Fiscal Stimulus in Recession: Evidence from a Tax Credit Programme

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Abstract

Before the start of the recent worlwide recession, to promote long-run growth Italy introduced an R&D tax credit programme that would have been in force for the three years 2007-09. Just after the first year, however, the new right-wing political party in power suspended the incentive. The very high level reached in the meantime by the public debt was one of the argument adduced to justify this measure. Only at the end of the 2008 the government decided to renew the credit. This gave us the chance of exploiting a quasi-experiment to assess the effect of an exogenous countercyclical fiscal stimulus during recession. Using firm level data, we show that the tax credit has been effective in stimulating R&D expenditure only for non-ICT firms.

1 Introduction

In this paper we investigate the response of firm expenditure to a fiscal stimulus supplied by the Italian government at the beginning of the recent economic crises. The stimulus consists of countercyclical tax credit for current and capital expenditures related to R&D projects. Results show the effectiveness of the stimulus to raise private expenditures for firms not in the ICT sector. The estimated elasticity is around 1: one euro of foregone tax revenue induces a contemporaneous increase in firm expenditure by one euro.

A diffused opinion relates the small rate of growth of the Italian economy in the recent years at least in part to the large gap in the R&D investment between Italy and other developed countries: in 2005 the percentage of R&D expenditure on GDP in Italy was only 1.09. Among selected OECD countries reported in figure 1 only UK, Italy and Spain invest in R&D less than 2% of GDP - 1.72, 1.09 and 1.12 respectively.[1] The Italian investment in R&D is the lowest among above cited countries. Italy has also a low percentage of ICT investment on gross fixed capital formation: 11.6 in 2005.[2] The corresponding values for United States, United Kingdom, Finland and Sweden are all above 21% (26.5, 24.6, 21.2 and 25.6 respectively). Other countries usually compared to Italy, as France and Germany, invest in ICT more than 14% of their gross fixed capital formation. Only the investment of Austria and Spain is similar to the Italian ones, having values of 11.9 and 10.9 respectively. Even if the ICT investment is considered directly linked to innovation and growth, the fiscal stimulus was conceived as a general measure aimed to fill the gap in R&D investment.

According to a national law issued at the end of the 2006 to promote long-run growth, R&D tax credit would have been offered to all eligible Italian firms for the three years 2007-2009. However, the change of the political party in power during the first half of the 2008, when the need to reduce the very high public debt was becoming a matter of urgency in Italy, determined a structural change in the management of the incentive programme. The new government soon announced its purpose to limit in some way the extent of the subsidy for both the 2008 and 2009, or to cease it at all. Only at the end of the year, however, an upper bound to the maximum amount of forgone tax revenue and a selection procedure in the choice of recipient firms were introduced. The delay between the announcement of the reform and its realization determined that at the beginning of the 2009 firms knew whether they

[1] R&D investment of other countries is: France 2.11, Germany 2.51, Austria 2.46, Finland 3.48, Sweden 3.56 and United States 2.59.

[2] The source of data is "OECD Factbook 2010: Economic, Environmental and Social Statistics."

had achieved the tax credit relative to expenditures already realized in the year before and planned for the next future. This peculiar characteristic of the reform gives us the chance of designing a quasi-experiment to assess the firm response to a fiscal stimulus during the recent economic crises. In particular, the break in the credit programme allows to compare the difference in outcomes after and before the government intervention for the group affected by it to this difference for an unaffected group of firms asking for the credit.

Non-ICT firms behavior documents the effectiveness of a transitory tax cut to stimulate private expenditure during recession. At the same time, the unresponsiveness to the fiscal stimulus of ICT firms—that is, those firms that have been realizing most of innovations in recent years—questions the validity of a short duration subsidy programme to affect long-run growth.

This paper is related to two different strands of empirically investigation. One is relative to the relationship between R&D and its price. Economic studies usually treat R&D as a capital input (knowledge) into a firm's production function. The price for this input is the implicit rental rate, or user cost, after taxes. By reducing the price of an input, tax credit allows to estimate the elasticity of such input with respect to its price. Empirical studies generally find a statistically significant R&D cost elasticity at or above unity, though some notable exception is available.[3] The most important differences in our empirical methodology investigation relative to these studies is our period of analysis, that is during a very strong economic crises, and the separate account of ICT and non-ICT firms. The differential response of these two groups of firms may explain some of the variability in the estimated elasticities.

Since the fiscal stimulus we consider also allows firms to benefit from the tax credit for current expenditures, our work is also related to studies investigating the short-run effect of fiscal policy. Some recent evidence suggests that such effect may be strongly sensitive to the state of the business cycle. For instance, very large output multipliers of public spending are estimated in recession by Auerbach and Gorodnichenko (2012a) for a panel of developed countries, Italy and Owyang, Ramey and Zubairy

[3] In general, two main approaches have been proposed to ascertain the effectiveness of tax credit. One is based on the comparison between tax credit social return and cost while the other one is based on comparing the tax revenue loss and the difference between the R&D level conditional upon the tax credit regime and the counterfactual one, that is how much R&D firms would have done without the incentive. However, since the former approach is difficult to be implemented, due to the need of calculating the opportunity cost of the tax revenue loss, empirical studies focus on the latter. A large body of evidence refers to US, mainly due to the availability of data. Firm level studies tend to converge on the conclusion that the tax price elasticity of total R&D is about one: one dollar of foregone tax revenue induces a dollar increase in R&D investment (see, for instance, Hall, 1993; Hines, 1993; Berger, 1993). This finding is at odds with evidence in Wilson (2009). By exploiting variation at state level in US, Wilson yields an elasticity estimate of 0.17 in the short-run and 0.68 in the long-run. However, he also concludes that the aggregate R&D user cost elasticity is near-zero; actually, state R&D spending is negatively affected by tax preferences in other states, suggesting that local subsidies draw R&D across borders rather than encouraging R&D spending.

Looking at Canadian firms and relying on substantial variations in the tax credit rate during time and respect to the type of firms subsidized, Dagenais, Mohnen and Therrien (1997) find a weakly significant effect on the amount of R&D performed with a long run effect almost 20 times the short-run effect– 0.07 in the short term and 1.09 in the long term. These results are not confirmed by Baghana and Mohnen (2009). Relying on a survey about manufacturing firms in Quebec and administrative data, they estimates a short term price elasticity of 0.10, that raises to 0.14 in the long run. Moreover, small firms are more price responsive (with an elasticity of 0.14 and 0.19 respectively in the short and long term) than large firms, whose estimated elasticity is not significantly different from 0.

There is much heterogeneity in the specific features of the tax credit schemes across countries and over time. Hence, there are very few studies at country level. One relevant exception is Bloom et al. (2002) who examine nine OECD countries over a 19-year period. They find evidence that tax credit is effective in increasing R&D investment—even after controlling for demand, country-specific fixed effects and world macro-economic shocks. Their findings suggest that a 10% fall in the cost of R&D stimulates on impact (yearly-data) a 1% rise in the level of R&D, a value which increases to 10% when dynamic effects are considered, that is a long-run elasticity of 1. The Italian Fund for Technological Innovation (FIT) of the Ministry for Economic Development is evaluated in a study of De Blasio et al. (2011) take advantage of the unexpected shortage of public funds relative to the Fund for Technological Innovation to implement a regression discontinuity design. By comparing firms that applied for funding before and after the shortage occurred, they find no evidence of the programme's effectiveness: subsidized firms do not invest more in either tangible or intangible assets. Finally Bronzini and Iachini (2011) study the performance of incentive programmes within the regions of Emilia Romagna, providing weak evidence in favor of subsidy's effectiveness: overall, the program did not create additional investment but for small enterprises which increase their investment by, on average, the same amount of the grant received.

(2013) for Canada.[4] Our evidence for non-ICT firms is consistent with these findings.

Finally, we note that the present paper is in the spirit of the narrative approach by Romer and Romer (2010) as the tax credit programme we rely on was introduced to promote long-run growth, and thus it was undertaken for reasons essentially unrelated to other factors influencing the private sector in the short run.

The rest of the paper is organized as follows. Section 2 describes the empirical strategy and the data; the results of the empirical analysis are detailed in section 3 and section 4 concludes.

2 Empirical strategy

The large gap in the R&D investment between Italy and other developed countries is generally considered linked to the small rate of growth of the Italian economy in the recent years. In 2005 the percentage of Italian R&D expenditure on GDP was only 1.09.[5] Similar values are showed only by Spain - 1.12 - and UK - 1.72. As emerges by Figure 1, other OECD countries invest in R&D more than 2% of their GDP. Among European countries the greater investors are the Scandinavian ones, with percentages of 3.48 - Finland - and 3.56 - Sweden. The corresponding values of France, Germany and Austria are between 2.11 and 2.51%. Outside Europe the percentage of R&D expenditure on GDP is 2.04 in Canada, 2.59 in US and 3.31 in Japan. In general a high investment in R&D does not necessarily correspond to a high ICT investment and viceversa. In 2005 the percentage of ICT investment[6] on gross fixed capital formation was more than 14% in France, Germany and Japan. The corresponding values for United States, United Kingdom, Finland and Sweden are all above 21% - 26.5, 24.6, 21.2 and 25.6 respectively. In Italy the percentage of ICT investment on gross fixed capital formation was 11.6. Similar values are shown by Spain - 10.9 - and Austria - 11.9. Among reported countries only Italy and Spain have low ICT and R&D investment at the same time. Even if both ICT and R&D investment foster innovation and growth, the fiscal stimulus is aimed to fill only the gap in R&D investment.

Our empirical investigation relies on the volume tax credit regime introduced in Italy by the "Law 296, 27 December 2006". According to this law, all firms but those in financial distress could apply for the credit in any year during 2007-2009, when the regime would have been in force. Firms were allowed to deduct 10% of the total amount of eligible R&D expenditures from the corporate taxes—up to the maximum amount of 50 millions of euros for each year. If firm carried out its R&D activities in cooperation with universities and/or public research agencies this percentage raised to 40%. Eligibility attained to all kinds of spending—personnel, tools and machinery, patents, materials—needed to finance (i) base research, (ii) applied research and (iii) experimental development projects. Details are provided by the "Decree 76, 28 March 2008".

Two events determined a structural break in the design of the tax credit mechanism during the 2008. In April of this year, when the recent economic crises was diffusing in Italy too, the former opposing right party won the national political election. Soon after it took the power, the new government announced its purpose either to eliminate the fiscal stimulus or to cut its total amount relative to that supplied the year before, when all firms asking for the tax credit were able to achieve it.[7] In fact, at the end of the year the "Decree 185, 29 November 2008" introduced an upper bound to the amount of forgone tax revenue: overall firms could not apply for tax credit larger than 1,627 millions of euros during 2008-09. This determined the deny of a number of applications asking for the credit. Moreover, by the Decree the government introduced an unusual selection procedure. Any firm

[4] Differently from Auerbach and Gorodnichenko (2012b), simmetric effects of public spending are found instead by Owyang, Ramey and Zubairy (2013) for the U.S.

[5] It is the Gross domestic expenditure on R&D (GERD) as a percentage of GDP. GERD is total intramural expenditure on research and development performed on the national territory during a given period.

The source of data is "Main Science and Technology Indicators, OECD Science, Technology and R&D Statistics".

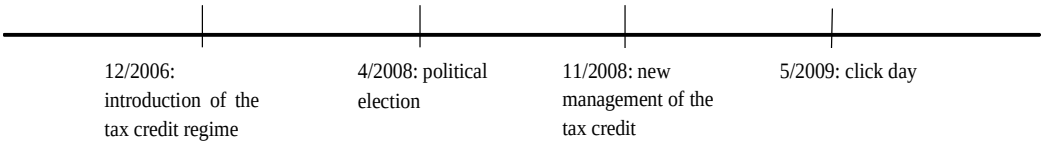
[6] According to OECD, ICT investment covers the acquisition of equipment and computer software that is used in production for more than one year. ICT has three components: information technology equipment (computers and related hardware); communications equipment; and software. Software includes acquisition of pre-packaged software, customised software and software developed in-house.

[7] Although by the Law 296 the size of the subsidy available to each firm was constrained, no limit was settled to the total number of firms able to be subsidized.

applying for the fiscal stimulus had to fill an electronic form[8] available on the Internal Revenue Service (IRS) website. Through the form firms provided detailed information about their R&D projects and the relative expenditures realized during the 2008 and planned for the 2009.[9] Starting from a given date to be determined—the click day—the firms would have submitted the forms to the IRS electronically. According to the chronological order in which the IRS received the forms and a priority right in favor of R&D activities started before the 29th of November 2008, firms' selection was determined given the fulfillment of the total tax credit cap.[10]

The break in the management of the incentive programme determined three important consequences. First, the change of the political party in power determined high uncertainty among firms whether the tax credit programme would have been preserved. Thus, during the 2008 all R&D expenditures were realized by firms unaware about the possibility of benefiting from the credit. At the end of the year the uncertainty was partially resolved, though the cap to the aggregate amount of the stimulus determined a constraint to the number of subsidized firms. Second, the uncertainty was completely resolved on the sixth of May 2009—the so called click day—when the selection took place.[11] Since then, any firm was aware whether it had achieved the incentive relative to the current and/or past year. Thus, differently from the previous year in 2009 most of the R&D expenditures were realized by firms aware whether they had achieved or not the tax credit. Third, the duration of the electronic selection procedure was extremely short as in few seconds the constraint due by the total tax credit cap was already binding. Many applications were rejected and only a subset of projects entailed with the priority right received the incentive.[12] The main implication for the present paper is that the outcome of such procedure resembled that of a randomized selection with a technological device choosing which firms to subsidize, without any examination of their characteristics. Figure 2 shows the time-line of relevant dates.

Figure 2: Time_line



The empirical model is based on the structural break in the management of the tax credit. In 2009, the split between those firms benefiting of the fiscal stimulus and the others determined the treated and control groups. The treated group is composed of firms that in 2009 knew to be stimulated; other firms are part of the control group. Note that both treated and untreated firms knew their status before spending decisions for the 2009 were taken and after having realized all expenditure for the 2008. The uncertainty about the implementation of the stimulus was such that in 2008 instead all firms took decisions under a veil of ignorance. Therefore, a difference-in-difference (DD) or a panel fixed effect approach may be exploited. The DD estimator is constructed by comparing the difference in outcomes after and before the tax credit regime break—that is after and before the government intervention—for the group affected by it to this difference for the unaffected group.

Formally, let $RD_{i,t}$ the outcome of interest for firm i at time t, that is R&D expenditure. The baseline DD specification is

$$RD_{i,t} = \alpha_0 + \alpha_1 YEAR_t + \alpha_2 TREATED_i + \beta TREATMENT_{i,t} + \varepsilon_{i,t} \quad (1)$$

where $YEAR$ is a dummy with 1 in 2009 and 0 in 2008, $TREATED$ is a dummy with 1 for the treated firms and 0 otherwise, $TREATMENT$ is the interaction term constructed as $YEAR \times TREATED$,

[8] Firms started R&D activities before the 29th of November 2008 had to fill just one form for all the R&D expenses. Instead, firms started R&D activities after this date had to fill one form for each R&D project they would achieve the incentive.

[9] In 2007 it was sufficient to fill up the R&D tax credit box in the income tax return to profit from the tax credit.

[10] According to the IRS newsletter 17/E, an R&D activity begins when there is some formal decision aimed at realizing it. The decision must ensue from a certain date document.

[11] Previously, at the end of the 2008 the government announced that the incentive programme would have been financed.

[12] The IRS determination N.100/E revelas that at least one firm whose research project started before the 11/29/2008 did not receive the credit.

and $\varepsilon_{i,t}$ is an error term. The year dummy accounts for all aggregate factors causing variation in the R&D expenditure between the two periods while the dummy picking treated firms captures any systematic difference between treated and untreated unrelated to the effect of the tax credit. If the orthogonality condition between $\varepsilon_{i,t}$ and the interaction term holds, then β identifies the impact of the fiscal stimulus on R&D expenditures. In this case its value may be estimated consistently by the OLS method.

2.1 Data

The data set is based on information from three different sources: the R&D survey realized every year by ISTAT; firms' balance sheets also provided by ISTAT; the outcome of the tax credit selection procedure provided by the IRS.

The R&D survey contains yearly information on private R&D expenditure for about 5.000 firms. In particular, data are available on the amount of expenditure carried on within (intramural) or outside (extramural) the bounds of the firm, according to the type of R&D activity realized by the firms—base research, applied research and experimental development. Information also allow to distinguish among personnel, current and capital expenditure. The requirement for contributing to the survey is that firm declares a positive amount of intramural R&D expenditure. In the baseline specification our outcome variable is the total amount of R&D expenditure expressed in terms of total assets Thus the parameter β would identify the causal effect that 10% tax credit has on this variable. We are interested in whether β is statistically greater than zero and how large its value is relative to the mean expenditure before the treatment.

The R&D survey together with information provided by the IRS allow to distinguish among treated, untreated and non-participant firms, the latter being those not applying for the tax credit. It follows that when the largest sample is used then firms considered for the empirical analysis are $4,120$ in 2009, roughly one half of them treated, and $4,185$ in 2008 whereof about 73% will learn one year later to benefit from the tax credit for expenditures realized in 2008. In dealing with the DD approach, we consider these firms equivalent in terms of characteristics to those treated in 2009. Actually, a subset of them are indeed part of the 2009 survey. This also allow to estimate a firm-specific fixed effect model with a reduced number of observations.

In the following we present some figures and tables in order to describe our data.

Figure 3 shows the firms' R&D expenditure year by year - data are in thousand of euros. Overall firms invest in R&D more than 3 billions of euros in 2007. In the next years the corresponding values are about 4.3 billions of R&D expenditure in 2008 and 3 billions of euros in 2009. Summing up, during the period the R&D tax credit was in force firms invested in R&D more than 10 billions of euros.

Table 1 displays the sectorial distribution of firms and R&D expenditure in our dataset. As concerns the distribution of firms, both in 2008 and 2009 sector having the highest number of firms is machinery and equipment, followed by metal products. The distribution appears quite concentrated - 15 sectors in 2008 and 16 sectors in 2009 have more than 100 firms, while sector having less than 10 firms are 30 in both years. Firms belonging to sector 72 - scientific research and development - are about 3.5% of the sample - less than wholesale trade that represents more than 4% of firms. The sectorial distribution of R&D expenditures differs from that of firms: sector having the highest percentage of expenditure is manufacture of motor vehicles, trailers and semi-trailers both in 2008 and 2009. About 65% of R&D expenditure is concentrated in 7 sectors of activity and 35% is scattered among the remaining 65 sectors each of them representing less than 4% of R&D investment.

The distribution of firms and R&D expenditure by size is shown in Table 2. Employees are grouped into four classes, according to the EU Commission definition of micro - small - medium size and large enterprises.[13] In 2008 43% of firms are small and about 13% are micro enterprises and together represent about 10% of R&D expenditure. In 2009 the corresponding values are 43% and 15% for small and micro enterprises which represent about 10% of R&D expenditure again. Actually, medium-sized firms are about 30% of the sample and invest in R&D more than 1 billion of euros. Not

[13] 2003/361/EC: COMMISSION RECOMMENDATION of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises.

surprisingly large firms invest more in R&D: 762 firms invest more than 7 billions of euros in 2008 and 789 spend more than 9 billions of euros in 2009.

3 Results

Table 3 shows our basic result. The table reports mean values of R&D expenditures for treated and untreated firms as well as their difference in 2008 and 2009. As expected, in 2008 the mean expenditure is virtually the same for the two groups of firms: the difference is 0.0025 and it is insignificantly different from zero. In 2009 the difference is 0.0124 that is five times larger than that in the previous year. However, due to the high variability of R&D expenditures this difference too is not statistically different from zero at 5% level.

Since the tax credit attains at R&D activities, differential response may be expected between non-ICT and ICT-producing firms due their very different characteristics. For instance, by comparing these two groups of firms, Bruinshoofd and de Haan (2005) conclude that those in the ICT sector are relative information intensive and risky firms, holding more precautionary cash and having lower leverage targets. As well known, ICT firms have strongly contributed to economic growth worldwide during the last twenty years directly through technological advance in the production of computers and telecommunications equipment and, to some extent, also indirectly thanks to the use of ICT goods by all manufacturing and services industries.[14] Most important for the present paper, since innovations are crucial for market performance of ICT firms they are forced to continuously upgrade their products and create new ones. Thus although the level of R&D spending of ICT firms is relatively high it may be the case that their decisions are less sensitive to *short*-lived fiscal stimulus like the one we consider, when compared to those of other firms. Our hypothesis is that non-ICT firms plan R&D projects at a certain time and they realize them when economic conditions are preferable. On the contrary, non-ICT firms invest less in R&D because results of the R&D activity are not fundamental to their normal activities. Thus, the R&D tax credit may induce such firms to anticipate their R&D investment.

Table 4 confirms our conjecture. For non-ICT firms mean expenditure difference between treated and untreated in 2009 is 0.0112, statistically different from zero (p-value is 0.0007). The corresponding difference for ICT firms is much lower in relative terms and insignificantly different from zero. We also note that in both cases the difference between treated and untreated firms is virtually zero in 2008.

The rest of the empirical investigation may be intended as a robustness analysis supporting our basic conclusion.

Table 5 reports results relative to the baseline equation which echo those in Table 4 relative to the whole sample of firms. Column (1) displays the estimated results of the baseline equation while in column (2) we add some control variables.[15] The coefficient of *TREATMENT* is estimated not significantly different from zero: overall firms receiving the incentive invest in R&D, on average, as much as those not receiving it. The dummy *YEAR* is significative in both columns: firms' R&D investment is higher in 2009 than in 2008. Controlling for firm specific and fixed effects, i.e. specification in column

[14] For instance, regarding the U.S. empirical evidence clearly shows that thecnological advance in the production of computer hardware, peripherals, and telecommunications equipment have contributed importantly to the speed up in overall productivity growth, though some disagreement exists on the role of information technology for the non-durable manufacturing sector (Gordon, 2000; Oliner and Sichel, 2000; van Ark et al., 2003).

[15] They are:

- Debt: total debt over total asset;
- Output: output over total asset;
- Cash Flow: cash-fow over total asset;
- Regions: dummies for the region where the R&D activity is realized;
- Sectors: dummies for the sector of activity the firm belongs to;
- Size: dummies for the size of the firm;
- Legal Form: dummies for the legal form of the firm.

2, *TREATED* becomes significative: treated firms invest in R&D, on average, more than untreated ones.

In table 6 we estimate our equation dividing the sample according to the sector of activities firms belong to: ICT or non-ICT.[16]

As before, results of the estimated equation are reported in columns (1) and (3) for non-ICT and ICT firms respectively. The estimated coefficient of *TREATMENT* is positive and statistically significant only for non-ICT firms. This confirms our hypothesis that non-ICT enterprises achieving the incentive invest more than untreated non-ICT firms**.** In particular, regarding the non-ICT sector the coefficient of the treatment variable is estimated as large as 0.00718. When interpreted in terms of R&D cost elasticity evaluated at the mean expenditure for the sample in 2008, it implies that a 1 percentage point increase in R&D credit rate results in a contemporaneous increase in total R&D around 1.5%. This effect is remarkably similar to the in-state elasticity estimated by Wilson (2009) for the U.S. states. Since *TREATMENT* is not significantly different from zero in the ICT group we may conclude that the R&D tax credit was effective in stimulating the R&D expenditure only for firms belonging to non-ICT sector of activity. Adding a large number of controls does not affect the main evidence. In columns (2) and (4) we report results by allowing for Total Debt, Output, and Cash Flow all expressed in terms of Total Asset as well as fixed effects specific to regions, sectors, size and legal form of the private firms. Again the estimated coefficient of *TREATMENT* is positive and statistically significative only for non-ICT firms. *YEAR* is significative in all specifications but (1): the R&D investment in 2009 is higher than in 2008; *TREATED* is significative only in non-ICT sectors: treated firms invest in R&D, on average, more than untreated ones. Among controls Output is significative both for non-ICT and ICT firms, while Cash Flow is significative only for ICT firms.

Finally, to improve on robustness in table 7[17] we show estimates of a firm-specific fixed effect model. Unfortunately, this drastically reduces the number of observations. Our main result is confirmed: the tax credit was effective in stimulating the R&D expenditure only for non-ICT firms while it has no effect on the R&D investment when considering the ICT firms.

4 Conclusions

During the three years 2007-09 a R&D tax credit programme for current and capital expenditures has been in force in Italy. The fiscal stimulus was aimed to promote long-run growth. In 2008, however, the right-wing party won the political elections and suspended the incentive because of the very high level of the public debt. At the end of the 2008 the government decided to renew the credit but introducing a structural change in the management of the incentive programme. The change consists of an upper bound to the maximum amount of forgone tax revenue and a selection procedure in the choice of recipient firms. These firms knew whether they had achieved the tax credit relative to expenditures already realized in the year before and planned for the next future only at the beginning of 2009, when the selection procedure was realized. This gave us the chance of designing a quasi-experiment to assess the effect of an exogenous countercyclical fiscal stimulus during recession. In particular, the structural break in the management of incentive allows us to compare the difference in outcomes after and before the achieving of fiscal incentive for the group receiving it to this difference for an unaffected group of firms asking for the credit. Using firm level data, we show that the tax credit has been effective in stimulating R&D expenditure only for non-ICT firm. In line with previous empirical studies, for this group of firms we estimate an elasticity around 1: one euro of foregone tax revenue induces a contemporaneous increase in firm expenditure by one euro. Actually, the unresponsiveness to the fiscal stimulus of ICT firms questions the validity of a short duration subsidy programme to affect long-run growth.

[16] A description of ICT sector is in appendix.

[17] The meaning of the different columns is the same as for table 6.

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Appendix

A The R&D tax credit programme

The Decree 76, 28 March 2008 identifies the type of firms allowed to apply for the credit as well as eligible activities and expenditures. All firms but those in financial distress may apply. Eligible activities concern: (i) theoretical or experimental works aimed to create new knowledge about the foundations of phenomena and observable events, without direct applications or practical use; (ii) planned research aimed to learn new knowledge in order to create or improve products, processes or services; creation of complex systems components essential to industrial research; (iii) acquisition, combination and use of scientific, technological or business knowledge direct to the realization of plans and projects for new, improved or modified products, processes or services. Eligible expenses, up to a maximum amount of 50 millions of euros per year, concerns: (a) research employees; (b) lab tools and equipment; (c) buildings and lands devoted to the realization of R&D centre; (d) contractual research, technical skills and patents; (e) consulting services; (f) general expenses; (g) costs of materials and supply. General expenses are eligible up to amount of 10% of personnel expenditure.

B Definitions of main variables

The source of all data is ISTAT. The R&D expenditure is the sum of intramural and extramural expenditure at firm level as reported by the annual R&D survey, "*Rilevazioni Istat sulla R&S nelle imprese*". Balance sheet data refer to the "*Archivio dei bilanci d'impresa Istat* available at "*Direzione centrale delle rilevazioni censuarie e dei registri statistici*". In particular, Debt is the total debt of the firm while Cash Flow is constructed as profit plus total reserves less depreciation. The region-specific fixed component identifies the region where the firm realizes the R&D activity. Regarding the size firms are grouped according to the EU Commission definition of micro, small, medium-sized and large enterprises. The classification of sector of activity is Ateco 2007.

B.1 The ICT sector

Our definition of ICT-sector relies on Pilat and Lee (2001). As usual, they distinguish between ICT-producing and ICT-using industries. As concerns the ICT-producing sector, Pilat and Lee use the standard definition of OECD (2000) and sort the ICT-producing firms into manufacturing and services. In its turn, the ICT services firms are divided into "goods related" and "intangible". At odds, the literature does not univocally identify firms belonging to the ICT-using sector. The main problem is that lots of firms are, at the same time, ICT producers and users. Pilat and Lee classify as ICT-using industries: wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods, financial intermediation, real estate, renting and business activities. Pilat and Lee classification of economic activity is ISIC rev3**,** firms in our dataset are classified according to NACE REV 2, thus we change the ICT classification of Pilat and Lee from ISIC rev3 to ISIC rev4 and then to NACE REV 2.ICT definition (Pilat and Lee, 2001), Nace rev 2 classification, 4 digit.

ICT-Producing Manufacturing

26 Manufacture of computer, electronic and optical products
27 Manufacture of electrical equipment
28 Manufacture of machinery and equipment n.e.c.
32 Other manufacturing
33 Repair and installation of machinery and equipment
95 Repair of computers and personal and household goods

ICT-Producing Services intangible

58 Publishing activities
60 Programming and broadcasting activities
61 Telecommunications
62 Computer programming, consultancy and related activities

63 Information service activities

ICT-Producing Services goods related

46 Wholesale trade, except of motor vehicles and motorcycles
77 Rental and leasing activities

ICT-Using Industries

09 Mining support service activities
45 Wholesale and retail trade and repair of motor vehicles and motorcycles
46 Wholesale trade, except of motor vehicles and motorcycles
47 Retail trade, except of motor vehicles and motorcycles
52 Warehousing and support activities for transportation
64 Financial service activities, except insurance and pension funding
65 Insurance, reinsurance and pension funding, except compulsory social security
66 Activities auxiliary to financial services and insurance activities
69 Legal and accounting activities
70 Activities of head offices; management consultancy activities
71 Architectural and engineering activities; technical testing and analysis
72 Scientific research and development
73 Advertising and market research
74 Other professional, scientific and technical activities
77 Rental and leasing activities
80 Security and investigation activities
85 Education
94 Activities of membership organisations

C Tables and figures

Table 1. Sectorial composition, 2008-2009.

Sector of activities		2008				2009			
		Firms		R&D exp.		Firms		R&D exp.	
5	Mining of coal and lignite	1	0.02%	2055	0.02%	1	0.02%	1309	0.01%
6	Extraction of crude petroleum and natural gas	1	0.02%	171683	1.72%	1	0.02%	283313	2.44%
8	Other mining and quarrying	8	0.15%	1898	0.02%	7	0.13%	1217	0.01%
10	Manufacture of food products	194	3.57%	146620	1.47%	173	3.18%	199433	1.72%
11	Manufacture of beverages	21	0.39%	6586	0.07%	19	0.35%	10217	0.09%
12	Manufacture of tobacco products	1	0.02%	292	0.00%	1	0.02%	800	0.01%
13	Manufacture of textiles	123	2.26%	73770	0.74%	133	2.45%	91289	0.79%
14	Manufacture of wearing apparel	72	1.32%	190151	1.90%	110	2.02%	217443	1.87%
15	Manufacture of leather and related products	61	1.12%	70248	0.70%	72	1.32%	77874	0.67%
16	Manufacture of wood and of products of wood and cork, except furniture; manu	57	1.05%	14066	0.14%	56	1.03%	15756	0.14%
17	Manufacture of paper and paper products	43	0.79%	37593	0.38%	50	0.92%	42287	0.36%
18	Printing and reproduction of recorded media	45	0.83%	13039	0.13%	40	0.74%	13622	0.12%
19	Manufacture of coke and refined petroleum products	6	0.11%	12017	0.12%	5	0.09%	5859	0.05%
20	Manufacture of chemicals and chemical products	251	4.62%	346774	3.47%	232	4.27%	336436	2.90%
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	75	1.38%	474326	4.75%	79	1.45%	790292	6.81%
22	Manufacture of rubber and plastic products	244	4.49%	235163	2.35%	233	4.29%	214688	1.85%
23	Manufacture of other non-metallic mineral products	143	2.63%	100704	1.01%	137	2.52%	92894	0.80%
24	Manufacture of basic metals	107	1.97%	107637	1.08%	106	1.95%	97867	0.84%
25	Manufacture of fabricated metal products, except machinery and equipment	491	9.03%	296191	2.96%	429	7.89%	260131	2.24%
26	Manufacture of computer, electronic and optical products	314	5.78%	1091950	10.93%	322	5.92%	1196613	10.31%
27	Manufacture of electrical equipment	297	5.46%	363698	3.64%	278	5.11%	450713	3.88%
28	Manufacture of machinery and equipment n.e.c.	980	18.03%	1061707	10.63%	960	17.66%	1333951	11.50%
29	Manufacture of motor vehicles, trailers and semi-trailers	127	2.34%	1150430	11.51%	119	2.19%	1560029	13.45%
30	Manufacture of other transport equipment	53	0.98%	1077090	10.78%	46	0.85%	1084421	9.35%
31	Manufacture of furniture	144	2.65%	58889	0.59%	95	1.75%	54193	0.47%
32	Other manufacturing	98	1.80%	65677	0.66%	103	1.90%	66231	0.57%
33	Repair and installation of machinery and equipment	98	1.80%	60848	0.61%	97	1.78%	78237	0.67%
35	Repair and installation of machinery and equipment	7	0.13%	72526	0.73%	8	0.15%	8704	0.08%
36	Water collection, treatment and supply	5	0.09%	2473	0.02%	7	0.13%	4378	0.04%
37	Sewerage	3	0.06%	756	0.01%	4	0.07%	1894	0.02%
38	Waste collection, treatment and disposal activities; materials recovery	22	0.40%	4470	0.04%	20	0.37%	4439	0.04%
39	Remediation activities and other waste management services	3	0.06%	726	0.01%	2	0.04%	1162	0.01%
41	Construction of buildings	16	0.29%	5821	0.06%	15	0.28%	7468	0.06%
42	Civil engineering	11	0.20%	15820	0.16%	9	0.17%	12465	0.11%
43	Specialised construction activities	74	1.36%	20960	0.21%	72	1.32%	52255	0.45%
45	Wholesale and retail trade and repair of motor vehicles and motorcycles	11	0.20%	3549	0.04%	11	0.20%	5723	0.05%
46	Wholesale trade, except of motor vehicles and motorcycles	224	4.12%	280839	2.81%	247	4.54%	332059	2.86%
47	Retail trade, except of motor vehicles and motorcycles	12	0.22%	6737	0.07%	11	0.20%	6208	0.05%
49	Land transport and transport via pipelines	21	0.39%	30057	0.30%	17	0.31%	23320	0.20%
50	Water transport	1	0.02%	151	0.00%	3	0.06%	614	0.01%
52	Warehousing and support activities for transportation	14	0.26%	10562	0.11%	14	0.26%	43237	0.37%
53	Postal and courier activities	1	0.02%	16209	0.16%	1	0.02%	5	0.00%
56	Food and beverage service activities	4	0.07%	1720	0.02%	5	0.09%	2590	0.02%
58	Publishing activities	9	0.17%	3421	0.03%	15	0.28%	4110	0.04%
59	Motion picture, video and television programme production, sound recording	3	0.06%	1319	0.01%	1	0.02%	396	0.00%
60	Programming and broadcasting activities	5	0.09%	8938	0.09%	5	0.09%	9606	0.08%
61	Telecommunications	13	0.24%	763446	7.64%	17	0.31%	1059854	9.13%
62	Computer programming, consultancy and related activities	381	7.01%	207699	2.08%	473	8.70%	247788	2.14%
63	Information service activities	27	0.50%	14233	0.14%	31	0.57%	19867	0.17%
64	Financial service activities, except insurance and pension funding	33	0.61%	162224	1.62%	32	0.59%	198648	1.71%
65	Insurance, reinsurance and pension funding, except compulsorysocial security	3	0.06%	5499	0.06%	3	0.06%	6828	0.06%
66	Activities auxiliary to financial services and insurance activities	1	0.02%	603	0.01%	1	0.02%	760	0.01%
68	Real estate activities	11	0.20%	98388	0.98%	6	0.11%	21959	0.19%
69	Legal and accounting activities	1	0.02%	25	0.00%	4	0.07%	260	0.00%
70	Activities of head offices; management consultancy activities	40	0.74%	27477	0.28%	35	0.64%	21281	0.18%
71	Architectural and engineering activities; technical testing and analysis	82	1.51%	138978	1.39%	99	1.82%	236662	2.04%
72	Scientific research and development	189	3.48%	755359	7.56%	195	3.59%	560595	4.83%
73	Advertising and market research	8	0.15%	1284	0.01%	9	0.17%	10166	0.09%
74	Other professional, scientific and technical activities	61	1.12%	26772	0.27%	69	1.27%	31956	0.28%
77	Rental and leasing activities	6	0.11%	2300	0.02%	5	0.09%	4103	0.04%
78	Employment activities	1	0.02%	175	0.00%	1	0.02%	110	0.00%
79	Travel agency, tour operator reservation service and related activities	3	0.06%	2472	0.02%	4	0.07%	1944	0.02%
80	Security and investigation activities	4	0.07%	3921	0.04%	2	0.04%	582	0.01%
81	Services to buildings and landscape activities	5	0.09%	2250	0.02%	5	0.09%	2797	0.02%
82	Office administrative, office support and other business support activities	21	0.39%	3645	0.04%	22	0.40%	5494	0.05%
85	Education	9	0.17%	1535	0.02%	9	0.17%	1768	0.02%
86	Human health activities	17	0.31%	48366	0.48%	22	0.40%	65135	0.56%
87	Residential care activities	1	0.02%	25	0.00%	1	0.02%	20	0.00%
88	Social work activities without accommodation	1	0.02%	23	0.00%	1	0.02%	25	0.00%
91	Libraries, archives, museums and other cultural activities	2	0.04%	823	0.01%	2	0.04%	706	0.01%
95	Repair of computers and personal and household goods	5	0.09%	1719	0.02%	4	0.07%	759	0.01%
96	Other personal service activities	9	0.17%	3652	0.04%	12	0.22%	4544	0.04%

Notes. The sectorial classification is NACE Rev 2. Monetary values are in thousand of euros.

Table 2. Distribution of firms and R&D expenditure by class of employees.

	2008				2009			
Size	Firms		R&D		Firms		R&D	
	N.	%	exp.	%	N.	%	exp.	%
<10	722	13.28	277,510	2.78	814	14.98	186,899	1.61
10-49	2,336	42.98	723,951	7.25	2,318	42.65	996,217	8.58
50-249	1,615	29.72	1,220,398	12.21	1,514	27.85	1,179,815	10.17
>=250	762	14.02	7,769,190	77.76	789	14.52	9,239,428	79.64

Notes. Monetary values are in thousand of euros.

Table 3. Mean values, whole sample

	All				
	Treated		Untreated		
	obs	mean	obs	mean	diff
2008	3,036	0.0757	1,149	0.0732	0.0025
2009	2,062	0.0953	2,058	0.0829	0.0124

Table 4. Mean values, non-ICT vs ICT

	Non-ICT sector					ICT sector				
	Treated		Untreated			Treated		Untreated		
	obs	mean	obs	mean	diff	obs	mean	obs	mean	diff
2008	2,006	0.0471	731	0.0431	0.0040	1,030	0.1314	418	0.1257	0.0057
2009	1,286	0.0574	1,310	0.0462	0.0112*	776	0.1582	748	0.1471	0.0111

Table 5. RD Tax Credit

	All	
	(1)	(2)
Treatment	0.00991	0.00431
	(1.25)	(0.84)
Year	0.00970*	0.0157**
	(2.23)	(3.93)
Treated	0.00253	0.0116**
	(0.56)	(3.64)
Constant	0.0732***	-0.0065
	(20.62)	(-0.10)
N	8305	8305

Notes. Column (2) includes debt, output, cashflow and dummies for: sector of activities, province, juridic form and size. The significance level of coefficients is denoted by: * (5 per cent) and ** (1 per cent).

Table 6. RD Tax Credit: ICT vs non-ICT firms

	non-ICT		ICT	
	(1)	(2)	(3)	(4)
Treatment	0.00718*	0.00649*	0.00543	-0.00018
	(2.37)	(2.59)	(0.35)	(-0.02)
Year	0.00307	0.00875**	0.0214*	0.0254**
	(1.87)	(4.99)	(3.24)	(3.54)
Treated	0.00399*	0.00881**	0.00565	0.01867*
	(2.51)	(6.85)	(0.67)	(2.24)
Debt		-0.00833		-0.04962*
		(-1.24)		(-2.68)
Output		0.0280**		0.09516**
		(8.76)		(5.55)
Cash Flow		-0.01437		-0.23494**
		(-0.59)		(-3.47)
Constant	0.0431**	0.1309**	0.1257**	0.3137**
	(30.33)	(11.44)	(23.47)	(18.70)
N	5332	5332	2972	2972

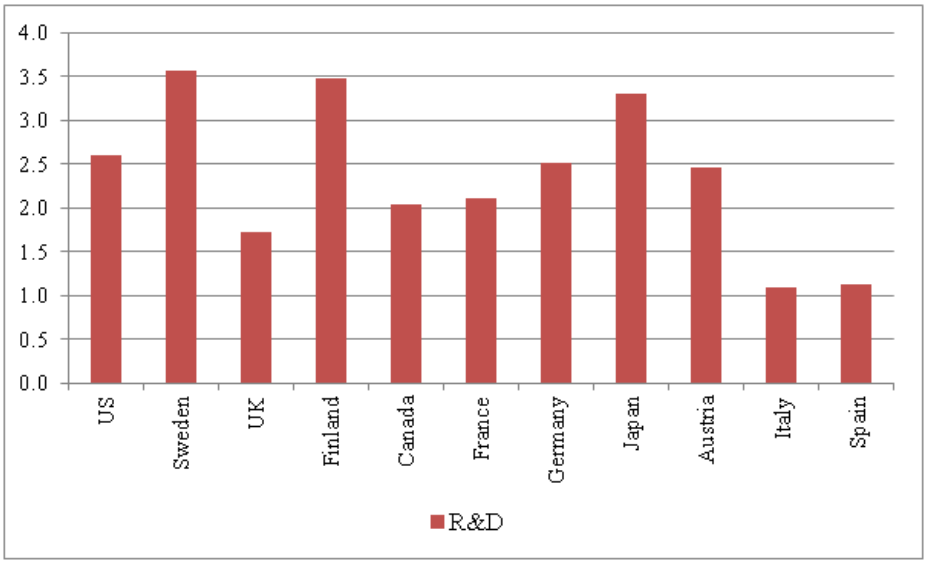
Notes. Columns (2) and (4) contain dummies for: sector of activities, region, juridic form and size. The significance level of coefficients is denoted by: * (5 per cent) and ** (1 per cent).

Table 7: RD Tax Credit, Panel Results

	non-ICT		ICT	
	(1)	(2)	(3)	(4)
Treatment	0.00288*	0.00359**	-0.00353	0.00182
	(2.08)	(3.58)	(-0.52)	(0.24)
D.Debt		-0.0337*		0.0234
		(-2.48)		(0.18)
D.Output		0.0155**		0.1074**
		(7.26)		(3.02)
D.Cash Flow		-0.00651		-0.3391**
		(-0.52)		(-7.59)
Constant	-0.0000125	-0.1479*	0.00888*	0.0368
	(-0.02)	(-2.18)	(2.01)	(1.33)
N	1737	1737	928	928

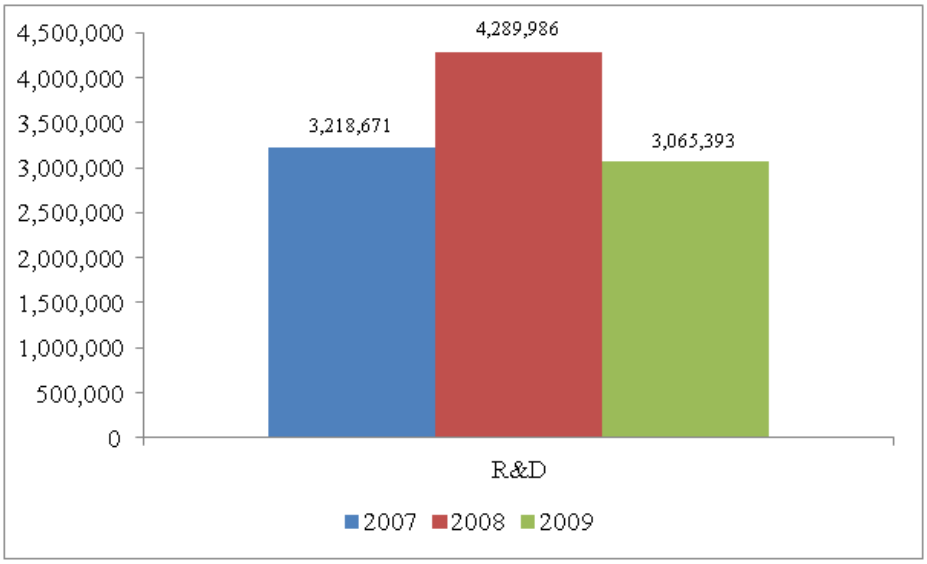
Notes. Columns (2) and (4) contain dummies for: sector of activities, region, juridic form and size. The significance level of coefficients is denoted by: * (5 per cent) and ** (1 per cent).

Figure 1: Percentage share of R&D investment in selected OECD countries, 2005.



Notes. Countries on the x-axis are ordered on the basis of their investment in ICT, according to a decreasing order.

Figure 3: Firms R&D expenditure.



Notes. Data are in thousand of euros.