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University of Naples Federico II

University of Salerno

Bocconi University, Milan

CSEF - Centre for Studies in Economics and Finance
DEPARTMENT OF ECONOMICS – UNIVERSITY OF NAPLES
80126 NAPLES - ITALY
Tel. and fax +39 081 675372 – e-mail: csef@unisa.it

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Liquidity and Firm Response to Fiscal Stimulus

Antonio Acconcia[*] and Claudia Cantabene[**]

Abstract
A stimulus programme allowed firms in Italy to receive a tax credit for R&D expenditure in 2009. We show large heterogeneity in the firm response. Among firms that usually smooth R&D through time, the tax credit did not have any effect. Among traditional firms, the response was mainly dependent on the amount of internal liquidity. Firms with relative large cash holdings raised R&D with respect to 2008 while firms with low levels of cash did not. The latter mainly used the tax credit to mitigate the negative impact of the credit crunch.

JEL classification: E62, E22, H32, D92

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[*] Università di Napoli Federico II, DISES and CSEF. Corresponding address: Antonio Acconcia, Department of Economics and Statistics, University of Naples Federico II, via Cintia, Monte S. Angelo, 80126 Naples, Italy. E-mail: antonio.acconcia@unina.it.

[**] Seconda Università di Napoli.

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1 Introduction

Does countercyclical fiscal stimulus help to sustain demand? Despite its relevance, the answer to this question remains highly controversial because of the difficulty to identify empirically the causal link. Recent contributions—spurred by the widespread resort to fiscal policy to counteract the global crisis—have mainly called attention to the effects of tax rebates at household level (e.g. Shapiro and Slemrod, 2003; Johnson, Parker, and Souleles, 2006; Agarwal, Liu, and Souleles, 2007; Parker, Souleles, Johnson, and McClelland, 2013; Misra and Surico, 2014; Jappelli and Pistaferri, 2014) and the effects of public spending shocks at national or subnational level (e.g. Barro and Redlick, 2011; Ramey, 2011; Auerbach and Gorodnichenko, 2012; Nakamura and Steinsson, 2014; Acconcia, Corsetti, and Simonelli, 2014). In this paper, we contribute empirical micro-evidence to this literature by focusing instead on firms. In particular, we look at the effect on R&D expenditure of the transitory tax credit supplied to Italian firms in 2009, just after the recent credit crunch.

Two features qualify our case study as suitable for dealing with the identification issue. The first one is the mechanism adopted to select the subsidized firms. Since 10 am on the 'click day', any firm asking for the tax credit had to apply via the *Agenzia delle Entrate* online application portal. The selection of the treated firms would have been determined according to the chronological order in which the electronic applications arrived, given the fulfillment of an aggregate tax credit cap and without any project screening or examination of firms' characteristics. In fact, the selection process was extremely fast as almost all applications arrived to the *Agenzia delle Entrate* soon after the 10 am and in few seconds the aggregate constraint was already binding, determining the rejection of many applications**.** The second feature consisted in the possibility for sorted firms to carry forward any amount of the credit in excess of current year tax to offset future taxes. Thus, the incentive we consider was not restricted to firms with enough tax liabilities in 2009. By looking at recessionary years, the restriction to profitable firms would have raised the potential concern of a selection bias affecting the firm response estimates. Arguably, these two features provide a pool of treated and untreated firms useful to identify the causal effect of a fiscal stimulus, by comparing the response to the stimulus of subsidized firms to the behavior of a control group composed of those firms not sorted for the stimulus, though they asked for it.

The possibility of relying on incentive for R&D expenditure strengthens our identification. In general, the introduction of a policy that is biased in favor of investing in a

given year should affect the firm behavior only if the elasticity of investment to transitory change in its price is different from zero. Pushed by dynamic market competition, firms operating in high-tech industries tend however to 'continuously' upgrade existing products and create new ones. This implies an high flow of yearly R&D expenditure—if compared to that of traditional firms—and, more important, a sluggish response of R&D to changes in its cost (Hall and Lerner, 2010). Hence, if we are indeed capturing the response to a transitory countercyclical fiscal shock we should observe that our treatment has a much lower impact for high-tech firms.

We show large heterogeneity in the firm response to the fiscal stimulus. The effect of the tax credit for firms operating in traditional industries mainly depends on the amount of internal liquidity and the stock of debt the firms inherit at the beginning of the credit crisis. Treated firms with relative high amounts of cash—that is, above the sample mean—increased R&D significantly more than the corresponding untreated ones, the difference being increasing with the cash holdings. In particular, for firms in the third quartile of the cash distribution, 10 percent tax credit induced about 20 percent higher R&D. Treated firms with relative poor amounts of cash, instead, mainly relied on the tax credit to mitigate the negative effect of the credit crunch on the financing of their investment. No effect at all of the tax credit is found for firms operating in high-tech industries, consistent with their tendency to smooth R&D over time.[1]

There is recent evidence that fiscal stimulus in the form of tax rebate may heterogeneously affect households behavior by their available liquidity and degree of indebtedness. Agarwal, Liu, and Souleles (2007) show that after the 2001 stimulus, spending rose most for consumers who were initially most likely to be liquidity constrained. Heterogeneity in the response is also found by Shapiro and Slemrod (2009), who suggest that low-income individuals might use a rebate to pay off debt, as well as Misra and Surico (2014). Consistent with this evidence, Jappelli and Pistaferri (2014) find that the MPC out of rebate checks in Italy is 0.65 for the lowest cash-on-hand households and 0.30 for the highest.[2] Specific to our study is the analysis of fiscal stimulus response

[1] Even for these firms we report, however, a positive relationship between R&D expenditure and cash, consistent with the findings by Brown, Fazzari, and Petersen (2009) and, previously, Himmelberg and Petersen (1994).

[2] More evidence on heterogeneity of households behavior is reported by Gross and Souleles (2002), Mian and Sufi (2014), Acconcia, Corsetti, and Simonelli (2015), Surico and Trezzi (2015). Gross and Souleles (2002) show that increases in credit card limits generate a significant rise in debt. As this effect is not homogeneous across people but depends on how close they are to their credit utilization rate limits, the authors infer the existence of liquidity constraints affecting consumer behavior. Mian

at firm level. Yet, our results that traditional firms with internal funds availability increased R&D while other firms did not—arguably because either they smooth R&D or are liquidity constrained—resonate with previous findings on consumer behavior.

Our paper is also related to the debate on the investment-cash sensitivity. A large number of papers in corporate finance documents a positive correlation between firm investment and internal funds. Interpreting such evidence as due to a causal effect is, however, difficult as cash is often correlated with omitted variables that represent the profitability of investment (Alti, 2003). Not properly controlling for such variables may thus imply a spurious investment-cash correlation or at least an upward bias of its estimate. Since growth perspectives were severely depressed at the time of our investigation, arguably the finding that the investment-cash sensitivity only holds for treated firms does alleviate the concern that such sensitivity is due to a misspecified regression model. In particular, as this finding is achieved after a credit crunch, it seems natural to interpret it as due to financing constraints.[3]

As we look at an episode of R&D tax credit, the paper contributes to the large and still growing literature on 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. Thus, by reducing the price of an input, the tax credit allows to estimate the elasticity of such input with respect to its price. Becker (2015) and Zúñiga-Vicente, Alonso-Borrego, Forcadell, and Galán (2014) provide recent systematic reviews on emprical findings related to R&D subsidies.[4] Although many previous studies find an R&D

and Sufi (2014), instead, show that low income households aggressively borrow and spend when increases in house prices allow to liquefy the larger value of home equity. For the same rise in house prices, households living in high income zip codes are instead unresponsive, both in their borrowing and spending behavior. Acconcia, Corsetti, and Simonelli (2015) show that liquidity-enhancing transfer raises non-durable consumption by households with low liquidity and bank debt, but makes no difference for liquid households. Surico and Trezzi (2015) provide evidnce on the heterogeneous effects of residential property taxes on consumer spending.

[3]The standard approach to investigate the role of internal liquidity for investment consists in comparing the size of the investment-cash sensitivity for groups of firms characterized by different degrees of financing constraints. Fazzari, Hubbard, and Petersen (1988) and many others interpret the larger sensitivity by firms classified as relatively constrained as evidence of financing constraints. As shown by Kaplan and Zingales (1997), however, the same empirical strategy may suggest an alternative interpretation in terms of reluctance to borrow. Moreover, Cleary (1999) and Moyen (2004) show that the lack of strong empirical identification is often a great concern to infer either causal interpretation. In particular, the specific criterion used to select constrained firms may drive the results in favor of one or another interpretation. Differently from this literature, in our framework the sample split into two groups of firms is due to the treatment assignment, which also determines the incentive to invest. In this way, we may identify why firms might be induced to increase their levels of investment and whether liquidity matters.

[4]See also Hall and Reenen (2000), Hall (1993) and Hines, Hubbard, and Slemrod (1993).

cost elasticity around 1—like our average estimate for traditional industries—or even larger, thus supporting the additionality hypothesis, valuable contributions showing negligible effects of subsidies are available. For instance, with state-level data for the U.S. Wilson (2009) yields an elasticity greater than one which becomes however close to zero if cross-border effects are taking into account.[5]

Cantabene, Nascia, and Perani (2011) and Cantabene and Nascia (2014) have already evaluated the 2009 R&D tax credit in Italy, limiting however the analysis to the average effect and employing a different strategy from our. In particular, Cantabene and Nascia (2014) conclude for a strong impact of the public stimulus which is estimated about twice the average effect we estimate for traditional firms.[6] Arguably, this difference might be explained as while they look at the R&D level and compare applicants and non-applicant firms, we restrict to applicants and look at the R&D change. With the former strategy the concern of bias estimate due to unobserved firms' characteristics might be quite relevant. This justifies our choice of using the pool of applicants, paying particular attention to the pre-treatment behavior of the firm.[7] The second main difference between the present paper and the previous studies consists in our detailed analysis of the role of cash in determining heterogeneous effects of the subsidy.

Further evidence on R&D subsidy in Italy has been recently provided by Bronzini and Iachini (2014) who find substantial heterogeneity in the impact of a program implemented in northern Italy: small enterprises increased investments—by approximately the amount of the subsidy received—whereas larger firms did not. Among previous studies, evidence on the additionality effect of R&D subsidy is found by Parisi and Sembenelli (2003) for a panel of firms over 1992-97 while [8]

Finally, while we investigate the effect of a fiscal stimulus, our evidence also accords with recent results on the effects of a credit supply shock. For a sample of U.S. firms

[5] Few studies are available at country level, given the specific features of the tax credit programmes across countries and over time. Bloom, Griffith, and Van Reenen (2002) examine nine OECD countries over a 19-year period and find evidence that tax credit is effective in increasing R&D investment, with a long-run elasticity of one. Significant effects of long-lasting changes in corporate taxation are also reported by Cummins, Hassett, and Hubbard (1994) for business fixed investment.

[6] Cantabene, Nascia, and Perani (2011) instead reported no impact at all of the tax credit.

[7] Note that Cantabene, Nascia, and Perani (2011) and Cantabene and Nascia (2014) select the sample of firms such that any firm in the sample applied for the credit in 2009 but not in 2007, and compare R&D in these two years. However, since the information about the R&D investment in 2007 of non-applicant firms is available for a number of firms lower than that of applicants in 2009, they end up with a number of firms lower than that in the present paper.

[8] Bronzini, de Blasio, Pellegrini, and Scognamiglio (2008) find that the 2000 tax credit programme, for capital goods different from R&D, was effective in stimulating total investment.

Duchin, Ozbas, and Sensoy (2010) show that the negative effect of the recent credit shock has been greatest for firms with low cash reserves or high net short-term debt. Evidence supporting this conclusion is reported by Campello, Giambona, Graham, and Harvey (2011) who suggest that credit lines eased the impact of the financial crisis on corporate spending, and Almeida, Campello, Laranjeira, and Weisbenner (2009) showing a significative decrease in investment of firms that needed to refinance a large fraction of their obligations during the crisis. For a sample of Italian firms, Cingano, Manaresi, and Sette (2013) show that liquidity drought accounts for more than 40 percent of drop in investments during 2007-10. Our finding that the change in R&D of treated firms is inversely correlated with the change in cash holdings is consistent with these results.

The rest of the paper is organized as follows. Section 2 presents institutional details, data, and the econometric strategy. Sections 3 and 4 describe, respectively, the basic results and sensitivity analysis. Section 5 concludes.

2 Empirical Strategy

According to the 'Law 296, 27 December 2006', Italian firms could have applied for a volume tax credit in any year during 2007-2009. The tax credit would have allowed firms to deduct 10 percent of the total amount of eligible R&D expenditures from the corporate taxes—up to the amount of 50 millions of euros for each firm-year. Eligibility attained to all kinds of spending—personnel, tools and machinery, patents—needed to finance base research, applied research and experimental development projects. No limit was settled to the total number of firms that could have been subsidized.

At the beginning of 2008, however, the national political election determined the change of the political party in power. Soon after it took the power, the new right-wing government announced its intention to operate in order to reduce the public deficit. Among the first actions taken, the funding of the R&D tax credit introduced in 2006 by the former left-wing party in power was withdrawn. Actually, firms could no more rely on the fiscal subsidy.

At the end of 2008, the diffusion in Italy of the recent credit (and economic) crisis induced the government to partially reconsider its original purpose of fiscal austerity. In fact, together with countercyclical measures devoted to sustain households consumption the government also considered the possibility of some measure in favor of firms for 2009. Since the Law 296 was still in place, the R&D tax credit was restored fairly

soon. It was the unique stimulus program introduced at that time in favor of firms. Differently from the past, however, the extent of the stimulus was severely limited. An upper bound to the amount of forgone tax revenue and an electronic selection procedure in the choice of recipient firms characterized the new programme. The 'Decree 185, 29 November 2008' fixed at 1,627 millions of euros the maximum total amount of tax credit available for all firms. Moreover, the same decree introduced an electronic selection procedure. Starting from a due date—the 'click day'—any firm applying for the fiscal stimulus had to fill an electronic application form, available on the website of the *Agenzia delle Entrate*. By applying for the tax credit, firms had to provide information about their R&D expenditures planned for 2009 if sorted for the tax credit.[9] In fact, according to the chronological order in which the *Agenzia delle Entrate* received the applications, firms' selection would have been determined given the fulfillment of the total tax credit cap. Actually, few seconds after the beginning of the selection process the aggregate tax-credit cap was already reached; many applications were thus rejected. This allows to split the pool of firms according to whether they are sorted or not for the stimulus due to the upper bound in its size. Arguably, the very short duration of the selection process, realized without any examination of the firms' characteristics, would suggest that its outcome is equivalent to that of random assignments.

The empirical analysis consists of two main parts. The first one is devoted to the estimate of the average effect of the tax credit. The second part investigates the role of internal liquidity in determining an heterogeneous effect of the tax credit across firms. In doing so, we always split the sample of firms according to traditional and high-tech firms, given the different theoretical predictions regarding the impact of a short-run fiscal stimulus for R&D. Finally, we test the parallel trends assumption to validate our main conclusion.

Information about planned R&D conditional on the tax credit, together with that relative to the treatment assignment, allows us to test whether planned R&D differs among the two groups of treated and untreated firms. This provides some evidence on the randomness of the selection mechanism. Moreover, by comparing planned and actual R&D expenditure, for both treated and untreated firms, we provide the first evidence on the tax-credit impact. If the tax credit matters than we should observe planned R&D—conditional on the tax credit—higher than achieved R&D for untreated firms.

[9] The tax credit received by treated firms was, however, related to the actual R&D expenditure realized during 2009.

The fundamental threat to identification of the tax subsidy is that firms that applied first for it, and thus received the tax credit, are somehow different in terms of observable or unobservables from firms that applied later, missed the cutoff and thus received no marginal subsidy. Our panel of firms allows to construct a second test of the effect of the tax credit. In this case we look at the 2008-09 *change* of R&D expenditure for both treated and untreated firms. Formally, our baseline empirical specification is

$$\Delta R\&D_i = \alpha + \beta DT_i + \theta X_i + \varepsilon_i \tag{1}$$

where the left-hand side variable is the firm i *change* in actual R&D expenditure (over 2008-09) scaled by the book value of total assets, DT is a binary treatment variable identifying firms receiving the tax credit, X is a set of controls and ε is an error term. If the error term is independent from DT, then the parameter β would identify the causal average effect that 10% tax credit has on R&D expenditure. We are interested in whether β is statistically greater than zero and how large its value is relative to the mean expenditure of the control group.[10] The controls include a full set of dummies taking into account differences in the size (number of employees) of firms, the region where firm is located, the production sector (according to the NACE-REV2 classification), and the firms' legal form, as well as the age of the firm and a proxy for the production technique.

By exploiting a data panel we are able to disentangle the effect of the fiscal stimulus on R&D expenditure from a firm-specific effect. As our outcome variable is the change of R&D the concern that time invariant firm characteristics potentially correlated with the treatment status may bias the estimate of β should not be relevant. The potential bias is differenced out in dealing with R&D yearly changes. Nonetheless, we add to equation (1) the controls X relative to firms' characteristics prior to the selection procedure. The sensitiveness of β to such controls would be a concern for our identifying assumption. We anticipate, however, that as expected these controls are not relevant for the estimate of β, they only affect the standard error of the estimator.

Once assessed the average effect of the tax credit on R&D, we look at whether such average masks some heterogeneity across firms. In particular, we investigate the role of internal liquidity by extending the former empirical specification as follows:

$$\Delta R\&D_i = \alpha + \beta DT_i + \gamma_1 CASH_i + \gamma_2 \left(DT \times CASH\right)_i + \vartheta H_i + \eta_i \tag{2}$$

where $CASH$ is a measure of firm's liquidity and H is a larger set of controls than

[10] Conditional on controls, the OLS estimator of β is the difference in the group means of $\Delta R\&D$.

X. In our preferred specifications $CASH$ consists of the beginning of 2009 cash stock plus the 2009 earning/loss due to extraordinary and nonrecurring operations—scaled by the lagged value of total assets—expressed in terms of deviation from the sample average. Hence, β would identify the effect of the tax credit evaluated at the average value of $CASH$ while γ_1 and γ_2 would provide evidence on the sensitivity of R&D to internal funds among untreated and treated firms, respectively.

Moyen (2004) explains why investment may be more or less sensitive to the liquidity, depending on whether the estimated regression allows or not for debt. To control for this channel, we allow for either the beginning of year stock of debt or the change in debt over 2008-09. The output change is also included among the controls H.

Finally, we provide evidence relative to the pre-treatment period to investigate whether our result on the heterogeneous effect of the subsidy depends on different trends characterizing the R&D paths of treated and untreated firms. We would like to asses that the outcome in treatment and control group would have followed the same time trend in the absence of the treatment. Thus, we look at the $R\&D$ change of the two groups of firms before the treatment, that is over 2007-08.

Inference in cross-sectional analysis can be misleading if there is spatial correlation within groups of observations. As in different context regarding Italy (see, for instance, Guiso, Sapienza, and Zingales, 2004), we posit that decisions of firms belonging to the same administrative region might be correlated, as a result of an unobserved cluster effect due to common regional rules. Our inference will therefore be based on standard errors robust to spatial correlation at regional level and heteroskedasticity. The main results also hold, however, by using not-robust standard errors.

In the following, after having presented the basic results for the average effect of the tax credit we investigate the role of liquidity for determining an heterogeneous response. Then, after a number of checks relative to estimates of equation (2), we extend the sample period by including the 2007. In this case the number of firms employed in the empirical analysis is reduced respect to the baseline specification. With this restricted sample, however, we may check that our main results are not driven by trends differentiating the expenditure of treated firms unrelated to the tax credit.

2.1 Data

Data on planned R&D expenditure and information about the assignment of the tax credit come from the *Agenzia delle Entrate* while actual R&D expenditure comes from the yearly R&D surveys of the Italian Institute of Statistics (ISTAT). As these surveys are mainly realized to monitor the evolution of R&D by private firms, in each survey the share of firms producing high-tech goods is a bit larger than the corresponding share in the population of Italian firms. Planned R&D is available for about $14,000$ firms—roughly 80% of all firms asking for the tax credit—while actual R&D is available for a lower number of firms, that is those which are part of the R&D surveys. In particular, for the years 2008 and 2009 of our interest we may rely on a panel of $2,662$ firms. Two third of all firms operate in traditional industries (see the appendix for the formal definition of traditional and high-tech firms).

On average, actual R&D expenditure of firms in the sample was about 7.6 percent of total assets in 2008 and 8 percent in 2009. Regarding the firm distribution across industry, it follows that 'Manufacture of Machinery and Equipment' and 'Manufacture of Fabricated Metal Products, Except Machinery and Equipment' are those industries with the largest number of firms. The former consists of 547 firms, that is about 20 percent of the total sample; the latter instead of 234 firms (about 9 percent). By looking at the size in 2008, it follows that firms are equally distributed between micro-small and medium-large size. As expected, small-size firms are the most abundant, being about 41 percent of the total sample of firms. Medium-size firms are about 32 percent of the total.

Table 1 reports mean values for R&D expenditure, three measures of internal liquidity, debt and sales in 2009, as percentage of total assets. As expected, R&D differs a lot across the two groups of high-tech and traditional firms. High-tech firms invest almost three times more than other firms in the sample: in 2009 the average investment of the two groups of firms was 4.92 percent and 14.56 percent, respectively. Differences also emerge for the measures of liquidity. In particular, we notice that firms in traditional industries were characterized by lower cash stock—before the assignment of the tax credit—and cash flow than other firms in the sample. For both these variables, the mean difference test suggests to reject the null hypothesis of equal means—with a very low p-value.[11] Finally, note that in terms of debt the two groups of firms were on

[11] Note that the relative large cash of high-tech firms is a main feature shared by similar firms analyzed in the literature (see, for instance, Bruinshoofd and de Haan, 2005).

average very similar.

3 Main Results

3.1 Basic Evidence

When firms asked for the tax credit, they provided information about the R&D expenditure they aimed at realizing during 2009 *if* subsidized. We use such information provided by the *Agenzia delle Entrate* to assess whether treated and untreated firms planned on average the same or different amounts of R&D expenditure. In particular, in the first column of Table 2 it is reported the result of the mean difference test comparing all available treated and untreated firms, whereas in the rest of the table we restrict to either traditional or R&D-intensive firms.[12] Clearly, no difference emerges in terms of planned R&D expenditure, before the assignment of the tax credit, between firms that will become treated or untreated, whatever the sample considered.

If the tax credit has been effective at stimulating R&D in 2009, then we should observe actual expenditure lower than planned one among the untreated firms. Once realized of not having been sorted for the tax credit, any firm should also realize that the spending planned conditional on the fiscal stimulus is higher than the optimal. For treated firms, instead, the difference between the two variables should be insignificantly different from zero. By looking at firms within the survey, we use again the mean difference test to investigate this hypothesis.[13] Results for all industries are reported in columns (1) and (2) of Table 3. It follows that while treated firms achieved the planned R&D expenditure, the mean difference between planned and actual expenditure is negative and strongly statistically significant for the untreated firms, the t-statistic being -3.03. Thus, for firms not sorted for the tax credit the actual amount of R&D spending was lower than the amount planned in case of subsidy. Overall, the same conclusion holds if the test is applied within traditional and high-tech industries—see columns (3)-(6) of the table. We note that much of the statistical significance reported above for the entire sample of untreated firms is driven by those in traditional industries.

Table 4 shows evidence relative to the effect of the tax credit by looking at the *change* of actual R&D spending over 2008-09: its impact turns out to be economically

[12] Note that, differently from all evidence regarding actual spending, the test involving planned spending can be developed using about 80 percent of all firms asking for the tax credit.

[13] Actual R&D spending is only available for firms within the R&D surveys.

and statistically significant only for firms operating in traditional industries. Such finding is robust to the inclusion of a large number of controls. More specifically, in column 1 of the table we show results of regressing the R&D change in traditional industries on a dummy identifying those firms receiving the treatment. On average, the untreated firms did not show any change in their expenditure while, consistent with previous evidence, treated firms increased it. The magnitude of the response to the financial stimulus is economically relevant. To translate our result in terms of elasticity to the tax credit we rely on a back-of-the-envelope calculation. The estimated change of R&D expenditure due to the tax credit is 0.0034, that is 8 percent more than the average R&D expenditure of the control group in 2009. By interpreting the tax credit as a reduction of the R&D cost by 10 percent (Cummins, Hassett, and Hubbard, 1994; Bloom, Griffith, and Van Reenen, 2002), previous estimate implies that the R&D elasticity to its cost is -0.8, a value in the ball-park of estimates suggested by the literature briefly reviewed in the introduction.[14]

In column 2 we report results adding a full set of dummies controlling for size, region, sector and legal form of the firms in the sample as well as the age of the firms. Arguably, these variables are not themselves outcome of the stimulus programme. In particular, firm size and age are often used to capture the severity of financial constraints in case of capital market imperfections under the maintained assumption that smaller and younger firms have less access to external capital markets (Hadlock and Pierce, 2010). Hence, they might be particularly relevant to explain investment. Finally, we also add a proxy for the capital-labor ratio of the firms, namely the share of total expenditure for labor input over total assets. Estimate of the coefficient attached to the treatment dummy is the same as before. The main effect of enlarging the set of regressors is in terms of efficiency: the t-statistic related to the coefficient estimate raises from 2.40, without any control, up to 3.49. As expected when the treatment is randomly assigned, the OLS estimator of the treatment coefficient in a multiple regression model has a smaller variance than the OLS estimator in a single regression model, with only the treatment variable. When the treatment is randomly assigned, the main effect of the controls may be in terms of lower variance of the error term. If the treatment is assigned in a way that is related to the X's, then the OLS estimator without controls is inconsistent.[15]

[14] The estimated effect of the subsidy is lower than that reported by Cantabene and Nascia (2014) who compare the difference in R&D between treated and untreated firms in 2009 with the corresponding difference in 2007, when firms in the sample did not apply for the tax credit.

[15] Actually, a large discrepancy between estimates reported in columns 1 and 2 would suggest that

In the last two columns of Table 4 we report evidence relative to firms operating in R&D-intensive industries. We find that R&D does not respond to the fiscal stimulus. Unconditionally and conditional to the set of controls the same result emerges, that is the point estimate of the treatment dummy is very close to zero. This result is consistent with theoretical models suggesting a weak response of R&D to *short*-lived fiscal stimulus like the one we consider, due to the irrelevance of transitory changes in R&D cost for the decision to invest (Hall and Lerner, 2010).

We close this section by looking at the difference between treated and untreated firms—operating in traditional industries—in terms of internal funds available before the treatment as well as other firms' characteristics. Mean difference tests suggest that the two groups of firms are very similar whatever measure of cash is considered: the difference in the cash stock before the treatment and that in the cash flow during 2009 are insignificantly different from zero (see Table 5). Moreover, no difference is found in terms of age, capital-labour ratio, change of debt over 2008-09 and location between north and south of Italy, too. Conversely, the debt before treatment of treated firms emerges to be significantly lower than that of untreated firms; the difference, however, is not large: 58 percent instead of 61 percent. Thus, overall treated and untreated firms appear quite similar in terms of pre-treatment characteristics.

3.2 The Role of Liquidity

Having assessed, for firms in traditional industries, the *average* relevance of the tax credit supplied at the onset of the recent credit crunch, we now look at whether the responses to the fiscal stimulus were homogeneous across firms. In fact, because of the crunch we expect that the fiscal stimulus mainly affected firms with enough internal funds to increase their R&D. To investigate on this possibility we enlarge the estimated regression by adding our measure of liquidity and its interaction with the treatment dummy DT. The theory does not provide a clear guidance on which measure of liquidity, either cash flow or cash stock, is the relevant one to investigate its impact on investment. For instance, Kashyap, Lamont, and Stein (1994) focus on the sensitivity of investment to the cash stock that a firm has available at the beginning of the year while others on the sensitivity of investment to cash flow (e.g. Fazzari, Hubbard, and Petersen, 1988). On a theoretical ground, the effect of extra cash should be the same, independent of

the treatment is not randomly assigned. Of course, if the probability of being treated depends on unobserved variables uncorrelated with those in X, then the control provided by the X's would be unsatisfactory.

whether it enters the firm in the current period (as cash flow) or whether it was present in the firm at the beginning of the period, as cash stock (Kaplan and Zingales, 1997). From an empirical point of view, however, the use of cash stock might be preferred to not incur the risk of endogeneity bias. Thus, in column 1 of Table 6 we consider the beginning of period cash stock plus current earnings or losses unrelated to operational activities of the firms. The coefficient of *CASH* (entered as difference with respect to its mean) is zero, while the coefficient of its interaction with *DT* is positive and statistically different from zero. Hence, the effect of the tax credit on R&D of treated firms increases with the size of the available internal funds.

Evidence on the investment-cash sensitivity may be biased in two different ways. First, with more favorable opportunities firms invest more. If unconstrained firms issue debt to fund additional investment and the effect of debt financing on investment is not taken into account by the regression specification, then this misspecification magnifies the relevance of internal funds for investment (Moyen, 2004). Thus, omitting the debt variable the estimate of the investment-cash sensitivity might be biased upward. Second, if the size of debt is a good indicator of credit constraint—that is the higher is the debt the stronger is the constraint—then omitting it would bias downward the coefficient of cash, if cash and debt are positively correlated. Column 2 of Table 6 also allows for the beginning of period debt (entered as difference with respect to its mean) and its interaction with *DT* while in column 3 we further extend the model with the growth of sales, which is an usual measure of firm performance. The coefficient of $DT \times CASH$ raises up to 0.063 and the corresponding t-statistic up to 4.03. These findings mainly reflect the negative correlation between *CASH* and *DEBT*, which holds for both treated and untreated firms.

Regarding the debt of the firms, the estimated coefficients relative to the beginning of period debt stock, and its interaction with the treatment dummy—that is *DEBT* and $DT \times DEBT$— are, respectively, negative and positive. Moreover, if we substitute the *DEBT* variable with its change over 2008-09 to capture the new debt issue, then neither this variable nor its interaction with *DT* are statistically relevant (results not reported). We interpret these findings as evidence that during a credit crisis external funds are poorly suited for funding larger expenditure of the firms.

The coefficient of *SALES* is positive and statistically significant, while the coefficient of its interaction with *DT* is insignificantly different from zero. This asymmetry provides further support to our identifying strategy. Even though demand for goods produced by traditional firms might be relevant for R&D, this demand-side channel

does not determine a differential behavior between our treated and untreated firms.

Under the maintained assumption that the debt to capital ratio is a good proxy for the strength of credit constraints, the investment-cash sensitivity should increase with debt. In the last two columns of Table 6, we show estimates of empirical models that allow for the interactions between *DEBT* and *CASH* for treated and untreated firms. The coefficient of the interaction is estimated positive and strongly significant for the treated, the attached t-ratio being about 4 (see the last column of the table); it is instead insignificantly different from zero for the group of untreated firms. Both results accord with previous evidence showing that cash matters for R&D expenditure only among treated firms. A formal test, however, does not strongly reject the null hypothesis of the equality of these two coefficients (the t-statistic is 1.50).

The relevance of *CASH* for the impact of the treatment implies heterogeneous firm response to the tax credit. In fact, for firms with low amount of internal funds—around the 25-*th* percentile of the *CASH* distribution—the effect of the tax credit is insignificantly different from zero. Oppositely, for firms that at the onset of the credit crisis had abundance of internal funds—around the 75-*th* of distribution—the effect of the treatment is twice the average effect.[16] Consistent with this evidence, if the sample is splitted according to the median of *CASH* then R&D appears to be sensitive to cash only for firms above the median (results not reported).

3.2.1 High-Tech Industries

As shown before, within high-tech industries we did not find evidence of an average effect of the tax credit. Moreover, when we estimate the various specifications of our empirical model it follows that the interactions between *DT* and *CASH*, *DEBT*, and *SALES* are always insignificantly different from zero at 5 percent level. Therefore, to simplify the exposition in Table 7 we report results when these interactions are omitted. Interestingly enough, estimates of the coefficients attached to *CASH* and $CASH \times DEBT$ are very similar to the corresponding estimates recovered previously for the group of treated firms. Hence, in this case too the R&D-cash sensitivity increases with the beginning of year debt. Differently from traditional firms, we do not find instead any direct effect of the variable *DEBT* on R&D. Finally, as before it follows that R&D is positively correlated with *SALES*.

[16] When interpreted in terms of R&D cost elasticity (evaluated at the sample mean of R&D expenditure in 2008) this effect is 1.7, a value remarkably similar to the short-run in-state estimate of Wilson (2009) for the U.S.

4 Sensitivity Analysis and Robustness

In this section, we further investigate the properties of our empirical model for firms within traditional industries. Specifically, we further analyze the role of firm liquidity, age, and size. Moreover, we investigate the influence of anticipation effects on our estimates.

4.1 Further Evidence on Liquidity

Previous estimates were based on the definition of *CASH* which avoids the risk of endogeneity. For completeness, we now show that the main evidence is, however, not driven by this specific measure of liquidity. In column 1 of Table 8 evidence is based on an alternative measure of liquidity which only considers the beginning of the year amount of internal funds; in column 2, instead, we extend the definition of *CASH* by adding contemporaneous depreciation. Hence, in the latter case the new variable *LIQ* becomes the sum of cash stock at the beginning of 2009 plus the cash flow related to this year, similar to the measure used by Kaplan and Zingales (1997). The new estimates clearly show that our main findings are confirmed. When we use the broad measure of liquidity, estimates of the average effect of the tax credit and the investment-cash sensitivity increase respect to the baseline specification.

If internal liquidity is indeed used for funding larger expenditure of the treated firms we expect a negative relationship between changes in expenditure and changes in the stock of available liquidity. To investigate on this, in column 3 the variable *LIQ* corresponds to the first difference of *CASH*. When compare the new coefficients estimates with previous ones we do not find any relevant difference but for the coefficient of $DT \times LIQ$ that as expected is estimated negative. We would like to stress that the coefficient of *LIQ* for the untreated firms is again estimated insignificantly different from zero. Hence, the negative relationship between changes in expenditure and liquidity only holds for firms that reacted to the tax credit by increasing the level of R&D.

A complementary set of results is reported in the last three columns of Table 8 where we extend the estimated specifications with the lagged R&D expenditure, interpretable as a further control for firm characteristics. Estimates are qualitatively and statistically similar to the counterpart. Interestingly enough, the coefficient of the new regressor is virtually zero suggesting that, differently from financial variables, the past value of R&D does not help to forecast R&D change at the onset of the recent credit crisis.

These new specifications and results, therefore, address the potential concern that our empirical results could be the artifact of the definition of liquidity adopted. By using the cash-flow instead of the cash stock as measure of internal funds, the strength of the liquidity effect on R&D expenditure would raise.

4.2 More Evidence on Age and Size

Our main finding holds even after controlling for firm age and size and scaling the monetary variables with the value of total assets. Yet, we now provide further evidence that such finding is not driven by a specific set of firms particularly young/old or small/large. In Table 9 we segment the sample into four groups—with roughly the same number of observations—according to the firms' age and show the effects of dropping each group of firms in turn. Overall, the basic evidence still holds. Differences across columns of the table are very negligible. Results of a similar exercise are reported in Table 10 where we redo estimates of our preferred specifications by dropping firms according to the size identifier. Again, we do not find that a specific group of firms drives the main conclusion, though we note that the effect of the tax credit is on average larger for the smaller group of firms.

The robustness of the relationship between R&D and cash may seem at odds with a result often proposed by the literature on corporate finance. It is usually suggested that smaller and younger firms should be characterized by larger investment-cash sensitivity since, under capital market imperfections, these firms should have less access to external funds. Without going into the substance of this argument, we would like to note that a similar result holds among our set of firms after dropping from the empirical model the variables related to the firm debt (results available upon request). Arguably, this evidence raises the concern that a misspecification bias may drive the conclusions stressing the relevance of the investment-cash sensitivity only for small and young firms.

4.3 Parallel Trends and Anticipation Effect

By comparing estimates of the baseline specification with and without controls, we provided a simple test of the randomness of our treatment assignment. In this section we further investigate this issue as well as the role of *CASH* by taking into account the *R&D* change and the control variables for the pre-treatment year, 2008. In this way, we may investigate the potential role of past factors in determining differences in current *R&D*. More importantly, by allowing for the lagged dependent variable in our

empirical model we may control for inertial effect as well as intertemporal substitution of subsidized expenditure. One may argue that in the first half of 2008 very clever entrepreneurs anticipated that the government would have introduced some stimulus programme in the next future and thus decided to reduce their expenditure to wait for better days. Incidentally, the argument goes, these entrepreneurs were also able to win the lottery of the treatment assignment.[17]

As a first instance, we note that the mean difference of *R&D* change, between treated and untreated firms, is not statistically different from zero in the pre-treatment year (see Table 11). Thus, our main conclusion that treated firms increased their investment because of the treatment is not due to a differential trend characterizing the *R&D* path of such firms respect to that of the untreated ones. Moreover, as before we find again that treated and untreated firms are very similar whatever measure of cash is considered. Similarly, there is no difference in the mean difference of sales growth, age and location between the South and the rest of Italy. Consistent with previous results the only difference between the two groups of firms is in terms of the debt in 2007. Finally, we note note that evidence on the pre-treatment period is not driven by the drop in the number of firms we may rely on, which is about halved when we add data relative to 2007. In fact, if we repeat the mean difference test for 2009 by using the reduced sample then the *R&D* difference between treated and untreated firms is confirmed with a point value which is very similar to that obtained with the larger sample. Overall, these findings support our assumption that recipient firms and rejected applicants are similar mainly in terms of cash available.

In Table 12 (first three columns) we show results when the empirical model is enlarged by adding the lagged *R&D* change. Estimates are qualitative and quantitative very similar to those reported previously. In particular, it is confirmed the large heterogeneity of the firm response to the tax credit by the amount of internal funds. Measured as R&D cost elasticity, the impact of the tax credit is about 1 at the mean of *CASH*, it is insignificantly different from 0 below the mean and about 2 at the $75th$ percentile. The invariance of results respect to the baseline accords with the insignificance of the estimated coefficient attached to $\Delta R\&D_{-1}$, the related t-statistic being -0.61.

In principle, an issue may arise adding the lagged dependent variable to the regression: it may be correlated with the error term, consequently OLS estimates are not consistent (Nickell, 1981). The easiest solution to this problem is to use $R\&D_{-2}$

[17] Auerbach and Hines (1988) provide systematic evidence on the role of expectations of future tax changes for corporate investments in U.S.

as instrument for $\Delta R\&D_{-1}$. When the IV strategy is implemented results are the same as the OLS ones confirming the randomness of the treatment and the relevance of liquidity to take advantage from the tax credit (see the last three columns of Table 12).

5 Conclusions

The widespread resort to fiscal stimulus at the onset of the recent crisis has determined new evidence at household level on whether countercyclical fiscal policy matters. We contributed to this literature by supplying complementary evidence at firm level during a credit crunch. In particular, we investigated the firm response to the R&D tax credit supplied to sorted Italian firms in 2009.

Among firms that usually tend to smooth R&D over time, that is high-tech firms, we did not find any effect of the tax credit. We found, instead, an effect which depends on cash holdings among firms operating in traditional industries. In particular, we estimated that 10 percent tax credit induced about 20 percent higher R&D among firms with cash around the 75-th percentile of the corresponding sample distribution. Conversely, we did not estimate any effect among firms with low amounts of cash available; they used the tax credit to face the shrinking credit supply. Overall, our findings accord with recent evidence on tax rebate at household level for Italy and the US.

The public policy we studied is a short-term subsidy supplied to firms in bad time. The response to such policy may be quite different from the response to a more persistent measure, unrelated to the business cycle, such as one aimed at fostering economic growth in the long-run. This may explain why we found a strong role for liquidity, which is absent in related studies investigating the relationship between R&D and its price.

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Appendix

A The tax credit

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 euro per year, concerns: (a) research employees; (b) lab tools and equipment; (c) buildings and lands devoted to the realization of R&D projects; (d) contractual research, technical skills and patents; (e) consulting services; (f) general expenses; (g) raw materials. General expenses are eligible up to 10% of personnel expenditure.

B Definitions of variables

The data set is based on information from three different sources. The R&D survey realized by ISTAT provides data on investment. Balance sheet data comes from the '*Archivio dei bilanci d'impresa Istat*' available at '*Direzione centrale delle rilevazioni censuarie e dei registri statistici*'. The outcome of the tax credit selection procedure is provided by the *Agenzia delle Entrate*. For the empirical analysis we rely on the following variables. Monetary values are expressed in thousands of euro at current prices.

- R&D: It is the sum of intramural (that is, within the bounds of the firm) and extramural (that is, outside the bounds of the firm) R&D expenditure at firm level, scaled by total assets, as reported by the annual R&D survey, 'Rilevazioni Istat sulla R&S nelle imprese'. The former refers to investment in R&D activities realized employing firm's personnel and equipment; the latter refers to expenditures related to R&D activities realized by other firms or public agency.
- CASH: The beginning of 2009 level of cash plus the 2009 earning/loss due to extraordinary and nonrecurring operations (scaled by 2008 total assets).
- CASH STOCK: The beginning of 2009 level of cash (scaled by 2008 total assets).
- CASH FLOW: It is the sum of profit and total reserves less depreciation (scaled by 2008 total assets).
- CASH (Alternative): The sum of CASH and contemporaneous depreciation.

- DEBT: The beginning of 2009 total debt of the firm as reported by the balance sheet (scaled by 2008 total assets). Total debt includes total bank liabilities, bonds, other current and non current liabilities.
- AGE: The number of days between the firm's birth date and the end of 2015.
- SOUTH: Dummy indentifying firms located in the south of Italy.
- SALES: The growth rate over 2008-09 of total sales revenue (scaled by total assets) as reported by the balance sheet.
- Total assets: The sum of current and non current assets as reported by the firm's balance sheet.

Moreover, the region-specific dummies identify the region where the R&D activity is realized. If a firm realizes its R&D activities in more than one plant the region is where the firm has its legal residence. The sector-specific dummies identify the sector of activity the firm belongs to. Sectors are defined according to the NACE-REV2 classification. The dummies for firm size refer to four groups of firms according to the EU Commission definition of micro-, small-, medium-, and large-sized firm. According to the article 2 of the Commission Recommendation dated 6 May 2003 the category of micro-, small- and medium-sized enterprises is made up of enterprises which employ fewer than 250 persons. Within such category, a small (micro) enterprise is defined as an enterprise which employs fewer than 50 (10) persons. We adapt this to institutional features of Italian labor market and use, respectively, 15 and 60 persons to identify the two groups of firms. The dummies for the legal form are constructed according to the '*Classificazione delle forme giuridiche delle unità legali*'.

C High-tech Firm

Our definition of high-tech firms reflects that of firms producing R&D-intensive goods, that is ICT producers and firms part of the 'Market research, Other professional, Scientific and Technical Activities' industry (based on the NACE-REV2 classification). High-tech firms are those identified by Pattinson, Montagnier, and Moussiegt (2000). In particular, as the OECD classification is based on the ISIC-REV3 standard while firms in our dataset are classified according to NACE-REV2 four digit classification, we rely on the ISIC-REV4 classification to identify high-tech firms in our data set.

Table 1: Descriptive Statistics

	Traditional	High Tech	Difference
R&D	4.92	14.56	9.64*** (0.000)
CASH	5.21	9.17	3.96*** (0.000)
CASH STOCK	5.82	9.20	3.37*** (0.000)
CASH FLOW	5.52	6.51	0.99*** (0.004)
DEBT	59.5	57.9	-1.65 (0.055)
Observations	1843	819	

Note: The table shows the 2009 mean values of R&D expenditure, different measures of liquidity, and the beginning of period stock of debt (all as percent of total assets) as well as their difference across the two groups of traditional and high-tech firms. CASH STOCK is the beginning of 2009 level of cash while CASH adds earning/loss due to extraordianry and nonrecurrent operations during 2009 to CASH STOCK. CASH FLOW is the sum of profit and total reserves less depreciation. We report in brackets p-values of mean difference tests.

Table 2: Planned R&D of Treated and Untreated firms

	(1)	(2)	(3)
	All	Traditional	High Tech
Treated - Untreated	0.002	-0.002	-0.004
	(0.88)	(-1.00)	(-0.54)
Observations	14098	10054	4044

Note: The table shows results of the mean difference test to compare planned R&D expenditure (scaled by total assets) in 2009 of treated and untreated firms. We report in brackets the t-statistic. Statistical significance is denoted as follows: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table 3: Planned Vs. Actual R&D Expenditure

	(1)	(2)	(3)	(4)	(5)	(6)
	All Industries		Traditional		High Tech	
	Treated	Untreated	Treated	Untreated	Treated	Untreated
Actual - Planned	-0.003	-0.008**	-0.004*	-0.008***	0.000	-0.008
	(-1.38)	(-3.03)	(-2.15)	(-4.07)	(0.01)	(-1.06)
Observations	1371	1291	940	903	431	388

Note: The table shows results of the mean difference test to compare planned and actual R&D expenditure (both scaled by total assets) in 2009. We report in brackets the t-statistic. Statistical significance is denoted as follows: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table 4: R&D Response to Fiscal Stimulus

	(1)	(2)	(3)	(4)
	Traditional		High Tech	
DT	0.0034**	0.0035***	-0.0022	0.0002
	(2.40)	(3.49)	(-0.33)	(0.03)
Observations	1843	1843	819	819
Estimated Elasticity	0.78	0.80	-0.15	0.01

Note: The table shows the R&D response of firms to the tax credit. The outcome variable is the change in R&D expenditure (scaled by total assets) over 2008-09. The variable DT is a dummy that equals 1 in case of assignment of the tax credit. Estimated models in columns 2 and 4 include a full set of dummies for region, sector, size and legal form of firms as well as firm age and total labor expenditure scaled by beginning of period total assets. Elasticity refers to the R&D cost elasticity implied by the coefficient of DT. Statistical significance is denoted as follows: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 5: Treated Vs. Untreated Firms
Mean Difference Test

Variable	Untreated	Treated	Difference
$\Delta R\&D$	-0.000	0.003	0.0034*
			(0.0164)
CASH	0.050	0.054	0.0034
			(0.3245)
CASH STOCK	0.058	0.058	-0.0005
			(0.8818)
CASH FLOW	0.055	0.055	0.0000
			(0.9953)
CASH (Alternative)	0.097	0.100	0.0038
			(0.3541)
DEBT	0.613	0.579	-0.0338***
			(0.0000)
Diff of DEBT	-0.022	-0.020	0.0023
			(0.3515)
LABOR	0.194	0.197	0.0032
			(0.4614)
SALES	-0.107	-0.130	-0.0231*
			(0.0317)
SOUTH	0.021	0.019	-0.0019
			(0.6620)
AGE	11,770	11,967	196
			(0.3045)
N	903	940	1843

Note: The table shows mean difference tests between treated and untreated firms for the outcome variable and a number of firm characteristics. Statistical significance is denoted as follows: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$ (p-value in brackets). See the Appendix for variable definitions.

Table 6: The Role of Cash

	(1)	(2)	(3)	(4)	(5)
DT	0.0033***	0.0034***	0.0035***	0.0040***	0.0047***
	(3.36)	(3.94)	(4.00)	(3.31)	(5.53)
DT*CASH	0.0447***	0.0628***	0.0635***	0.0827***	0.0888***
	(3.00)	(3.82)	(4.09)	(3.73)	(4.83)
CASH	0.0044	-0.0010	-0.0009	0.0060	-0.0001
	(0.37)	(-0.08)	(-0.08)	(0.38)	(-0.01)
DT*DEBT		0.0281**	0.0287**	0.0267***	0.0264***
		(2.67)	(2.80)	(2.91)	(2.90)
DEBT		-0.0074	-0.0089**	-0.0091*	-0.0087*
		(-1.66)	(-2.16)	(-2.09)	(-2.06)
DT*SALES			-0.0132*	-0.0133	-0.0133
			(-1.74)	(-1.60)	(-1.59)
SALES			0.0172***	0.0172***	0.0173***
			(2.92)	(2.96)	(2.91)
DT*DEBT*CASH				0.1362	0.2178***
				(1.50)	(3.82)
DEBT*CASH				0.0820	
				(1.03)	
Observations	1843	1843	1842	1842	1842

Note: The table shows the response of firm to the tax credit. The left-hand side variable is the change in R&D expenditure (scaled by total assets) over 2008-09. The variable DT is a dummy that equals 1 in case of assignment of the tax credit. CASH is the beginning of 2009 level of cash plus earning/loss due to extraordianry and nonrecurrent operations during 2009 (scaled by 2008 total assets). DEBT is the beginning of 2009 total debt (scaled by 2008 total assets). SALES is the growth rate of sales over 2008-09. All estimated models include a full set of dummies for region, sector, size and legal form of firms as well as firm age and total labor expenditure scaled by beginning of period total assets. Standard errors robust to spatial correlation at regional level and heteroskedasticity. Statistical significance is denoted as follows: $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 7: High-Tech Industries

	(1)	(2)	(3)
DT	-0.0007	-0.0000	-0.0018
	(-0.09)	(-0.00)	(-0.27)
CASH	0.0552	0.0563	0.0879**
	(1.63)	(1.63)	(2.52)
DEBT	0.0146	0.0166	0.0081
	(0.73)	(0.81)	(0.37)
SALES		0.0006***	0.0006***
		(6.70)	(6.31)
DEBT*CASH			0.3467**
			(2.82)
Observations	819	819	819

Note: The table shows the response of firm to the tax credit. The left-hand side variable is the change in R&D expenditure (scaled by total assets) over 2008-09. The variable DT is a dummy that equals 1 in case of assignment of the tax credit. CASH is the beginning of 2009 level of cash plus earning/loss due to extraordianry and nonrecurrent operations during 2009 (scaled by 2008 total assets). DEBT is the beginning of 2009 total debt (scaled by 2008 total assets). SALES is the growth rate of sales over 2008-09. All estimated models include a full set of dummies for region, sector, size and legal form of firms as well as firm age and total labor expenditure scaled by beginning of period total assets. Standard errors robust to spatial correlation at regional level and heteroskedasticity. Statistical significance is denoted as follows: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table 8: Further Evidence

	(1)	(2)	(3)	(4)	(5)	(6)
DT	0.0038***	0.0050***	0.0037***	0.0045***	0.0059***	0.0046***
	(2.97)	(4.49)	(3.80)	(3.75)	(6.30)	(4.59)
DT*LIQ	0.0537**	0.1088***	-0.0435**	0.0539**	0.1125***	-0.0438**
	(2.23)	(4.23)	(-2.44)	(2.27)	(4.48)	(-2.49)
LIQ	0.0011	-0.0288	0.0051	0.0017	-0.0270	0.0039
	(0.07)	(-1.48)	(0.22)	(0.11)	(-1.38)	(0.17)
DT*DEBT	0.0247**	0.0302***	0.0179*	0.0256**	0.0313***	0.0186*
	(2.66)	(3.66)	(1.77)	(2.65)	(3.76)	(1.77)
DEBT	-0.0102**	-0.0127**	-0.0096**	-0.0109**	-0.0131**	-0.0101**
	(-2.33)	(-2.52)	(-2.21)	(-2.54)	(-2.81)	(-2.40)
DT*SALES	-0.0136*	-0.0133	-0.0139*	-0.0133*	-0.0130	-0.0134*
	(-1.87)	(-1.64)	(-2.04)	(-1.89)	(-1.63)	(-2.07)
SALES	0.0172***	0.0173**	0.0171***	0.0169***	0.0170**	0.0169***
	(2.96)	(2.84)	(2.91)	(2.98)	(2.85)	(2.92)
DT*DEBT*LIQ	0.0488	0.2598***	0.1221**	0.0350	0.2522***	0.0989*
	(0.60)	(4.63)	(2.23)	(0.42)	(4.58)	(1.98)
DEBT*LIQ	0.0587	-0.0688	-0.0351	0.0695	-0.0534	-0.0375
	(0.90)	(-0.97)	(-0.62)	(1.11)	(-0.71)	(-0.73)
Lag R&D				-0.0735	-0.0787	-0.0711
				(-1.42)	(-1.43)	(-1.39)
Observations	1842	1842	1842	1842	1842	1842

Note: The table shows the response of firm to the tax credit. The left-hand side variable is the change in R&D expenditure (scaled by total assets) over 2008-09. The variable DT is a dummy that equals 1 in case of assignment of the tax credit. In columns 1 and 4 the variable LIQ is CASH STOCK; in columns 2 and 5 LIQ is the sum of CASH STOCK plus CASH FLOW; in columns 3 and 6 LIQ corresponds to the first difference of CASH. DEBT is the beginning of 2009 total debt (scaled by 2008 total assets). SALES is the growth rate of sales over 2008-09. All estimated models include a full set of dummies for region, sector, size and legal form of firms as well as firm age and total labor expenditure scaled by beginning of period total assets. Standard errors robust to spatial correlation at regional level and heteroskedasticity. Statistical significance is denoted as follows: $*p < 0.1$, $**p < 0.05$, $***p < 0.01$.

Table 9: Dropping Groups of Firms by Age

	(1)	(2)	(3)	(4)	(5)
DT	0.0047***	0.0062***	0.0042***	0.0039***	0.0037***
	(3.98)	(5.54)	(4.52)	(3.25)	(6.03)
DT*CASH	0.0994***	0.0969***	0.0849***	0.0595***	0.1006***
	(4.90)	(4.54)	(3.58)	(4.40)	(4.56)
CASH	0.0002	0.0001	-0.0104	0.0043	0.0034
	(0.02)	(0.01)	(-0.75)	(0.32)	(0.45)
DT*DEBT	0.0287**	0.0284**	0.0210*	0.0246***	0.0273***
	(2.36)	(2.53)	(1.73)	(3.02)	(3.21)
DEBT	-0.0088	-0.0088	-0.0056	-0.0076	-0.0136**
	(-1.68)	(-1.64)	(-1.31)	(-1.69)	(-2.49)
DT*DEBT*CASH	0.2499***	0.2559***	0.1725*	0.1244	0.2840***
	(3.74)	(4.55)	(2.07)	(1.70)	(2.95)
DT*SALES	-0.0133	-0.0143	-0.0123	-0.0136*	-0.0105*
	(-1.46)	(-1.61)	(-1.46)	(-1.83)	(-2.09)
SALES	0.0172**	0.0172***	0.0159***	0.0141*	0.0250***
	(2.82)	(3.05)	(2.89)	(1.82)	(8.14)
Observations	1475	1473	1473	1474	1473

Note: The table shows the response of firm to the tax credit. The left-hand side variable is the change in R&D expenditure (scaled by total assets) over 2008-09. Each column reports estimates after dropping one group of firms in turn, given the five equal frequency grouping intervals relative to the variable age. The variable DT is a dummy that equals 1 in case of assignment of the tax credit. CASH is the beginning of 2009 level of cash plus earning/loss due to extraordianry and nonrecurrent operations during 2009 (scaled by 2008 total assets). DEBT is the beginning of 2009 total debt (scaled by 2008 total assets). SALES is the growth rate of sales over 2008-09. All estimated models include a full set of dummies for region, sector, size and legal form of firms as well as firm age and total labor expenditure scaled by beginning of period total assets. Standard errors robust to spatial correlation at regional level and heteroskedasticity. Statistical significance is denoted as follows: $*p < 0.1$, $**p < 0.05$, $***p < 0.01$.

Table 10: Dropping Groups of Firms by Size

Size Dropped	<15	16-50	51-99	100-250	>250
DT	0.0030***	0.0040**	0.0051***	0.0058***	0.0053***
	(3.90)	(2.56)	(4.89)	(5.89)	(4.36)
DT*CASH	0.0779**	0.0595**	0.0817***	0.1026***	0.0972***
	(2.54)	(2.55)	(3.70)	(4.74)	(4.90)
CASH	0.0032	-0.0053	0.0037	0.0017	-0.0016
	(0.62)	(-0.34)	(0.20)	(0.13)	(-0.15)
DT*DEBT	0.0236***	0.0204*	0.0282**	0.0251**	0.0273**
	(4.28)	(1.90)	(2.50)	(2.34)	(2.50)
DEBT	-0.0064	-0.0123**	-0.0089*	-0.0057	-0.0097
	(-1.57)	(-2.23)	(-1.78)	(-1.43)	(-1.59)
DT*DEBT*CASH	0.2312**	0.0590*	0.2303***	0.2525***	0.2594***
	(2.61)	(1.90)	(3.33)	(3.75)	(7.05)
DT*SALES	-0.0046	-0.0171***	-0.0154	-0.0202***	-0.0057
	(-0.50)	(-2.97)	(-1.51)	(-3.09)	(-0.38)
SALES	0.0126***	0.0145*	0.0177**	0.0247***	0.0180**
	(3.20)	(2.01)	(2.38)	(6.24)	(2.86)
Observations	1646	1230	1494	1547	1451

Note: The table shows the response of firm to the tax credit. The left-hand side variable is the change in R&D expenditure (scaled by total assets) over 2008-09. Each column reports estimates after dropping the headline group of firms identified in terms of the average number of employees in 2009. The variable DT is a dummy that equals 1 in case of assignment of the tax credit. CASH is the beginning of 2009 level of cash plus earning/loss due to extraordianry and nonrecurrent operations during 2009 (scaled by 2008 total assets). DEBT is the beginning of 2009 total debt (scaled by 2008 total assets). SALES is the growth rate of sales over 2008-09. All estimated models include a full set of dummies for region, sector, size and legal form of firms as well as firm age and total labor expenditure scaled by beginning of period total assets. Standard errors robust to spatial correlation at regional level and heteroskedasticity. Statistical significance is denoted as follows: $*p < 0.1$, $**p < 0.05$, $***p < 0.01$.

Table 11: Treatment and Pre-treatment Years

	Treatment Year			Pre-treatment Year		
Variable	Untreated	Treated	Difference	Untreated	Treated	Difference
$\Delta R\&D$	0.000	0.003	0.0031*	-0.003	-0.004	-0.0013
			(0.0431)			(0.3679)
CASH	0.051	0.053	0.0024	0.053	0.056	0.0026
			(0.6562)			(0.6980)
CASH STOCK	0.058	0.058	-0.0000	0.065	0.063	-0.0022
			(0.9924)			(0.6725)
CASH FLOW	0.056	0.052	-0.0037	0.067	0.071	0.0039
			(0.5965)			(0.2529)
CASH (Alternative)	0.096	0.099	0.0024	0.101	0.104	0.0024
			(0.7192)			(0.6732)
DEBT	0.581	0.558	-0.0234**	0.625	0.590	-0.0347***
			(0.0095)			(0.0000)
Diff of DEBT	-0.021	-0.016	0.0046	-0.044	-0.033	0.0114*
			(0.0535)			(0.0425)
LABOR	0.190	0.190	-0.0001	0.217	0.218	0.0009
			(0.9895)			(0.8557)
SALES	-0.109	-0.148	-0.0387*	0.009	-0.033	-0.0428
			(0.0358)			(0.0903)
SOUTH	0.024	0.016	-0.0084	0.024	0.016	-0.0084
			(0.3732)			(0.3732)
AGE				12,615	12,615	0.2979
						(0.9992)
N	458	575	1033	458	575	1033

Note: The table shows results of mean difference tests between treated and untreated firms for the outcome variable and a number of firm's characteristics. The treatment year is 2009. The pre-treatment year is 2008; in this case $\Delta R\&D$ is the change over 2007-08 while CASH STOCK and DEBT refer to the beginning of 2008. Other variables are defined accordingly. P-values are reported in brackets.

Table 12: Anticipation Effect and Business Cycle

	(1)	(2)	(3)	(4)	(5)	(6)
	25-th	Mean	75-th	25-th	Mean	75-th
DT	-0.0036	0.0032***	0.0098***	-0.0031	0.0035***	0.0101***
	(-1.27)	(3.37)	(3.92)	(-1.13)	(4.74)	(4.16)
Observations	1033	1033	1033	1033	1033	1033
Estimated Elasticity		0.76	2.32		0.84	2.40

Note: First two columns report OLS estimates, last two columns report IV estimates. Results refer to our preferred specification (last column of Table 5) extended with the lagged value of the left-hand-side variable. The IV estimates are obtained using the level of R&D in 2007 as instrument. Statistical significance is denoted as follows: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$