 2043 | Coef. | Std.Err. |
| lsize03 | .270*** | .027 |
| group | -.456*** | .088 |
| foreign | -.208*** | .078 |
| exporturn1 | .332*** | .094 |
| exporturn2 | .526*** | .110 |
| finemp03 | .008** | .004 |
| cashturn03 | -.044 | .223 |
| *11 sector variables included* | | |
| cons | -1.423*** | .148 - - |
| LR chi2(12)= | 249.75 | |
| Prob>chi2 = | 0 | |
| Log likelihood = | -1277.6767 | |
| Pseudo R2 = | 0.0890 | |
| Correct prediction rate = | 63.19% | |

*Asterisks indicate significance at the *** 1%, ** 5% and * 10% level.*

Table 3: Probit regression on the global sample

The only significant financial characteristic is the debt charges per employee ratio . Subsided firms More ambitious projects and more ambitious growth strategy

Then, we compare the treated and non treated firms on the basis of their propensity score. Imposing the common support only leads to a loss of 6 firms, which represents only 0.029% of the global sample. Firms' repartitions for the treated sample is close to normal distribution . The kernel density propensity score is displayed in figure X.

Before matching the treated and reference samples, we run the stratification balancing test. The balancing property is satisfied. Next table presents the average treatment on the treated.

Firms benefiting from public support invest on average 1.447 % more in internal R&D than non subsided. The figure rises to 1.478% if we si l'on observe le montant total de recherche et développement. Results also show that firms earn on average 4.125 % more on international markets. This mean difference is quite contrasted by a higher variability. This supports the complementarity hypothesis exposed by Golovko and Valentini (2011[20]). Public schemes appears to be a triggering element of the virtuous relationship between innovation and exporting activities. Obtaining innovation subsidies impact on firm's growth strategy. Companies their behaviour . This is consistent with the results observed on firm's employment, and on it's productivity.

| Treatment variable | *substot* |
|---|---|
| Number of obs | 2037 |
| Untreated | 904 |
| treated | 1133 |
| treated off. supp. | 6 |
| Common support : | [.129, 1] |
| Number of blocks | 9 |
| *Estimated propensity score :* | |
| mean | .559 |
| std. dev. | .167 |
| var. | .028 |
| Skewness | -.0925 |
| Kurtosis | 2.564 |

Table 4: propensity score specification, model 1

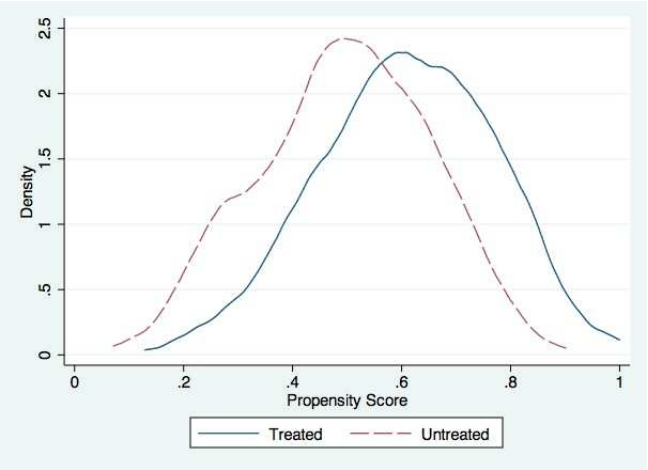


Figure 1: propensity score, model 1

| | *model 1* | | |
|---|---|---|---|
| | ATT | S.E. | Bs. T-stat |
| rdint | 1.447 | 0.273 | 5.301*** |
| rdtot | 1.478 | 0.340 | 4.348*** |
| expint | 4.125 | 1.386 | 2.977*** |

Table 5: results of the matching analysis

note : *bootstrapped standard errors obtained after 1000 replications*
*Asterisks indicate significance at the *** 1% ** 5% level. and * 10% level.*

## 4.2 Focus on fiscal schemes impact

In a second step of our analysis, we focus on the specific effects of tax credits. Attribution characteristics of such schemes are more easily observable by the researcher, We integrate the attribution of direct grants by sample differentiation. We first observe the effects of receiving only fiscal subsidies (compared to no public support). Then we estimate the impact of receiving fiscal and direct subsidies (compared to receiving only direct ones).

Then, we compare the treated and non treated firms on the basis of their propensity score. Imposing the common support only leads to a loss of 6 firms, which represents only 0.029% of the global sample. Firms' repartitions for the treated sample is close to normal distribution (table X) . The kernel density propensity score is displayed in figure X.

To asses the quality of our results, we run the stratification balancing test. The balancing property is satisfied for both models. Next table presents the average treatment on the treated.

Obtaining only tax credits enhance both R&D investment and export turnover. In this case again, our results support the complementarity hypothesis investigated in the first part of this article.

| Treatment variable : | *Fiscal only* | | *Fiscal and direct* | |
|---|---|---|---|---|
| | Coef. | Std.Err. | Coef. | Std.Err |
| lsize03 | .322*** | .034 | .362*** | .053 |
| group | -.313*** | .106 8 | -.239 | .178 |
| foreign | -.048 | .097 | .077 | .128 |
| exporturn1 | .672*** | .136 | .146 | .200 |
| exporturn2 | .874*** | .150 | .511** | .225 |
| finemp03 | .007* | .004 | .005 | .005 |
| cashturn03 | .496 | .323 | .143 | .277 |
| *11 sector variables included* | | | | |
| cons. | -2.575*** | .206 | -2.117*** | .291 |
| LR chi2(18)= | 283.65 | | 146.62 | |
| Prob>chi2 = | 0 | | 0 | |
| Log likelihood = | -856.77 | | -309.99 | |
| Pseudo R2 = | 0.142 | | 0.1913 | |
| Number of obs = | 1490 | | 554 | |
| Correct prediction rate = | 67.99% | | 71.07% | |

*Asterisks indicate significance at the *** 1%, ** 5% and * 10% level.*

Table 6: Probit regression on the global sample

| Treatment variable | *onlyfiscal* | *fiscal and direct* |
|---|---|---|
| Number of obs | 1490 | 553 |
| Untreated | 904 | 278 |
| treated | 586 | 275 |
| treated off. supp. | 0 | 2 |
| Common support : | $[0, 1]$ | $[0.046, 0.997]$ |
| Number of blocks | 7 | 6 |
| *Estimated propensity score :* | | |
| mean | .394 | .50 |
| std. dev. | .202 | .242 |
| var. | .041 | .059 |
| Skewness | .068 | .195 |
| Kurtosis | 2.29 | 2.00 |

Table 7: Matching specifications, models 2 and 3

# 5 Sensitivity analysis

## 5.1 Sensitivity analysis 1 : Ichino Test

The conditional independance assumption (CIA) is crucial to assess the robustness of our results. If subsided and non subsided firms differs in terms of unobserved characteristics, our results would

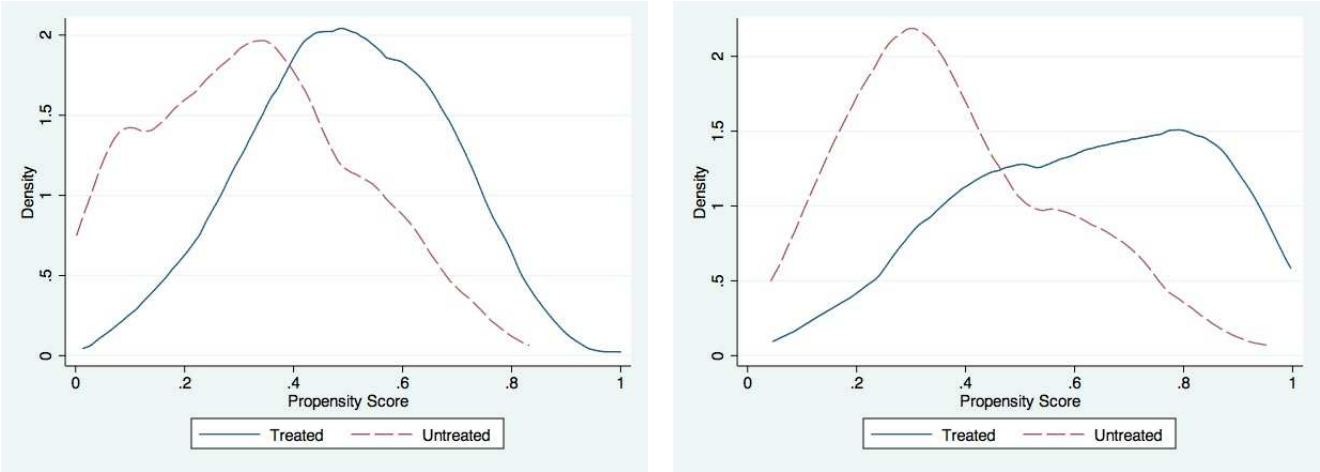


Figure 2: propensity scores, models 2 and 3

| | *Model 2* | | | *Model 3* | | |
|---|---|---|---|---|---|---|
| output variable | ATT | S.E. | Bs. T-stat | ATT | S.E. | Bs. T-stat |
| rdint | 1.372 | 0.277 | 4.955*** | 2.539 | 0.675 | 3.760*** |
| rdtot | 1.200 | 0.370 | 3.246*** | 3.338 | 0.869 | 3.840*** |
| expint | 4.696 | 1.750 | 2.683*** | 3.023 | 3.135 | 0.964 |

*bootstrapped standard errors obtained after 1000 replications*
*Asterisks indicate significance at the *** 1% ** 5% level. and * 10% level.*

Table 8: results of the matching analysis

be biased, and therefore cannot be trusted. Therefore, we need to check the sensitivity of the results when the CIA is assumed to fail. There is a growing literature considering such step as necessary when implementing propensity score matching (Caliendo and Kopeining (2008), . Since it is not possible to test directly the uncofundness hypothesis, we use the simulation-based analysis developped by Ichino & al. (2008 [28]). This method has been merely used in the labour economics field. The idea is to include in the point estimates a potential confunder U in the set of matching variables. U measures an unobserved ability parameter, using different distributional assumptions. Results of the simulation tests are displayed in appendix 1 and 2.

Overall, none of the simulated average treatment on the treated is significantly different with the baseline etimate ( $\frac{\Delta ATT}{ATT^{ref}} < 5\%$)

One may notice that results for past export, when the output variables is *EXPINT* is significantly . This may be explained by the nature of the simulated cofunder, which approximates the lagged output. Furthermore, Tommaso and Nannicini (2008 ) explain that a dangerous cofunder has both $\Gamma > 1$ & $\Lambda > 1$, and display an ATT distant from the target reference value.

In the latter case, A last parameter needs to be taken into consideration. The cofunder needs to be credible, meaning that a variable with the simulated characteristics exists, and can actually be

included in the empirical model. In our case, it seems highly improbable to find a variable that have the same characteristics than a lagged variable, and may rise a selection effect by an order of $10^5$.
These simulations support the robustness of the matching estimates, whatever the distribution chosen for U. unobservable characteristics may influence both outcome and selection effect, but do not seems to affect the estimated outcome differentials .

## 5.2 Sensitivity Analysis 2 :

We stated before that our results were relevant if we consider the following assumption :

- *Investment into export activity (inputs) and export turnover (outputs) are simultaneous.*

Then, analysing subsidies earned in 2006 on same year's export output is relevant. This hypothesis needs to be discussed. Export, as a dynamical process, may imply a delay between investment and returns on international markets. To assess the robustness of our results, we will relax this assumption by considering that :

- *Investment into export activity (inputs) only impacts export turnover (outputs) after one year, and have no immediate influence.*

Under this assumption, the outcome to be considered is the export intensity for the year 2007 (EXPINT07) . As well, subsidies awarded during 2007 and should not distort our results. We can also deepen our analysis by estimating the effect of R&D subsidies on export intensity growth between 2006 and 2007 (EXPGROWTH).

**results for export 2007**

| | *var : expint7* | | |
|---|---|---|---|
| | ATT | S.E. | Bs. T-stat |
| model1 | 5.198 | 1.326 | 3.919*** |
| model2 | 5.590 | 2.050 | 2.727*** |
| model3 | 4.811 | 3.381 | 1.423 |

Table 9: results of the matching analysis

note : *bootstrapped standard errors obtained after 1000 replications*
*Asterisks indicate significance at the *** 1% ** 5% level. and * 10% level.*

Results for export turnover for 2006 and 2007 are identical .

| *var : expgrowth* | | | |
|---|---|---|---|
| | ATT | S.E. | Bs. T-stat |
| model1 | 1.073 | 0.600 | 1.788* |
| model2 | 0.894 | 0.633 | 1.412 |
| model3 | 1.788 | 0.745 | 2.399** |

Table 10: results of the matching analysis

note : *bootstrapped standard errors obtained after 1000 replications*
*Asterisks indicate significance at the *** 1% ** 5% level. and * 10% level.*

**results for export growth**

Studying export growth between 2006 and 2007 gives us some insights of dynamical evolution of export activity, and therefore on the durability of behavioural change.

# 6 Conclusion

In this article we investigated external effects of public R&D incentives on export activity. The relationship between innovation and export activities has been well-established in the literature. The Inno-Grips report ( 2010 [26]) goes as far as to mentions affirm that these they are "*two sides of one coin.*" Until now, most evaluations of public support for innovation have focused solely on the direct impact of public intervention on investment in R&D at the firm's level. This measure is sufficient to assess that public policy makers have reach their objectives. Such studies do not provide informations on behavioural changes that may have been induced by direct subsidies or tax credits. The relationship between innovation and export is a particularly relevant to explore firms growth strategy. Causal effects linking both activities have been widely analysed, and the literature provides a strong conceptual framework. These models explain innovation and export decisions as rational cost-benefits analysis, mainly depending on firms idiosyncratic productivity. Reviewing the literature on subsidy efficiency as well as the studies on the relationship between innovation and export activities, we were able to identify three main effects that might indirectly affect public intervention. These may either amplify or distort the efficiency of government intervention. If public subsidies successfully increase the intensity of companies' R&D, we should observe higher export intensity, especially in case of intra-period complementarity between the two activities. On the contrary, these additional effects could imply a reduction of exporting intensity if the firm switches its priorities to favor the subsidized activity. The "priority effect" can also be inverted if public intervention favoring innovation does not increase its R&D intensity. Whether such crowding out comes from a freerider behaviour problem or from a threshold barrier to innovation, the company may use the allocated funds to increase its investment in export activity. To test

these hypotheses, we developed a quasi-experimental analysis divided into two stages. We were thus able to observe the impact of innovation subsidies on both activities. In a first step, we estimated the effect of French R&D subsidies on the targeted activity. In a second step, we replicated this evaluation on the firm's export intensity. We took into account the main source of heterogeneity in public policy design, which is the nature of public intervention. For each sample, we ran two distinct estimations in order to observe the presence of indirect effects of the public intervention. These estimations provide highly interesting results. A first conclusion concerns the process of allocating subsidies. We observe a "picking the winner" strategy, meaning that public policy makers aim to support more promising firms. Subsided projects were however not the safest ones, as shown by the positive influence of financial charges per employee. Comparing firms that obtained both types of subsidies with those only subsided by direct schemes shows that there only few differences between these groups. Based on their propensity score, we matched treated and reference samples for the three models. First of all, every model show a positive impact of public innovation policies on firm's R&D. We observe that public intervention in favour of innovation positively impacts export (complementarity effect) both in the baseline situation and when we focus on the awarding of fiscal schemes. Fostering innovation impacts firm's global strategy and does not only affect R&D effort. On the contrary, obtaining both kind of public incentives does not induce such behavioural change. We explain this by a threshold effect. Obtaining more public support does not induce a change in firm's global strategy. A sensitivity analysis (carried out according to the method described by Ichino et al., 2008 [28] supported the robustness of the matching estimates. Finally, relaxing the hypothesis of simultaneity between Export inputs and outputs doesn't change our results.

This emphasises the importance of considering export activity in the design of public policies for innovation. Finally, if policy makers aim at fostering export by subsiding innovation, multiplying allocated schemes is not efficient, as fiscal and direct subsidies may overlap.

Our empirical analysis presents some limitations.

Our methodology does not allow to explicitly take into account the innovation-export relationship, Observing complementarity between innovation and export on a French sample would be an interesting extension of our work. Evaluation studies are by nature dependant of the time and country considered (Kaiser 2004, Cerulli 2010) Our database covers a period between 2004 and 2006. Replicating our results on other countries and focussing on the current crisis period could strengthen their external validity. Finally, this analysis does not explicitly take into account export subsidies. Those are however very heterogeneous and usually focussed on the preliminary phases of the export process.

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# 7 Appendix

## APPENDIX 1 : Results of the robustness test

| Model 1 | Fraction U = 1 by treatment/outcome | | | | outcome effect | selection effect | ATT | *s.e* |
|---|---|---|---|---|---|---|---|---|
| | $p_{11}$ | $p_{10}$ | $p_{01}$ | $p_{00}$ | $\Gamma$ | $\Lambda$ | | |
| outcome : *rdint* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 1.447 | 0.000 |
| Neutral cofounder | 0.50 | 0.50 | 0.50 | 0.50 | 1.023 | 1.002 | 1.447 | 0.009 |
| *Cofounder like* | | | | | | | | |
| group | 0.30 | 0.35 | 0.29 | 0.23 | 0.862 | 1.029 | 1.447 | 0.007 |
| foreign | 0.45 | 0.40 | 0.42 | 0.38 | 1.222 | 1.143 | 1.442 | 0.017 |
| exporturn1 | 0.57 | 0.63 | 0.68 | 0.62 | 1.232 | 0.941 | 1.453 | 0.009 |
| exporturn2 | 0.39 | 0.28 | 0.22 | 0.19 | 1.309 | 1.935 | 1.426 | 0.069 |
| outcome : *rdtot* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 1.478 | 0.000 |
| Neutral cofounder | 0.50 | 0.50 | 0.50 | 0.50 | 1.035 | 1.007 | 1.479 | 0.013 |
| *Cofounder like* | | | | | | | | |
| group | 0.27 | 0.36 | 0.31 | 0.33 | 0.972 | 1.036 | 1.479 | 0.012 |
| foreign | 0.44 | 0.40 | 0.36 | 0.39 | 0.951 | 1.143 | 1.478 | 0.021 |
| exporturn1 | 0.55 | 0.64 | 0.61 | 0.64 | 0.906 | 0.920 | 1.474 | 0.018 |
| exporturn2 | 0.38 | 0.29 | 0.22 | 0.19 | 1.236 | 1.943 | 1.453 | 0.071 |
| outcome : *expint* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 4.125 | 0.000 |
| Neutral cofounder | 0.50 | 0.50 | 0.50 | 0.50 | 1.039 | 0.986 | 4.120 | 0.048 |
| *Cofounder like* | | | | | | | | |
| group | 0.44 | 0.22 | 0.48 | 0.25 | 2.857 | 0.917 | 4.215 | 0.129 |
| foreign | 0.40 | 0.42 | 0.34 | 0.40 | 0.765 | 1.201 | 4.181 | 0.117 |
| exporturn1 | 0.39 | 0.84 | 0.44 | 0.72 | 0.291 | 1.152 | 4.230 | 0.112 |
| exporturn2 | 0.60 | 0.02 | 0.55 | 0.01 | 123.322 | 1.379 | 3.248 | 0.279 |

Results for the model 2 :

Results for the model 3 :

| Model 2 | Fraction U = 1 by treatment/outcome | | | | outcome effect | selection effect | ATT | *s.e* |
|---|---|---|---|---|---|---|---|---|
| | $p_{11}$ | $p_{10}$ | $p_{01}$ | $p_{00}$ | $\Gamma$ | $\Lambda$ | | |
| outcome : *rdint* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 1.372 | 0.000 |
| Neutral cofounder | 0.50 | 0.50 | 0.50 | 0.50 | 1.016 | 1.005 | 1.372 | 0.011 |
| *Cofounder like* | | | | | | | | |
| group | 0.38 | 0.39 | 0.33 | 0.32 | 1.035 | 1.294 | 1.373 | 0.018 |
| exporturn1 | 0.60 | 0.64 | 0.65 | 0.62 | 1.202 | 0.987 | 1.374 | 0.007 |
| exporturn2 | 0.36 | 0.32 | 0.24 | 0.18 | 1.459 | 2.160 | 1.344 | 0.065 |
| outcome : *rdtot* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 1.200 | 0.000 |
| Neutral cofounder | 0.50 | 0.50 | 0.50 | 0.50 | 1.007 | 1.015 | 1.197 | 0.017 |
| *Cofounder like* | | | | | | | | |
| group | 0.35 | 0.40 | 0.31 | 0.33 | 0.931 | 1.314 | 1.209 | 0.025 |
| exporturn1 | 0.58 | 0.58 | 0.64 | 0.63 | 1.114 | 0.993 | 1.202 | 0.013 |
| exporturn2 | 0.37 | 0.32 | 0.20 | 0.19 | 1.095 | 2.139 | 1.198 | 0.075 |
| treatment : *expint* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 4.696 | 0.000 |
| Neutral cofounder | 0.50 | 0.50 | 0.50 | 0.50 | 1.002 | 1.005 | 4.698 | 0.065 |
| *Cofounder like* | | | | | | | | |
| group | 0.47 | 0.27 | 0.48 | 0.25 | 2.781 | 1.129 | 4.583 | 0.121 |
| exporturn1 | 0.43 | 0.89 | 0.45 | 0.72 | 0.307 | 1.232 | 4.864 | 0.108 |
| exporturn2 | 0.56 | 0.02 | 0.54 | 0.01 | 124.901 | 1.412 | 3.745 | 0.319 |

## APPENDIX 2 : Results of the robustness test for sectors variables

| Model 3 | Fraction U = 1 by treatment/outcome | | | | outcome effect | selection effect | ATT | *s.e* |
|---|---|---|---|---|---|---|---|---|
| | $p_{11}$ | $p_{10}$ | $p_{01}$ | $p_{00}$ | $\Gamma$ | $\Lambda$ | | |
| outcome : *rdint* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 2.539 | 0.000 |
| Neutral cofounder | 0.50 | 0.50 | 0.50 | 0.50 | 1.064 | 0.960 | 2.550 | 0.044 |
| *Cofounder like* | | | | | | | | |
| exporturn2 | 0.51 | 0.31 | 0.26 | 0.18 | 1.838 | 2.835 | 2.499 | 0.178 |
| outcome : *rdtot* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 3.338 | 0.000 |
| Neutral cofounder | 0.50 | 0.50 | 0.50 | 0.50 | 1.071 | 1.040 | 3.334 | 0.029 |
| *Cofounder like* | | | | | | | | |
| exporturn2 | 0.53 | 0.32 | 0.15 | 0.20 | 0.706 | 2.743 | 3.500 | 0.177 |
| treatment : *expint* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 3.023 | 0.000 |
| Neutral cofounder | 0.50 | 0.50 | 0.50 | 0.50 | 1.137 | 0.960 | 3.080 | 0.340 |
| *Cofounder like* | | | | | | | | |
| exporturn2 | 0.68 | 0.03 | 0.63 | 0.01 | 7.82e+24 | 1.707 | 1.718 | 0.624 |

| Model 1 | Fraction U = 1 by treatment/outcome | | | | outcome effect | selection effect | ATT | *s.e* |
|---|---|---|---|---|---|---|---|---|
| | $p_{11}$ | $p_{10}$ | $p_{01}$ | $p_{00}$ | $\Gamma$ | $\Lambda$ | | |
| outcome : *rdint* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 1.447 | 0.000 |
| *Cofounder like* | | | | | | | | |
| sect8 | 0.19 | 0.04 | 0.10 | 0.06 | 1.791 | 1.258 | 1.437 | 0.019 |
| sect9 | 0.02 | 0.07 | 0.09 | 0.09 | 0.976 | 0.580 | 1.450 | 0.031 |
| sect11 | 0.01 | 0.05 | 0.04 | 0.08 | 0.501 | 0.537 | 1.430 | 0.022 |
| sect12 | 0.13 | 0.15 | 0.12 | 0.10 | 1.197 | 1.553 | 1.440 | 0.032 |
| outcome : *rdtot* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 1.478 | 0.000 |
| *Cofounder like* | | | | | | | | |
| sect2 | 0.02 | 0.02 | 0.11 | 0.06 | 2.484 | 0.310 | 1.551 | 0.060 |
| sect8 | 0.19 | 0.04 | 0.11 | 0.06 | 2.130 | 1.324 | 1.452 | 0.031 |
| sect9 | 0.03 | 0.06 | 0.10 | 0.09 | 1.102 | 0.587 | 1.486 | 0.037 |
| sect11 | 0.02 | 0.05 | 0.05 | 0.08 | 0.582 | 0.523 | 1.454 | 0.032 |
| sect12 | 0.12 | 0.15 | 0.09 | 0.10 | 0.778 | 1.634 | 1.499 | 0.042 |
| outcome : *expint* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 4.125 | 0.000 |
| sect2 | 0.01 | 0.04 | 0.01 | 0.09 | 0.067 | 0.366 | 3.921 | 0.164 |
| sect8 | 0.09 | 0.08 | 0.07 | 0.06 | 1.297 | 1.337 | 4.108 | 0.118 |
| sect9 | 0.05 | 0.06 | 0.06 | 0.10 | 0.608 | 0.584 | 4.008 | 0.103 |
| sect11 | 0.04 | 0.03 | 0.06 | 0.08 | 0.769 | 0.527 | 4.006 | 0.157 |
| sect12 | 0.16 | 0.13 | 0.13 | 0.08 | 1.706 | 1.496 | 3.985 | 0.135 |

| Model 2 | Fraction U = 1 by treatment/outcome | | | | outcome effect | selection effect | ATT | *s.e* |
|---|---|---|---|---|---|---|---|---|
| | $p_{11}$ | $p_{10}$ | $p_{01}$ | $p_{00}$ | $\Gamma$ | $\Lambda$ | | |
| outcome : *rdint* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 1.372 | 0.000 |
| *Cofounder like* | | | | | | | | |
| sect2 | 0.00 | 0.01 | 0.05 | 0.07 | 0.761 | 0.090 | 1.361 | 0.048 |
| sect3 | 0.11 | 0.07 | 0.07 | 0.05 | 1.742 | 1.754 | 1.360 | 0.028 |
| sect4 | 0.04 | 0.04 | 0.05 | 0.07 | 0.725 | 0.6298 | 1.365 | 0.017 |
| sect5 | 0.07 | 0.10 | 0.06 | 0.06 | 1.007 | 1.514 | 1.373 | 0.022 |
| sect8 | 0.21 | 0.04 | 0.11 | 0.06 | 2.113 | 1.574 | 1.354 | 0.026 |
| sect9 | 0.01 | 0.05 | 0.07 | 0.09 | 0.818 | 0.461 | 1.370 | 0.034 |
| sect11 | 0.00 | 0.05 | 0.04 | 0.08 | 0.516 | 0.460 | 1.354 | 0.022 |
| sect12 | 0.19 | 0.15 | 0.12 | 0.10 | 1.282 | 1.839 | 1.367 | 0.037 |
| outcome : *rdtot* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 1.200 | 0.000 |
| *Cofounder like* | | | | | | | | |
| sect2 | 0.00 | 0.01 | 0.11 | 0.06 | 2.087 | 0.091 | 1.251 | 0.064 |
| sect3 | 0.13 | 0.06 | 0.06 | 0.05 | 1.332 | 1.683 | 1.197 | 0.038 |
| sect4 | 0.05 | 0.04 | 0.04 | 0.07 | 0.454 | 0.581 | 1.175 | 0.023 |
| sect5 | 0.07 | 0.10 | 0.07 | 0.06 | 1.107 | 1.415 | 1.202 | 0.024 |
| sect8 | 0.23 | 0.04 | 0.09 | 0.06 | 1.976 | 1.586 | 1.172 | 0.033 |
| sect9 | 0.02 | 0.05 | 0.09 | 0.09 | 1.106 | 0.419 | 1.204 | 0.045 |
| sect11 | 0.01 | 0.04 | 0.05 | 0.08 | 0.563 | 0.448 | 1.168 | 0.027 |
| sect12 | 0.17 | 0.16 | 0.09 | 0.10 | 0.966 | 1.895 | 1.215 | 0.051 |
| treatment : *expint* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 4.696 | 0.000 |
| *Cofounder like* | | | | | | | | |
| sect2 | 0.00 | 0.01 | 0.01 | 0.09 | 0.097 | 0.105 | 4.499 | 0.204 |
| sect3 | 0.06 | 0.12 | 0.06 | 0.05 | 1.340 | 1.683 | 4.573 | 0.152 |
| sect4 | 0.04 | 0.04 | 0.06 | 0.07 | 0.928 | 0.582 | 4.650 | 0.119 |
| sect5 | 0.08 | 0.10 | 0.09 | 0.05 | 1.837 | 1.431 | 4.610 | 0.109 |
| sect8 | 0.10 | 0.10 | 0.07 | 0.06 | 1.381 | 1.608 | 4.601 | 0.142 |
| sect9 | 0.04 | 0.04 | 0.06 | 0.10 | 0.590 | 0.437 | 4.524 | 0.181 |
| sect11 | 0.01 | 0.05 | 0.00 | 0.07 | 0.796 | 0.4644 | 4.619 | 0.151 |
| sect12 | 0.51 | 0.31 | 0.26 | 0.18 | 1.897 | 1.749 | 4.481 | 0.144 |

| Model 3 | Fraction U = 1 by treatment/outcome | | | | outcome effect | selection effect | ATT | $s.e$ |
|---|---|---|---|---|---|---|---|---|
| | $p_{11}$ | $p_{10}$ | $p_{01}$ | $p_{00}$ | $\Gamma$ | $\Lambda$ | | |
| outcome : *rdint* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 2.539 | 0.000 |
| *Cofounder like* | | | | | | | | |
| sect2 | 0.01 | 0.01 | 0.07 | 0.06 | 1.240 | 0.195 | 2.549 | 0.108 |
| sect9 | 0.03 | 0.05 | 0.05 | 0.10 | 0.534 | 0.491 | 2.507 | 0.070 |
| sect10 | 0.01 | 0.02 | 0.05 | 0.06 | 1.037 | 0.330 | 2.522 | 0.085 |
| sect11 | 0.01 | 0.05 | 0.00 | 0.07 | - $(p_{01} = 0)$ | 0.590 | 2.498 | 0.054 |
| outcome : *rdtot* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 3.338 | 0.000 |
| *Cofounder like* | | | | | | | | |
| sect2 | 0.01 | 0.01 | 0.09 | 0.06 | 2.104 | 0.191 | 3.388 | 0.168 |
| sect9 | 0.01 | 0.06 | 0.09 | 0.09 | 1.288 | 0.492 | 3.341 | 0.118 |
| sect10 | 0.01 | 0.02 | 0.06 | 0.06 | 1.522 | 0.407 | 3.353 | 0.119 |
| sect11 | 0.02 | 0.04 | 0.04 | 0.06 | 0.859 | 0.706 | 3.320 | 0.065 |
| treatment : *expint* | | | | | | | | |
| No cofounder | 0.00 | 0.00 | 0.00 | 0.00 | - | - | 3.023 | 0.000 |
| *Cofounder like* | | | | | | | | |
| sect2 | 0.00 | 0.03 | 0.02 | 0.08 | 0.222 | 0.236 | 2.925 | 0.455 |
| sect9 | 0.05 | 0.03 | 0.07 | 0.10 | 1.026 | 0.460 | 2.971 | 0.459 |
| sect10 | 0.02 | 0.02 | 0.10 | 0.04 | 3.687 | 0.273 | 3.206 | 0.616 |
| sect11 | 0.04 | 0.03 | 0.09 | 0.05 | 1.026 | 0.460 | 2.971 | 0.459 |