Impact Assessment of Tax Incentives to Foster Industrial Innovation in Brazil: The Case of Law 11,196/05

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This paper evaluates the effects of tax incentives for technological innovation in Brazil established by the Law 11,196/05 ("*Lei do Bem*"), to test whether they have increased resources for business innovation projects and had any significant impact on their results. The average treatment effect on the treated (ATT) is estimated using microdata on the firm level from the Brazilian Industrial Innovation Survey (PINTEC) conducted by IBGE, and applying a propensity score matching (PSM) technique, used in recent similar analyzes. Results suggest the policy positively affects R&D expenditures, number of research staff and the base of firms investing in innovation. Average impact on spending, nevertheless, falls short of the volume of tax break per firm. Moreover, benefited firms have more chances to innovate and experience higher growth in terms of overall number of employees. Such results are in accordance with findings of most of the empirical literature on innovation tax incentives. The study provides empirical support in favor of tax incentives as part of a government strategy to boost entrepreneurial innovation in the country.

Keywords: Tax incentives; technological innovation; impact assessment; "*Lei do Bem*".

JEL Codes: O38; O54; H25.

Working Paper

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Abstract

This paper evaluates the effects of tax incentives for technological innovation in Brazil established by the Law 11,196/05 ("*Lei do Bem*"), to test whether they have increased resources for business innovation projects and had any significant impact on their results. The average treatment effect on the treated (ATT) is estimated using microdata on the firm level from the Brazilian Industrial Innovation Survey (PINTEC) conducted by IBGE, and applying a propensity score matching (PSM) technique, used in recent similar analyzes. Results suggest the policy positively affects R&D expenditures, number of research staff and the base of firms investing in innovation. Average impact on spending, nevertheless, falls short of the volume of tax break per firm. Moreover, benefited firms have more chances to innovate and experience higher growth in terms of overall number of employees. Such results are in accordance with findings of most of the empirical literature on innovation tax incentives. The study provides empirical support in favor of tax incentives as part of a government strategy to boost entrepreneurial innovation in the country.

Keywords: tax incentives; technological innovation; impact assessment*; "Lei do Bem".*

Resumo

Este trabalho tem por objetivo realizar uma avaliação quantitativa de impacto dos incentivos fiscais à inovação tecnológica concedidos pela Lei 11.196/05 – a "Lei do Bem", a fim de verificar se eles têm contribuído para o incremento de recursos para projetos de inovação empresarial, assim como para seus resultados. A estimação do efeito médio do tratamento nas unidades tratadas (ATT) é conduzida a partir de dados desagregados no nível da firma da Pesquisa de Inovação Industrial do IBGE (PINTEC), através do *propensity score matching* (PSM), que vem sendo empregado em análises recentes do gênero. Os resultados obtidos sugerem que a política afeta positivamente os investimentos em P&D, o número de pesquisadores contratados e a base de empresas que investem em inovação. A pesquisa também apresenta evidências de que as firmas beneficiadas possuem maiores chances de inovar e apresentam crescimento mais acentuado em termos de pessoal empregado. Os resultados obtidos encontram-se de acordo com a maior parte da literatura empírica sobre incentivos fiscais para inovação. O estudo apresenta evidência empírica da relevância de incentivos fiscais como parte de uma estratégia de política pública para fomentar a inovação empresarial no país.

Palavras-chave: incentivos fiscais; inovação tecnológica; avaliação de impacto; Lei do Bem.

Introduction

Governments have devised and adopted policies to foster industrial innovation since the second half of the 20th century (previously they were part of broader defense and industrial development plans). Industrial innovation strategies have evolved substantially over time: the introduction of research and development (R&D) incentive schemes in the 1970s; the emergence of regional or territorial policies and the concept of 'national system of innovation' in the 1980s; and the growth of horizontal policies to avoid government failures in the 1990s.[1]

A group of authors have recently suggested the emergence of a new paradigm for the role of the state in technological development based less on protectionism or direct state action and more on promoting international competitiveness, attracting foreign investments, and supporting local innovative companies (in this sense, Evans, 2008 – '21st Century Developmental State'; Mazzucato, 2011 – 'entrepreneurial state'; Rodrik, 2008 - 'innovation-led growth'; and Trubek, 2009 – 'new developmental state'). In Brazil, this paradigm shift took place in the beginning of the last decade with the Industrial, Technological and Foreign Trade Policy (2003) followed by the Productive Development Policy (2008) and, more recently, the Greater Brazil Plan (2012). The National Strategy of Science, Technology and Innovation (ENCTI; MCTI, 2012a), issued in 2012, clearly expressed such a policy orientation by stating a set of goals to be achieved by the national innovation system.

Different countries have resorted to tax incentives as part of their strategy to indirectly finance business innovation projects. Such instruments have gained ground and are in accordance with this new policy paradigm, for they are said to reduce economic distortions caused by public sector action and are more 'market friendly' (Hall and Van Reenen, 2000; OECD, 2014a). According to Bloom et al. (1997), since the 1990s policy-makers became increasingly interested in tax incentives. Since then, a substantial body of knowledge on the subject has been produced including several empirical studies that tried to identify and measure impacts of this policy tool (as detailed in section 3).

This paper's aim is to contribute to this discussion by understanding the Brazilian experience with tax incentives for innovation. The object of the analysis is the horizontal fiscal policy at the federal level established by Law 11,196/05, also known as the 'Goodness Law' ("*Lei do Bem*"). The objective is to present a quantitative impact assessment of these incentives, in order to check whether they have contributed to increasing business innovation investments and efforts (measured by firms' expenditures and research personnel), as well as to their results

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[1] For a brief history of innovation policies in OECD countries, see World Bank (2010).

(assessed through success in innovating, firm growth and productivity).[2] The policy impact is assessed using disaggregated data at the firm level from the Industrial Innovation Survey (PINTEC)[3] collected by the Brazilian Institute of Geography and Statistics (IBGE) and applying the propensity score matching (PSM) to estimate the average treatment effect on the treated (ATT).

The second part of the paper following this introduction presents the concept and economic rationale for tax incentives, along with data that shows the increasing use of this policy tool in the last decades across countries. In the third section the relevant literature related to evaluation and impact assessment of innovation tax incentives is reviewed, summarizing the most important and frequent findings. The fourth part describes the implementation and institutional framework of the Brazilian tax policy, and presents a general overview of the incentives using aggregate data. The fifth part details the empirical research strategy, including the estimation method and data. The sixth part presents and discusses the results of this study. The seventh and final section summarizes the findings and provides concluding remarks.

2 Tax Incentives for Industrial Innovation

2.1 Theoretical background and economic rationale: distinctions between direct subsidies and tax incentives.

Public financing of innovation activities and expenditures is supported by different economic theories. The presence of market failures renders private investment in this activity suboptimal, thus requiring additional public resources to supplement it. The seminal works of Nelson (1959) and Arrow (1962) presented some of the first and most influential theoretical arguments on the subject. The first focused on basic research, which requires public support due to the uncertainty inherent to such projects. Nelson argued that under a perfect competitive market the allocation of resources for innovation would be optimal, but three market failures that do not allow such a situation to arise: indivisibility of results, inappropriability (presence of positive externalities), and uncertainty.

This literature developed and tested other arguments, such as information asymmetry and moral hazard (Hall and Lerner, 2009), financial constraints (Hall, 1990; Himmelberg and

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[2] For a detailed description of the outcome variables, see section 5.4.
[3] *"Pesquisa de Inovação Industrial"*.

Petersen, 1994), job qualifications and salary increase (Berman, Bound and Griliches, 1994) and capacity for imitation (Cohen and Levinthal, 1989).

Currently, the main argument raised to justify public financing of innovation is the limited appropriability of results caused by knowledge spillovers (Köhler, Laredo and Rammer, 2012;[4] Griffith, Sandler and Van Reenen, 1995;[5] EC, 2014.[6]). The main point is that technological innovation, understood as the creation of knowledge and its application to practical purposes (Frascati Manual - OECD, 2015), cannot be fully appropriated due to its non-rival and non-excludable properties (Arrow, 1962). Intellectual property laws can only mitigate this market failure by granting monopoly rights to the inventor (Griffith et al., 1995), as such protection is usually limited in time and scope.

A vast body of literature attempted to measure the percentage of knowledge spillovers of technological innovation (for a review of this topic, see Griliches, 1992; and Wieser, 2005). These analyses suggest the level of spillovers can change drastically, depending on their geographic dispersion (Jaffe, 1993; Peri, 2005), economic sector (Malerba, Mancusi and Montobbio, 2013), or scope (basic or applied) of the R&D activity (Nelson, 1959; U.S. JEC, 2010). Regardless of such differences, spillovers represent a substantial share of the results from firms' technological efforts. In a recent analysis, Bloom, Schankerman and Van Reenen (2012) estimated them to be at least twice the size of internalized returns. For this reason, technological innovation can be considered for analytical purposes as an activity similar to the provision of public goods (as suggested in Hall and Van Reenen, 2000;[7] Verspagen and De Loo, 1999;[8] Verspagen, 1992;[9] and Malerba et al. 2013)[10]. Government funding is then justified as relevant to raise R&D to socially efficient levels.

But knowledge spillovers and positive externalities are only part of the reason why governments employ resources for funding R&D. A second motivation is the importance of

4 "The principal economic rationale for business R&D tax incentives – as for any government support of private R&D – is the presence of knowledge spillovers." (Köhler et al., 2012, p. 7).
5 "The main economic argument in favour of government support for industrial R&D, which is based on the idea that society benefits from this R&D via 'spillovers' […]". (Griffith et al., 1995, p. 24).
6 "But markets left on their own will probably generate less innovation than would be desirable from society's point of view. The reason is that knowledge is not completely excludable: ideas can be easily copied and used by other firms." (EC, 2014, p. 18).
7 "Economists generally agree that the market will fail to provide sufficient quantities of R&D as it has some characteristics of a public good." (Hall and Van Reenen, 2000).
8 "The public good character of knowledge has recently been widely recognized in economics." (Verspagen and De Loo, 1999, p. 216).
9 "Intuitive support for the assumption of exogenous technological change might be found in the public good characteristics of innovation." (Verspagen, 1992, p. 634).
10 "Technology is typically considered as non-rival and R&D investments have both private and public returns." (Malerba et al., 2013, p. 699).

innovation as a driver of economic growth, as acknowledged by economic theory since the works of Schumpeter (1911) and Solow (1957), and constituting the building blocks of neoclassical and neoschumpeterian growth models (Rivera-Batiz and Romer, 1991; Grossman and Helpman, 1991; Romer, 1990; Sala-i-Martin, 1990; Nelson and Winter, 2005; and, more recently, Bloom and Van Reenen Schankerman, 2015).[11]

On the other hand, theoretical arguments also suggested the existence of negative effects and externalities arising from R&D activities. The most important are losses incurred by firms using technologies that became obsolete (Aghion and Howitt, 1992), and redundancy of research conducted by different firms in isolation (Jones and Williams, 1998). However, even considering these negative factors, different studies (Russo, 2004; Jones and Williams, 1998; and Griliches, 1992)[12] concluded that positive externalities seem to prevail, leading to suboptimal private investment in innovation and efficiency-enhancing properties of government funding.

To correct or reduce inefficiencies caused by market failures and increase the technological and growth levels of the economy, governments have a range of policy tools, such as conducting research in public laboratories and institutions, directly financing business projects, increasing human capital, and implementing economic regulation (for a review on these measures, see Edler, 2013; and Edler, Cunningham, Gök and Shapira, 2013).

According to Bloom, Griffith and Van Reenen (2002), from the second half of the 20th century the U.S. and European countries adopted tax incentives to indirectly finance innovation in industry, in order to face the competition from other economies with high rates of technological progress, such as Japan and South Korea. Bloom, Chennells, Griffith and Van Reenen (1997) explained the evolution of these benefits in eight developed countries, drawing attention to the leadership of Canada during most of the 1980s and early 1990s. In the U.S., the 'Economic Recovery Tax Act' enacted in the early 1980s approved a tax credit for incremental R&D outlays. In the first five years, the amount of tax waiver was about seven billion U.S. dollars[13] (U.S. G.A.O., 1989).[14]

The theoretical reasoning to justify tax incentives is the same as for other types of innovation support. Their implementation and economic rationale, however, follow a different

[11] For a review of the neoclassical approach see Verspagen (1992).
[12] "In spite all of these difficulties, there has been a significant number of reasonably well done studies all pointing in the same direction: R&D spillovers are present, their magnitude may be quite large, and social rates of return remain significantly above private rates." (Griliches, 1992, p. 24).
[13] Current values.
[14] For a description of tax incentives in the U.S. until the mid-1990s see Hall (1995).

argument. Tax incentives do not supplement private investment as direct funding schemes, but they reduce the tax cost of innovation projects (or the 'user cost of R&D capital', as the concept adopted by Bloom et al., 1997; Hall and Van Reenen, 2000; and Bloom, Van Reenen and Griffith, 2002), thereby increasing the number of economically profitable and viable projects.

Tax reduction affects firms' economic incentives and business strategies differently than direct funding. The main advantage of this policy strategy reported in the literature is its 'market-oriented' nature, in the sense that the government does not decide the projects to be funded nor interfere in their implementation (Hall and Van Reenen, 2000; OECD, 2014a). Private decision-making and allocation of resources is thus preserved, reducing allocative distortions arising from government intervention.

Moreover, tax incentives are not subject to the informational problem of public agents. EC (2014) argued that the state agent seldom is in a better position to identify projects or enterprises with greater profit or success potential. Exempting the government of such responsibility also reduces the size and cost of the administrative structure necessary to manage the incentives. Finally, this type of incentive tends to reduce uncertainty, favoring long-term business planning (Köhler et al., 2012).

Other positive features of tax incentives *vis-à-vis* direct benefits are: (a) neutrality and impartiality, for tax breaks apply to all firms indistinctly, without picking off winners (Nelson and Winter, 2005); (b) a lower sensitivity to short-term political changes (EC, 2014; Hall and Van Reenen, 2000); and (c) indirect subsidies through taxation are more tolerated in international trade agreements (OECD, 2013a).

Economic literature has also pointed to disadvantages of the fiscal approach. The leading downside is a possible low elasticity of R&D spending with respect to the reduction of tax costs due to the crowding-out effect (Hall and Van Reenen, 2000). Another drawback is the potential conflict of interests: public money should preferentially finance projects with high levels of knowledge spillovers. Companies, on the other hand, would rather reduce positive externalities by developing technologies with higher rates of appropriability and internalized returns (Hall and Van Reenen, 2000). In the extreme case of sectors with very high levels of spillovers or low private return of innovations, direct financing can be a more suitable strategy (EC, 2014).

General rules regulating incentives (a typical feature of tax legislations) can also make it more difficult for incentives to be customized to suit specific cases, such as young start-ups or enterprises without a substantial taxable income base. Furthermore, a sudden increase of demand for researchers can impact wages because of inelasticity, thus reducing R&D

additionality, (OECD, 2014a). Avellar (2008) suggested a tax relief may not affect firms' perception of technological risks, and therefore not raise the base of innovative companies. Bastos (2004) challenged the neutrality argument by sustaining that tax incentives mostly benefit large corporations.

A final and important issue that puts fiscal policies for innovation in check is government competition to attract investments, that may lead to a zero-sum game with budget reductions in all relevant countries (OECD, 2013a). This argument is known as 'footloose R&D' and was initially raised by Bloom and Griffith (2001). The literature has not reached a consensus on the topic, and there are empirical studies that confirmed (Bloom and Griffith, 2001; Wilson, 2009; Knoll, Baumann and Riedel, 2014) and rejected the argument (Thomson, 2009; Athukorala and Kohpaiboon, 2006).

2.2 Institutional arrangement and structures of tax incentives.

A tax relief is any form of discount, credit or special treatment granted by the government to firms with positive innovation spending or implementing innovative projects (OECD, 2015; EC, 2014; Köhler et al., 2012). These incentives can have different arrangements or levels of tax breaks, depending on the policy objectives and specific features of the tax system. OECD (2011, 2014a, 2015b), Van Pottelsberghe (2003), EC (2014) and Köhler et al. (2012) divide such arrangements into similar categories (with minor differences), as follows:

1. *Tax credits* are subtracted directly from the amount of tax due after it has been calculated, reducing the tax burden. According to Köhler et al. (2012), it is currently the most widespread form of incentives.

2. *Allowances* are deducted from the tax base before liability is calculated, thus allowing firms to subtract R&D outlays from the taxable profit or income. In the case of special or privileged deductions ('enhanced'), the amounts to be deducted are multiplied by a factor determined by the legislation.

3. *Accelerated depreciation or amortization* of equipment or technology acquired from third parties at higher rates for accounting purposes, reducing taxation in the short-term.

4. *Reduction or exemption of taxes levied on innovation inputs*, such as researchers' compensation or value added tax on purchased equipment.

5. *Reduction or exemption of taxes levied on innovation output,* as the case of licensing rights or income arising from the sale of new products, such as "patent box" schemes (EC, 2014; OECD, 2014a; Köhler et al., 2012).

Despite the differences, it is not clear in the literature what type of incentive is more appropriate or suitable to each specific situation or objective. Such decision should be taken considering the features of each tax system, the group of potential beneficiaries and the objectives pursued by the policy. OECD (2011) and Van Pottelsberghe (2003) presented a set of guidelines for the design of tax incentives, stressing the importance of internal coherence of the policy, but not detailing recommendations on each category to be used. Moreover, it is common that different benefits are combined into a broader policy design (see section 2.3 below).

In addition to these basic categories, there is a secondary set of features or options distinguishing tax incentives in different countries. Table 1 summarizes the main points discussed or reported in the literature. These studies do not recommend a best design or strategy to be followed *a priori,* although this does not mean such features are not relevant. Griffith et al. (1995) pointed out that the design of fiscal policy can substantially impact its results, generating distortions on economic incentives or inefficiencies. These features should not, therefore, be considered simple administrative details. Hall (1993) concluded that about 30% of companies benefiting from tax incentives in the U.K. actually had negative tax credit in 1989.

Many of these policy design choices imply a tradeoff between comprehensiveness and cost of the policy; or between horizontal or vertical strategies. Loose or broad definitions of R&D or authorized expenditures, for example, expand the scope of incentivized activities, but also increase the budget cost of the policy. Incentives may be applicable to the entire industry (horizontal benefits) or only to sectors deemed strategic by the government.

2.3 Summary of the international experience.

Since the first experiences in the second half of the 20th century, many countries have approved tax regimes that favor innovation and R&D related activities. According to an OECD report (2015a), 28 countries of the group have resorted to some form of tax relief for this purpose in 2015, in addition to other important economies like India, China, Russia, South Africa and Brazil. Deloitte (2014) presented a detailed description of incentives in thirty countries considered attractive for technological development. OECD (2014a) pointed out tax incentives are present in virtually every nation, the main exceptions being Mexico,[15] Germany,[16] Estonia and Switzerland.

Table 1

Possible arrangements for the design of tax incentives

Policy feature	Relevance for policy design	Possible arrangements
Definition of R&D	Identification and delimitation of incentivized projects and activities	Different possibilities (international standard - Frascati Manual, OECD, 2015a).
Deductible expenses	Definition of deductible or benefited operations and expenditures	(a) Cost only; and (b) Cost and capital (includes purchase of equipment and capital goods).
Incentive scheme	Defines the R&D expenditure criteria considered to calculate the incentive	(a) Volume (all spending considered); and (b) Incremental (only the amount exceeding previous years' expenditures - fixed or moving base).
Incentive rate	Percentage of expenditures' deduction or tax reduction	Different values.
Cap/ceiling	Maximum value of benefits or allowed percentage of deduction	Different values.
Benefited company	Definition of firms allowed to benefit from the tax break	(a) Only the R&D performing company; and (b) Other firms of the group.
Targeting (1)	Features limiting the group of eligible benefited companies	(a) All firms (no targeting); and (b) Only firms that comply with particular requirements (e.g., micro and small enterprises).
Targeting (2)	Benefitting sectors	(a) Horizontal policy (applicable to all industrial sectors); and (b) Vertical policy (strategic sectors or activities only).
Location of R&D	Location of R&D activities	(a) Only activities within the country or in particular regions; and (b) No geographical restrictions.
Time for claiming incentives	Fiscal year in which expenditures can be deducted or tax credits can be used	(a) In the same fiscal year; and (b) Subsequent (carry-forward) or previous (carry-back) years.
Policy term	Defines period of time for which incentives are valid	(a) Indeterminate; and (b) Temporary.

Source: Van Pottelsberghe (2003), EC (2014), OCDE, (2014a and 2015a) and Köhler et al. (2012).

As mentioned, the institutional structure of incentives varies significantly from one country to another, considering the categories and criteria described in Section 2.2 above. Table 2 summarizes data collected and presented in OECD (2015b) for a group of selected countries.

[15] According to Deloitte (2014), tax incentives were abolished as part of a reform of the fiscal legislation in 2010. They were replaced by direct funding.

[16] The country abolished tax benefits due to the complexity of the tax system (Van Pottelsberghe, 2003). Deloitte (2014) informed their reintroduction is currently under discussion.

This schematic summary reveals the multiplicity of possible arrangements, although some practices or strategies are more frequent. Hall and Van Reenen (2000) stressed that country factors and features that lead to the design of fiscal policies is an important topic of political economy that may present important insights.[17] Köhler et al. (2012) emphasized policies not only impact innovation spending but also firms' behavior and productive structure, including their collaboration networks, making incentives design even more relevant.

Table 2

Summary of tax incentives schemes in selected countries

Country	Tax credit		Allow-ances	Accel. deprec./ amort.	Capital spending[a]		Favored treatment for small enterprises	Innovation results
	Volume	Incre-mental			Machin-ery	Intan-gible assets		
Austria	X				X	X		
Australia	X				X	X	X	
Belgium	X		X	X		X	X	X
Brazil[b]			X	X	X	X		
Canada	X						X	
Chile	X			X	X	X		
China			X	X				X
South Korea		X					X	X
Denmark	X			X				
Spain		X		X	X	X	X	X
U.S.		X						
France	X			X		X	X	X
Ireland	X				X	X		X
Iceland	X				X	X		X
Italy		X				X	X	
Japan		X				X	X	
Netherlands			X		X	X	X	X
Norway	X				X		X	
U.K.	X		X	X		X	X	X
Russia			X	X	X			X
Sweden								
Turkey			X		X	X		X

[a] Expenditures on real estate not considered.
[b] OECD (2015b) does not mention tax incentives for machinery and equipment in Brazil. Nonetheless, Tax on Industrialized Products (IPI) exemption may be considered a tax credit, as described in section 4.2 below.
Source: OECD (2015b). Data refer to December 2015.

Not only more countries are resorting to this policy tool, but its use has also been intensified, giving tax incentives a greater relevance within innovation strategies. As estimated

[17] "Finally, the issue political economy cuts through many of the issues here. […] Understanding the process by which different policies are conceived and come to life is as important as evaluating their effects once they are born and grown up." (Hall and Van Reenen, 2000, p. 467).

by Warda (2013), the '*1-(b-index)*'[18] for the average of OECD countries increased from 0.02 to 0.12 for 1981 and 2011; cases of significant raise in the generosity of the tax regime happened in France (from -0.01 to 0.34), Portugal (-0.01 to 0.41), Spain (0.14 to 0.35) and South Korea (from -0.03 to 0.1). Figure 1 presents the evolution of this index for a group of countries, including the Brazilian case for comparative purposes, using the estimates of Araújo (2010).

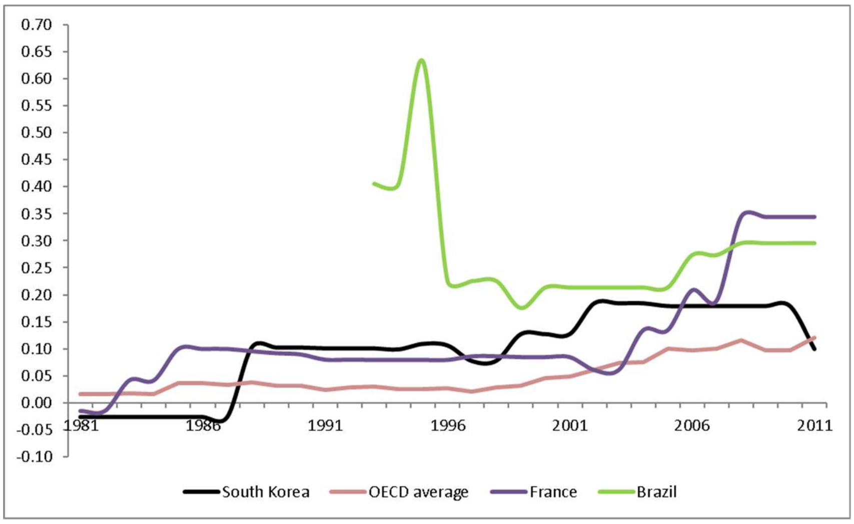

Figure 1. Evolution of the '*1-(b-index)*' for selected countries. Source: Araujo (2010) and Warda (2013).

Estimates of tax relief for R&D activities in OECD countries is estimated around 40 billion U.S. dollars in 2013; the value increases by 10 billion if incentives in China, Brazil and South Africa are considered (OECD, 2015b). Figure 2 presents the total volume of tax incentives for a group of countries in 2013. It is interesting to note that a high volume is not necessarily linked to a high rate of incentives, in light of the size of the national industry and economies of scale that arise thereof. As an example, the '*1-(b-index)*' of the two countries with highest volumes of tax breaks (U.S. and China) was 0.07 and 0.14, respectively.

[18] The 'b-index' measures the gross profit a representative company must have to offset a monetary unit of R&D outlay. The value is reduced by the tax incentive, for part of the cost is compensated by the benefit. Thus, the '*b-index*' decreases with an increase of the incentive rate. The '*1-(b-index)*', on the other hand, modifies such metric, turning it into a measure of tax generosity. It is directly proportional to the incentive rate.

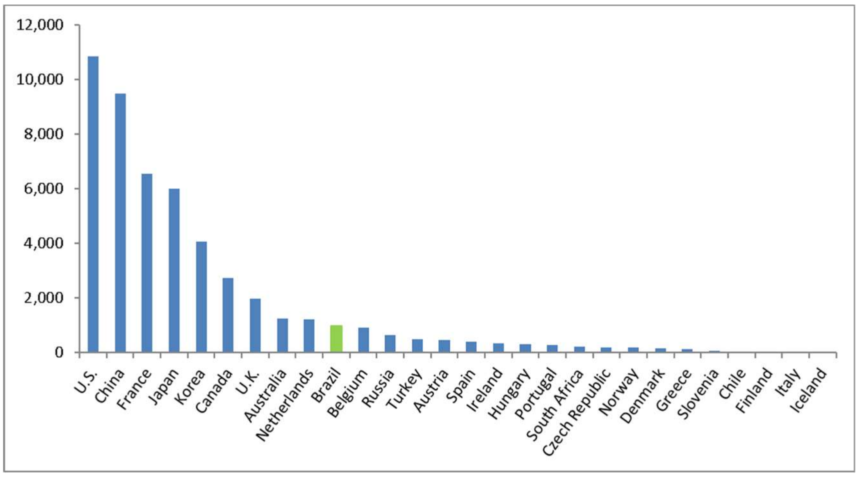

Figure 2. Volume of tax breaks for innovation in selected countries. Current values in US million dollars of 2013. Source: OCDE (no date).

The upsurge in the values of tax waivers is influenced by the increasing importance attributed to innovation policies over the past decades, along with the rise of GDP, business R&D expenditures, and the diversification of countries and actors competing for innovation resources (OECD, 2008).[19] But these general trends only partially explain the trajectory of tax incentives. Figure 3 shows how much of government incentives were granted to business innovation through tax benefits in 2006 and 2013. In most of the countries the proportion has raised, suggesting fiscal benefits did not only increase but became relatively more important in national innovation strategies, which seems to confirm the idea of a new paradigm in public policies for innovation, as discussed in the introduction section.

[19] The rising trend was however reduced by the international crisis of 2008-2010, as companies and governments had to adjust the innovation budgets and change their composition, focusing on productivity enhancing projects and reducing fragmentation of resources (OECD, 2014a).

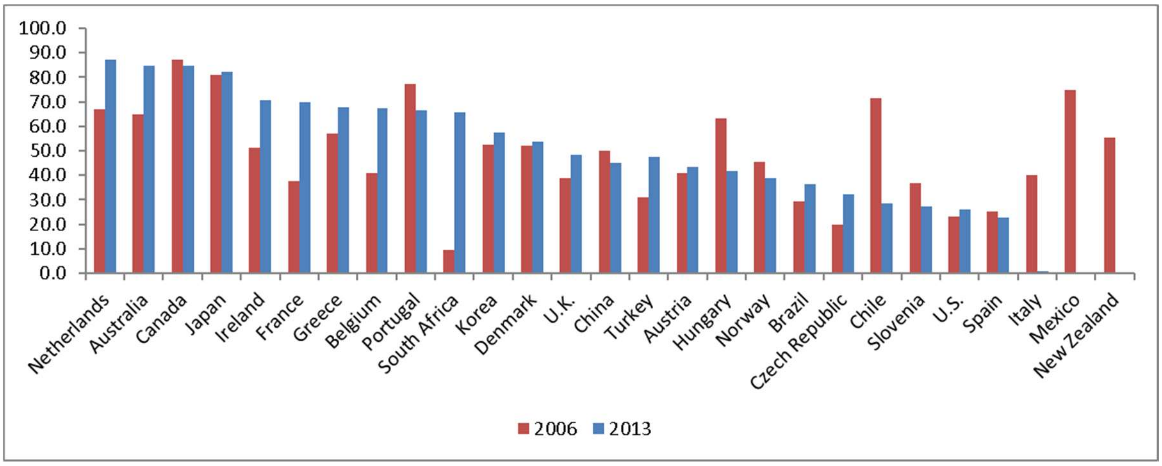

Figure 3. Tax Incentives as percentage of total government support to business R&D. Source: OECD (2015b).

3 The Economic Literature on Impact Assessment of Innovation Tax Policies

The existence of theoretical arguments backing the implementation of tax measures does not mean they are necessarily successful in increasing innovation investments, in light of the shortcomings of such tools as discussed in section 2.1. Studies assessing the impact of these policies have made substantial progress in recent decades by incorporating new quantitative and econometric methods. One of the pioneering analyses in this field is Griliches (1958), who estimated the impact of public and private funds in hybrid corn research and found positive results of government investment in R&D.

Evaluation of innovation tax policies became more frequent since the 1980s along with their increased use in different countries. A large body of literature analyzed and assessed incentives in several countries. Due to the relevance of the subject for policy recommendations and the growing number of empirical studies, different authors prepared literature surveys, trying to compare and summarize the findings and investigation strategies. I use surveys dated in different moments to track the evolution of this literature over time, summing up the main points and challenges identified at each moment in Table 3. Reviews and meta-analyses considered but not expressly included in the table are: Brown (1985), Daguenais et al. (1997), Mohnen (1999), Klette, Moen and Griliches (2000), Ientile and Mairesse (2009), OECD (2011), Castellacci and Lie (2013) and Gaillard-Ladinska, Non and Straathof (2014).

Table 3

Summary of surveys on the literature of impact assessment of tax incentives for innovation

Study	No. of analyzed studies	Period of publication of studies	Main methods of analysis identified	Findings on methods of analysis	Findings on impact estimate
Hall (1995)	16	1983-1993	Estimation of R&D demand equation, estimation of cost elasticity, case study and interviews.	Estimation of social return seldom applied; few studies at the firm level; administrative costs not considered.	Incremental R&D is slightly smaller than tax waive. Effects grow over time.
Hall and Van Reenen (2000)	20	1983-1997	Estimation of R&D demand equation, estimation of cost elasticity and case study.	Estimation of social return seldom applied; few analyzes of policies outside the U.S.; scarce attempts to assess impact on variables other than R&D expenditures.	Small impact of incentives – elasticity of R&D close to unitary; small effect on the short-term, but grows with time.
Van Potthels-berghe (2003)	20	1983-2003	Estimation of R&D demand equation, estimation of cost elasticity and case study.	Studies at the micro level fail to consider knowledge spillovers. Studies at the macro level assign direct impacts to incentives. Analyses are complementary.	Tax incentives increase R&D spending; low price elasticity; larger long-term effects.
Köhler, et al. (2012)	18	1993-2012	Estimation of R&D demand equation, estimation of cost elasticity, matching, regressions using different estimators (logit, probit, GMM)	Main shortcomings: reverse causality; valid instrumental variables; high adjustment costs; definition of a control group; relabeling; dated studies.	Incentives impact R&D spending even in the short-term; tax credits and incentives on total R&D have higher impact; firms' innovation rate is also affected, but impact on productivity is unclear.
EC (2014)	34	1997-2013	Structural Approach[a] Direct Approach [b]	Main challenges: use of natural and social experiments; reverse causality; selection bias; adjustment costs; relabeling; multiple treatments; publication bias; emphasis of the literature on R&D spending.	Most studies identify impact on R&D spending. More rigorous studies identify elasticity less than one. Incentives impact innovation generated by firms. Results vary according to the design of incentive and size of firms.

[a] Estimates elasticity of R&D to changes in the tax cost.
[b] Compares treatment and control groups.

These surveys suggest majority of studies reach a similar conclusion for the impact of tax incentives on R&D inputs. The findings generally point to: (a) evidence of impact even in the short-term; (b) a return close to (but lower than) unit; and (c) a growing impact over the long-term. Evolution of employed methods of analysis suggests studies at the firm level gained importance over aggregate investigations. They also became more sophisticated by using more rigorous estimation techniques (such as instrumental variables, GMM and matching). The challenges raised by more recent surveys refer to advanced and contemporary econometric and quantitative topics, instead of more general and basic problems pointed to by the first surveys.

According to Hall (1995) and Hall and Van Reenen (2000), limited availability of data explain the relative small number of studies estimating social costs and benefits of tax policies. For this reason, most of the analyses resort to the cost-benefit approach, comparing the amount of tax break with the incremental R&D by firms.

The literature surveys and meta-analyses also suggest two groups of methods for estimating the impact of tax incentives: the structural and direct approach (as the categories used by EC, 2014; and Gaillard-Ladinska et al., 2014. Hall and Van Reenen, 2000; and Ientile and Mairesse, 2009 also mention case studies and quasi-experiments, but the volume of papers is not large).

In the structural approach the researcher estimates the change in the innovation investment levels caused by a reduction of the user cost of R&D using a model expressed by an R&D demand equation (EC, 2014). The concept was developed and first used by Hall and Jorgenson (1967), Auerbach (1982) and King and Furleton (1984), and it aims to summarize in a single measure the tradeoff of innovation projects faced by firms, including capital depreciation, tax costs, and discount rate (Auerbach, 1982; Wilson, 2009). The estimated coefficient of the user cost of R&D variable represents the elasticity of spending. A similar but alternative technique replaces the variable for a dummy indicating the firm received tax incentives (Hall, 1995).

The structural approach was the chief method used in studies during the 1980s and 1990s. Some of the papers using this method are Eisner et al. (1984), Bernstein (1986), Hall (1993), Berger (1993), Daguenais et al. (1997), Bloom et al. (1998), Bloom et al. (2002), Klassen et al. (2004), Wilson (2009), McKenzie and Sershun (2010) and Crespi, Giuliodori, Giuliodori and Rodriguez (2016). Its main advantage is the theoretical foundation, for it requires an explicit model explaining how tax incentives impact R&D spending. The main drawback, on the other hand, is the reverse causality problem. As tax incentives and innovation investments are simultaneously observed and assessed, this raises concerns about endogeneity and consistency of regressions.

The direct approach is more recent (all studies mentioned in EC, 2014, were published after 1990). Impact is estimated as a treatment effect or through regressions that do not require an implicit economic structural model. It relies less on economic theory and uses the comparison between treatment and selected control groups (EC, 2014). Such empirical strategies necessarily employ analysis at the firm level, thus requiring greater data availability.

The main advantage of the direct approach is the array of statistical techniques and econometrics. On the other hand, it usually lacks (or is not built upon) an economic model that explains firms' behavior and how they react to tax incentives. Moreover, considering tax benefits are rarely assigned randomly, estimation in this case is subject to selection bias, meaning treated companies may be intrinsically superior to the control group, thus overestimating treatment effects. Different techniques are used in order to mitigate this problem, such as matching, difference-in-differences and sensitivity analysis.

Table 4 presents an overview of studies using the direct approach.[20] The table specifies the country or region considered in each study, the main methodological choices and findings. Although this literature review is limited to tax incentives, the approach has also been extensively used to evaluate direct government funding for innovation, as in Aschhoof (2009), Almus and Czarnitzki (2003), Benavente et al. (2012), Araujo et al. (2012) and De Negri et al. (2009).[21]

The results of these studies confirm what the literature surveys previously discussed. All identify a significant impact of tax incentives on innovation input, although the magnitude of the effect varies and some specific results are conflicting (Corchuelo and Martinez-Ros, 2009 did not find significant results for small firms, while Hægeland and Moen, 2007 found the additionality for these companies to be higher than for other groups).

The majority of studies limit their analysis to the impact of incentives on R&D spending or innovation inputs, confirming the conclusions of Hall and Van Reenen (2000) and EC (2014). The few studies that investigated innovation output found significant results, suggesting these are relevant matters to be addressed. Firms' performance, on the other hand, is mainly analyzed by Czarnitzki et al. (2011), who could not find significant differences between treated and control units.

The most frequent empirical strategies used to mitigate the selection bias problem are the propensity score matching (with nearest neighbor, kernel and radius matching algorithm) and two-stages Heckman.

[20] This literature summary is limited to such method because it is the one applied in this empirical study, as justified in section 5.
[21] For a review of the literature on direct incentives, see Cunningham, Gök and Larédo (2012).

Table 4

Literature review – Estimation of Impact of Tax Incentives Using the Direct Approach

Study	Country / region	Dependent variable (input)[a]	Dependent variable (output)	Estimator / empirical strategy	Tax incentive variable	Main findings
Guceri (2015)	UK	R&D spending		Diff-in-diff	Treatment dummy	18% increase in R&D spending.
Aralica et al. (2013)	Croatia	R&D spending	New products New processes	Matching – nearest neighbor; kernel; within caliper	Treatment dummy	Incentives increase the number of innovative firms, but not R&D spending; significant impact on new products, not on new processes.
Dumont (2013)	Belgium	Private R&D spending		Two-stages Heckman Maximum likelihood	Tax incentives only or with regional subsidies	Additionality effect of tax incentives decreases if firms also receive regional subsidies.
Yang et al. (2012)	Taiwan	R&D spending		Kernel matching	Treatment dummy	53.8% increase on R&D spending; impact varies according to the sector.
Duguet (2012)	France	Private R&D spending; no. of researchers		Kernel matching	Treatment dummy	Incentives increase R&D and number of researchers.
Czarnitzki et al. (2011)	Canada		New product; new product sales; originality of innovation; profitability of firm; Market share; competitiveness	Nearest neighbor matching	Treatment dummy	Impact on new products, sale of new products and originality of innovation; no significant difference in performance variables (profitability, market share and competitiveness).
Carboni (2011)	Italy	Private R&D spending		Nearest neighbor matching	Treatment dummy	Increase of € 1,163.00 in R&D spending. Tax incentives have a greater impact than direct incentives.
Yohei (2011)	Japan	R&D spending		Matching - nearest neighbor; kernel; within caliper	Treatment dummy	Incentives impact decision to carry out R&D, and raises spending by more than two times.

(continued)

Study	Country / region	Dependent variable (input)[a]	Dependent variable (output)	Estimator / empirical strategy	Tax incentive variable	Main findings
Bérubé and Mohnen (2009)	Canada		New product sales; new product; innovation novelty	Nearest neighbor matching	Tax incentives only or with direct funding	Firms receiving both tax incentives and direct funding innovate more and with greater originality.
Corchuelo and Martinez-Ros (2009)	Spain	R&D spending		Two-stages Heckman Matching – nearest neighbor; kernel	Treatment dummy	Incentives positively affect technological efforts, but impact is only significant for large firms.
Hægeland and Møen (2007)	Norway	R&D spending		Diff-in-diff	Treatment dummy	Positive impact on number of innovative firms and R&D spending; greater impact on smaller firms, with low technological levels or skills. Weak impact on cooperation with universities.
Ho (2006)	US	R&D spending Employment		Diff-in-diff Diff-in-diff-in-diff Matching – nearest neighbor; within caliper	Treatment dummy	Positive impact on R & D spending; no evidence of impact on employment in the whole sample. Weak evidence of positive impact on high-tech industry.
Avellar (2008)	Brazil	R&D spending Innovation expenditures		Nearest neighbor matching	Treatment dummy	Benefited firms increased R&D spending by 64%. No significant impact on innovation expenditures.
Kannebley Jr. and Porto (2012)	Brazil	Technical personnel		Tobit with fixed effects Matching – nearest neighbor; kernel; within caliper	Treatment dummy	Informatics Law: no evidence of significant impact on R&D spending; Law 11,196/05: significant impact on R&D of 7% to 11% in average.
Shimada, Kannebley Jr. and De Negri (2014)	Brazil	R&D spending Technical personnel		Tobit with fixed effects Nearest neighbor matching	Treatment dummy	Significant impact of 86% to 108% on R&D spending, and of 9% on technical personnel.

[a] The variable "R&D spending" can be considered in different forms (absolute value, value per worker, log-linear transformation, growth rate or percentage of sales).

Table A1 in the Appendix builds on the literature review by presenting information on covariates used in each study to match treatment and control groups. It is relevant to note the diversity of variables considered in each study. This may be partially attributed to a different understanding among scholars about relevant factors affecting probability of treatment, but it also reflects differences in the requirements and institutional design of tax policies, along with data availability for each country. One can find, nonetheless, that the following group of variables is more frequently employed in these studies: (a) firm size (measured by number of employees); (b) economic sector; (c) geographical location; (d) exports; (e) age; and (f) a measure of financial constraint or availability of resources (measured either by size of debts, profitability or access to external funds).

Nearly all studies displayed in Table 4 investigate policies implemented in developed and industrialized countries. One of the few exceptions, Aralica et al. (2013) noted one should not expect the same results to be found in developing economies as in developed countries. In this case, firms' behavior and technological strategies are more focused on improving productivity through acquisition of new equipment and knowledge from companies in developed countries.

Finally, the last three papers of the table are studies that evaluated tax incentives for innovation in Brazil using the direct approach. Avellar (2008) investigates the impact of the previous policy in place until 2005. Kannebley Jr. and Porto (2012) and Shimada et al. (2013) analyze the current policy established by Law 11,196/05. Methodology and results of these papers do not present relevant differences from international studies, except for Kannebley Jr. and Porto's (2012) findings that the national informatics policy did not have a significant impact on the industry's innovation levels.

4 Tax Incentives for Innovation in Brazil: The Law 11,196/05

This section describes the fiscal policy for innovation in Brazil, including a brief review of the political context in which these measures were adopted (subsection 4.1), the institutional framework and main rules shaping the incentives (subsection 4.2), main aggregate data available on the tax waiver and benefited companies (subsection 4.3), and previous studies on and evaluations of the policy (section 4.4).

4.1 Industrial policy and tax incentives for innovation in Brazil as from the 1990s.

Tax benefits became relevant as a policy tool to increase industry's competitiveness and technology levels in Brazil from the beginning of the 1990s. This policy shift can be better understood in the context of the broad structural reform taking place in the country during this period, affecting the monetary, fiscal and foreign trade policies, with the objective of promoting liberalization and opening of the market to foreign competition (Baumann, 1999; Castro, 2011; Pinheiro, Gill, Servén and Thomas, 2004).

These reforms changed the landscape of the Brazilian science and technology policy. Up to that point, the focus of the government had been on building up a research infrastructure by setting up and equipping laboratories and research institutes. Promoting business innovation was not considered a priority (Tigre et al., 1999). The Industrial and Foreign Trade Policy[22] enacted by President Collor de Mello in 1990, on the other hand, was based on fostering competition and competitiveness of national firms (Erber and Vermulm, 1993). The government reduced (or, in some cases, extinguished) market reserve and protectionist measures, and tax breaks were used to preserve the national industrial sector and foster its technological development. The Informatics Law (Law 8,248/91) and the reform of the Manaus Free Trade Zone (Law 8.387/91) are examples of such policies.

In 1993, the government enacted the Law 8,661/03, approving a comprehensive innovation tax policy for the industry, the Industrial Technological Development Program[23] (PDTI), and for the agricultural sector, the Agricultural Technological Development Program[24] (PDTA). In the case of PDTI, the benefits were: deductibility of R&D expenses from the income tax base (IR), up to 8% of the total tax due; exemption of the Tax for Industrialized Products (IPI)[25] for equipment and machinery; accelerated depreciation or amortization of purchased machinery, equipment and technology; tax credit for withhold income tax and reduction of the Tax on Financial Operations in the case of payments of royalties abroad; and deductibility of payments for technology transfer agreements (Law 8,661/93, art. 4, I to VI).

[22] "*Política Industrial e de Comércio Exterior*".
[23] "*Programa de Desenvolvimento Tecnológico Industrial*".
[24] "*Programa de Desenvolvimento Tecnológico da Agropecuário*".
[25] "*Imposto sobre Produtos Industrializados*".

The PDTI tax incentives were later substantially reduced, as part of a broader fiscal reform introduced by Law 9,532/97. Tigre et al. (1999) argued that such incentives were 'virtually extinguished', a reference to the drop on the number of approved projects (Corder and Salles-Filho, 2004). New incentives were later introduced by Law 10,637/02: benefiting firms were allowed to deduct R&D spending from the income tax base for the purpose of calculating both the IR and the Social Contribution on Net Profit (CSLL).[26]

The low number of firms that benefited and the results of the PDTI may be considered modest, if we take into account that this was a comprehensive policy applicable to the entire industrial sector. In eleven years of the program, only 267 companies benefited, and the total volume of tax breaks did not reach US$ 100 million[27] (Avellar, 2008). According to Pacheco (2007) and Corder and Salles-Filho (2004), the main problems that impaired a further expansion of the PDTI were the high concentration of R&D activities in a few industrial groups and the non-applicability of the most important incentive, deductibility for income tax calculation, to small businesses.

Nevertheless, Pacheco (2007) and Avellar (2008) highlighted the leverage of the policy, with the high values of R&D investments per benefited firms. Furthermore, the empirical study by Avellar (2008) found statistically significant impacts of the PDTI for R&D spending of 86% to 108%.

In the first half of the 2000s, a new industrial policy framework brought tax incentives to a more central position in the innovation policy debate. The Industrial, Technological and Foreign Trade Policy (PITCE)[28] of 2003 emphasized the importance of innovation from a different perspective than development policies of the 1970s and 1980s, focusing on raising competitiveness and building comparative advantages at the international level. According to Campanário, Silva and Costa (2005), horizontal policy and innovation are cornerstones of the PITCE.

In light of this new policy concept, in 2004 Congress approved Law 10,973/04, also known as the "Innovation Law", with a set of regulations and incentives to foster innovation, entrepreneurial R&D, and also cooperation between companies and research institutes. The law provided for the approval of new tax incentives, according to a bill to be proposed by the government executive branch (art. 28 of Law 10,973/04).

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[26] "*Contribuição Social sobre o Lucro Líquido*".
[27] Current value.
[28] "*Política Industrial, Tecnológica e de Comércio Exterior*".

The federal government enacted the Provisional Measure 252/05, with a set of tax reductions to boost the economy and increase competitiveness of the productive sector. Tax incentives for innovation were designed as part of this broader tax reform. The explanatory memorandum submitted by the Ministries of Finance and of Development, Industry and Foreign Trade stated "[...] the adopted measures increase the economic efficiency and support productive investment, creating conditions for a faster growth over the next years [...]".[29]

Provisional Measure 252/05 became ineffective as it was not approved by Congress within the time limit determined by the Brazilian Constitution.[30] The incentives and tax breaks were later included into another bill (result of Congress debates on Provisional Measure 255/05) that was approved and converted into Law 11.196/05, commonly referred to as "Law of Goodness".

4.2 The Tax Incentives of Law 11,196/05.

Chapter III of Law 11,196/05 ended the PDTI, while establishing a new institutional framework expanding tax incentives for innovation. At first the law provided for six tax benefits, but this number was later increased by amendments introduced by Laws 11,487/07, 11,744/08 and 12,350/10. Table 5 describes and classifies the incentives according to the analytical groups in subsection 2.2 above.

The law adopts a broad and internationally accepted definition of technological innovation as any new product or manufacturing process that enhances productivity or increases competitiveness (according to the Oslo Manual – OECD, 2005 – and the Frascati manual - OECD, 2015a). R&D is defined in art. 2 of Decree 5,798/06 as including basic and applied research, experimental development, basic industrial technology, and technical support services.

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[29] "[...] *as medidas ora adotadas, ao ampliar a eficiência econômica e estimular o investimento produtivo, criam condições para um crescimento mais acelerado da economia ao longo dos próximos anos* [...]". (CD, no date).

[30] Art. 62 of the Federal Constitution determines provisional measures should lose effectiveness if not converted into law within a period of sixty days, renewable once for an identical period of time.

Table 5

Tax incentives of Law 11,196/05 and later amendments

Activity or spending	Relevant tax	Type of incentive	Description of the incentives
		R&D expenditures	
Internal R&D spending, contracts with universities or research institutes; outsourcing to micro and small firms	IR[a] CSLL[b]	Allowance	Deduction of 160% of R&D spending (art. 17, I, §2 and art. 19) Additional 20% deduction in case of new research staff (art. 19, §1) Additional 20% deduction in the case of patented or registered agricultural product (art. 19, §3)
Research projects with science and technology institutes	IR[a] CSLL[b]	Allowance	50% to 250% of the cost of the Project (does not add to other incentives; art. 19-A)[e]
		Fixed cost and capital expenditures	
Purchase of machinery and equipment	IPI[c]	Tax reduction	50% of the tax value (art. 17, II)
	IR[a]	Accelerated depreciation	Full depreciation at the first year (art. 17, III)[f]
	CSLL[b]	Accelerated depreciation	Full depreciation at the first year (art. 17, III)[f]
Purchase of facilities, machinery and equipment	IR[a]	Allowance	Non-depreciated assets may be deducted from profit tax base (art. 20)[e]
Intangible goods	IR[a]	Accelerated amortization	Full depreciation at the first year (art. 17, IV)[e]
		IP protection	
Registration of intellectual property	IRF[d]	Tax reduction	Total exemption (art. 17, VI)[e]

[a] Income Tax.
[b] Social Contribution on Net Profit.
[c] Tax on Industrialized Products.
[d] Withhold Income Tax.
[e] According to an amendment by Law 11,487/07.
[f] According to an amendment by Law 11,774/08.
Source: Law 11,196/05 and further amendments.

The law does not clearly state the requirements for firms to benefit from the tax incentives. Taking only the deductibility of R&D expenses (the most important incentive in terms of volume, as discussed below), the minimum eligibility requirements are:

1. operate under the real profit tax regime: this is the tax base from which expenditures are deducted (art. 19);

2. tax clearance certificate (art. 23);

3. R&D expenditures during the fiscal year; and

4. taxable income at the same fiscal year: the law does not provide for deduction of expenses in subsequent or previous years (carryforward or carryback schemes).

In the case of IPI reduction for the purchase of machinery and equipment, the only requirement established by the law is proof of tax clearance.

The incentives may be considered a horizontal policy, in the sense they do not focus on specific industrial sectors or activities nor differentiate rates according to geographical criteria. The law requires, however, that spending should be made or paid to persons or companies located within national territory (art. 22, II).

Unlike other countries (see Table 2), Brazil does not adopt any favored treatment for small enterprises, with the only exception that R&D outsourced to these firms can be included in the calculation of incentives by the contracting company.

The policy design actually makes it more difficult for small firms to obtain the tax benefits. The requirement that companies operate under the real profit tax regime works as an entry barrier. Pursuant to the Brazilian tax legislation, firms with yearly revenue of up to 78 million Brazilian *reais*[31] can opt for the presumed profit regime (excluding specific cases such as financial institutions), and those with even lower income (up to 3.6 million Brazilian *reais*[32] annually) can opt for the SIMPLES regime.[33] In such cases, the law assumes a percentage of the revenue to be considered as profit for tax purposes. As these schemes are based on a presumed tax base, the regulations expressly forbid these companies to benefit from any tax deduction,[34] including those provided for in Law 11,196/05.

In order to better understand how restrictive this limitation is under an innovation policy perspective, it is worth considering that in 2013 only 155,000 firms opted for the real profit tax regime, which represents approximately 3% of the total number of operating companies in the country in that year (Receita Federal, 2015).

Regarding the duration of the policy, currently the law does not establish any deadline for the incentives, neither a maximum time limit nor a number of years for a company to benefit from them.

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[31] Around 25 US million dollars, considering the exchange rate of R$1,00=US$ 0,30, effective on August 3rd, 2016.

[32] Around 1,1 US million dollars, considering the exchange rate of R$1,00=US$ 0,30, effective on August 3rd, 2016.

[33] "*Regime Especial Unificado de Arrecadação de Tributos e Contribuições devidos pelas Microempresas e Empresas de Pequeno Porte - SIMPLES Nacional*".

[34] Decree 3.000/99, art. 526; and art. 19 of Normative Instruction SRF 608/06.

4.3 Main aggregate data about the incentives.

Firms claiming tax incentives must submit each year a report to the Ministry of Science, Technology and Innovation (MCTI), detailing the activities and expenditures to be deducted for tax purposes. Based on this information, MCTI publishes an annual report of the tax incentives for innovation, with aggregate data on benefited firms. According to the 2014 report, around 1.2 thousand companies claimed at least one of the incentives provided by the law that year. MCTI technical staff recommended the approval for nearly a thousand firms (MCTI, 2016).[35]

Figure 4 and Figure 5 present the evolution of the main indicators of incentives: The first displays total volume of R&D investment and tax break of the benefited firms, as well as the leverage of the policy; and the second shows the total number of recommended firms, along with the average tax incentive and R&D investment per year.

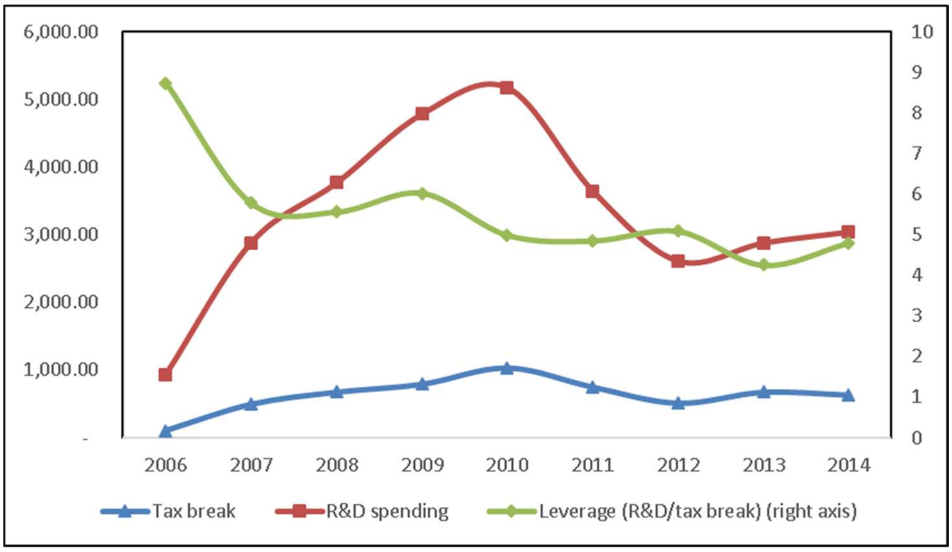

Figure 4. Aggregate investment in R&D, tax break and policy leverage for the group of benefited firms (recommended by the MCTI). Current values in US million dollars. Values converted pursuant to the exchange rate of the last day of each fiscal year. Source: MCTI (2016, 2015, 2013, 2012, 2011, 2010, 2009, 2008, 2007).

[35] The MCTI technical staff merely checks if firms complied with the legal requirements. Such analysis does not constitute prior approval of the incentives by government officials.

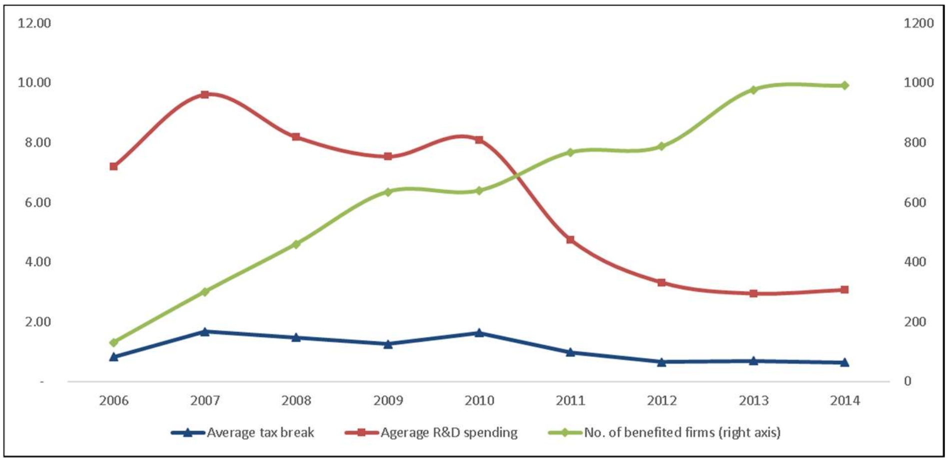

Figure 5. Average investment in R&D and tax incentive per firm; number of benefited companies (recommended by the MCTI). Current values in US million dollars. Values converted pursuant to the exchange rate of the last day of each fiscal year. Source: MCTI (2016, 2015, 2013, 2012, 2011, 2010, 2009, 2008, 2007).

Comparing these data against the previous policy (the PDTI) as discussed above, one can see the new framework established by Law 11,196/05 constituted a turning point in terms of the number of beneficiary companies and volume of incentives.

During the early years (2006-2009), innovation investments and tax incentives grew sharply. In the following period (2010-2012), however, both indicators experienced a decrease, in spite of the continuous rise in the number of participating companies. The MCTI attributed this problem to "bad economic results ", without further details (MCTI, 2013, p. 25). The growing number of benefited firms along with the drop of aggregate investments and tax breaks led to a sharp drop in the average indicators per firm, as shown in Figure 5. The last two years of the series (2013-2014) suggest the downward trend may have ceased, which can only be assessed once data for the following years are disclosed.

Table 6 shows the number of benefited firms by region, according to data disclosed by MCTI. Most of the companies are located in the southeast, particularly in the state of São Paulo. Benefited firms operate in different industrial sectors, as presented in Table 7. The industries with the highest levels of participation in the policy are transport equipment, software, chemical/petrochemical and electronics.

Table 6

Benefited firms, innovation investments, and volume of tax break per country region (2014).

Country region	Benefited firms		Innovation Investments		Tax incentives	
	No	%	U.S. millions	%	U.S. millions	%
Southeast	727.00	60.28	2349.03	77.29	485.43	76.70
South	388.00	32.17	435.97	14.34	93.76	14.82
Northeast	43.00	3.57	81.43	2.68	18.55	2.93
North	26.00	2.16	145.72	4.79	29.79	4.71
Midwest	22.00	1.82	27.03	0.89	5.34	0.84
Total	1206	100	3039.18	100	632.86	100

[a] Only firms recommended by the MCTI.
Source: MCTI, 2016.

Table 7

Number of benefited firms per year and industrial sector

Industrial Sector	Number of benefited firms[a]								
	Year								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Transport equipment	30	81	114	111	147	154	125	189	190
Software	4	1	20	31	45	57	65	98	141
Chemical / Petrochemical	22	26	32	55	67	70	99	97	81
Electronics	13	45	66	53	42	65	57	72	86
Food	4	14	33	40	46	57	67	71	74
Consumer goods	2	21	33	37	46	52	49	59	36
Metallurgy	22	26	32	43	45	43	47	43	39
Pharmaceutical	11	13	16	31	37	37	42	39	44
Mining	2	1	1	4	7	13	18	19	17
Paper	5	7	7	12	13	14	17	17	19
Textile	1	4	6	9	9	10	6	17	4
Construction	3	7	17	17	7	13	11	16	17
Furniture	0	8	11	14	8	21	22	15	4
Agribusiness	0	14	23	20	10	13	11	13	15
Telecommunications	0	3	17	21	6	2	1	9	12
Others	11	29	32	44	104	146	150	203	212
Total	130	300	460	542	639	767	787	977	991

[a] Only firms recommended by the MCTI.
Source: MCTI (2016, 2015, 2013, 2012, 2011, 2010, 2009, 2008 and 2007).

As a last remark, according to the MCTI report (MCTI, 2016), deductibility of R&D expenses represents the largest bulk of incentives petitioned by firms. Around 74% of the total refers to deduction from the income tax base, 26% refers to deduction from CSLL, and less than 1% comes from the reduction of the IPI (data refers to 2014).

4.4 Studies and evaluations about the tax incentives.

The MCTI annual reports have a descriptive and informative character and do not focus on evaluating the results or the impacts of the incentives. They present, nevertheless, general conclusions and information regarding the implementation of the policy. The 2014 report (MCTI, 2016) affirmed that the Law 11,196/05 supports the development of business R&D, improving and adding new features to products and processes. It also presented a critical appraisal about the innovation projects described by firms, noting that in many cases they fail to adequately explain the new technology and novelty of the research. Problems in the spending breakdown are also common (MCTI, 2016). The general picture points to R&D not being a systematic and continuous activity conducted by the firms, thus raising problems in its implementation and bookkeeping.

So far only few studies have investigated and assessed the results of tax incentives for innovation of Law 11,196/05. Two of them are econometric assessments mentioned in Table 4. The object of both papers is to evaluate the impact of policy innovation inputs and present similarities in their empirical strategy approach and choice of estimators. They first apply a matching algorithm to select a control group, which is followed by panel data with fixed effects estimators. Kannebley Jr. and Porto (2012) used research technical staff as the dependent variable, and Shimada et al. (2014) also introduced R&D expenditures. Both studies found similar additionality impact on research technical staff (around 10%), while the effect on R&D spending found by Shimada et al. (2014) is substantially higher (over 100%).

Kannebley Jr. and Porto (2012) also employed qualitative techniques to evaluate the policy, based on interviews with firms' management. They claimed the incentives were relevant to preserve the levels of R&D investment and take higher risks. They also enabled firms to intensify or pursue their innovation strategies further, in accordance with the 'market-oriented' nature of tax incentives argument. The shortcomings pointed to by firms were mainly related to the management and control processes established by government authorities, rather than to the incentives themselves. Documents and bureaucratic procedures were considered excessive and burdensome, and particularly not suited for small and medium-sized enterprises.

Other studies used different methodologies to evaluate the incentives. Araujo (2010) calculated their impact on the '*b-index*' around 8%, with further reductions due to subsequent amendments. Calzolaio and Dathen (2012) used aggregate data and found the law intensified innovation activities but failed to increase the pool of innovative firms. Fabiani and Sbragia (2016) analyzed data from 26 benefited firms and concluded the incentives are relevant to foster R&D but improvements on the policy design are necessary to increase results. Matias-Pereira (2015) analyzed the MCTI reports and other studies and found evidence that gains were achieved by participating companies.

5 Empirical Strategy: Methodology and Data

The econometric study described herein aims to assess and estimate the impact of the tax incentives provided by the Law 11,196/05 on benefited firms. The first part of the investigation focuses on firms' innovation efforts and investments. The objective is to test for the presence and to measure the magnitude of additionality effects of the incentives, so as to verify whether there was an actual increase in the levels of innovation inputs, or if this is a case of full crowding-out, in which firms diverted any additional resources to other activities.

The presence of positive impacts on inputs does not necessarily imply that outputs and firms' performance are also positively affected. The final outcome of innovation projects is influenced by different factors other than total volume of investments. As discussed in section 2.1 above, there are arguments to maintain that outputs may not be impacted by public support, even if inputs are: (a) moral hazard, suggesting firms develop riskier projects when financed by public funds (Arrow, 1962); (b) upsurge of inputs' price, especially through researchers' compensation; and (c) relabeling of different activities as innovation expenditures. For these reasons, the second part of this empirical investigation assesses whether the fiscal policy had any observable and measurable impact on firms' innovation results and business performance.

For this study, I use disaggregate data at firm level and adopt the direct approach mentioned in section 3 above. Treatment impact is estimated through a non-experimental technique, the propensity score matching (PSM), following the literature summarized in Table 4. The main references used for the development of the empirical strategy are Rosenbaum and Rubin (1983), Dehejia and Wahba (1999, 2002), Caliendo and Kopeinig (2005), Wooldridge (2002) and Rosenbaum (2010), to which I refer to for a detailed explanation of the PSM method.

This empirical strategy was chosen for a number of reasons. First, the available data is more suited for this method, for the identification of benefited firms is disclosed in MCTI annual reports, but the breakdown of incentives per company is classified information and not available under Brazilian law. With such information, it was possible to generate binary treatment dummy variables indicating participation in the policy, and dividing firms into treatment and control groups.[36]

Furthermore, by ensuring the common support assumption and balancing the distribution of covariates, PSM permits a direct comparison of outcomes and a more robust estimation of causality. Linear regression analyses, on the other hand, commonly uses all units within the sample, skipping or disregarding large differences between them, thus affecting the consistency and reliability of results (Domingue and Briggs, 2009).[37]

Another advantage of PSM is it does not depend on the correct functional form of the model to estimate the causality between treatment and outcome variables (Zanutto, 2006). Rubin (2006) also mentioned PSM enjoys an "ethical advantage", because the outcome variable is not considered in the estimation of the propensity score, therefore it does not influence the treatment probability model. This is not the case in most of linear or parametric regressions.

Finally, the direct approach is currently applied in a great number of empirical studies investigating innovation policies, as discussed in section 3. The use of the same research method makes the results more comparable with this literature.

This empirical research complements and advances in several ways the previous quantitative impact assessments of the tax incentives provided by Law 11,196/05 (as mentioned in Table 4). First, the impact of the policy is measured not only on R&D spending but also on the broad category of innovative activities, which includes basic or applied research and experimental development as well as other secondary activities the acquisition of goods, services and external knowledge related to innovation. Second, I also investigate whether the policy increased the base of companies investing and achieving innovation. And, finally, I investigate innovation output and firms' performance variables, which have not been considered in previous studies. These additional variables provide a more

[36] The estimation of a R&D demand equation, on the other hand, would require the value of incentive for each firm.
[37] For this reason, Angrist and Pischke (2008) suggest to use the PSM to select the sample, but estimate the impact through linear regression.

comprehensive and detailed understanding of how the policy affects the technological efforts of firms.

This study is also the first to assess the impact of the Brazilian policy using the Average Treatment Effect on the Treated (ATT) estimator (Dehejia and Wahba, 1999, as explained below) in a difference-in-differences framework.[38] Finally, the earlier analyses did not use data from the 2011 edition of PINTEC (IBGE, 2013). In this sense, the results described herein can be used to compare whether previous findings remain valid or if later developments of the policy led to significant changes in its impact.

5.1 Empirical strategy: theoretical basis.

The rationale and main goal of the selected research strategy is to estimate the causal effect of treatment - in this case, the tax incentives for innovation established by the law. Dehejia and Wahba (2002) defined causality as "a manipulation or treatment that brings about a change in the variable of interest, compared to some baseline, called the control" (p. 152).

The question is presented by the authors as follows: in a population indexed by (i), (Y_{i1}) is the value of the outcome variable if unit i is exposed to treatment ($t = 1$), while (Y_{i0}) is the value if the unit is subject to control (absence of treatment; $t = 0$). I am interested in estimating the average effect of treatment on treated units ($\tau|t = 1$), which, by definition, means the difference between the expected value of the outcome variable in these individuals and the value of that variable if they had not received treatment:

$$\tau|_{t=1} = E(Y_{i1}|t_i = 1) - E(Y_{i0}|t_i = 1) \qquad (1)$$

As one cannot observe both values for one single unit, it is necessary to apply a counterfactual method to estimate the expected value for treated units in the absence of treatment ($E(Y_{i0}|t_i = 1)$). In the case of experimental studies, the expected value of the control group serves such purpose, since random treatment assignment ensures it to be the same as the treatment group if it had not been treated.

[38] The previous studies have used the PSM to select the observations, but the impact was not estimated through the ATT.

$$E(Y_{i0}|t_i = 1) = E(Y_{i0}|t_i = 0) \rightarrow \tau|_{T=1} = E(Y_{i1}|t_i = 1) - E(Y_{i0}|t_i = 0) \quad (2)$$

In the case of observational studies, however, the researcher has to take into account a possible selection bias problem (Dehejia and Wahba, 2002), making the counterfactual estimation a more complex operation. For innovation policies, it is likely and expected that treatment assignment is not random, and that companies benefiting from government incentives are in average already in a better position or have higher skills or capacity to innovate. Such differences on the units' features tend to create a bias that overestimates the impact of the policy in case of a direct comparison between the two groups, for the baseline expected value of the treatment group may be higher than that of the control group ($E(Y_{i1}|t_i = 0) > E(Y_{i0}|t_i = 0)$).

In order to overcome this problem, the estimation requires a preliminary step that minimizes such differences, making the control group a suitable counterfactual for treated units. The objective of the PSM is to work as this first stage. The main assumptions of the method are:

1. *Conditional independence assumption*:[39] treatment assignment can be considered as if determined by a set of independent observable variables (X_i). Once these are controlled for, assignment can be deemed as random, and there is no significant difference between individuals subject to treatment and those in the control group. The value of (Y_{i0}) thus becomes independent of treatment

$$(Y_{i0} \perp\!\!\!\perp t_i|X_i) \rightarrow E(Y_{i0}|t_i = 1) = E(Y_{i0}|t_i = 0) \quad (3)$$

2. *Propensity score:* the set of independent variables (X_i) can be merged into a single propensity score ($p(X_i)$) that reflects the probability of treatment assignment (Dehejia and Wahba (1999)). The only purpose and advantage of this index is to deal with the 'curse of dimensionality' (Caliendo and Kopeinig, 2005) of the model ($t_i \perp\!\!\!\perp X_i|p(X_i)\,; Y_{i0} \perp\!\!\!\perp t_i|p(X_i)$).

3. *Stable unit treatment value assumption* (Wooldridge, 2002): treatment impacts only the unit receiving it, without any spillovers or secondary impact on control units. This

[39] Proposition 1 in Dehejia e Wahba (2002), ignorability of treatment in Rosenbaum and Rubin (1983), or assumption ATE.1 in Wooldridge (2002).

assumption is hardly true in the case of innovation policies because of knowledge spillovers. Such violation, however, actually means the impact is underestimated, for it does not take into consideration the effect of the policy on the expected value of (Y_{i0}), the baseline value. Estimated results of the empirical study, for this reason, can be interpreted as a minimum additionality effect, disregarding spillovers.

4. *Common support* (Aschhoff, 2009): for each treatment or control unit there is at least one observation in the other group, respectively, with a similar set of observable variables. This assumption requires the exclusion of observations with a propensity score above the maximum level common to both groups, as well as those below the minimum common level.

If these assumptions are met, the average treatment effect on treated units (ATT) can be identified as (Dehejia and Wahba, 1999):

$$\tau|_{t=1} = E\{E(Y_i \mid t_i = 1, p(X_i)) - E(Y_i \mid t_i = 0, p(X_i)) \mid t_i = 1\} \quad (4)$$

The PSM is implemented in two stages. First, it is necessary to estimate the propensity score with the available variables, using a probit or logit probability model. After estimating ($p(X_i)$), the second step is to select and apply an algorithm to match treated and control units (Dehejia and Wahba, 1999). This is a particularly important choice, each of which present advantages and disadvantages. Algorithms using few control units (nearest neighbor, radius matching with reduced caliper) have the advantage of comparing more homogeneous individuals, but they discard or disregard a large number of observations from the sample. On the other hand, matching using a greater number of controls (kernel or radius matching with a high caliper) use more information from different observations, with a greater heterogeneity that may jeopardize one of the main advantages of the PSM.

The specification and matching should be evaluated with a means test to confirm that matched treatment and control groups do not have an average with statistically significant variations in the observable variables (balancing condition).

With the exception of dummy outcome variables, treatment effect was calculated using a difference-in-differences estimator that considers the evolution of outcome variables before and after treatment impact. This method helps to minimize selection bias even further by eliminating fixed effects. Its key assumption is that, in the absence of treatment, trends for treated and control units would be the same. Treatment, therefore, changes the evolution of outcome variables for treated units, and the impact is measured by estimating the departure from the trends of the control unit (Blundell and Dias, 2000; Angrist and Pischke, 2008).

5.1.1 Sensitivity analysis to hidden variable bias.

Even after applying the PSM and the means test, there still remains the risk of selection bias caused by unobserved variables, so that conditional probability of treatment assignment for treated and control groups is not the same. According to Rosenbaum (2010), in observational studies one can never completely eliminate the possibility of such bias. For this reason, the author suggests a sensitivity test that measures the maximum size this bias can take before compromising the results of the PSM.[40]

Essentially, the Rosenbaum bounds test investigates the ratio of odds of treatment for treated (π_k) and control (π_l) units (represented by the parameter (Γ)), calculated as follows (Rosenbaum, 2010):

$$\frac{1}{1+\Gamma} < \frac{\pi_k}{\pi_k+\pi_l} < \frac{\Gamma}{1+\Gamma} \tag{5}$$

The test gradually increases the parameter (Γ), in order to find the maximum value it can take due to the presence of unobserved variables. To sum up, if the impact estimate remains statistically significant (pursuant to the adopted confidence level) for high values of (Γ), the results are considered sufficiently insensitive to a possible hidden selection bias.

There is no rule of thumb recommended by the literature for a minimum acceptable value of (Γ). According to Becker and Caliendo (2007), the test indicates the worst-case scenario in which bias caused by an omitted variable would invalidate the results, but that does not mean such bias actually exists or has such magnitude. Diprete and Gangl (2004) argued that, for the confidence interval to include zero (removing statistical significance), it is necessary that any omitted variables (a) actually affect the chances of treatment assignment differently for treated and control groups, increasing the odds ratio to at least the

[40] "The sensitivity of an observational study to bias from an unmeasured covariate *u* is the magnitude of the departure from the naive model that would need to be present to materially alter the study's conclusions." (Rosenbaum, 2010, p. 76).

size of the observed bounds; and (b) also influence the outcome variable so strongly as to almost perfectly determine the difference between matched observations. One can also argue that, as a comprehensive group of relevant covariates influencing treatment is included in the estimation of the propensity score, the accepted threshold should decrease, for it is less likely that remaining omitted variables would influence the results substantially.

As examples of values of this test accepted in the literature, Aralica and Bótric (2013) found R&D spending to lose significance at a 90% confidence level for ($\Gamma < 1.4$), while Diprete and Gangl (2004) accepted (Γ) values ranging between 1.15 and 2.3.

5.2 Empirical strategy: practical features.

This section summarizes the key choices for the implementation of the PSM analysis. In the research design, I have followed closely the international literature reviewed in section 3, with minor changes to adapt to the Brazilian policy context and availability of data.

The average treatment effect on the treated (ATT) was estimated for two groups of outcome variables: first, those measuring technological effort or inputs of firms' innovation projects; and those indicating innovation output and performance of firms.

PSM was estimated using the covariates described in section 5.4 below and a logistic functional distribution, following Busom, Corchuelo and Martinez-Ros (2014), Becker and Caliendo (2007) and Yang (2012).[41] Considering the sample of firms changes for each outcome variable in light of missing values and the objective of each regression (as explained in subsection 5.3 below), a specific propensity score was estimated for each case, so it would more appropriately reflect the probability of treatment for that group. Following different empirical studies presented in Table 4, treated observations were matched with their first nearest neighbor in the control group.

It is assumed that, in the case of spending and other input variables, impact takes place and is observed at the same year of treatment, i.e. 2011. As for the output and performance variables, there must be a time lag for projects and investments fostered or funded by the incentives to mature, so that their results can be assessed. As the main database is updated every three years, this is considered the maturing period. This is close to the international practice (*t-2*) recommended by the Oslo Manual (OECD, 1997). Therefore, for these variables, I consider treatment occurs in 2008 and results are observed in 2011.

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[41] Caliendo and Kopeinig (2005) stated the choice between logistic and probit models is not critical for the binary treatment case).

In order to obtain the confidence interval and significance value of the regressions, I estimated the heteroskedasticity-consistent analytical standard errors as proposed by Abadie and Imbens (2006), using two neighbors to calculate conditional variance.

For each case, a means test was ran to assess quality of matching and ensure covariates are balanced between the two compared groups. In this test, the following indicators are analyzed (a) the t-test results for each covariate, to check if differences in means are significant; (b) reduction on the standardized bias for each covariate; (c) reduction of the pseudo-R^2 value for the matched sample, that indicates how much regressors explain participation probability; (d) the joint significance F-test; and (e) the mean and median bias for the matched sample (Caliendo and Kopeinig, 2005).

The sensitivity analysis was calculated through the Wilcoxon sign rank test (upper and lower bounds for p-values) and the Hodges-Lehman point estimates and confidence intervals, using (Γ) intervals of (0.1) up to the value of two. Parameter (Γ) reaches critical value when the upper bound reaches zero or p-value is greater than 0.05. Sensitivity to hidden bias is indicated by how close the critical value of (Γ) is to one.

As a robustness check, PSM was again estimated applying two alternative algorithms, to minimize the shortcomings of the nearest neighbor matching: kernel; and radius matching within caliper of 20% of the standard deviation of the propensity score (as recommended in Austin, 2011).[42] As an alternative specification, I calculated the ATT excluding the sector dummy variables from the propensity score model.

5.3 Dataset and sample design.

Three databases with information disaggregated at the firm level were merged to generate the dataset used in this empirical study. The main one is the PINTEC, a comprehensive survey on industrial innovation conducted by IBGE every three years. For this analysis, the 2008 and 2011 editions (IBGE, 2010 and 2013) are considered.

The list of firms that benefited from the tax incentives is disclosed by the MCTI in its yearly reports (MCTI, 2009 and 2012b). The third database is the list of exporting and importing firms in the year preceding participation in the policy (2007 and 2010), disclosed by the Brazilian Ministry of Development, Industry and Foreign Trade (MDIC, no date).

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[42] As the Abadie and Imbens (2006) standard errors estimation procedure is not applicable to these cases, regressions were bootstrappted using one hundred repetitions.

Disaggregated firm data was merged and organized in an unbalanced panel dataset with two periods (t = 2008, 2011), thus allowing intertemporal analysis of policy impact (difference-in-differences). For this reason, only firms present in both editions of PINTEC are used in the analysis. Nominal values for 2008 were deflated using the IGP-DI index.[43]

The baseline value for the outcome variables is observed in (*t-3*), i.e., 2008. For this reason, all firms that benefited from the tax incentives before this year were excluded from the dataset, ensuring the trend is not biased at the outset. I also ignored all firms of the control group that received the incentives at any point in time, in order to assure secondary effects will not disturb the results. In the case of outcome variables indicating innovation input, treated firms that benefited from the incentives in 2008 were ignored. Table 8 summarizes the sample design of treatment and control groups for the two analyses (input, and output/performance variables).

Table 8

Policy participation requirements for a firm to be considered in the treatment and control groups

Outcome variables	Group	Firm was only considered in the group if it complied with all of the following requirements			
		Did the firm participate in the policy			
		before 2008?	in 2008?	between 2008 and 2011?	in 2011?
Input	Treatment	No	No	Yes or no	Yes
	Control	No	No	No	No
Output	Treatment	No	Yes	Yes or no	Yes or no
	Control	No	No	No	No

The PINTEC sample comprises a large and diverse group of firms with different capabilities and potentials for innovation. In order to enhance quality of the matching, size of the sample was limited using variables present in the PINTEC survey. Samples were chosen for each outcome variable under analysis, considering the objective of the investigation and in order to balance number of observations and homogeneity of firms for each case. Table 10 below presents the sample criteria used for each outcome variable.

[43] This is the same deflation index used in FAPESP (2011) for innovation expenditures.

Finally, in order to avoid that outlier observations bias the analysis, maximum and minimum values were established for each variable, excluding observations out of this range.

5.4 Variables and descriptive statistics.

Treatment variables are binary dummies indicating whether the firm benefited from the tax incentives in the relevant year. Table 9 presents the number of firms in the treatment and control groups considering different samples.

Table 9

Number of observations per treatment group

Sample delimitation criterion	No. of observations			
	Treatment in 2008 (Output and performance variables)		Treatment in 2011 (input variables)	
	Control	Treated	Control	Treated
Whole PINTEC sample	13,403 (98.7%)	177 (1.3%)	13,403 (97.8%)	303 (2.2%)
Innovated in the last 3 years	5,901 (97.5%)	151 (2.5%)	5,901 (95.7%)	267 (4.3%)
Positive innovative spending[a]	5,072 (97.2%)	146 (2.8%)	5,072 (95.0%)	264 (5.0%)
Positive R&D spending	1,874 (93.5%)	131 (6.5%)	1,874 (89.1%)	228 (10.9%)

Percentage of observations for each group of total in parenthesis. Number of control units for both treatment years match because they present the same requirements (see Table 8).
[a] The broad category of innovative activities adopted by PINTEC includes: internal and external R&D; acquisition of knowledge from third parties; software license or acquisition; acquisition of machinery and equipment; training; introduction of innovations in the market; and industrial design and other measures for production and distribution (IBGE, 2013).

Outcome variables are defined in Table 10, along with the delimitation criterion used to select the sample for each analysis. Continuous variables represent the difference between real values in 2011 and 2008, while dummy variables consider exclusively the value in 2011.

Table 10

List of outcome variables, definition and sample delimitation criterion

Group	Variable	Description	Sample delimitation criterion
Input	*in_exp*	Innovative activities expenditures - difference between 2011 and 2008 values (continuous)[a]	Firms that innovated in the last 3 years and had positive innovative activities expenditures in the last year.[b]
	rd_exp	R&D expenditures - difference between 2011 and 2008 values (continuous)	Firms that innovated in the last 3 years and had positive R&D expenditures in the last year.[b]
	researcher	Total number of R&D personnel - difference between 2011 and 2008 values (continuous)[c]	Firms that innovated in the last 3 years and had positive R&D expenditures in the last year.[b]
	in_dummy	Positive innovative activities expenditures (dummy)	Firms with no innovative spending in 2008.
	rd_dummy	Positive R&D expenditures (dummy)	Firms with no R&D spending in 2008.
Output and performance	*inovator*	Firm innovated in the last 3 years (dummy)	Whole PINTEC sample
	new_sales	Share of new products in total sales - difference between 2011 and 2008 values (continuous)	Whole PINTEC sample
	new_exp	Share of new products in total exports - difference between 2011 and 2008 values (continuous)	Whole PINTEC sample
	revenue	Net revenue- difference between 2011 and 2008 values (continuous)	Whole PINTEC sample
	personnel	Total employment- difference between 2011 and 2008 values (continuous)	Whole PINTEC sample
	rev_person	Net revenue per employee- difference between 2011 and 2008 values (continuous)	Whole PINTEC sample

[a] The broad category of innovative activities adopted by PINTEC includes: internal and external R&D; acquisition of knowledge from third parties; software license or acquisition; acquisition of machinery and equipment; training; introduction of innovations in the market; and industrial design and other measures for production and distribution (IBGE, 2013).
[b] The PINTEC only requests information on expenditures for the last year of each survey.
[c] Part-time researchers are weighted according to the work time dedicated to firm's R&D.

Effect of the policy on input or technological effort was measured through five indicators: firms' spending with innovation, considering both innovative activities and strict R&D; size of R&D staff; and whether firms that did not have any expenditures in innovative activities and R&D in 2008 started to invest by 2011. For the output and performance analysis, six outcome variables were considered: whether government funding increased the chances of a firm to innovate (dummy variable '*inovator*'), impacting the base of innovative companies; if newly developed products represented a higher share of sales and exports of incentivized firms; and if, after the maturing period, benefited firms had significantly outperformed their control group matches in terms of total employment, net revenue, and net revenue per employee (as a measure of productivity).

Following the recent literature (Guceri, 2015; Dumont, 2013; Duguet, 2012, and Yang, 2012), Figures Figure 6 to Figure *16* present the 'naïve estimator' for each outcome variable, or the direct comparison of means for treated and control groups without any prior matching. It provides a first indication on whether treated units present a superior outcome, without considering selection bias problems. Continuous variables are displayed in a boxplot format, while binary ones are depicted in stacked percentage columns. Moreover, Table 11 provides descriptive statistics for all outcome variables.

The naive estimator suggests the policy affected four out of five input variables, i.e. positively impacting R&D expenditures, hiring of research personnel and base of firms investing in both innovative activities and R&D. The mean value of innovative expenditures for control and treated groups, on the other hand, is highly similar, suggesting absence of treatment effect.

The direct comparison indicates that the policy positively impacted the base of innovative companies, share of new products in total sales and company size, and that it had no effect on share of new products in exports and net revenue. Surprisingly, the productivity variable (*rev_person*) points to a negative impact of the policy.

These results provide a first basis for the empirical study, as it suggests the tax benefits have affected innovation investments, results and performance of benefited firms. These impressions are tested through the PSM procedure, as previously described.

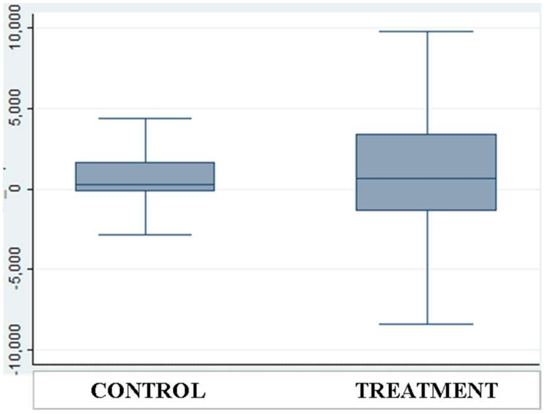

Figure 6. Innovative activities expenditures for control and treatment groups (difference between 2011 and 2008 real values). Treatment in 2011. Excludes outside values. Source: IBGE (2010 and 2013; confidential data).

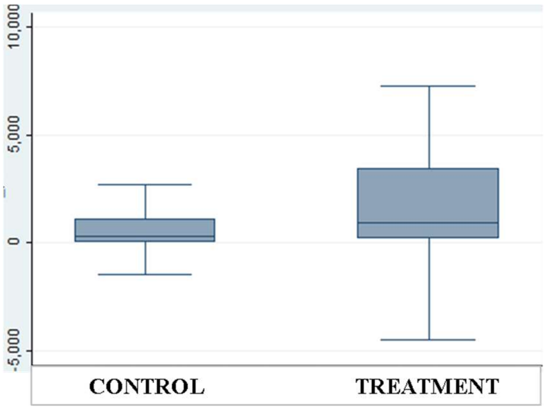

Figure 7. R&D expenditures for control and treatment groups (difference between 2011 and 2008 real values). Treatment in 2011. Excludes outside values. Source: IBGE (2010 and 2013; confidential data).

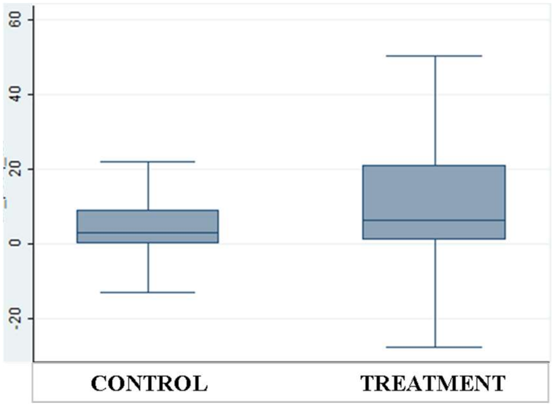

Figure 8. Total number of researchers for control and treatment groups (difference between 2011 and 2008 real values). Treatment in 2011. Excludes outside values. Source: IBGE (2010 and 2013; confidential data).

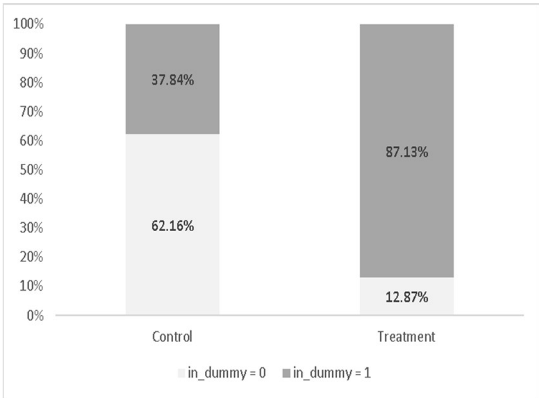

Figure 9. Share of firms with positive innovation activities expenditures in the treatment and control groups. Treatment in 2011. Source: IBGE (2010 and 2013; confidential data).

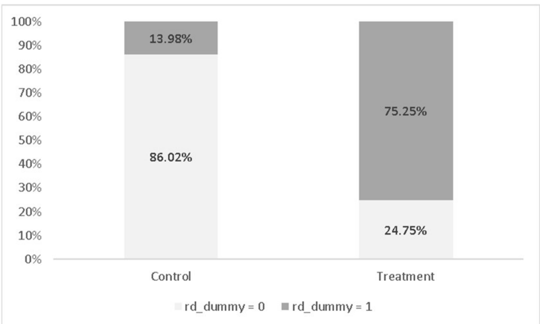

Figure 10. Share of firms with positive R&D expenditures in the treatment and control groups. Treatment in 2011. Source: IBGE (2010 and 2013; confidential data).

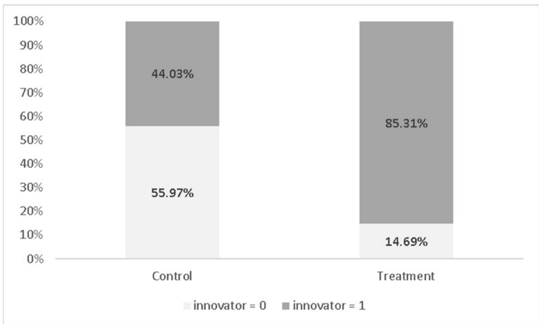

Figure 11. Share of firms that innovated in the 2008-2011 period for treatment and control groups. Treatment in 2008. Source: IBGE (2010 and 2013; confidential data).

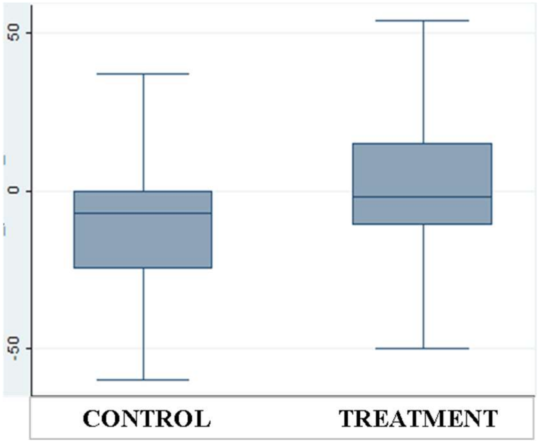

Figure 12. Share of new products in total sales (difference between 2011 and 2008 real values). Treatment in 2008. Outside values excluded. Source: IBGE (2010 and 2013; confidential data).

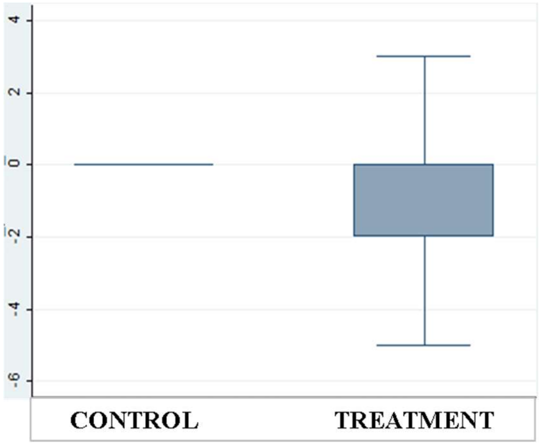

Figure 13. Share of new products in total exports (difference between 2011 and 2008 real values). Treatment in 2008. Outside values excluded. Source: IBGE (2010 and 2013; confidential data).

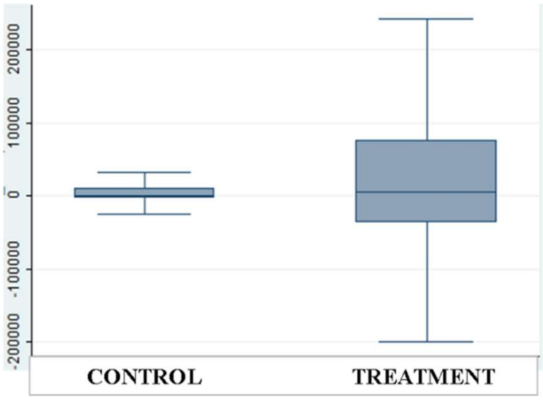

Figure 14. Net revenue for treatment and control groups (difference between 2011 and 2008 real values). Treatment in 2008. Outside values excluded. Source: IBGE (2010 and 2013; confidential data).

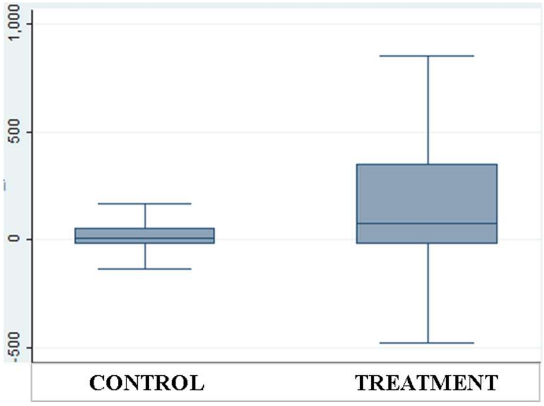

Figure 15. Total employment for treatment and control groups (difference between 2011 and 2008 real values). Treatment in 2008. Outside values excluded. Source: IBGE (2010 and 2013; confidential data).

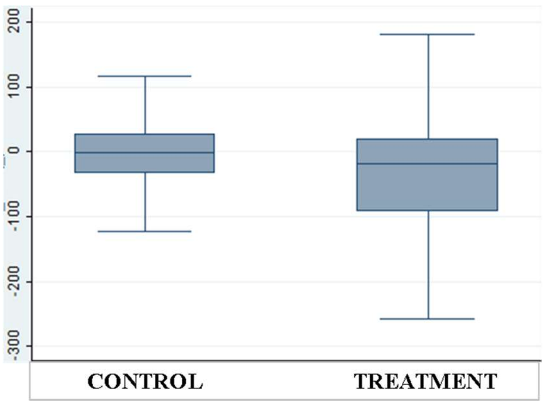

Figure 16. Net revenue per employee for treatment and control groups (difference between 2011 and 2008 real values). Treatment in 2008. Outside values excluded. Source: IBGE (2010 and 2013; confidential data).

Table 11

Descriptive Statistics of outcome variables

Group	Variable	Unit	Treatment	N	Mean	Std.Dv.
Input	*in_exp*	R$1,000	0	2540	2865.72	70514.74
			1	220	-1260.73	38929.78
	rd_exp	R$1,000	0	1135	2136.02	36877.84
			1	189	3862.40	23897.93
	researcher	No. of researchers[a]	0	1135	12.87	159.35
			1	189	15.83	40.24
	in_dummy	Binary	0	13403	0.378	0.485
			1	303	0.871	0.335
	rd_dummy	Binary	0	13403	0.140	0.347
			1	303	0.752	0.432
Output and performance	*inovator*	Binary	0	13403	0.440	0.496
			1	177	0.853	0.355
	new_sales	% of total sales	0	2235	-10.143	2.175
			1	133	3.233	0.270
	new_exp	% of exports	0	2235	-2.622	0.393
			1	133	-.2093	0.031
	revenue	R$1,000	0	6406	8226.55	213812.8
			1	155	27650.29	715835.8
	personnel	No. of employees	0	6412	36.77	489.75
			1	155	268.75	1164.98
	rev_person	R$1,000	0	6271	-3.46	322.55
			1	154	-112.07	408.52

Source: IBGE (2010 and 2013; confidential data).

Observable covariates affecting odds of treatment used to estimate the propensity score are: (a) firm size (number of employees – log-linearized; *personnel*); (b) net revenue; (log-linearized; *revenue*); (c) age (*age*); (d) dummy for national controlling capital (*nac_control*); (e) dummy for foreign controlling capital (*for_control*); (f) dummy for continuous R&D activity in the last three years (*rd_cont*); (g) dummy for firms part of a corporate group (*group*); (h) dummy for importing firms in (*t-1*; *imp*); (i) dummy for exporting firms in (*t-1*; *exp*); (j) dummy for main firm market being international (*for_market*); (ix) dummies for each of the five country regions (North - N, Northeast - NE, Middle west - CO, Southeast - SE and South - S), excluding the state of São Paulo to avoid collinearity; and (k) industrial sector dummies, using the National Classification of Economic Activities (CNAE; 2 digits). Main descriptive statistics for these variables are shown in Table A2 and Table *A3* in the Appendix.

6 Results

This section describes and analyses the results pursuant to the described empirical strategy. The first subsection shows the estimations for input or technological efforts variables and the second focuses on output and performance. The third part presents the results for the sensitivity analysis and robustness checks, and the fourth discusses the findings.

6.1 Input or technological effort variables.

Table 12 presents the estimated logit propensity score for the input outcome variables, with the effect of each covariate on probability of treatment in 2011. The estimated models reveal relevant information about factors determining participation in the policy. Net revenue is the single most important continuous covariate, with a positive and significant coefficient even at a 99% confidence level for all cases; meaning that companies with higher income are more likely to benefit. Continuous development of R&D activities also increases probability of obtaining tax incentives. Other variables that present significant results (at a 95% confidence level) in at least some of the estimations are export in the previous year (positive impact) and the dummy for foreign market being the firm's main target (negative effect).

The results of the means test for covariates and for the propensity score in each model are presented in Table A4 to Table *A8* of the Appendix. For all models, variables do not present significant differences (at a 95% confidence level) for treatment and control groups, with the single exception of the *'revenue'* variable for the *'in_dummy'* propensity score. Standardized bias is substantially reduced for the majority of variables. In all cases, log-likelihood test ($p>chi^2$) does not reject joint insignificance hypothesis for matched samples, and pseudo-R^2, mean and median bias also drop considerably. In light of these results, I understand to have good grounds to accept the propensity score specification, as it has balanced almost all covariates between the two groups, thus reducing differences between matched observations and mitigating possible bias selection.

Table 12

Estimated propensity score - input outcome variables

Covariates	Outcome Variables				
	in_exp	*rd_exp*	*researcher*	*in_dummy*	*rd_dummy*
personnel	-0.148(0.156)	-0.04(0.166)	0.012(0.148)	-0.145(0.191)	-0.104(0.133)
age	0.006(0.008)	0.004(0.008)	0.004(0.008)	-0.012(0.013)	0(0.008)
nac_control	-0.762(0.595)	-1.357(0.679)**	-0.789(0.511)	0.697(0.561)	0.193(0.42)
for_control	-0.695(0.58)	-1.021(0.658)	-0.507(0.496)	0.326(0.558)	-0.092(0.403)
rd_cont	1.381(0.217)***	1.056(0.451)**	0.926(0.385)	2.043(0.307)***	2.086(0.203)***
group	0.301(0.222)	0.247(0.241)	0.28(0.206)	0.357(0.333)	0.334(0.217)
revenue	0.744(0.145)***	0.513(0.152)***	0.508(0.132)***	0.856(0.19)***	0.769(0.124)***
imp	0.824(0.41)**	0.674(0.431)	0.808(0.425)*	0.644(0.567)	0.34(0.335)
exp	0.67(0.298)**	0.462(0.325)	0.266(0.29)	0.885(0.465)*	0.649(0.272)**
for_market	-1.181(0.466)**	-0.794(0.48)*	-0.781(0.368)**	0.486(0.506)	-0.408(0.397)
dummyN	-0.093(0.814)	-1.225(1.102)	-1.226(0.765)	n/a[b]	-1.103(0.799)
dummyNE	-0.474(0.475)	-0.428(0.485)	-0.508(0.458)	-0.103(0.645)	-0.047(0.437)
dummySE[a]	-0.164(0.298)	-0.078(0.306)	0.122(0.268)	-0.031(0.476)	0.207(0.295)
dummyS	0.347(0.223)	-0.03(0.245)	0.11(0.229)	0.884(0.36)**	0.727(0.236)***
dummyCO	-0.932(0.797)	-1.393(1.099)	-0.627(0.705)	n/a[b]	-1.954(1.19)
cnaedummy1	-1.34(1.178)	-1.943(0.554)***	-3.14(1.553)**	-2.787(1.38)**	-2.025(1.166)*
cnaedummy2	-1.147(1.406)	-1.647(0.906)*	-3.188(1.697)*	-0.738(1.45)	-0.348(1.237)
cnaedummy3	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy4	-2.075(1.315)	-2.221(0.807)***	-3.446(1.654)**	-1.176(1.414)	-1.796(1.319)
cnaedummy5	n/a[b]	n/a[b]	-3.705(1.881)**	-1.863(1.65)	-2.135(1.515)
cnaedummy6	-1.678(1.378)	-1.742(0.802)**	-2.784(1.662)*	-2.288(1.62)	-1.852(1.337)
cnaedummy7	n/a[b]	n/a[b]	-2.798(2.006)	n/a[b]	-1.872(1.585)
cnaedummy8	-0.789(1.234)	-1.545(0.716)**	-2.882(1.594)*	-1.266(1.35)	-1.41(1.232)
cnaedummy9	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy10	n/a[b]	n/a[b]	n/a[b]	n/a[b]	-1.948(1.539)
cnaedummy11	-1.08(1.19)	-1.657(0.575)***	-2.764(1.54)*	-2.083(1.352)	-1.26(1.151)
cnaedummy12	-0.196(1.241)	-0.887(0.678)	-2.154(1.569)	-0.43(1.379)	-0.041(1.18)
cnaedummy13	-1.844(1.268)	-3.033(0.877)***	-4.104(1.648)**	-1.407(1.347)	-1.412(1.197)
cnaedummy14	-0.742(1.246)	-1.843(0.75)**	-2.941(1.609)*	-0.344(1.27)	-0.732(1.187)
cnaedummy15	-1.892(1.388)	-1.939(0.861)**	-2.722(1.616)*	-1.722(1.558)	-0.686(1.187)
cnaedummy16	-1.354(1.238)	-1.58(0.646)**	-2.777(1.572)*	-2.186(1.551)	-1.249(1.194)
cnaedummy17	-1.582(1.273)	-2.547(0.768)***	-2.872(1.561)*	-1.119(1.589)	-0.962(1.229)
cnaedummy18	-0.938(1.203)	-1.355(0.593)**	-2.361(1.551)	n/a[b]	-0.438(1.162)
cnaedummy19	-1.26(1.197)	-1.821(0.6)***	-2.79(1.555)*	-0.361(1.251)	-0.376(1.137)
cnaedummy20	-0.237(1.195)	-1.147(0.617)*	-1.976(1.552)	0.183(1.248)	-0.141(1.137)
cnaedummy21	0.335(1.338)	0.278(1.045)	-0.982(1.66)	n/a[b]	0.478(1.26)
cnaedummy22	-0.724(1.235)	-1.17(0.715)	-2.245(1.616)	-0.786(1.389)	-0.257(1.18)
cnaedummy23	-1.013(1.328)	-1.516(0.808)*	-2.733(1.642)*	-0.192(1.603)	-0.743(1.352)
cnaedummy24	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy25	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy26	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy27	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy28	n/a[b]	n/a[b]	n/a[b]	n/a[b]	-0.633(1.344)
cnaedummy29	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy30	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy31	-1.165(1.531)	-1.161(1.057)	-3.348(1.819)*	-2.043(1.876)	-0.723(1.465)
cnaedummy32	1.243(1.118)	n/a[b]	-1.197(1.589)	1.005(1.306)	0.609(1.162)
cnaedummy33	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy34	n/a[b]	n/a[b]	-2.386(2.257)	n/a[b]	-1.278(1.959)
cnaedummy35	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy36	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy37	n/a[b]	n/a[b]	-0.186(2.303)	n/a[b]	n/a[b]
cnaedummy38	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy39	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
constant	-10.381(1.626)***	-6.435(1.304)***	-6.146(2.012)***	-13.726(2.182)***	-12.435(1.58)***
N	2062	988	1155	2492	5212
Log-likelihood	-411.923	-332.296	-407.71255	-189.60668	-437.274
Pseudo-R2	0.251	0.165	0.173	0.3548	0.3177
Prob > chi2	0.000	0.000	0.000	0.000	0.000

[a] Not considered firms in the state of São Paulo.

[b] Excluded due to collinearity.

Logit model.

Standard errors in parenthesis. * p<.10; ** p<.05; *** p<.01.

The estimated ATT is displayed in Table 13. Results confirm the naïve estimator previously presented, although with a smaller magnitude (as expected). I find the policy has had a significant average impact on R&D expenditures of treated firms of around 495 thousand Brazilian *reais* (around 264 thousand U.S. dollars)[44]. Spending is estimated to have increased around 76% more than it would have in the absence of the policy. I also find an average impact of around 4.9 researchers on R&D personnel, a 51% relative effect compared to the growth observed in (matched) control units.

Table 13

Estimated Average Treatment Effect on the Treated – Input variables

Outcome Variable	Unit	Sample	Mean		Difference	Relative effect
			Treated	Controls		
in_exp	R$ 1,000	Unmatched	597.157	506.924	90.233 (170.874)	0.178
		ATT	497.753	969.862	-472.108 (373.262)	-0.487
rd_exp	R$ 1,000	Unmatched	1149.307	646.055	503.252 (101.293)***	0.779
		ATT	1151.187	655.466	495.722 (169.634)***	0.756
researcher	No. of researchers	Unmatched	14.190	7.462	6.728 (1.332)***	0.902
		ATT	14.391	9.541	4.850 (2.217)**	0.508
in_dummy	Binary	Unmatched	0.825	0.317	0.508 (0.059)***	1.603
		ATT	0.820	0.590	0.230 (0.094)**	0.390
rd_dummy	Binary	Unmatched	0.698	0.133	0.565 (0.030)***	4.248
		ATT	0.689	0.578	0.111 (0.038)***	0.192

Standard errors in parenthesis. * p<.10; ** p<.05; *** p<.01.
Matching algorithm: nearest neighbor.
Standard error estimated according to Abadie and Imbens (2006).

Results also indicate that the policy contributed to increase the base of companies pursuing innovation. Benefited enterprises that did not have any spending in innovative activities in 2008 were 23% more likely to start investing by 2011 (a 39% relative effect, if compared to the chances of firms in the control group). In the case of strict R&D, the chances increased by 11% (a 19.2% relative effect). On the other hand, no significant evidence of impact on general spending on innovative activities was found.

[44] According to the exchange rate of the last day of 2011.

Table 14

Estimated propensity score - output and performance outcome variables

Covariates	*Outcome Variable*					
	inovator	*new_sales*	*new_exp*	*revenue*	*personnel*	*rev_person*
personnel	0.352(0.162)**	0.263(0.185)	0.263(0.185)	0.335(0.163)**	0.431(0.18)**	0.335(0.163)***
age	-0.006(0.008)	0.001(0.009)	0.001(0.009)	-0.005(0.008)	-0.011(0.009)	-0.005(0.008)
nac_control	0.544(0.406)	0.65(0.471)	0.65(0.471)	0.537(0.425)	0.461(0.455)	0.537(0.425)
for_control	1.001(0.409)	0.967(0.472)**	0.968(0.472)**	0.984(0.427)**	0.948(0.451)**	0.984(0.427)**
rd_cont	2.005(0.222)***	1.356(0.256)***	1.357(0.256)***	1.986(0.223)***	2.013(0.232)***	1.986(0.223)***
group	0.171(0.228)	0.106(0.255)	0.106(0.255)	0.157(0.23)	0.166(0.241)	0.157(0.23)
revenue	0.528(0.137)***	0.623(0.16)***	0.623(0.16)***	0.552(0.138)***	0.586(0.149)***	0.552(0.138)***
imp	-0.378(0.255)	-0.326(0.299)	-0.327(0.299)	-0.37(0.255)	-0.474(0.263)*	-0.37(0.255)
exp	0.821(0.357)**	0.935(0.463)**	0.934(0.463)**	0.828(0.359)**	0.983(0.378)**	0.828(0.359)**
for_market	-0.517(0.373)	-0.303(0.417)	-0.303(0.417)	-0.626(0.385)	-1.041(0.479)**	-0.626(0.385)
dummyN	-0.118(0.565)	-0.483(0.649)	-0.483(0.649)	-0.168(0.568)	-0.224(0.59)	-0.168(0.568)
dummyNE	-0.356(0.526)	0.001(0.559)	0.002(0.559)	-0.371(0.528)	-0.451(0.547)	-0.371(0.528)
dummySE[a]	-0.392(0.364)	-0.283(0.407)	-0.282(0.407)	-0.478(0.376)	-0.499(0.41)	-0.478(0.376)
dummyS	1.21(0.236)***	1.298(0.272)***	1.299(0.272)***	1.214(0.237)***	1.246(0.248)***	1.214(0.237)***
dummyCO	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy1	-3.069(1.266)**	-1.362(0.893)	-1.361(0.893)	-3.307(1.315)**	-3.327(1.375)**	-3.307(1.315)**
cnaedummy2	-4.07(1.763)**	-2.087(1.477)	-2.083(1.479)	-4.292(1.815)**	-2.854(1.678)*	-4.292(1.815)**
cnaedummy3	-3.039(1.821)*	-1.3(1.632)	-1.301(1.632)	-3.254(1.855)*	-3.336(1.909)*	-3.254(1.855)*
cnaedummy4	-3.948(1.439)***	-1.926(1.117)*	-1.925(1.117)*	-4.203(1.484)***	-4.317(1.544)***	-4.203(1.484)***
cnaedummy5	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy6	-3.914(1.457)***	-1.325(1.166)	-1.325(1.167)	-4.168(1.501)***	-4.764(1.719)***	-4.168(1.501)***
cnaedummy7	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy8	-3.577(1.449)**	-1.548(1.134)	-1.548(1.134)	-3.784(1.493)**	-4.049(1.562)**	-3.784(1.493)**
cnaedummy9	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy10	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy11	-2.989(1.289)**	-1.301(0.94)	-1.301(0.94)	-3.279(1.34)**	-3.701(1.406)***	-3.279(1.34)**
cnaedummy12	-2.159(1.331)	-0.171(0.974)	-0.17(0.974)	-2.453(1.378)*	-2.863(1.455)*	-2.453(1.378)*
cnaedummy13	-3.066(1.31)**	-1.173(0.983)	-1.172(0.983)	-3.339(1.358)**	-3.728(1.432)***	-3.339(1.358)**
cnaedummy14	-3.294(1.376)**	-1.503(1.133)	-1.502(1.133)	-3.472(1.42)**	-4.198(1.541)***	-3.472(1.42)**
cnaedummy15	-3.03(1.33)**	-0.995(1.044)	-0.995(1.044)	-3.073(1.377)**	-3.451(1.438)**	-3.073(1.377)**
cnaedummy16	-3.106(1.338)**	-0.757(0.984)	-0.756(0.984)	-3.369(1.386)**	-3.589(1.446)**	-3.369(1.386)**
cnaedummy17	-1.434(1.266)	0.607(0.871)	0.608(0.871)	-1.669(1.316)	-1.976(1.385)	-1.669(1.316)
cnaedummy18	-2.236(1.289)*	-0.246(0.917)	-0.245(0.917)	-2.497(1.337)*	-2.746(1.412)*	-2.497(1.337)*
cnaedummy19	-2.013(1.257)	0.091(0.854)	0.092(0.854)	-2.272(1.306)*	-2.55(1.375)*	-2.272(1.306)*
cnaedummy20	-1.704(1.252)	0.613(0.882)	0.611(0.882)	-1.929(1.304)	-2.409(1.381)*	-1.929(1.304)
cnaedummy21	-3.592(1.586)**	-1.199(1.37)	-1.199(1.37)	-3.812(1.625)**	-4.124(1.916)**	-3.812(1.625)**
cnaedummy22	-2.476(1.379)*	-1.456(1.333)	-1.455(1.333)	-2.746(1.426)*	-2.977(1.486)**	-2.746(1.426)*
cnaedummy23	-2.094(1.352)	0.107(1.046)	0.108(1.046)	-2.351(1.398)*	-2.661(1.469)*	-2.351(1.398)*
cnaedummy24	-2.255(1.59)	0.237(1.421)	0.236(1.421)	-2.444(1.627)	-2.68(1.695)	-2.444(1.627)
cnaedummy25	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy26	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy27	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy28	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy29	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy30	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy31	-4.815(1.505)***	-3.678(1.397)***	-3.68(1.397)***	-5.095(1.544)***	n/a[b]	-5.095(1.544)***
cnaedummy32	-2.356(1.423)*	n/a[b]	n/a[b]	-2.596(1.459)*	-2.716(1.526)*	-2.596(1.459)*
cnaedummy33	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy34	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy35	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy36	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy37	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy38	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
cnaedummy39	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]	n/a[b]
constant	-11.214(1.56)***	-13.566(1.42)***	-13.57(1.42)***	-11.117(1.63)***	-11.651(1.80)***	-11.117(1.63)***
N	5397	2061	2061	5241	5169	5285
Log-likelihood	-408.62534	-299.83656	-299.86132	-352.62538	-364.634	-403.20654
Pseudo-R2	0.4099	0.3784	0.3783	0.399	0.41	0.412
Prob > chi2	0.000	0.000	0.000	0.000	0.000	0.000

Logit model.

Standard errors in parenthesis. * p<.10; ** p<.05; *** p<.01.

[a] Not considered firms in the state of São Paulo.

[b] Excluded due to collinearity.

6.2 Innovation output and performance variables.

Table 14 displays the estimation results for the treatment probability model for innovation outcome and performance variables. As in the case of input variables, revenue, continuous R&D and exports are relevant factors positively influencing participation in the policy in 2008. In addition, chances of obtaining tax incentives also grew with firm size, foreign capital control and location in the South region.

Table A9 to Table *A14* in the Appendix display the means tests for covariates. Again, I consider the results satisfy the balancing condition in general. Very few variables present significant difference after the matching, with substantial reduction of the standardized bias for the majority of the cases. Likelihood-ratio test ($p>chi^2$) does not present evidence of significant joint differences in any of the matched samples, and pseudo-R^2, mean and median bias also display low values.

Finally, Table 15 provides results for the ATT. The only significant impacts are on probability of innovation and firm size. The estimation suggests firms benefiting from the tax incentives had on average 12% more chance of innovating within the next three years (relative effect of 16.2%). The estimated impact on firm size is substantial. Treated companies grew on average more than four times their respective matches from the control group (relative effect of 324%). Contrary to the naive estimator, there is no evidence of impact on the share of new product on sales, although the coefficient is positive as expected. Results for other variables also did not achieve statistical significance.

Table 15

Estimated Average Treatment Effect on the Treated – Output and performance variables

Outcome Variable	Unit	Sample	Treated	Controls	Difference	Relative effect
inovator	Binary	Unmatched	0.849	0.497	0.351 (0.041)***	0.706
		ATT	0.841	0.724	0.117 (0.050)**	0.162
new_sales	Percentage of total sales	Unmatched	3.233	-10.144	13.376 (3.234)***	-1.319
		ATT	3.787	-3.967	7.754 (5.733)	-1.955
new_exp	Percentage of total exports	Unmatched	-0.209	-2.622	2.412 (2.304)	-0.920
		ATT	0.016	-1.451	1.467 (5.050)	-1.011
revenue	R$ 1,000	Unmatched	15027.197	4501.571	10525.626 (3963.172)***	2.338
		ATT	11207.670	3016.920	8190.750 (16978.925)	2.715
personnel	No. of employees	Unmatched	136.143	31.940	104.203 (12.849)***	3.262
		ATT	140.674	33.194	107.481 (37.336)***	3.238
rev_person	R$ 1,000	Unmatched	-112.556	-7.197	-105.359 (25.937)***	14.639
		ATT	-111.265	-13.604	-97.661 (66.951)	7.179

Standard errors in parenthesis. * p<.10; ** p<.05; *** p<.01.
Matching algorithm: nearest neighbor.
Standard error estimated according to Abadie and Imbens (2006).

6.3 Sensitivity analysis and robustness checks.

I addressed the sensitivity of the estimates to hidden bias due to omitted variables using the Rosenbaum bounds procedure, as explained in section 5.1.1 above. The test was only applied to the outcome variables for which impact estimates presented statistical significance. Results are displayed in Table 16.

In the case of R&D expenditures and firm size, the cut-off point is found within the interval ($1.2 < \Gamma < 1.3$) for the Hodges-Lehmann estimates (columns 7 and 8) and ($1.3 < \Gamma < 1.4$) for the Wilcoxon signed-rank test (column 3). This means the odds ratio between treatment and control groups has to rise at least 20% above unity to render the ATT statistically insignificant. Considering the comprehensiveness of covariates used in the study, I understand the result is moderately insensitive to hidden bias.

The Wilcoxon signed-rank test (column 3) indicates the ATT loses significance at ($\Gamma > 1.4$) for the innovative expenditures dummy, and at ($\Gamma > 1.3$) for the R&D expenditures and innovation dummies. These results suggest the estimates are fairly insensitive and robust. However, the Hodges-Lehmann estimates (columns 7 and 8) challenges such conclusion, as the critical value is found at low levels of (Γ).

In the case of R&D personnel, both tests indicate significance is lost at low (Γ) values, meaning this estimate may be very sensitive to influence from unobserved variables.

Estimates for robustness checks (alternative matching algorithms and model specification) are presented in Table 17. Results persist to be valid in at least two of the alternative specifications for all input outcome variables with the exception of research personnel, which remains positive but loses statistical significance.

Results for the innovator dummy and firm size are positive in all cases, and remain statistically significant in two and one of the alternative specifications, respectively. It is also interesting to note that the share of new products in total sales is found to be significant in two of the robustness checks, indicating a possible impact on this variable as well.

Table 16

Rosenbaum bounds sensitivity analysis of hidden bias due to omitted variables

Outcome Variable	Gamma	sig+	sig-	t-hat+	t-hat-	CI+	CI-
	1	0.000603	0.000603	453.136	453.136	199	712.235
	1.1	0.002887	0.000099	396.141	517.623	131.732	783.773
	1.2	0.00989	0.000015	340.37	569.711	59.7755	851.316
	1.3	0.026253	2.20E-06	289.882	624.975	-3.02048	914.139
	1.4	0.05714	3.10E-07	239.029	671.271	-60.7515	984.084
rd_exp	1.5	0.106327	4.10E-08	193.051	718.53	-109.885	1050.95
	1.6	0.174582	5.40E-09	143.979	767.018	-148.164	1105.84
	1.7	0.259197	6.90E-10	103.621	813.977	-193.754	1155.25
	1.8	0.35473	8.60E-11	57.7	854.867	-232.533	1205.1
	1.9	0.45446	1.10E-11	15.855	895.686	-269.458	1249.73
	2	0.551896	1.30E-12	-17.9925	935.621	-310.24	1295
	1	0.077376	0.077376	2.2	2.2	-0.725	5.6
	1.1	0.19005	0.024339	1.3	3.175	-1.6	6.675
	1.2	0.35133	0.006643	0.525	4.025	-2.42	7.68
	1.3	0.529442	0.001619	-0.095	4.85	-3.3	8.7
	1.4	0.689974	0.00036	-0.65	5.5	-4.025	9.8
researcher	1.5	0.813043	0.000074	-1.275	6.2775	-4.695	10.7
	1.6	0.895823	0.000014	-1.825	6.95	-5.3	11.55
	1.7	0.945847	2.70E-06	-2.4	7.625	-5.89	12.55
	1.8	0.973509	4.70E-07	-3	8.3375	-6.45	13.675
	1.9	0.98771	8.00E-08	-3.5	9	-6.9	14.69
	2	0.994556	1.30E-08	-4	9.7	-7.45	15.525
	1	0.005294	0.005294	4.40E-07	4.40E-07	-4.40E-07	0.5
	1.1	0.010786	0.002401	4.40E-07	0.5	-4.40E-07	0.5
	1.2	0.019383	0.001082	-4.40E-07	0.5	-4.40E-07	0.5
	1.3	0.031621	0.000486	-4.40E-07	0.5	-4.40E-07	0.5
	1.4	0.047809	0.000217	-4.40E-07	0.5	-4.40E-07	0.5
in_dummy	1.5	0.068019	0.000097	-4.40E-07	0.5	-4.40E-07	0.5
	1.6	0.092105	0.000043	-4.40E-07	0.5	-4.40E-07	0.5
	1.7	0.11975	0.000019	-4.40E-07	0.5	-4.40E-07	0.5
	1.8	0.150515	8.50E-06	-4.40E-07	0.5	-4.40E-07	0.5
	1.9	0.183879	3.80E-06	-4.40E-07	0.5	-4.40E-07	0.5
	2	0.219289	1.70E-06	-4.40E-07	0.5	-4.40E-07	0.5
	1	0.005615	0.005615	-4.20E-07	-4.20E-07	-4.20E-07	-4.20E-07
	1.1	0.012026	0.002398	-4.20E-07	-4.20E-07	-4.20E-07	-4.20E-07
	1.2	0.022431	0.001014	-4.20E-07	-4.20E-07	-4.20E-07	-4.20E-07
	1.3	0.03762	0.000426	-4.20E-07	-4.20E-07	-4.20E-07	-4.20E-07
	1.4	0.058042	0.000178	-4.20E-07	-4.20E-07	-4.20E-07	4.20E-07
rd_dummy	1.5	0.083773	0.000074	-4.20E-07	-4.20E-07	-4.20E-07	0.5
	1.6	0.114551	0.00003	-4.20E-07	-4.20E-07	-4.20E-07	0.5
	1.7	0.149839	0.000013	-4.20E-07	-4.20E-07	-4.20E-07	0.5
	1.8	0.188911	5.20E-06	-4.20E-07	-4.20E-07	-4.20E-07	0.5
	1.9	0.230936	2.10E-06	-4.20E-07	-4.20E-07	-4.20E-07	0.5
	2	0.275049	8.70E-07	-4.20E-07	-4.20E-07	-4.20E-07	0.5
	1	0.004764	0.004764	-4.50E-07	-4.50E-07	-4.50E-07	-4.50E-07
	1.1	0.011221	0.001819	-4.50E-07	-4.50E-07	-4.50E-07	-4.50E-07
	1.2	0.0225	0.000683	-4.50E-07	-4.50E-07	-4.50E-07	-4.50E-07
	1.3	0.039876	0.000253	-4.50E-07	-4.50E-07	-4.50E-07	4.50E-07
	1.4	0.06415	0.000093	-4.50E-07	-4.50E-07	-4.50E-07	0.5
inovator	1.5	0.095538	0.000034	-4.50E-07	-4.50E-07	-4.50E-07	0.5
	1.6	0.133681	0.000012	-4.50E-07	-4.50E-07	-4.50E-07	0.5
	1.7	0.177745	4.40E-06	-4.50E-07	-4.50E-07	-4.50E-07	0.5
	1.8	0.226569	1.60E-06	-4.50E-07	-4.50E-07	-4.50E-07	0.5
	1.9	0.278817	5.60E-07	-4.50E-07	4.50E-07	-4.50E-07	0.5
	2	0.333114	2.00E-07	-4.50E-07	4.50E-07	-4.50E-07	0.5
	1	0.000958	0.000958	83.5	83.5	29	152.5
	1.1	0.004185	0.000174	69	102	16.5	167.5
	1.2	0.01333	0.00003	56	117	6.5	182
	1.3	0.033359	4.80E-06	46	130	-3.5	196
	1.4	0.069213	7.50E-07	36.5	142	-15	212
personnel	1.5	0.123858	1.10E-07	28.5	152.5	-23	225.5
	1.6	0.196985	1.60E-08	19.5	163	-31	236.5
	1.7	0.284956	2.40E-09	14	172.5	-38.5	246.5
	1.8	0.381837	3.30E-10	7.00001	181	-46	256.5
	1.9	0.480924	4.60E-11	1.99998	189.5	-52.5	267
	2	0.576122	6.30E-12	-5	198.5	-60.5	275.5

* gamma - log odds of differential assignment due to unobserved factors; sig+ - upper bound significance level; sig- - lower bound significance level; t-hat+ - upper bound Hodges-Lehmann point estimate; t-hat- - lower bound Hodges-Lehmann point estimate; CI+ - upper bound confidence interval (a= .95); CI- - lower bound confidence interval (a= .95).

Table 17

Robustness checks results

Group	Variable	Sample	Kernel Matching[a]	Radius Matching[b]	Nearest Neighbor (no sector dummies)[c]
Input	*in_exp*	Unmatched	90.233(170.874)	90.233(170.874)	86.41(167.71)
		ATT	-183.263(240.921)	-162.852(243.528)	-304.62(322.52)
	rd_exp	Unmatched	503.252(101.293)***	503.252(101.293)***	500.38(100.34)***
		ATT	266.682(134.513)**	188.605(136.852)	382.94(181.06)***
	researcher	Unmatched	6.728(1.332)***	6.728(1.332)***	6.44(1.36)***
		ATT	3.708(1.95)*	3.157(1.985)	2.71(2.54)
	in_dummy	Unmatched	0.508(0.059)***	0.508(0.059)***	0.52(0.06)***
		ATT	0.225(0.065)***	0.174(0.067)***	0.13(0.06)**
	rd_dummy	Unmatched	0.565(0.03)***	0.565(0.03)***	0.57(0.03)***
		ATT	0.129(0.043)***	0.082(0.044)*	0.09(0.04)**
Output and performance	*inovator*	Unmatched	0.351(0.041)***	0.351(0.041)***	0.37(0.04)***
		ATT	0.14(0.042)***	0.132(0.045)***	0.06(0.05)
	new_sales	Unmatched	0.266(0.079)***	0.266(0.079)***	0.26(0.08)***
		ATT	0.158(0.071)***	0.165(0.072)**	-0.01(0.06)
	new_exp	Unmatched	0.01(0.061)	0.01(0.061)	0.01(0.06)
		ATT	0.069(0.078)	0.098(0.08)	-0.03(0.09)
	Revenue	Unmatched	10525.626(3963.172)***	10525.626(3963.172)***	10398.43(3848.62)***
		ATT	8782.778(8608.515)	5833.114(8558.738)	16700.84(14766.85)
	Personnel	Unmatched	104.203(12.849)***	104.203(12.849)***	106.09(12.81)***
		ATT	62.125(25.851)**	30.7(24.151)	31.02(33.37)
	rev_person	Unmatched	-105.359(25.937)***	-105.359(25.937)***	-107.24(25.32)***
		ATT	-57.833(39.174)	-58.699(38.691)	-108.59(68.43)

Standard errors in parenthesis. * p<.10; ** p<.05; *** p<.01.
[a] Matching algorithm: kernel. Standard error estimated by 100 bootstrap iterations.
[b] Matching algorithm: radius within caliper (20% of the standard deviation of the propensity score). Standard error estimated by 100 bootstrap iterations.
[c] Matching algorithm: nearest neighbor. Standard error estimated according to Abadie and Imbens (2006).

6.4 Discussion of the results.

I analyze the results of this empirical study in light of the literature on innovation tax incentives and impact assessment summarized in sections 2 and 3, and the features and specifics of the Brazilian policy described in section 4.

The first relevant point is the positive impact on R&D spending of beneficiary firms, indicating the incentives effectively raise private investment on innovation and technological efforts of local industry. The study empirically rejects the hypothesis of full crowding-out, meaning public indirect financing complements private resources at some level. The estimation suggests a positive impact of 76% on the trend of expenditures increase. As a downside, the estimated impact per firm (around 495 thousand Brazilian *reais*) is less than a third of the average value of tax incentives each firm obtained that year (around 1,84 million Brazilian *reais*).

Such results follow the standard findings of the empirical literature on tax incentives. As discussed and summarized in Table 3, most of the studies so far have found the additional investment per dollar of incentive to be below one, at least in the short-run. The estimated value of impact is similar to the ones found by other studies mentioned in Table 4: it exceeds the estimates of Guceri (2015), Yang et al. (2012) and Avellar (2008) (18%, 54% and 64%, respectively), but is inferior to the spending raise of more than two times found by Yohei (2011). The analysis also confirms findings of previous studies on the Brazilian tax incentives for innovation, and the result is closer to Shimada et al. (2014): 86% to 108%, than to Kannebley Jr. and Porto (2012): 7% to 11%.

There is also evidence that the policy increased hiring of research personnel, although such result should be taken with caution, for it did not prove to be very robust to hidden bias or model specification. Positive impact on R&D staff is in accordance with the conclusions of Duguet (2012), Shimada et al. (2014) and Kannebley Jr. and Porto (2012).

The results also indicate the Brazilian policy was successful in encouraging firms to begin investing in innovation. The same empirical finding was obtained by Aralica et al. (2013) and Hægeland and Møen (2007), and it challenges the theoretical argument that tax incentives are not particularly suited for increasing the base of innovative companies (Bastos, 2004).

The study also suggests impact of the policy on innovation output. This is a particularly important finding, for the number of studies that analyzed such variables is still small. The main finding is that benefited firms had 12% higher chances of innovating. Bérubé and Mohnen (2009) also found firms receiving public support innovate more. This may be interpreted as evidence that, at a minimum, impact of tax incentives is not fully jeopardized by moral hazard, relabeling of activities and increase of input prices.

The ATT suggests benefited firms experienced a substantial employment growth because of the policy. This is an important result for, among the few studies that analyzed firm's performance, Czarnitzki et al. (2011) did not find any impact. However, interpretation of this finding is challenging, especially considering that no positive impact on net revenue was found. The reason behind this employment raise may be a relevant subject for a survey or qualitative research on the policy.

Contrary to Czarnitzki et al. (2011), Aralica et al. (2013) and Bérubé and Mohnen (2009), this study does not present evidence of impact of the policy on new products sales or exports, although the sign of the ATT is consistently positive and it achieves statistical significance in alternative matching algorithms (as part of the robustness checks). Moreover, no evidence of effect on firms' productivity was found. The same result was obtained by Cappelen, Raknerud and Rybalka (2007) and Colombo, Grilli and Murtinu (2011).

These are particularly troubling results from an innovation policy perspective. The endogenous growth literature identifies as main drivers of economic growth the increase in factor productivity (Romer, 1990; and Grossman and Helpman, 1989, 1990) and design of new products (Aghion and Howitt, 1990; Grossman and Helpman, 1991). These should be crucial objectives of an innovation policy, and this study's findings suggest Brazilian tax incentives did not contribute to achieving these goals.

The treatment probability models (propensity score) also provide relevant information to understand which firms seek and obtain the tax incentives. Estimates confirm net revenue is a crucial factor determining participation in the policy, which is in accordance with the theoretical argument that tax incentives are more appropriate for large companies. It also provides grounds to the critique that the policy design disfavors small firms, whether because it requires adoption of the real profit tax regime or because deduction of expenses can only be carried out within the same fiscal year.

The models also suggest continuous R&D activities and exports are important factors explaining participation in the policy. These are expected results, for firms with such features are more likely to invest substantial resources on innovation, benefiting more from the incentives. Other variables significant for a meaningful group of estimates are foreign controlling capital and firm size.

7 Concluding Remarks

This paper presented an impact assessment of the tax incentives provided by Law 11,196/05. This policy represented an inflection point on the use of fiscal measures to foster industrial innovation in Brazil, both in terms of tax generosity, investment volume and number of benefited firms.

Following a branch of the international empirical literature on innovation policy, I applied the propensity score matching and estimated the average treatment effect on benefited firms using microdata from the PINTEC editions of 2008 and 2011 and other databases. The empirical results suggest the policy positively affected firms' R&D

investments and research staff, rejecting the hypothesis of full crowding-out. The average estimated impact, nevertheless, falls short of the volume of tax break per firm.

The policy also increased the base of firms investing in innovation and actually innovating. Finally, there is also evidence of impact on company size. These findings provide empirical support in favor of tax incentives as a relevant part of the government strategy to boost entrepreneurial innovation in the country.

On the other hand, this study provides no evidence of impact on firms' productivity and new products' sales and exports. This is an important result for it may reveal shortcomings of the policy design, implying the need of reform to improve these indicators. This result also points to the importance of investigating more carefully how beneficiary companies have invested additional resources raised by public funding.

The study has limitations arising from the applied empirical strategy that may be object of future researches. The PSM does not account for knowledge spillovers between firms, considered a major side effect and source of growth caused by technological progress (Griffith et al., 1995).

Finally, this study is part and contributes to the recent development of the empirical economic literature on innovation policies, aiming at evaluating and providing empirical evidence for the debate and improvement of government action. Most of the observed results are consistent and in accordance with similar researches on tax incentives in other countries.

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Appendix

Table A1

List of Covariates used in Studies applying the Direct Approach

Study	Firm size[a]	Part of Corporate group	Economic sector	Year	Export	Financial constraint	R&D intensity	Other public funding	Previous R&D spending	Age	Capital	Profita-bility	Indebt-edness	Location	Others
Guceri (2015)	X	X	X	X											X
Aralica et al. (2013)	X	X			X										X
Dumont (2013)	X		X	X										X	X
Yang et al. (2012)	X		X	X					X	X	X	X			
Duguet (2012)			X	X	X		X	X							
Czarnitzki et al. (2011)	X				X	X	X	X							X
Carboni (2011)	X		X		X	X		X			X		X		
Yohei (2011)	X		X			X				X		X	X	X	X
Bérubé e Mohnen (2009)	X		X			X								X	X
Corchuelo e Martinez-Ros (2009)	X		X			X		X	X						X
Hægeland e Møen (2007)				X				X							X
Ho (2006)	X														
Avellar (2008)	X		X		X					X			X	X	X
Kannebley Jr. e Porto (2012)	X		X	X						X				X	X
Shimada, Kannebley Jr. e De Negri (2014)	X		X		X					X	X				X

[a] Measured by total employment.

Table A2

Descriptive Statistics for independent variables (input analysis)

Statistics		Variable														
		personnel	*age*	*nac_control*	*for_control*	*rd_cont*	*group*	*revenue*	*imp*	*exp*	*for_market*	*dummyN*	*dummyNE*	*dummySE*	*dummyS*	*dummyCO*
N		13706	6670	13706	13706	13564	13706	13704	13706	13706	13706	13706	13706	13706	13706	13706
Mean		4.59	26.23	0.94	0.09	0.12	0.14	9.20	0.39	0.32	0.04	0.04	0.10	0.18	0.28	0.05
std.dv.		1.43	12.89	0.25	0.28	0.33	0.35	2.30	0.49	0.46	0.21	0.19	0.30	0.38	0.45	0.22
Percentil	5%	2.56	8.00	0.00	0.00	0.00	0.00	5.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	25%	3.76	15.00	1.00	0.00	0.00	0.00	7.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	50%	4.57	25.00	1.00	0.00	0.00	0.00	9.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	75%	5.42	38.00	1.00	0.00	0.00	0.00	10.62	1.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00
	95%	6.94	45.00	1.00	1.00	1.00	1.00	12.49	1.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00

Real 2011 values for whole PINTEC sample. Source: PINTEC 2011 (confidential disaggregate data).

Table A3

Descriptive Statistics for independent variables (output and performance analysis)

Statistics		Variable														
		personnel	*age*	*nac_control*	*for_control*	*rd_cont*	*group*	*revenue*	*imp*	*exp*	*for_market*	*dummyN*	*dummyNE*	*dummySE*	*dummyS*	*dummyCO*
N		6567	6565	6567	6567	6526	6566	6562	13580	13580	6565	13580	13580	13580	13580	13580
Mean		5.27	23.22	0.90	0.13	0.14	0.25	10.23	0.31	0.31	0.07	0.04	0.10	0.17	0.28	0.05
std.dv.		1.14	12.90	0.31	0.34	0.35	0.43	1.74	0.46	0.46	0.25	0.20	0.30	0.38	0.45	0.22
Percentil	5%	3.61	5.00	0.00	0.00	0.00	0.00	7.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	25%	4.54	12.00	1.00	0.00	0.00	0.00	9.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	50%	5.18	22.00	1.00	0.00	0.00	0.00	10.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	75%	5.91	35.00	1.00	0.00	0.00	1.00	11.29	1.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00
	95%	7.34	42.00	1.00	1.00	1.00	1.00	12.96	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00

Real 2008 values for whole PINTEC sample. Source: PINTEC 2008 (confidential disaggregate data).

Table A4

Results of the Means Test for the estimated propensity score. Outcome Variable: in_exp

Variable	Mean		%bias	%reduct	t-test		V(T)/
	Treated	Control		|bias|	t	p>|t|	V(C)
revenue	1.80E+05	2.80E+05	-11.4	65	-1.55	0.122	0.07
personnel	5.9526	6.0015	-4.6	94.1	-0.42	0.674	0.65
nac_control	0.7551	0.82993	-20.1	56.3	-1.58	0.114	.
for_control	0.27211	0.19048	20.8	51.8	1.66	0.098	.
rd_cont	0.7551	0.72109	7.5	91.9	0.66	0.509	.
group	0.31293	0.30612	1.6	96.1	0.13	0.9	.
imp	0.85034	0.87075	-4.8	91.6	-0.5	0.615	.
exp	0.77551	0.79592	-4.4	92.9	-0.43	0.671	.
for_market	0.04762	0.02041	12.6	-237.2	1.29	0.199	.
dummyN	0.01361	0.02041	-5	42.2	-0.45	0.653	.
dummyNE	0.04082	0.06803	-11.3	43.9	-1.03	0.305	.
dummySE	0.13605	0.11565	5.7	8.8	0.53	0.599	.
dummyS	0.34694	0.36735	-4.4	47.6	-0.36	0.716	.
dummyCO	0.01361	0.0068	4.5	68.7	0.58	0.563	.
cnaedummy1	0.10204	0.10884	-2.2	36.2	-0.19	0.85	.
cnaedummy2	0.01361	0.01361	0	100	0	1	.
cnaedummy3	0	0	0	100	.	.	.
cnaedummy4	0.02041	0.02721	-3.8	76.9	-0.38	0.703	.
cnaedummy5	0	0	0	100	.	.	.
cnaedummy6	0.01361	0.0068	4.7	62.5	0.58	0.563	.
cnaedummy7	0	0	0	100	.	.	.
cnaedummy8	0.04762	0.05442	-3.4	64.5	-0.26	0.792	.
cnaedummy9	0	0	0	100	.	.	.
cnaedummy10	0	0	0	100	.	.	.
cnaedummy11	0.12925	0.10884	6.8	73.7	0.54	0.591	.
cnaedummy12	0.04762	0.02721	11.5	44.7	0.92	0.358	.
cnaedummy13	0.02721	0.02041	3.2	85.4	0.38	0.703	.
cnaedummy14	0.04082	0.04762	-3.7	-22.9	-0.28	0.778	.
cnaedummy15	0.01361	0.03401	-15.8	-137.4	-1.15	0.253	.
cnaedummy16	0.04082	0.04762	-3.1	73.1	-0.28	0.778	.
cnaedummy17	0.02721	0.05442	-14.2	-5.4	-1.18	0.24	.
cnaedummy18	0.08163	0.08163	0	100	0	1	.
cnaedummy19	0.08844	0.06803	7.3	-188.5	0.65	0.516	.
cnaedummy20	0.08844	0.08844	0	100	0	1	.
cnaedummy21	0.02041	0	17.4	-94.7	1.74	0.082	.
cnaedummy22	0.04762	0.04762	0	100	0	1	.
cnaedummy23	0.02041	0.02721	-4.7	-37.4	-0.38	0.703	.
cnaedummy24	0	0	0	100	.	.	.
cnaedummy25	0	0	0	100	.	.	.
cnaedummy26	0	0	.	.	.	.	.
cnaedummy27	0	0	0	100	.	.	.
cnaedummy28	0	0	0	100	.	.	.
cnaedummy29	0	0	.	.	.	.	.
cnaedummy30	0	0	.	.	.	.	.
cnaedummy31	0.0068	0.0068	0	100	0	1	.
cnaedummy32	0.11565	0.12925	-4.8	68.6	-0.35	0.723	.
cnaedummy33	0.0068	0	6.7	-48.9	1	0.318	.
cnaedummy34	0	0	0	100	.	.	.
cnaedummy35	0	0	0	100	.	.	.
cnaedummy36	0	0	0	100	.	.	.
cnaedummy37	0	0	0	100	.	.	.
cnaedummy38	0	0	0	100	.	.	.
cnaedummy39	0	0	.	.	.	.	.
Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias		
Unmatched	0.228	251.05	0	18.2	12.6		
Matched	0.057	22.71	0.911	4.7	3.5		

Variables' results for matched sample only.

Table A5

Results of the Means Test for the estimated propensity score. Outcome Variable: rd_exp

Variable	Mean		%bias	%reduct	t-test		V(T)/
	Treated	Control		|bias|	t	p>|t|	V(C)
revenue	3.60E+05	5.60E+05	-23.6	4.7	-1.17	0.244	0.21*
personnel	6.1754	6.1979	-2	97.1	-0.17	0.868	0.73
age	28.341	28.719	-2.9	82	-0.25	0.804	1.36
nac_control	0.73333	0.76296	-7.7	82.5	-0.56	0.577	.
for_control	0.28889	0.25926	7.2	80.2	0.54	0.587	.
rd_cont	0.95556	0.91852	12.8	64.5	1.25	0.212	.
group	0.37037	0.37037	0	100	0	1	.
imp	0.86667	0.82222	11	73.2	1.01	0.315	.
exp	0.79259	0.77037	4.9	87.9	0.44	0.66	.
for_market	0.05185	0.02222	13	-242.7	1.29	0.199	.
dummyN	0.01481	0	12.1	-682.9	1.42	0.157	.
dummyNE	0.04444	0.02222	9.4	32.6	1.02	0.311	.
dummySE	0.15556	0.14074	4.1	-120.3	0.34	0.733	.
dummyS	0.2963	0.34074	-9.6	-66.7	-0.78	0.435	.
dummyCO	0.00741	0.01481	-5	75.5	-0.58	0.563	.
cnaedummy1	0.12593	0.08889	11.7	-91.8	0.98	0.328	.
cnaedummy2	0.02222	0.02963	-5.8	20.3	-0.38	0.703	.
cnaedummy3	0	0	0	100	.	.	.
cnaedummy4	0.02222	0.02222	0	100	0	1	.
cnaedummy5	0	0	0	100	.	.	.
cnaedummy6	0.02222	0.02222	0	100	0	1	.
cnaedummy7	0	0	0	100	.	.	.
cnaedummy8	0.03704	0.04444	-4	55.3	-0.31	0.759	.
cnaedummy9	0	0	0	100	.	.	.
cnaedummy10	0	0	0	100	.	.	.
cnaedummy11	0.14815	0.11111	11.5	27.2	0.9	0.367	.
cnaedummy12	0.05185	0.06667	-7.8	40.1	-0.51	0.608	.
cnaedummy13	0.01481	0.01481	0	100	0	1	.
cnaedummy14	0.02963	0.03704	-4.4	-320.3	-0.34	0.736	.
cnaedummy15	0.02222	0.03704	-10.5	-568.2	-0.72	0.475	.
cnaedummy16	0.05185	0.05185	0	100	0	1	.
cnaedummy17	0.02222	0.00741	6.6	77.7	1.01	0.315	.
cnaedummy18	0.08889	0.08889	0	100	0	1	.
cnaedummy19	0.07407	0.07407	0	100	0	1	.
cnaedummy20	0.07407	0.08148	-3.2	76.8	-0.23	0.821	.
cnaedummy21	0.02222	0.00741	12.7	3.6	1.01	0.315	.
cnaedummy22	0.03704	0.03704	0	100	0	1	.
cnaedummy23	0.02222	0.01481	4.8	-26.2	0.45	0.653	.
cnaedummy24	0	0	0	100	.	.	.
cnaedummy25	0	0	.	.	.	.	.
cnaedummy26	0	0	.	.	.	.	.*
cnaedummy27	0	0	0	100	.	.	.
cnaedummy28	0	0	0	100	.	.	.
cnaedummy29	0	0	.	.	.	.	.
cnaedummy30	0	0	.	.	.	.	.
cnaedummy31	0.00741	0.02963	-21.1	-258.6	-1.35	0.177	.
cnaedummy32	0.1037	0.13333	-9.9	-95.8	-0.75	0.453	.
cnaedummy33	0	0	0	100	.	.	.
cnaedummy34	0	0	0	100	.	.	.
cnaedummy35	0	0	0	100	.	.	.
cnaedummy36	0	0	0	100	.	.	.
cnaedummy37	0	0	0	100	.	.	.
cnaedummy38	0	0	0	100	.	.	.
cnaedummy39	0	0	.	.	.	.	.
Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias		
Unmatched	0.155	123.41	0	14.5	9.6		
Matched	0.048	17.78	0.986	4.9	3.2		

Variables' results for matched sample only.

Table A6

Results of the Means Test for the estimated propensity score. Outcome Variable: researcher

Variable	Mean		%bias	%reduct	t-test		V(T)/
	Treated	Control		|bias|	t	p>|t|	V(C)
revenue	6.60E+05	1.00E+06	-24.1	16.1	-1.37	0.172	0.36*
personnel	6.423	6.3647	4.8	93.6	0.45	0.649	0.69*
age	28.731	30.183	-10.9	38.7	-0.94	0.346	0.79
nac_control	0.69714	0.70857	-2.8	93.6	-0.23	0.816	.
for_control	0.34286	0.33714	1.3	96.7	0.11	0.91	.
rd_cont	0.94857	0.96	-3.9	87.3	-0.51	0.61	.
group	0.41714	0.37714	8.7	78.2	0.76	0.446	.
imp	0.89714	0.88571	3	93.6	0.34	0.732	.
exp	0.80571	0.82286	-3.9	90.8	-0.41	0.681	.
for_market	0.07429	0.06857	2.2	19.6	0.21	0.836	.
dummyN	0.01714	0.02857	-8.5	-250.7	-0.71	0.476	.
dummyNE	0.04	0.02286	7.4	51.7	0.92	0.359	.
dummySE	0.17143	0.15429	4.7	-32.8	0.43	0.665	.
dummyS	0.26286	0.30857	-10.1	-15.7	-0.95	0.345	.
dummyCO	0.01714	0.00571	6.9	48.9	1	0.316	.
cnaedummy1	0.10286	0.13143	-9.5 -	6009.3	-0.83	0.407	.
cnaedummy2	0.01714	0.00571	9.5	-184.2	1	0.316	.
cnaedummy3	0	0	0	100	.	.	.
cnaedummy4	0.01714	0.00571	7.4	24.3	1	0.316	.
cnaedummy5	0.00571	0	5.7	36.3	1	0.318	.
cnaedummy6	0.01714	0.01714	0	100	0	1	.
cnaedummy7	0.00571	0.00571	0	100	0	1	.
cnaedummy8	0.03429	0.02286	6.3	-14.4	0.64	0.522	.
cnaedummy9	0	0	0	100	.	.	.
cnaedummy10	0	0	0	100	.	.	.
cnaedummy11	0.13143	0.16	-9.1	17.8	-0.76	0.45	.
cnaedummy12	0.06857	0.07429	-2.7	84.9	-0.21	0.836	.
cnaedummy13	0.01714	0.01143	3	86.5	0.45	0.654	.
cnaedummy14	0.02857	0.01143	10.1	-470.6	1.14	0.253	.
cnaedummy15	0.02857	0.01714	7.3	-87.5	0.71	0.476	.
cnaedummy16	0.04571	0.08571	-18.1 -	2422.1	-1.51	0.132	.
cnaedummy17	0.04571	0.01714	11.6	30	1.53	0.126	.
cnaedummy18	0.08571	0.09714	-4.4	50	-0.37	0.712	.
cnaedummy19	0.06857	0.05714	4.3	27.5	0.44	0.661	.
cnaedummy20	0.09714	0.09143	2.2	90.6	0.18	0.855	.
cnaedummy21	0.02286	0.02857	-4.7	62.1	-0.34	0.736	.
cnaedummy22	0.02857	0.04571	-10.8	-301	-0.85	0.398	.
cnaedummy23	0.01714	0.00571	7.9	-18.7	1	0.316	.
cnaedummy24	0	0	0	100	.	.	.
cnaedummy25	0	0	.	.	.	.	.
cnaedummy26	0	0	.	.	.	.	.*
cnaedummy27	0	0	0	100	.	.	.
cnaedummy28	0	0	0	100	.	.	.
cnaedummy29	0	0	.	.	.	.	.
cnaedummy30	0	0	.	.	.	.	.
cnaedummy31	0.01143	0.01143	0	100	0	1	.
cnaedummy32	0.08571	0.09143	-2	-28	-0.19	0.851	.
cnaedummy33	0	0	0	100	.	.	.
cnaedummy34	0.00571	0	9.4	-51.7	1	0.318	.
cnaedummy35	0	0	0	100	.	.	.
cnaedummy36	0	0	0	100	.	.	.
cnaedummy37	0.00571	0.00571	0	100	0	1	.
cnaedummy38	0.00571	0	10	-22.2	1	0.318	.
cnaedummy39	0	0	.	.	.	.	.
Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias		
Unmatched	0.162	159.32	0	14.2	8.8		
Matched	0.05	24.23	0.932	5.3	4.4		

Variables' results for matched sample only.

Table A7

Results of the Means Test for the estimated propensity score. Outcome Variable: in_dummy

Variable	Mean		%bias	%reduct	t-test		V(T)/
	Treated	Control		|bias|	t	p>|t|	V(C)
revenue	3.00E+05	1.50E+06	-41.8	-65	-1.99	0.049	0.02*
personnel	6.0075	6.1027	-7.1	94.3	-0.43	0.671	0.55*
age	25.459	22.23	24.6	-58.9	1.44	0.152	1.38
nac_control	0.70492	0.72131	-4.6	92.2	-0.2	0.843	.
for_control	0.39344	0.39344	0	100	0	1	.
rd_cont	0.57377	0.54098	8.4	94.5	0.36	0.718	.
group	0.36066	0.40984	-11.7	81.1	-0.55	0.58	.
imp	0.86885	0.78689	19.3	82.6	1.2	0.234	.
exp	0.80328	0.72131	18.5	82	1.06	0.291	.
for_market	0.11475	0.04918	26.8	-53.4	1.32	0.19	.
dummyN	0	0	0	100	.	.	.
dummyNE	0.06557	0.08197	-6.6	76.3	-0.34	0.732	.
dummySE	0.13115	0.18033	-13.2	-183.2	-0.74	0.458	.
dummyS	0.36066	0.37705	-3.6	54.4	-0.19	0.853	.
dummyCO	0	0	0	100	.	.	.
cnaedummy1	0.04918	0.01639	11.4	-13.4	1.01	0.313	.
cnaedummy2	0.03279	0	27	-942	1.43	0.156	.
cnaedummy3	0	0	0	100	.	.	.
cnaedummy4	0.03279	0.04918	-10.2	39.1	-0.45	0.651	.
cnaedummy5	0.01639	0	8.5	75.2	1	0.319	.
cnaedummy6	0.01639	0	10.3	36.9	1	0.319	.
cnaedummy7	0	0	0	100	.	.	.
cnaedummy8	0.06557	0.04918	9.8	-90.5	0.39	0.7	.
cnaedummy9	0	0	0	100	.	.	.
cnaedummy10	0	0	0	100	.	.	.
cnaedummy11	0.04918	0.01639	12.1	56.7	1.01	0.313	.
cnaedummy12	0.04918	0.06557	-9.8	52.8	-0.39	0.7	.
cnaedummy13	0.04918	0.08197	-15.6	-21.8	-0.73	0.469	.
cnaedummy14	0.08197	0.14754	-32.1	-209.8	-1.13	0.26	.
cnaedummy15	0.01639	0.03279	-10.1	-200.5	-0.58	0.563	.
cnaedummy16	0.01639	0	7.2	58.1	1	0.319	.
cnaedummy17	0.01639	0.01639	0	100	0	1	.
cnaedummy18	0	0	0	100	.	.	.
cnaedummy19	0.16393	0.13115	12	-17.2	0.51	0.613	.
cnaedummy20	0.14754	0.16393	-6.5	77.5	-0.25	0.805	.
cnaedummy21	0	0	0	100	.	.	.
cnaedummy22	0.04918	0.01639	17.9	-980.9	1.01	0.313	.
cnaedummy23	0.01639	0.03279	-11.5	-8.2	-0.58	0.563	.
cnaedummy24	0	0	0	100	.	.	.
cnaedummy25	0	0	0	100	.	.	.
cnaedummy26	0	0	.	.	.	.	.*
cnaedummy27	0	0	0	100	.	.	.
cnaedummy28	0	0	0	100	.	.	.
cnaedummy29	0	0	0	100	.	.	.
cnaedummy30	0	0	0	100	.	.	.
cnaedummy31	0.01639	0.06557	-56.8 -	2481.8	-1.37	0.173	.
cnaedummy32	0.09836	0.08197	6.6	74.7	0.31	0.754	.
cnaedummy33	0	0	0	100	.	.	.
cnaedummy34	0	0	0	100	.	.	.
cnaedummy35	0	0	0	100	.	.	.
cnaedummy36	0	0	0	100	.	.	.
cnaedummy37	0	0	0	100	.	.	.
cnaedummy38	0.01639	0.03279	-33.5	-806.7	-0.58	0.563	.
cnaedummy39	0	0	0	100	.	.	.
Sample	LR chi2	p>chi2	MeanBias	MedBias	R	%Var	
Unmatched	634.18	0	23.2	13.1	0.62	50	
Matched	21.99	0.782	9.3	6.6	0.41*	75	

Variables' results for matched sample only.

Table A8

Results of the Means Test for the estimated propensity score. Outcome Variable: rd_dummy

Variable	Mean		%bias	%reduct	t-test		V(T)/
	Treated	Control		|bias|	t	p>|t|	V(C)
revenue	2.90E+05	3.70E+05	-3	88.4	-1	0.32	0.95
personnel	6.0663	6.2573	-14.2	88.6	-1.59	0.113	1.02
age	27.778	28.896	-8.5	45	-0.7	0.487	1.1
nac_control	0.77778	0.71852	16.6	71.9	1.12	0.264	.
for_control	0.2963	0.37037	-19.1	70.9	-1.29	0.198	.
rd_cont	0.62963	0.53333	24.7	83.9	1.61	0.11	.
group	0.37037	0.35556	3.5	94.3	0.25	0.801	.
imp	0.85185	0.88148	-7	93.7	-0.71	0.476	.
exp	0.76296	0.74815	3.3	96.8	0.28	0.778	.
for_market	0.06667	0.1037	-15.1	13.4	-1.09	0.277	.
dummyN	0.01481	0.01481	0	100	0	1	.
dummyNE	0.05926	0.02222	14.9	46.5	1.54	0.125	.
dummySE	0.16296	0.11852	11.9	-155.9	1.05	0.295	.
dummyS	0.34815	0.34815	0	100	0	1	.
dummyCO	0.00741	0	4.1	79.4	1	0.318	.
cnaedummy1	0.05926	0.05926	0	100	0	1	.
cnaedummy2	0.02963	0.06667	-30.5 -	1077.1	-1.42	0.156	.
cnaedummy3	0	0	0	100	.	.	.
cnaedummy4	0.01481	0.00741	4.6	72.5	0.58	0.563	.
cnaedummy5	0.00741	0.00741	0	100	0	1	.
cnaedummy6	0.01481	0.01481	0	100	0	1	.
cnaedummy7	0.00741	0.00741	0	100	0	1	.
cnaedummy8	0.02963	0.00741	13.3	-158.2	1.35	0.177	.
cnaedummy9	0	0	0	100	.	.	.
cnaedummy10	0.00741	0.00741	0	100	0	1	.
cnaedummy11	0.08148	0.06667	5.5	80.4	0.46	0.644	.
cnaedummy12	0.05185	0.07407	-13.3	36	-0.75	0.454	.
cnaedummy13	0.03704	0.01481	10.6	17.4	1.15	0.252	.
cnaedummy14	0.03704	0.02222	7.3	30	0.72	0.475	.
cnaedummy15	0.04444	0.05185	-4.6	-35.8	-0.28	0.777	.
cnaedummy16	0.03704	0.02963	3.2	81.1	0.34	0.736	.
cnaedummy17	0.02963	0.03704	-3.9	54.7	-0.34	0.736	.
cnaedummy18	0.06667	0.08148	-7.1	45.8	-0.46	0.644	.
cnaedummy19	0.12593	0.11852	2.7	73.5	0.19	0.853	.
cnaedummy20	0.11111	0.12593	-5.9	79.6	-0.38	0.708	.
cnaedummy21	0.02222	0.02963	-6.6	-0.1	-0.38	0.703	.
cnaedummy22	0.05926	0.06667	-4.1	-144.2	-0.25	0.803	.
cnaedummy23	0.01481	0.00741	5.2	51.1	0.58	0.563	.
cnaedummy24	0	0	0	100	.	.	.
cnaedummy25	0	0	0	100	.	.	.
cnaedummy26	0	0	.	.	.	.	.*
cnaedummy27	0	0	0	100	.	.	.
cnaedummy28	0.01481	0.01481	0	100	0	1	.
cnaedummy29	0	0	0	100	.	.	.
cnaedummy30	0	0	0	100	.	.	.
cnaedummy31	0.00741	0	8.5	-288.9	1	0.318	.
cnaedummy32	0.08148	0.08148	0	100	0	1	.
cnaedummy33	0	0	0	100	.	.	.
cnaedummy34	0	0	0	100	.	.	.
cnaedummy35	0	0	0	100	.	.	.
cnaedummy36	0	0	0	100	.	.	.
cnaedummy37	0	0	0	100	.	.	.
cnaedummy38	0.00741	0	15.1	-309.7	1	0.318	.
cnaedummy39	0	0	0	100	.	.	.
Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias		
Unmatched	0.297	634.18	0	23.2	13.1		
Matched	0.078	28.97	0.791	5.6	3.5		

Variables' results for matched sample only.

Table A9

Results of the Means Test for the estimated propensity score. Outcome Variable: innovator

Variable	Mean		%bias	%reduct	t-test		V(T)/
	Treated	Control		|bias|	t	p>|t|	V(C)
personnel	6.717	6.8591	-12	91.1	-0.99	0.322	0.87
age	26.607	27.248	-4.8	79.5	-0.41	0.685	1.11
nac_control	0.61379	0.66207	-11.8	85.1	-0.85	0.394	.
for_control	0.46897	0.44138	6.5	92.6	0.47	0.639	.
rd_cont	0.73793	0.73793	0	100	0	1	.
group	0.53793	0.6	-13.3	80	-1.07	0.287	.
revenue	12.602	12.769	-10.1	93.5	-0.87	0.384	0.74
imp	0.75862	0.86207	-22.7	75.2	-2.26	0.025	.
exp	0.90345	0.91034	-1.7	98.7	-0.2	0.841	.
For_market	0.09655	0.07586	7.6	34.1	0.63	0.532	.
dummyN	0.04138	0.03448	3.5	-9756	0.31	0.76	.
dummyNE	0.03448	0.04828	-5.1	69.8	-0.59	0.557	.
dummySE	0.09655	0.08276	4	79.8	0.41	0.682	.
dummyS	0.3931	0.42069	-5.9	71.7	-0.48	0.634	.
dummyCO	0	0	0	100	.	.	.
cnaedummy1	0.12414	0.14483	-6.6	-153.3	-0.51	0.607	.
cnaedummy2	0.0069	0.02069	-11.3	-283.8	-1.01	0.316	.
cnaedummy3	0.0069	0.01379	-10.8	-121.5	-0.58	0.563	.
cnaedummy4	0.01379	0.01379	0	100	0	1	.
cnaedummy5	0	0	0	100	.	.	.
cnaedummy6	0.01379	0.0069	4.4	75.3	0.58	0.563	.
cnaedummy7	0	0	0	100	.	.	.
cnaedummy8	0.01379	0.02759	-10.4	-5.3	-0.82	0.411	.
cnaedummy9	0	0	0	100	.	.	.
cnaedummy10	0	0	0	100	.	.	.
cnaedummy11	0.07586	0.05517	8.6	42.5	0.71	0.478	.
cnaedummy12	0.04828	0.04138	4.4	75.4	0.28	0.778	.
cnaedummy13	0.04138	0.10345	-29.4	-138.6	-2.05	0.042	.
cnaedummy14	0.02069	0.04828	-14.4	12.6	-1.29	0.199	.
cnaedummy15	0.04138	0.06207	-11.8	-35.2	-0.79	0.428	.
cnaedummy16	0.02759	0.03448	-3.1	85.4	-0.34	0.736	.
cnaedummy17	0.11724	0.13103	-5.6	80.8	-0.36	0.723	.
cnaedummy18	0.05517	0.06207	-3.5	63.2	-0.25	0.803	.
cnaedummy19	0.13793	0.11034	9.1	62.5	0.71	0.478	.
cnaedummy20	0.15172	0.05517	33.5	22.9	2.72	0.007	.
cnaedummy21	0.01379	0	13.7	-527.8	1.42	0.157	.
cnaedummy22	0.02069	0.02069	0	100	0	1	.
cnaedummy23	0.02759	0.01379	8.7	-139.8	0.82	0.411	.
cnaedummy24	0.0069	0	6.4	43.4	1	0.318	.
cnaedummy25	0	0	0	100	.	.	.
cnaedummy26	0	0	.	.	.	.	.*
cnaedummy27	0	0	0	100	.	.	.
cnaedummy28	0	0	0	100	.	.	.
cnaedummy29	0	0	0	100	.	.	.
cnaedummy30	0	0	0	100	.	.	.
cnaedummy31	0.01379	0.0069	7	-146.8	0.58	0.563	.
cnaedummy32	0.01379	0.02069	-4.4	60	-0.45	0.653	.
cnaedummy33	0	0	0	100	.	.	.
cnaedummy34	0.0069	0.0069	0	100	0	1	.
cnaedummy35	0	0	0	100	.	.	.
cnaedummy36	0	0	0	100	.	.	.
cnaedummy37	0	0	0	100	.	.	.
cnaedummy38	0	0	0	100	.	.	.
cnaedummy39	0	0	0	100	.	.	.
Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias		
Unmatched	0.411	569	0	29	16.4		
Matched	0.079	31.43	0.594	6	4.4		

Variables' results for matched sample only.

Table A10

Results of the Means Test for the estimated propensity score. Outcome Variable: new_sales

Variable	Mean		%bias	%reduct	t-test		V(T)/
	Treated	Control		|bias|	t	p>|t|	V(C)
personnel	6.826	6.7916	2.9	97.8	0.21	0.836	0.77
age	27.795	26.098	12.7	45.9	1.02	0.309	1.18
nac_control	0.62295	0.62295	0	100	0	1	.
for_control	0.45902	0.46721	-1.9	97.8	-0.13	0.898	.
rd_cont	0.77869	0.80328	-6.4	96.1	-0.47	0.638	.
group	0.52459	0.57377	-10.6	84.2	-0.77	0.442	.
revenue	12.719	12.792	-4.4	97.2	-0.33	0.745	0.61*
imp	0.79508	0.7541	9	90.2	0.76	0.446	.
exp	0.93443	0.93443	0	100	0	1	.
personnel	0.10656	0.13115	-9	21.7	-0.59	0.555	.
dummyN	0.04098	0	21	-58470.3	2.27	0.024	.
dummyNE	0.04098	0.03279	3	82.1	0.34	0.735	.
dummySE	0.10656	0.10656	0	100	0	1	.
dummyS	0.39344	0.42623	-7	66.4	-0.52	0.604	.
dummyCO	0	0	0	100	.	.	.
cnaedummy1	0.10656	0.11475	-2.6	-0.4	-0.2	0.839	.
cnaedummy2	0.0082	0.01639	-6.7	-128.1	-0.58	0.563	.
cnaedummy3	0.0082	0.02459	-25.6	-426.6	-1.01	0.315	.
cnaedummy4	0.01639	0.01639	0	100	0	1	.
cnaedummy5	0	0	0	100	.	.	.
cnaedummy6	0.01639	0	10.5	41.2	1.42	0.157	.
cnaedummy7	0	0	0	100	.	.	.
cnaedummy8	0.01639	0.02459	-6.2	37.4	-0.45	0.653	.
cnaedummy9	0	0	0	100	.	.	.
cnaedummy10	0	0	0	100	.	.	.
cnaedummy11	0.06557	0.08197	-6.9	54.4	-0.49	0.626	.
cnaedummy12	0.05738	0.0082	31.2	-75.3	2.17	0.031	.
cnaedummy13	0.03279	0.05738	-11.6	5.5	-0.92	0.357	.
cnaedummy14	0.01639	0.01639	0	100	0	1	.
cnaedummy15	0.04098	0.08197	-23.3	-167.9	-1.33	0.184	.
cnaedummy16	0.03279	0.03279	0	100	0	1	.
cnaedummy17	0.13115	0.09836	13.3	54.4	0.8	0.424	.
cnaedummy18	0.05738	0.04098	8.2	12.6	0.59	0.556	.
cnaedummy19	0.15574	0.17213	-5.4	77.7	-0.34	0.731	.
cnaedummy20	0.15574	0.13115	8.5	80.4	0.55	0.586	.
cnaedummy21	0.01639	0.01639	0	100	0	1	.
cnaedummy22	0.0082	0.0082	0	100	0	1	.
cnaedummy23	0.02459	0	15.6	-327.4	1.75	0.082	.
cnaedummy24	0.0082	0.01639	-7.6	32.7	-0.58	0.563	.
cnaedummy25	0	0	0	100	.	.	.
cnaedummy26	0	0	.	.	.	.	.*
cnaedummy27	0	0	0	100	.	.	.
cnaedummy28	0	0	0	100	.	.	.
cnaedummy29	0	0	0	100	.	.	.
cnaedummy30	0	0	0	100	.	.	.
cnaedummy31	0.0082	0.0082	0	100	0	1	.
cnaedummy32	0.01639	0.03279	-10.4	4.8	-0.82	0.41	.
cnaedummy33	0	0	0	100	.	.	.
cnaedummy34	0	0	0	100	.	.	.
cnaedummy35	0	0	0	100	.	.	.
cnaedummy36	0	0	0	100	.	.	.
cnaedummy37	0	0	0	100	.	.	.
cnaedummy38	0	0	0	100	.	.	.
cnaedummy39	0	0	0	100	.	.	.
Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias		
Unmatched	0.411	569	0	29	16.4		
Matched	0.055	17.78	0.98	5.3	1.9		

Variables' results for matched sample only.

Table A11

Results of the Means Test for the estimated propensity score. Outcome Variable: new_exp

Variable	Mean		%bias	%reduct	t-test		V(T)/
	Treated	Control		|bias|	t	p>|t|	V(C)
personnel	6.826	6.8148	0.9	99.3	0.07	0.946	0.79
age	27.795	26.287	11.3	51.9	0.91	0.362	1.21
nac_control	0.62295	0.60656	4	94.9	0.26	0.794	.
for_control	0.45902	0.48361	-5.8	93.4	-0.38	0.702	.
rd_cont	0.77869	0.80328	-6.4	96.1	-0.47	0.638	.
group	0.52459	0.56557	-8.8	86.8	-0.64	0.522	.
revenue	12.719	12.733	-0.9	99.4	-0.06	0.949	0.64*
imp	0.79508	0.7459	10.8	88.2	0.91	0.363	.
exp	0.93443	0.95082	-3.9	97	-0.55	0.584	.
personnel	0.10656	0.09836	3	73.9	0.21	0.834	.
dummyN	0.04098	0.0082	16.8	-46756.2	1.66	0.099	.
dummyNE	0.04098	0.02459	6.1	64.1	0.72	0.474	.
dummySE	0.10656	0.12295	-4.7	76	-0.4	0.689	.
dummyS	0.39344	0.40164	-1.8	91.6	-0.13	0.896	.
dummyCO	0	0	0	100	.	.	.
cnaedummy1	0.10656	0.11475	-2.6	-0.4	-0.2	0.839	.
cnaedummy2	0.0082	0.0082	0	100	0	1	.
cnaedummy3	0.0082	0.0082	0	100	0	1	.
cnaedummy4	0.01639	0	10.4	43.2	1.42	0.157	.
cnaedummy5	0	0	0	100	.	.	.
cnaedummy6	0.01639	0.0082	5.2	70.6	0.58	0.563	.
cnaedummy7	0	0	0	100	.	.	.
cnaedummy8	0.01639	0.02459	-6.2	37.4	-0.45	0.653	.
cnaedummy9	0	0	0	100	.	.	.
cnaedummy10	0	0	0	100	.	.	.
cnaedummy11	0.06557	0.07377	-3.4	77.2	-0.25	0.802	.
cnaedummy12	0.05738	0.01639	26	-46.1	1.7	0.09	.
cnaedummy13	0.03279	0.06557	-15.5	-26	-1.18	0.238	.
cnaedummy14	0.01639	0.01639	0	100	0	1	.
cnaedummy15	0.04098	0.06557	-14	-60.7	-0.85	0.395	.
cnaedummy16	0.03279	0.03279	0	100	0	1	.
cnaedummy17	0.13115	0.09836	13.3	54.4	0.8	0.424	.
cnaedummy18	0.05738	0.04918	4.1	56.3	0.28	0.777	.
cnaedummy19	0.15574	0.17213	-5.4	77.7	-0.34	0.731	.
cnaedummy20	0.15574	0.13115	8.5	80.4	0.55	0.586	.
cnaedummy21	0.01639	0.02459	-8.1	-273.1	-0.45	0.653	.
cnaedummy22	0.0082	0.0082	0	100	0	1	.
cnaedummy23	0.02459	0.01639	5.2	-42.5	0.45	0.653	.
cnaedummy24	0.0082	0.02459	-15.2	-34.6	-1.01	0.315	.
cnaedummy25	0	0	0	100	.	.	.
cnaedummy26	0	0	.	.	.	.	.*
cnaedummy27	0	0	0	100	.	.	.
cnaedummy28	0	0	0	100	.	.	.
cnaedummy29	0	0	0	100	.	.	.
cnaedummy30	0	0	0	100	.	.	.
cnaedummy31	0.0082	0.01639	-8.3	-193.4	-0.58	0.563	.
cnaedummy32	0.01639	0.02459	-5.2	52.4	-0.45	0.653	.
cnaedummy33	0	0	0	100	.	.	.
cnaedummy34	0	0	0	100	.	.	.
cnaedummy35	0	0	0	100	.	.	.
cnaedummy36	0	0	0	100	.	.	.
cnaedummy37	0	0	0	100	.	.	.
cnaedummy38	0	0	0	100	.	.	.
cnaedummy39	0	0	0	100	.	.	.
Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias		
Unmatched	0.411	569	0	29	16.4		
Matched	0.057	19.03	0.982	4.6	3		

Variables' results for matched sample only.

Table A12

Results of the Means Test for the estimated propensity score. Outcome Variable: revenue

Variable	Mean		%bias	%reduct	t-test		V(T)/
	Treated	Control		|bias|	t	p>|t|	V(C)
personnel	6.4889	6.4586	2.8	97.7	0.22	0.829	0.93
age	26.82	28.074	-9.6	67.6	-0.78	0.438	1.21
nac_control	0.63934	0.7623	-30.7	57.7	-2.11	0.036	.
for_control	0.41803	0.28689	31.3	59.1	2.16	0.032	.
rd_cont	0.70492	0.70492	0	100	0	1	.
group	0.5	0.43443	14.1	75.3	1.02	0.307	.
revenue	12.244	12.06	12.3	91.7	1.07	0.284	0.94
imp	0.72951	0.63115	20.9	66	1.65	0.1	.
exp	0.89344	0.86066	7.9	92.5	0.78	0.438	.
personnel	0.06557	0.07377	-3.4	-457.5	-0.25	0.802	.
dummyN	0.04098	0.02459	8.6	-390.5	0.72	0.474	.
dummyNE	0.04098	0.04098	0	100	0	1	.
dummySE	0.09016	0.06557	7.5	66.6	0.71	0.476	.
dummyS	0.42623	0.54918	-26.1	18.1	-1.93	0.055	.
dummyCO	0	0	0	100	.	.	.
cnaedummy1	0.12295	0.13115	-2.5	-2354.4	-0.19	0.848	.
cnaedummy2	0.0082	0.01639	-7.8	-27.9	-0.58	0.563	.
cnaedummy3	0	0	0	100	.	.	.
cnaedummy4	0.01639	0.0082	4.6	76.6	0.58	0.563	.
cnaedummy5	0	0	0	100	.	.	.
cnaedummy6	0.0082	0.0082	0	100	0	1	.
cnaedummy7	0	0	0	100	.	.	.
cnaedummy8	0.01639	0	10.8	-3.5	1.42	0.157	.
cnaedummy9	0	0	0	100	.	.	.
cnaedummy10	0	0	0	100	.	.	.
cnaedummy11	0.07377	0.0082	27.8	-163.5	2.61	0.01	.
cnaedummy12	0.04918	0.04098	4.8	76.1	0.31	0.759	.
cnaedummy13	0.04918	0.03279	7	22.8	0.64	0.52	.
cnaedummy14	0.01639	0.02459	-4.7	74.5	-0.45	0.653	.
cnaedummy15	0.02459	0.05738	-21.1	-2038.5	-1.29	0.198	.
cnaedummy16	0.03279	0.04098	-3.6	70.8	-0.34	0.735	.
cnaedummy17	0.13115	0.17213	-15.2	55.3	-0.89	0.374	.
cnaedummy18	0.06557	0.03279	15.4	-2.7	1.18	0.238	.
cnaedummy19	0.15574	0.21311	-18.2	36	-1.15	0.25	.
cnaedummy20	0.12295	0.09836	8.8	74.1	0.61	0.542	.
cnaedummy21	0.0082	0	8.7	-321.3	1	0.318	.
cnaedummy22	0.02459	0.04918	-14.2	-70.2	-1.02	0.31	.
cnaedummy23	0.03279	0.01639	10	-101	0.82	0.41	.
cnaedummy24	0.0082	0.0082	0	100	0	1	.
cnaedummy25	0	0	0	100	.	.	.
cnaedummy26	0	0	.	.	.	.	.*
cnaedummy27	0	0	0	100	.	.	.
cnaedummy28	0	0	0	100	.	.	.
cnaedummy29	0	0	0	100	.	.	.
cnaedummy30	0	0	0	100	.	.	.
cnaedummy31	0.0082	0.0082	0	100	0	1	.
cnaedummy32	0.01639	0.03279	-9.5	44.2	-0.82	0.41	.
cnaedummy33	0	0	0	100	.	.	.
cnaedummy34	0.0082	0	12.1	-23	1	0.318	.
cnaedummy35	0	0	0	100	.	.	.
cnaedummy36	0	0	0	100	.	.	.
cnaedummy37	0	0	0	100	.	.	.
cnaedummy38	0	0	0	100	.	.	.
cnaedummy39	0	0	.	.	.	.	.
Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias		
Unmatched	0.397	466.04	0	26.9	15.4		
Matched	0.092	30.59	0.538	7.3	4.6		

Variables' results for matched sample only.

Table A13

Results of the Means Test for the estimated propensity score. Outcome Variable: personnel

Variable	Mean		%bias	%reduct	t-test		V(T)/
	Treated	Control		|bias|	t	p>|t|	V(C)
personnel	6.5096	6.4735	3.4	97.5	0.28	0.783	1.03
age	26.814	27.403	-4.5	83.2	-0.37	0.711	1.18
nac_control	0.62791	0.63566	-1.9	97.5	-0.13	0.898	.
for_control	0.44186	0.4031	9.2	89	0.63	0.53	.
rd_cont	0.72093	0.75194	-7.9	94.9	-0.56	0.574	.
group	0.51163	0.49612	3.3	94.6	0.25	0.804	.
revenue	12.398	12.423	-1.6	99	-0.14	0.892	0.85
imp	0.73643	0.74419	-1.7	97.4	-0.14	0.888	.
exp	0.90698	0.93023	-5.7	94.9	-0.68	0.496	.
personnel	0.06202	0.03101	12.7	-527.4	1.18	0.239	.
dummyN	0.04651	0.0155	15.7	-353.2	1.44	0.152	.
dummyNE	0.03876	0.06977	-12.5	47.9	-1.1	0.273	.
dummySE	0.08527	0.05426	9.4	57.3	0.98	0.33	.
dummyS	0.4186	0.47287	-11.6	59.7	-0.87	0.383	.
dummyCO	0	0	0	100	.	.	.
cnaedummy1	0.12403	0.12403	0	100	0	1	.
cnaedummy2	0.00775	0	7.5	-17	1	0.318	.
cnaedummy3	0.00775	0	10.8	-73.8	1	0.318	.
cnaedummy4	0.0155	0.00775	4.4	77.9	0.58	0.563	.
cnaedummy5	0	0	0	100	.	.	.
cnaedummy6	0.00775	0	5.2	75.3	1	0.318	.
cnaedummy7	0	0	0	100	.	.	.
cnaedummy8	0.0155	0.00775	5.1	55.5	0.58	0.563	.
cnaedummy9	0	0	0	100	.	.	.
cnaedummy10	0	0	0	100	.	.	.
cnaedummy11	0.07752	0.1938	-48.4	-374.1	-2.76	0.006	.
cnaedummy12	0.04651	0.05426	-4.6	74.4	-0.28	0.777	.
cnaedummy13	0.04651	0.07752	-13.4	-23.4	-1.03	0.304	.
cnaedummy14	0.0155	0.0155	0	100	0	1	.
cnaedummy15	0.03876	0.03876	0	100	0	1	.
cnaedummy16	0.03101	0.02326	3.5	75.2	0.38	0.703	.
cnaedummy17	0.13178	0.11628	5.7	83.9	0.38	0.707	.
cnaedummy18	0.06202	0.04651	7.5	42.9	0.55	0.584	.
cnaedummy19	0.14729	0.13178	5	80.2	0.36	0.721	.
cnaedummy20	0.13178	0.07752	18.9	49.5	1.42	0.156	.
cnaedummy21	0.00775	0	8.4	-238.9	1	0.318	.
cnaedummy22	0.02326	0.03876	-9.1	3.2	-0.72	0.474	.
cnaedummy23	0.03101	0.0155	9.6	-175.2	0.82	0.411	.
cnaedummy24	0.00775	0	7.3	4	1	0.318	.
cnaedummy25	0	0	0	100	.	.	.
cnaedummy26	0	0	.	.	.	.	.*
cnaedummy27	0	0	0	100	.	.	.
cnaedummy28	0	0	0	100	.	.	.
cnaedummy29	0	0	0	100	.	.	.
cnaedummy30	0	0	0	100	.	.	.
cnaedummy31	0	0	0	100	.	.	.
cnaedummy32	0.0155	0.03101	-9.1	48.8	-0.82	0.411	.
cnaedummy33	0	0	0	100	.	.	.
cnaedummy34	0.00775	0	11.8	-27.8	1	0.318	.
cnaedummy35	0	0	0	100	.	.	.
cnaedummy36	0	0	0	100	.	.	.
cnaedummy37	0	0	0	100	.	.	.
cnaedummy38	0	0	0	100	.	.	.
cnaedummy39	0	0	.	.	.	.	.
Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias		
Unmatched	0.412	509.69	0	28.1	14.9		
Matched	0.06	20.9	0.863	5.7	4.5		

Variables' results for matched sample only.

Table A14

Results of the Means Test for the estimated propensity score. Outcome Variable: rev_person

Variable	Mean		%bias	%reduct	t-test		V(T)/
	Treated	Control		|bias|	t	p>|t|	V(C)
personnel	6.7093	6.73	-1.7	98.7	-0.14	0.889	0.77
age	26.729	27.993	-9.4	59.7	-0.79	0.431	1.04
nac_control	0.61111	0.60417	1.7	97.9	0.12	0.904	.
for_control	0.46528	0.46528	0	100	0	1	.
rd_cont	0.73611	0.75	-3.6	97.8	-0.27	0.788	.
group	0.53472	0.56944	-7.5	88.8	-0.59	0.555	.
revenue	12.599	12.565	2	98.7	0.17	0.861	0.74
imp	0.75694	0.81944	-13.7	85	-1.3	0.196	.
exp	0.90278	0.96528	-15	88.4	-2.15	0.033	.
personnel	0.09028	0.07639	5.1	55.8	0.43	0.671	.
dummyN	0.04167	0.00694	17.8	-49522.1	1.92	0.056	.
dummyNE	0.03472	0.04861	-5.2	69.6	-0.59	0.557	.
dummySE	0.09028	0.03472	16	18.8	1.95	0.052	.
dummyS	0.39583	0.43056	-7.4	64.4	-0.6	0.551	.
dummyCO	0	0	0	100	.	.	.
cnaedummy1	0.125	0.15278	-8.9	-240.1	-0.68	0.497	.
cnaedummy2	0.00694	0.03472	-22.7	-672.9	-1.65	0.1	.
cnaedummy3	0.00694	0.00694	0	100	0	1	.
cnaedummy4	0.01389	0.02083	-4.4	75.9	-0.45	0.653	.
cnaedummy5	0	0	0	100	.	.	.
cnaedummy6	0.01389	0.01389	0	100	0	1	.
cnaedummy7	0	0	0	100	.	.	.
cnaedummy8	0.01389	0.00694	5.2	47	0.58	0.563	.
cnaedummy9	0	0	0	100	.	.	.
cnaedummy10	0	0	0	100	.	.	.
cnaedummy11	0.07639	0.08333	-2.9	80.7	-0.22	0.829	.
cnaedummy12	0.04861	0.0625	-8.8	50.5	-0.51	0.608	.
cnaedummy13	0.04167	0.05556	-6.6	46.6	-0.55	0.585	.
cnaedummy14	0.02083	0.01389	3.6	78	0.45	0.653	.
cnaedummy15	0.04167	0.04167	0	100	0	1	.
cnaedummy16	0.02778	0.03472	-3.1	85.3	-0.34	0.736	.
cnaedummy17	0.11806	0.09722	8.5	71	0.57	0.57	.
cnaedummy18	0.05556	0.06944	-7	26	-0.49	0.628	.
cnaedummy19	0.13889	0.15972	-6.8	71.7	-0.49	0.621	.
cnaedummy20	0.14583	0.08333	21.7	50.1	1.67	0.097	.
cnaedummy21	0.01389	0	13.8	-532.2	1.42	0.157	.
cnaedummy22	0.02083	0.01389	4.3	63.6	0.45	0.653	.
cnaedummy23	0.02778	0.04167	-8.8	-141.4	-0.64	0.521	.
cnaedummy24	0.00694	0	6.5	43	1	0.318	.
cnaedummy25	0	0	0	100	.	.	.
cnaedummy26	0	0	.	.	.	.	.*
cnaedummy27	0	0	0	100	.	.	.
cnaedummy28	0	0	0	100	.	.	.
cnaedummy29	0	0	0	100	.	.	.
cnaedummy30	0	0	0	100	.	.	.
cnaedummy31	0.01389	0.00694	7	-148.6	0.58	0.563	.
cnaedummy32	0.01389	0	8.8	19.4	1.42	0.157	.
cnaedummy33	0	0	0	100	.	.	.
cnaedummy34	0.00694	0	5.4	69.3	1	0.318	.
cnaedummy35	0	0	0	100	.	.	.
cnaedummy36	0	0	0	100	.	.	.
cnaedummy37	0	0	0	100	.	.	.
cnaedummy38	0	0	0	100	.	.	.
cnaedummy39	0	0	0	100	.	.	.
Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias		
Unmatched	0.411	569	0	29	16.4		
Matched	0.051	19.97	0.952	5.1	3.6		

Variables' results for matched sample only.