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LIQUIDITY AND FIRMS' RESPONSE TO FISCAL STIMULUS*

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A stimulus programme allowed firms in Italy to receive tax credits for R&D expenditure in 2009. Among traditional firms, liquidity is relevant to the response to the stimulus: recipients firms with relative large cash holdings raised R&D expenditure, while those with low liquidity did not vary it. High-tech firms did not change their total R&D, consistent with their tendency to smooth R&D expenditure through time, though they changed its composition in favour of outsourcing activity and to the detriment of employment. When the fiscal stimulus pushed R&D higher, it also induced a positive transitory effect on the firm's performance.

Does countercyclical fiscal stimulus help to sustain demand? Despite its relevance, the answer to this question remains highly controversial because of the difficulty in identifying the causal link empirically. 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 (Shapiro and Slemrod, 2003; Johnson *et al.*, 2006; Agarwal *et al.*, 2007; Parker *et al.*, 2013; Jappelli and Pistaferri, 2014; Misra and Surico, 2014) and the effects of public spending shocks at national or subnational level (Barro and Redlick, 2011; Ramey, 2011; Auerbach and Gorodnichenko, 2012; Acconcia *et al.*, 2014; Nakamura and Steinsson, 2014). In this article, we contribute empirical micro-evidence to this literature by focusing instead on firms. In particular, we look at the tax credit related to R&D expenditure that the Italian government granted in 2009, just after the 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 subsidised firms. Any firm asking for the tax credit had to apply via the website of the Italian Revenue Agency starting from 10 am on the 'click day'. The selection of the treated firms would have been determined according to the chronological order in which the electronic applications arrived, given the fulfilment of an aggregate tax credit cap and without any project screening or examination of firms' characteristics. In fact, the selection process was extremely fast: almost all applications arrived to the Italian Revenue Agency soon after 10 am so that in less than a minute 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. The incentive we consider was not restricted to firms with tax liabilities in 2009. By looking at recessionary years, the restriction on profitable firms would have raised the potential concern of a selection bias affecting the estimate of the

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firm response. Arguably, these two features provide a pool of treated and untreated firms which is useful to identify the causal effect of a fiscal stimulus, by comparing the response to the stimulus of recipient firms to the behaviour of a control group composed of those firms not selected for the stimulus, though they applied for it.

We show large heterogeneity in the firm's response to the fiscal stimulus. For firms operating in traditional industries, the effect of the tax credit strongly depends on the amount of internal liquidity. Recipient firms with relative high amounts of cash increased R&D, more so if they were largely indebted, while the corresponding non-recipient ones – that is, applicant firms not assigned for the tax credit – did not change it. In particular, for firms above the median of the cash distribution, 10% tax credit induced about 20% higher R&D expenditure. This mainly determined larger demand for goods and outsourcing activity, with negligible effect on the demand for skilled workers. No effect at all of the tax credit is found, instead, among recipient firms with relatively poor amounts of cash. Arguably, these firms relied on the tax credit to mitigate the negative effect of the credit crunch on their investment.

In general, the introduction of a policy that is biased in favour of investing in a given year should affect investment only if its elasticity to 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 a 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). Indeed, among high-tech firms we did not find any effect of the tax credit on total expenditure. We noticed, however, a change in the composition of such expenditure in favour of outsourcing activity and to the detriment of skilled employees.[1]

There is recent evidence that fiscal stimulus in the form of tax rebate heterogeneously affects a household's behaviour on the basis of its available liquidity. Agarwal *et al.* (2007) show that after the 2001 stimulus in US spending rose mainly among consumers who were initially liquidity constrained. Large differences in the spending propensity of consumers because of differences in the amount of cash or the degree of indebtedness are estimated by Jappelli and Pistaferri (2014) for Italy and Shapiro and Slemrod (2009) for the US respectively. Acconcia *et al.* (2015) show that reconstruction funds after an earthquake raise non-durable consumption by households with low liquidity and bank debt but make no difference for liquid households.[2] Our results, where only traditional firms with relative high cash increased R&D after the economic stimulus, resonate with previous findings on households.

A large number of papers in corporate finance document a positive correlation between firm investment and internal funds. Interpreting it as evidence of the

[1] A positive relationship between R&D expenditure and liquidity also holds, consistent with the findings by Brown *et al.* (2009) and, previously, Himmelberg and Petersen (1994).

[2] More evidence on heterogeneity of households behaviour is reported by Gross and Souleles (2002), Mian and Sufi (2014), Misra and Surico (2014) and 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 utilisation rate limits, the authors infer the existence of liquidity constraints affecting consumer behaviour. Mian 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 behaviour.

investment sensitivity to cash is, however, difficult as cash is often correlated with omitted variables that represent the profitability of investment (Alti, 2003). Since growth perspectives were severely depressed at the time of our investigation, the finding that the investment-cash sensitivity only holds for recipient firms supports its causal interpretation. In particular, as this finding is achieved after a credit crunch, it seems natural to interpret it as due to financing constraints.[3]

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 taxation. Thus, by reducing the price of an input, the tax credit allows one to estimate the elasticity of such input with respect to its price.[4] Empirical evidence is quite mixed. Although many studies find an R&D cost elasticity around 1 or even larger, valuable contributions showing negligible effects of public subsidies are also available.[5] Our main conclusion suggests that the variety of estimates in the literature may be due, at least in part, to relevant differences in the sample compositions by type of firms and to the way the stimulus effect is identified.[6]

Cantabene *et al.* (2011) and Cantabene and Nascia (2014) have already evaluated the average effect of the 2009 R&D tax credit in Italy. 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.[7] Arguably, this difference is explained by the difference in the empirical strategy adopted. While they look at the R&D level and compare applicants and non-applicant firms, we restrict the sample to applicants only and look at the R&D change. With the former strategy the concern of biased estimate due to unobserved firms' characteristics might be quite relevant. Moreover, contrary to previous papers, we also show that liquidity is the key dimension in firms' balance sheets to maximise the response to the economic stimulus across traditional firms.[8]

[3] The standard approach to investigating the role of internal liquidity for investment consists in comparing the size of the investment-cash sensitivity for groups of firms characterised by different degrees of financing constraints. Fazzari *et al.* (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. In particular, Cleary (1999) and Moyen (2004) show that the lack of strong empirical identification is often a great concern to infer either causal interpretation. The specific criterion used to select constrained firms may drive the results in favour of one or another interpretation.

[4] Zúñiga-Vicente *et al.* (2014) and Becker (2015) provide recent systematic reviews on empirical findings related to R&D subsidies. See also Hall (1993), Hines *et al.* (1993) and Hall and Reenen (2000).

[5] Few studies are available at country level, given the specific features of the tax credit programmes across countries and over time. Bloom *et al.* (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 *et al.* (1994) for business fixed investment.

[6] With state-level data for the US, Wilson (2009) yields an elasticity greater than one which becomes however close to zero if cross-border effects are taken into account.

[7] Cantabene *et al.* (2011) instead reported no impact at all of the tax credit.

[8] With data relating to a programme implemented in northern Italy, Bronzini and Iachini (2014) stress the role of firm size in evaluating the effect of R&D subsidy: small enterprises increased investments – by approximately the amount of the subsidy received – whereas larger firms did not. Among previous studies for Italy, Bronzini *et al.* (2008) and Parisi and Sembenelli (2003) provide evidence on the average effect of subsidy on investment.

Finally, while we investigate the effect of a fiscal stimulus, the evidence provided also accords with recent results on the effects of a credit supply shock. For a sample of US firms Duchin *et al.* (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 *et al.* (2011) who suggest that credit lines eased the impact of the financial crisis on corporate spending, and Almeida *et al.* (2009) who show 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 *et al.* (2013) show that liquidity drought accounts for more than 40% drop in investments during 2007–10. Our findings 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 article is organised as follows. Section 1 presents institutional details, data and econometric strategy. Sections 2 and 3 describe, respectively, the basic results and sensitivity analysis. Section 4 looks at the type of spending stimulated by the tax credit while Section 5 shows the post-treatment performance. Section 6 concludes.

1. Empirical Strategy

According to 'Law 296 – 27 December 2006', Italian firms could apply for a volume tax credit in any year during 2007–9. The tax credit allowed 10% of the total amount of eligible R&D expenditures to be deducted from the corporate taxes – up to 50 million euro for each firm-year. The credit rate rose to 40% if R&D activity was carried out by universities and/or public research agencies on behalf of the firm. Eligibility was related 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 for the total number of firms that could be subsidised.

At the beginning of 2008, 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. Firms could no longer rely on the fiscal subsidy. At the end of 2008, however, the sudden diffusion of the 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 household consumption the government also considered the possibility of some measure in favour of firms. Since Law 296 was still in place, the R&D tax credit was restored fairly quickly. This sequence of events qualifies our study as useful to investigate the effect of an unanticipated and temporary fiscal shock.

The R&D tax credit was the unique stimulus programme introduced at that time in favour of firms. Different 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 characterised the new programme. The 'Decree 185, 29 November 2008' fixed the total amount of tax credit at 533.6 million euro. 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 Italian Revenue Agency. Firms' selection would have been realised according to the chronological order of the application arrival, given the fulfilment of the total tax credit cap. In practice, about two-thirds of total applications were rejected, allowing the pool of applicants to be split according to whether they were sorted or not for the stimulus due to the upper bound in its size. A main feature of the present study is the focus on applicants only. This is key for measuring the effect of interest accurately: arguably, applicants and non-applicants for a stimulus programme may be very different.

Information about R&D expenditure planned for 2009 at the time of the application was used to determine the group of recipients given the credit cap. The size of the subsidy received by sorted firms was related to the actual R&D expenditure realised during 2009 and was not conditional on increasing it, in respect to the past. The benefit, however, could be deferred over subsequent years, as sorted firms were allowed to carry forward any amount of the credit in excess of the 2009 tax to offset future years' taxes. Thus, any heterogeneous effect of the recession on the profitability of applicants did not affect the assignment of the tax credit.

The allocation of all funds occurred in an extremely short period of time as the aggregate cap was reached in less than one minute. The very short duration of the selection process realised on a first-come, first-served basis, without any examination of the firms' characteristics, would suggest that its outcome resembles that of random assignments. A firm which was successful and one which was not were separated by such a short period of time that the selection can be safely considered as random. Yet, since firms applied on-line we cannot exclude the possibility that applications that arrived later, missed the cutoff, and thus receiving no marginal subsidy might be related to firms with slower internet connections and/or higher costs of applying speedily. If these factors are endogenous to decisions affecting R&D expenditure then a simple comparison of treated and untreated firms would be unsatisfactory for estimating the effect of the fiscal stimulus correctly. Formal evidence reported below supports our identifying strategy. We anticipate that the allocation mechanism did not determine relevant differences between the two groups of firms in terms of their characteristics. Moreover, by relying on a data panel we are able to disentangle the stimulus effect from any firm-specific effect by looking at the change in R&D. Related to this, we provide evidence that, before the fiscal stimulus, recipient and non-recipient firms followed parallel trends.

The average effect of the tax credit is investigated through the following empirical model:

$$\Delta \mathrm{R\ \&\ D}_i = \alpha + \beta \mathrm{DT}_i + \theta X_i + \varepsilon_i, \tag{1}$$

where the left-hand side variable is the change in R&D expenditure (over 2008–9) of firm i 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 had 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.[9] The set X includes a full set of dummies taking into account differences across firms in size (number of employees), region of location, production sector (two-digit level, according to the NACE-REV2 classification), and legal form, as well as the founding date of the firms and a proxy for their production techniques, that is the total personnel costs scaled by lagged total assets.

Because of the credit crunch, we expect that the fiscal stimulus mainly affected firms with enough internal funds to increase their R&D. Thus, we investigate whether firm response to the stimulus was heterogeneous because of variations in the amount of liquidity and debt of the firms. We do so either by extending the former model with interaction terms between the identifier DT and the variables of interest or by estimating it with restricted samples of firms. The former strategy strengthens the efficiency of the estimates as it maximises the number of observations, while the latter shows more clearly whether the effect of interest is magnified for a specific group of firms.

The theory does not provide clear guidance on which measure of liquidity, either cash flow or cash stock, is to be preferred for investigating its impact on investment. For instance, Kashyap *et al.* (1994) focus on the sensitivity of investment to the cash stock available at the beginning of the year, while others focus on the sensitivity to cash flow (Fazzari *et al.*, 1988). On theoretical grounds, the effect of extra cash should be the same, independent of whether it accrues to the firm in the current period or was present in the firm at the beginning of the period (Kaplan and Zingales, 1997). From an empirical point of view, the use of cash stock might be preferred so as not to incur the risk of endogeneity bias. In the baseline specification, firm's liquidity is measured as the percentage of the sum of:

(*i*) lagged liquidity – cash, bank accounts, checks;
(*ii*) earning/loss due to extraordinary and non-recurring operations;
(*iii*) financial income and expenses; and
(*iv*) adjustments to the value of financial assets, over lagged total assets.

We show, however, that the main evidence is not driven by this specific definition.

In general, estimates of the investment–cash relationship may be biased in two different ways. Moyen (2004) explains the conflicting empirical evidence on the sensitivities of firms' investment to their internal funds, depending on whether the estimated regressions allow or not for debt. With more favourable 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, then this misspecification could spuriously magnify the relevance of internal funds (Moyen, 2004). At the same time, when the size of debt is a good indicator of credit constraint – that is, the higher the debt the stronger the constraint – then omitting it would bias the coefficient of cash downwards, if cash and debt are positively correlated. To control for the indebtedness of the firm, we use either the lagged total debt stock (scaled by lagged total assets) or its change over 2008–9. Total debt, as reported by the balance sheet, includes total bank liabilities, bonds and other current and non-current liabilities.

[9] Conditional on controls, the OLS estimator of β is the difference in the group means of ΔR&D.

When the extended version of (1) is estimated, the baseline empirical specification becomes:

$$\Delta \text{R\&D}_i = \alpha + \beta \text{DT}_i + \gamma_1 \text{CASH}_i + \gamma_2 (\text{DT} \times \text{CASH})_i + \varphi_1 \text{DEBT}_i + \varphi_2 (\text{DT} \times \text{DEBT})_i + \vartheta X_i + \eta_i, \quad (2)$$

where DT × CASH is the interaction between the measure of liquidity, CASH, and the treatment identifier DT while DT × DEBT is the interaction of the firm's debt with DT. In estimating (2) CASH and DEBT are taken as deviation from their sample average. Hence, the coefficient β identifies the effect of the tax credit evaluated at their average values whereas γ_2 and φ_2 provide evidence on the sensitivity of R&D expenditure to internal funds and debt among treated firms. Alternatively, we estimate (1) for restricted samples of firms according to values of CASH.

Inference in cross-sectional analysis can be misleading if there is spatial correlation within groups of observations. As in different contexts regarding Italy (Guiso *et al.*, 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 for treated and untreated firms. The main result also holds, however, by using not-clustered standard errors.

Finally, note that in doing the empirical analysis we often investigate traditional and high-tech firms separately, given the different theoretical predictions regarding the impact of a short-run fiscal stimulus for R&D.

1.1. *Data*

Information about the assignment of the tax credit and data on planned R&D expenditure come from the Italian Revenue Agency while actual R&D expenditure comes from the yearly R&D surveys of the Italian Institute of Statistics (ISTAT). As these surveys are mainly implemented to monitor the evolution of R&D by private firms, in each survey, the share of firms producing high-tech goods is much larger than the corresponding share in the population of Italian firms. In particular, for the years 2008 and 2009 in our period of interest, we can rely on a panel of 2,662 applicant firms. Two-thirds of all firms operate in traditional industries (see Appendix A for the formal definition of traditional and high-tech firms). For past years, R&D information is only available for a subset of these firms since the various surveys are based on rotating panels, whose degree of rotation is not constant through time. For instance, the number of applicants with R&D data available over 2007–9 drops to 1,473 as the degree of rotation was close to 50%. No information at all is available for 2005 and 2006; hence, in calculating the 2007 R&D change, we take the difference with respect to 2004.

On average, R&D expenditure of firms in the sample was about 7.5 and 7.9 percentage points of total assets in 2008 and 2009 respectively. Regarding the firm distribution across the 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% of the total sample; the latter instead of 234 firms

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**
			[0.010]
DEBT	59.5	57.9	−1.65*
			[0.045]
Observations	1,843	819	

Notes. The Table reports mean values relative to 2009 as well as differences in means across the two groups of traditional and high-tech firms. R&D is the total R&D expenditure divided by total assets (times 100). CASH is the sum of (*i*) lagged liquidity – cash, bank accounts, cheques – (*ii*) earning/loss due to extraordinary and non-recurring operations, (*iii*) financial income and expenses, (*iv*) adjustments to the value of financial assets as percentages of lagged total assets. CASH STOCK is lagged liquidity as a percentage of lagged total assets. CASH FLOW is the sum of (*i*) amortisation depreciation and write-downs, (*ii*) accruals for provisions and other accruals, (*iii*) net income as percentages of lagged total assets. DEBT is lagged value of total debt as a percentage of total assets. Total debt includes total bank liabilities, bonds, other current and non-current liabilities. Standard errors are robust to heteroscedasticity and spatial correlation at regional level. Statistical significance is denoted as follows: *p < 0.05, **p < 0.01, ***p < 0.001 (p-value in brackets).

(about 9%). By using 50 persons employed as a threshold, it follows that in 2009 firms are equally distributed between the micro-small (below the threshold) and the medium-large size (above the threshold). As expected, firms with persons employed in the range 16–49 are the most abundant, being about 33% of the total sample. Medium-size firms, that is those with 50–249 persons employed, are about 32% of the total.

Table 1 reports mean values for R&D expenditure, three measures of internal liquidity, debt and sales in 2009, as percentages 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% and 14.56%, respectively. Differences also emerge for the measures of liquidity. In particular, we notice that firms in traditional industries were characterised by lower cash stock – before the assignment of the tax credit – and cash flow. For both these variables, a standard test suggests rejecting the null hypothesis of equal means – with a very low p-value.[10] Finally, it should be noted that in terms of debt, the two groups of firms were on average very similar.

2. Basic Results

As preliminary evidence, we look at whether firms' characteristics are correlated with the outcome of the assignment procedure. The dummy identifying recipient and

[10] Note that the relative large amount of cash across high-tech firms is also reported by other authors for similar firms (Bruinshoofd and de Haan, 2005).

non-recipient firms is used as left-hand side variable in a logistic model with a large number of controls – continuous variables or dummies – on the right-hand side (see Table 2). Among all dummies considered neither those identifying the location of the firms nor those picking the type of industry are statistically significant in forecasting the outcome of the selection procedure. In particular, evidence implies that traditional firms as well as those in the south of the country were not disadvantaged by the

Table 2

Predicting the Assignment of the Fiscal Stimulus

	(1)	(2)	(3)	(4)	(5)
CASH	0.363	0.431	−0.010	−0.052	0.923
	(1.14)	(1.39)	(−0.03)	(−0.12)	(1.63)
CASH FLOW	0.406	0.178	−0.443	−1.082	1.250
	(0.85)	(0.39)	(−0.70)	(−1.55)	(1.31)
FINANCIAL ASSETS	−0.125	−0.186	−0.608	0.089	−0.748
	(−0.10)	(−0.16)	(−0.60)	(0.06)	(−0.60)
CREDITS	0.268	0.373	0.605	0.447	0.320
	(0.74)	(1.08)	(1.32)	(1.06)	(0.75)
DEBT	−0.337	−0.270	−0.359	−0.836***	0.480
	(−1.64)	(−1.40)	(−1.35)	(−4.26)	(1.33)
SALES level	0.038	0.326	0.241	0.710**	−0.040
	(0.15)	(1.41)	(1.04)	(2.98)	(−0.09)
PURCHASES	−0.166	−0.409*	−0.386	−0.752*	0.006
	(−0.89)	(−2.27)	(−1.60)	(−2.18)	(0.01)
DEPRECIATION-RISK	−0.542	−0.095	0.547	−0.084	−0.473
	(−0.41)	(−0.09)	(0.26)	(−0.06)	(−0.29)
TOTAL ASSETS	0.328	0.490	0.671	0.611*	0.061
	(1.24)	(1.90)	(1.72)	(2.36)	(0.41)
AGE	0.004	−0.001	−0.004	−0.005	0.012
	(0.55)	(−0.10)	(−0.49)	(−0.68)	(1.32)
CENTRE		0.277	0.068	0.311	0.162
		(0.26)	(0.06)	(0.28)	(0.15)
SOUTH		−0.205	−0.746	0.192	−0.639
		(−0.23)	(−0.81)	(0.20)	(−0.67)
HIGH-TECH		0.074	−0.019		
		(0.82)	(−0.18)		
Observations	2,662	2,662	1,473	1,843	819

Notes. The Table shows coefficientsestimates of logit models. The left-hand side variable is a dummy thatequals 1 in case of assignment of the tax credit. Estimates refer to 2009. CASH is the ratio of the sum of (*i*) lagged liquidity – cash, bank accounts, checks – (*ii*) earning/loss due to extraordinary and non-recurring operations, (*iii*) financial income and expenses, (*iv*) adjustments to the value of financial assets, to lagged total assets. DEBT is lagged value of the ratio of total debt to total assets. Results in column (3) are based on the lag of these varibles. CASH FLOW is the ratio of the sum of (*i*) amortisation depreciation and write-downs, (*ii*) accruals for provisions andother accruals, (*iii*) net income, to lagged total assets. SALES Level is total revenue from sales and services divided by total assets. DEPRECIATION-RISK is amortisation, depreciation and write-downs plus accruals for provisions and other accruals, divided by total assets. CREDITSis total credits divided by total assets. FINANCIAL ASSETS is total financial assets divided by total assets. PURCHASES is total purchases of raw materials and services divided by total assets. Results in columns (1), (2), (4) and (5) are based on the first lag of these varibles while results reported in column (3) are based on the second lag of the variables. CENTRE is a dummy with values equal to 1 for firms located in the centre of Italy. SOUTH is a dummy with values equal to 1 for firms located in the south of Italy. HIGH-TECH is a dummy with values equal to 1 for high-tech firms. Estimated models in columns (2)–(5) include a full set of dummies for sector (one-digit level) and legal form of the firms. Standard errors are robust to heteroscedasticity and spatial correlation at regional level. t-statistics in parentheses. Statistical significance is denoted as follows: *p < 0.05, **p < 0.01, ***p < 0.001.

procedure chosen for allocating the public funds. A statistically significant coefficient is only estimated for the dummy picking the stock companies, implying a larger share of this type of firm among the recipient ones by 13%. Regarding the balance sheet items, when the entire sample is considered there is no variable – dated either 2008 (see columns (1)–(2)) or 2007 (see column (3)) – correlated with the treatment dummy. The same conclusion applies when restricting the sample to high-tech firms (see column (5)). The unique statistically significant difference found between recipient and non-recipient firms is that relative to the debt of traditional firms (see column (4)); the size of the difference is, however, not economically relevant.

Table 3 shows evidence about the average effect of the fiscal stimulus by comparing the change in R&D expenditure of recipient and non-recipient firms. More specifically, we report results of mean-difference tests relative to 2009 – the treatment year – as well

Table 3

R&D Expenditure of Recipient and Non-recipient Firms

	(1) All firms	(2) Traditional	(3) High tech
Year 2009	0.176	0.336**	−0.221
	[0.439]	[0.013]	[0.711]
Observations	2,662	1,843	819
Year 2008	0.543	−0.131	2.150
	[0.276]	[0.345]	[0.162]
Observations	1,473	1,033	440
Year 2007	0.736	−0.059	2.379
	[0.308]	[0.691]	[0.220]
Observations	509	353	156
Year 2004	−1.882	−1.459	−1.199
	[0.565]	[0.351]	[0.895]
Observations	446	306	140
Year 2003	1.370	1.959	−0.185
	[0.170]	[0.135]	[0.869]
Observations	430	304	126
Year 2002	−0.327	−0.512	−0.558
	[0.847]	[0.818]	[0.816]
Observations	144	109	35
Year 2001	0.397	1.788	−4.949*
	[0.765]	[0.280]	[0.090]
Observations	97	77	20
Year 2000	0.798	−1.181	8.048*
	[0.495]	[0.150]	[0.077]
Observations	83	68	15
Year 1999	0.635**	0.444	1.399
	[0.018]	[0.161]	[0.167]
Observations	67	53	14

Notes. The Table shows mean-difference tests between recipients and non-recipients for R&D expenditure change. The 2007 change is calculated by taking the difference with respect to 2004, since data for 2005 and 2006 are not available. Standard errors are robust to heteroscedasticity and spatial correlation at regional level. Statistical significance is denoted as follows: *p < 0.1, **p < 0.05, ***p < 0.01 (p-value in brackets).

as to pre-treatment years since 1999 for restricted numbers of firms. Column (1) refers to all industries, while columns (2) and (3) report results for traditional and high-tech industries respectively.

Evidence for 2009 suggests that the effect of the fiscal stimulus is statistically significant for firms operating in traditional industries (see column (2)). Over 2008–9, the traditional non-recipient firms did not show any change in their expenditure while recipient ones increased it. The magnitude of the response to the financial stimulus is also 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 0.34, that is 8% 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% (Cummins *et al.*, 1994; Bloom *et al.*, 2002), our estimate implies that the R&D elasticity to its cost is −0.8, a value in the range of estimates suggested by the literature briefly reviewed in the introduction. We did not find a significant effect across high-tech firms. This is consistent with theoretical models suggesting the irrelevance of short-lived changes in R&D cost for the decision to invest by such firms (Hall and Lerner, 2010).

To explain the increase in R&D expenditure, one might argue that in the first half of 2008 very clever entrepreneurs anticipated that the government would introduce some stimulus programme in the near future and thus decided to reduce their expenditure to wait for better days.[11] The argument would also involve that these entrepreneurs (all operating in traditional industries) were also able to win the lottery of the treatment assignment. More generally, the observed increase in R&D might be due to different trends characterising the R&D paths of treated and untreated firms. Evidence on pre-treatment years is, however, clearly at odds with this argument. For all years for which we have data, the average R&D change of firms that were to be treated in 2009 is not statistically different from the corresponding value characterising untreated firms. Unfortunately, since information on the outcome variable comes from rotating panel surveys, the number of available firms falls progressively going backwards in time. However, the drop in the sample does not matter. For instance, if we repeat the mean-difference test relative to R&D change in 2009 by restricting it to firms for which we have data for 2007, the same conclusion emerges: the R&D difference between treated and untreatedfirms is confirmed – in the sub-sample of traditional industries – with a point value which is very similar to that reported in the first row of the Table. Hence, differenting trends do not undermine our investigation.

The point estimate of the average change in R&D after the fiscal stimulus is robust to controls for size, region, sector, legal form and age. Arguably, these variables are not themselves the 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 for explaining investment. Moreover, the result is also robust after controlling for the share of total expenditure for labour input over total assets, a

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

Table 4

Average Response to Fiscal Stimulus

	(1) All	(2) Traditional	(3) High tech
DT	0.212	0.346***	0.022
	(1.26)	(4.43)	(0.04)
Controls	Yes	Yes	Yes
Observations	2,662	1,843	819

Notes. The Table shows the response of the firms to the tax credit by estimating (1). The outcome variable is the change in R&D expenditure (scaled by total assets) over 2008–9. The variable DT is a dummy that equals 1 in case of assignment of the tax credit. Estimated models include a full set of dummies for region, sector (two-digit level), size and legal form of firms as well as firm founding date and total personnel costs scaled by lagged total assets. Standard errors are robust to spatial correlation at regional level and heteroscedasticity. We report t-statistics in parentheses. Statistical significance is denoted as follows: *p < 0.1, **p < 0.05, ***p < 0.01.

proxy for the capital-labour ratio of the firms. By exploiting (1) we find that estimates of the coefficient attached to the treatment dummy are virtually the same as those reported in Table 3. In particular, the estimated change in R&D expenditure during 2008–9 is 0.35 for traditional firms exactly as reported before (see Table 4, column (2)). Allowing for the controls, however, strongly affects the efficiency: the key t-statistic rises from 2.40 up to 4.43. As expected, when a treatment is randomly assigned the OLS-estimator variance of its effect in a multiple regression model is smaller than that in a single regression model, with only the treatment variable. The last column of the Table confirms that total R&D expenditure of high-tech firms does not change after the fiscal stimulus.

Information about planned R&D conditional on the tax credit allows us to construct a second test of the relevance of the fiscal stimulus. If the tax credit has been effective in stimulating R&D in 2009, then among the untreated firms we should observe actual expenditure lower than the planned one. Once having realised that it has not been selected for the tax credit, any firm should also realise that the spending planned conditional on the fiscal stimulus is higher than the optimal one. For treated firms, instead, the difference between the two variables should be insignificantly different from zero. Results of the mean-difference test, reported in Table 5, accord with these predictions. When the entire sample is considered, the t-statistic of main interest regarding the sample of non-recipients is −2.74; it is instead roughly 0 for the group of recipients (see columns (1) and (2)). The same test applied to the two sub-groups of traditional or high-tech firms makes clear that it is only across traditional firms that planned and actual expenditure of non-recipients are significantly different. In this case, the t-statistic becomes −3.77. Across high-tech firms planned expenditure is insignificantly different from the actual one for both recipient and non-recipient firms.

3. The Role of Liquidity

To assess the role of liquidity, we start by showing results of the empirical model with interactions for traditional firms. Since this specification suggests heterogeneous

Table 5

Planned Versus Actual R&D Expenditure

	(1)	(2)	(3)	(4)	(5)	(6)
	All industries		Traditional		High tech	
	Recipients	Control	Recipients	Control	Recipients	Control
Actual – planned	−0.294	−0.757**	−0.431	−0.758***	0.003	−0.753
	(−0.66)	(−2.74)	(−1.32)	(−3.77)	(0.00)	(−1.22)
Observations	1,371	1,291	940	903	431	388

Notes. The Table shows results of mean-difference tests to compare planned and actual R&D expenditure (both scaled by total assets) in 2009. Standard errors robust to spatial correlation at regional level and heteroscedasticity. We report the t-statistics in parentheses. Statistical significance is denoted as follows: *p < 0.1, **p < 0.05, ***p < 0.01.

effects of the tax credit, we further investigate the role of liquidity through a number of robustness checks and close the analysis with evidence for restricted samples. Then, we report evidence for high-tech firms.

3.1. *Traditional Firms*

Estimates of (2) show that the coefficient of CASH is negligible while that of its interaction with DT is positive and statistically different from zero across all specifications (see Table 6). In particular, when the regression model also includes the beginning of the period debt and its interaction with DT, the coefficient of DT × CASH rises from 0.045 up to 0.063 and the corresponding t-statistic up to 3.96 (see column (2)).[12] Virtually the same results hold if we allow for the growth of sales, a standard measure of firm performance, as reported in column (3).

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 that allow for the interactions between DEBT and CASH. The coefficient of the interaction is estimated positive and strongly significant for the treated, the attached t-statistic being about 4 (see the last column of the Table); it is instead insignificantly different from zero for the group of untreated firms.[13] Hence, the effect of the fiscal stimulus increases with the available liquidity of recipient firms and is strengthened by the size of the firm's debt. Moreover, note that if we substitute the DEBT variable with its change over 2008–9 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 suitable 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

[12] This finding mainly reflects the negative correlation between CASH and DEBT.

[13] A formal test, however, does not strongly reject the null hypothesis of the equality of these two coefficients (the corresponding t-statistic is 1.47).

Table 6

The Role of Liquidity

	(1)	(2)	(3)	(4)	(5)
DT	0.328***	0.336***	0.350***	0.405***	0.469***
	(4.25)	(4.73)	(4.91)	(4.07)	(6.48)
DT × CASH	0.045***	0.063***	0.064***	0.083***	0.089***
	(2.95)	(3.96)	(4.23)	(4.00)	(5.17)
CASH	0.004	−0.001	−0.001	0.006	−0.000
	(0.37)	(−0.08)	(−0.08)	(0.38)	(−0.01)
DT × DEBT		0.028***	0.029***	0.027***	0.026***
		(2.95)	(3.12)	(3.27)	(3.25)
DEBT		−0.007	−0.009**	−0.009**	−0.009*
		(−1.55)	(−2.05)	(−2.04)	(−1.99)
DT × SALES			−0.013**	−0.013**	−0.013**
			(−2.22)	(−2.14)	(−2.12)
SALES			0.017***	0.017***	0.017***
			(2.83)	(2.85)	(2.82)
DT × DEBT × CASH				0.001	0.002***
				(1.47)	(4.08)
DEBT × CASH				0.001	
				(1.07)	
Controls	Yes	Yes	Yes	Yes	Yes
Observations	1,843	1,843	1,842	1,842	1,842

Notes. The Table shows the response of the firms to the tax credit. The left-hand side variable is the change in R&D expenditure (scaled by total assets) over 2008–9. 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 firm liquidity (cash, bank accounts, cheques) plus the 2009 earning/loss due to extraordinary and non-recurring operations, financial income and expenses, adjustments to the value of financial assets, scaled by 2008 total assets. DEBT is the beginning of 2009 total debt of the firm as reported by the balance sheet scaled by 2008 total assets. SALES is the growth rate of total revenue from sales and services scaled by total assets. CASH, DEBT and SALES are considered as difference with respect the corresponding 2009 average. Estimated models include a full set of dummies for region, sector (two-digit level), size and legal form of firms as well as firm founding date and total personnel costs scaled by lagged total assets. Standard errors are robust to spatial correlation at regional level and heteroscedasticity. We report t-statistics in parentheses. Statistical significance is denoted as follows: *p < 0.1, **p < 0.05, ***p < 0.01.

produced by traditional firms might be relevant to R&D, this demand-side channel does not determine a differential behaviour between our treated and untreated firms.

Previous estimates were based on the definition of liquidity which avoids the risk of endogeneity. For completeness, we now address the potential concern that our results could be the artifact of the definition adopted. In column (1) of Table 7 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 sum to CASH values related to amortisation depreciation and write-downs, accruals for provisions and other accruals. Hence, in the latter case the new variable LIQ becomes 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 more comprehensive measure of liquidity, the investment-cash sensitivity of recipients increases in respect to the baseline specification.

If internal liquidity is indeed used for funding larger R&D expenditure we expect a negative relationship between changes in expenditure and changes in the stock of

Table 7

Further Evidence on Liquidity

	(1)	(2)	(3)	(4)	(5)	(6)
DT	0.362***	0.490***	0.361***	0.377***	0.504***	0.374***
	(3.65)	(5.16)	(4.61)	(3.91)	(5.21)	(4.75)
DT × LIQ	0.053**	0.108***	−0.041	0.054**	0.109***	−0.044
	(2.33)	(4.94)	(−1.47)	(2.53)	(5.07)	(−1.65)
LIQ	0.001	−0.029	0.003	0.001	−0.029	0.005
	(0.08)	(−1.59)	(0.10)	(0.07)	(−1.61)	(0.22)
DT × DEBT	0.024**	0.030***	0.017*	0.025***	0.030***	0.018*
	(2.70)	(3.30)	(1.78)	(2.89)	(3.55)	(1.89)
DEBT	−0.009*	−0.011**	−0.008*	−0.010**	−0.013**	−0.010**
	(−1.76)	(−2.05)	(−1.70)	(−2.28)	(−2.54)	(−2.21)
DT × SALES				−0.014**	−0.013**	−0.014**
				(−2.33)	(−2.11)	(−2.38)
SALES				0.017***	0.017***	0.017***
				(2.86)	(2.76)	(2.85)
DT × DEBT × LIQ	0.000	0.003***	0.001*	0.000	0.003***	0.001
	(0.57)	(3.55)	(1.75)	(0.65)	(3.46)	(1.65)
DEBT × LIQ	0.001	−0.001	−0.000	0.001	−0.001	−0.000
	(0.81)	(−1.19)	(−0.66)	(0.95)	(−1.07)	(−0.57)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,843	1,843	1,843	1,842	1,842	1,842

Notes. The Table shows the response of the firms to the tax credit. The left-hand side variable is the change in R&D expenditure (scaled by total assets) over 2008–9. 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 beginning of 2009 level of firm liquidity plus the 2009 earning/loss due to extraordinary and non-recurring operations, financial income and expenses, adjustments to the value of financial assets, amortisation depreciation and write-downs, accruals for provisions, and other accruals (scaled by 2008 total assets); in columns (3) and (6), LIQ is the first difference of firm liquidity divided by total assets in 2008. LIQ is considered as the difference from the 2009 average. Estimated models include a full set of dummies for region, sector (two-digit level), size and legal form of firms as well as firm founding date and total personnel costs scaled by lagged total assets. Standard errors are robust to spatial correlation at regional level and heteroscedasticity. t-statistics in parentheses. Statistical significance is denoted as follows: *p < 0.1, **p < 0.05, ***p < 0.01.

available liquidity. To investigate this, in column (3) the variable LIQ corresponds to the 2008–9 difference of firm liquidity divided by total assets in 2008. In this case, the coefficient of DT × LIQ becomes negative while the coefficient of LIQ – related to the non-recipients – remains insignificantly different from zero. Hence, the negative relationship between changes in expenditure and liquidity only holds for firms that increased R&D.

3.1.1. *Sensitivity analysis*

Our main finding holds even after controlling for firm age and size. 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 8 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 negligible. Results of a similar exercise are reported in Table 9 where we redo the estimates of our preferred specification by dropping firms according to the size identifier. Again, we do not find

Table 8

Dropping Groups of Firms by Age

	(1)	(2)	(3)	(4)	(5)
DT	0.472***	0.625***	0.416***	0.392***	0.375***
	(5.06)	(7.03)	(4.14)	(3.98)	(5.61)
DT × CASH	0.099***	0.097***	0.085***	0.060***	0.101***
	(5.20)	(4.41)	(3.65)	(2.76)	(4.18)
CASH	0.000	0.000	−0.010	0.004	0.003
	(0.02)	(0.01)	(−0.72)	(0.29)	(0.35)
DT × DEBT	0.029**	0.028***	0.021*	0.025***	0.027***
	(2.66)	(2.91)	(1.98)	(2.81)	(3.64)
DEBT	−0.009	−0.009	−0.006	−0.008	−0.014***
	(−1.62)	(−1.67)	(−1.06)	(−1.63)	(−2.85)
DT × SALES	−0.013*	−0.014**	−0.012*	−0.014*	−0.011**
	(−1.96)	(−2.20)	(−2.01)	(−1.88)	(−2.62)
SALES	0.017***	0.017***	0.016***	0.014*	0.025***
	(2.72)	(2.88)	(2.81)	(1.78)	(7.94)
DT × DEBT × CASH	0.002***	0.003***	0.002**	0.001*	0.003***
	(3.87)	(4.80)	(2.12)	(1.91)	(3.12)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	1,475	1,473	1,473	1,474	1,473

Notes. The Table shows the response of the firms to the tax credit. The left-hand side variable is the change in R&D expenditure (scaled by total assets) over 2008–9. Each column reports estimates after dropping one group of firms in turn according to the variable age. Estimated models include a full set of dummies for region, sector (two-digit level), size and legal form of firms as well as firm founding date and total personnel costs scaled by lagged total assets. t-statistics in parentheses. Statistical significance is denoted as follows: *p < 0.1, **p < 0.05, ***p < 0.01.

Table 9

Dropping Groups of Firms by Size

Size dropped	≤15	16–50	51–100	101–249	≥250
DT	0.297***	0.397***	0.507***	0.579***	0.533***
	(4.06)	(3.35)	(5.78)	(6.92)	(5.57)
DT × CASH	0.078**	0.060**	0.082***	0.103***	0.097***
	(2.71)	(2.28)	(3.51)	(5.26)	(5.09)
CASH	0.003	−0.005	0.004	0.002	−0.002
	(0.63)	(−0.31)	(0.20)	(0.13)	(−0.14)
DT × DEBT	0.024***	0.020*	0.028***	0.025***	0.027***
	(4.29)	(1.96)	(2.84)	(2.83)	(2.84)
DEBT	−0.006*	−0.012**	−0.009*	−0.006	−0.010
	(−1.76)	(−2.10)	(−1.71)	(−1.32)	(−1.60)
DT × SALES	−0.005	−0.017**	−0.015*	−0.020***	−0.006
	(−0.64)	(−2.47)	(−1.97)	(−4.06)	(−0.51)
SALES	0.013***	0.015*	0.018**	0.025***	0.018***
	(3.10)	(1.98)	(2.32)	(5.96)	(2.76)
DT × DEBT × CASH	0.002**	0.001	0.002***	0.003***	0.003***
	(2.58)	(1.38)	(3.63)	(3.94)	(8.18)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	1,646	1,230	1,494	1,547	1,451

Notes. The Table shows the response of the firms to the tax credit. The left-hand side variable is the change in R&D expenditure (scaled by total assets) over 2008–9. Each column reports estimates after dropping the headline group of firms identified in terms of the average number of employees in 2009. Estimated models include a full set of dummies for region, sector (two-digit level), size and legal form of firms as well as firm founding date and total personnel costs scaled by lagged total assets. Standard errors are robust to spatial correlation at regional level and heteroscedasticity. We report t-statistics in parentheses. Statistical significance is denoted as follows: *p < 0.1, **p < 0.05, ***p < 0.01.

Table 10

Controlling for Anticipation Effect

	(1) OLS	(2) IV	(3) OLS	(4) IV
DT	0.405***	0.355***	0.395***	0.346***
	(3.98)	(3.65)	(4.00)	(3.59)
DT × CASH	0.073***	0.068***		
	(3.67)	(2.90)		
CASH	−0.009	−0.007		
	(−0.51)	(−0.41)		
DT × CASH (alternative)			0.103***	0.101***
			(3.80)	(3.52)
CASH (alternative)			−0.047*	−0.046*
			(−1.80)	(−1.79)
DT × DEBT	0.029***	0.028***	0.035***	0.034***
	(2.77)	(2.99)	(2.78)	(2.86)
DEBT	−0.018**	−0.018**	−0.025**	−0.025**
	(−2.26)	(−2.25)	(−2.24)	(−2.25)
DT × SALES	0.002	0.002	0.002	0.002
	(0.23)	(0.24)	(0.29)	(0.30)
SALES	0.017***	0.017***	0.016***	0.016***
	(2.74)	(2.87)	(2.76)	(2.89)
DT × DEBT × CASH	0.002***	0.002***	0.002***	0.002***
	(4.32)	(4.47)	(4.63)	(4.81)
L.R&D	−0.060	−0.006	−0.058	−0.003
	(−0.78)	(−0.05)	(−0.77)	(−0.02)
Controls	Yes	Yes	Yes	Yes
Observations	1,033	1,033	1,033	1,033

Notes. The Table shows the response of the firms to the tax credit allowing for the lag of R&D expenditure. To compare OLS and IV results properly we always use the panel of firms available over 2007–9. Estimated models include a full set of dummies for region, sector (two-digit level), size and legal form of firms as well as firm founding date and total personnel costs scaled by lagged total assets. Standard errors are robust to spatial correlation at regional level and heteroscedasticity. t-statistics in parentheses. Statistical significance is denoted as follows: *p < 0.1, **p < 0.05, ***p < 0.01.

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 group of smaller firms.

It is usually suggested that smaller and younger firms should be characterised 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 note that a similar result holds among our set of firms after dropping the debt variable (results available upon request). This evidence raises the concern that a misspecification bias may drive some of the conclusions reported in the literature about the investment-cash sensitivity.

To control for inertial effect and intertemporal substitution of subsidised expenditure, we add the lagged R&D expenditure to our preferred specification. However, since the presence of this variable may induce inconsistent OLS estimates (Nickell, 1981), we also employ an IV strategy, using $R\&D_{-2}$ as an instrument for $R\&D_{-1}$. Table 10 shows that both OLS and IV estimates are qualitatively and quantitatively very similar to those reported before. The invariance of results with respect to the baseline accords with the insignificance of the estimated coefficient attached to $R\&D_{-1}$, whatever the measure of liquidity considered.

3.1.2. *Evidence for low and high liquidity firms*

Till now the role of liquidity has been investigated through estimates of interaction terms characterising (2). This approach has the advantage of maximising the number of observations, though it imposes the same coefficients for control variables across sub-groups of firms with different amounts of liquidity. The alternative is to estimate the basic model (1) with restricted samples thus allowing coefficients of controls to vary across specifications. This approach should more clearly highlight that our main conclusion is indeed driven by a specific group of firms. Figure 1 shows averages of R&D change when the sample of firms is split according to the median of the CASH distribution and the treatment identifier. Recipients with relatively high amounts of liquidity (that is, with values of CASH above the median) increased R&D by about 0.60 percentage points of total assets. The R&D change of recipients with low liquidity as well as that of the non-recipient firms – whatever the amount of liquidity – is instead very close to zero. In particular, among the four groups of firms only the R&D change of recipients with high liquidity is significantly different from zero.

More formal evidence allowing for controls is reported in Table 11. Columns (1) and (2) show that only among firms with high liquidity is R&D change estimated statistically different from zero with a point value of 0.54. Results not reported also show that, when restricting to firms in the upper quartile of the CASH distribution, the coefficient of DT rises up to 1 percentage point of total assets and remains statistically different from zero at 1%. Column (3) shows that after controlling for liquidity and debt – that is restricting the sample to the four hundred firms with relative high value of both CASH and DEBT – the coefficient of interest becomes even higher and strongly statistically different from zero (t-ratio is 6.38). This confirms that the sensitivity of R&D expenditure to cash is affected by the burden of debt. Finally, in the last two columns of the Table, we report evidence, using two different measures of the outcome variable. In column (4), the change in R&D is scaled by total

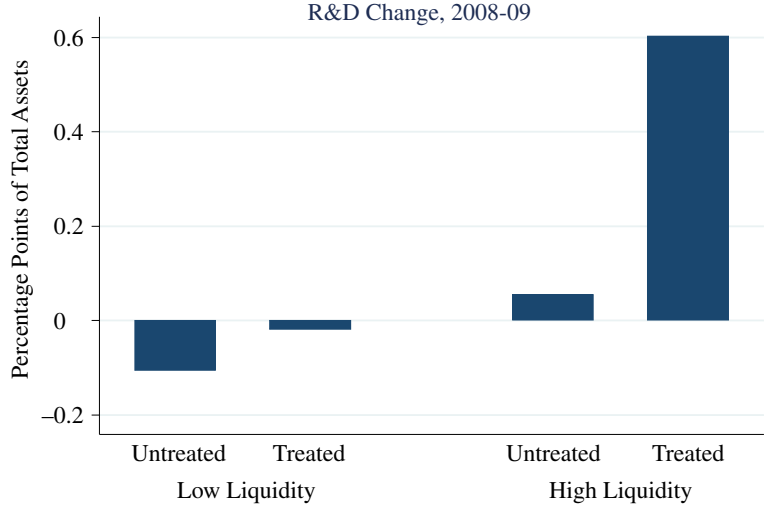

Fig. 1. *R&D Expenditure and Liquidity*

Note. Colour figure can be viewed at wileyonlinelibrary.com.

Table 11

Evidence on Restricted Samples

	(1)	(2)	(3)	(4)	(5)
DT	0.106	0.545***	1.343***	2.838***	0.197***
	(0.84)	(3.16)	(6.38)	(4.36)	(3.83)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	922	921	400	400	400
Elasticity	0.28	1.08	2.42	3.08	1.97

Notes. The Table shows the response of the firms to the tax credit by estimating (1) for the restricted sample of firms with values of CASH below (column (1)) or above (column (2)) the median, and values of CASH and DEBT roughly above the median (columns (3)–(5)). The left-hand side variable is either the change in R&D expenditure scaled by total assets (columns (1)–(3)), or the change in R&D expenditure scaled by the total number of employees in 2009 (column (4)), or the R&D proportional growth rate (column (5)). The variable DT is a dummy that equals 1 in case of assignment of the tax credit. Estimated models include a full set of dummies for region, sector (two-digit level), size and legal form of firms as well as firm founding date and total personnel costs scaled by lagged total assets. Standard errors are robust to spatial correlation at regional level and heteroscedasticity. t-statistics in parentheses. Statistical significance is denoted as follows: *p > 0.1, **p < 0.05, ***p < 0.01.

employment in 2009 while in column (5), the proportional growth rate of R&D is used: the main conclusion holds.

Table 11 also summarises our main evidence in terms of absolute value of the cost elasticity, evaluated at the sample mean of the R&D expenditure in 2008. For the high liquidity sample of firms, the elasticity is 1.08 when expenditure is scaled by total assets. It rises to 2 or even more if we further restrict the sample according to values of liquidity and debt. Similar values are obtained with the more comprehensive definition of liquidity, adding CASH, DEBT and SALES as further regressors or dropping all controls.[14]

3.2. *High-tech Firms*

As shown before, over 2008–9, average changes in R&D expenditure of treated and untreated high-tech firms were insignificantly different. If we estimate (2), the amount of liquidity does not induce differential effects of the fiscal stimulus across firms: coefficients of all interactions are not statistically different from zero at the 5% level. Therefore, to simplify the exposition, we report results without them (see Table 12). The main evidence is that in column (3), suggesting that R&D expenditure is positively correlated with cash and that the R&D-cash sensitivity increases with the size of debt.[15] This is consistent with the difficulty in raising external funds to finance investment, at least during recessionary years. Results not reported show that when the R&D expenditure is scaled by the number of persons employed, the coefficient of the treatment identifier is again estimated insignificantly different from zero. It even

[14] Note that the R&D cost elasticity is calculated assuming the 10% credit rate for the total amount of expenditure. Since this rate is actually higher for R&D activities outsourced to universities and public research agencies, the true elasticity is a bit lower.

[15] The size of the CASH coefficient is quite similar to that estimated for the treated traditional firms.

Table 12

R&D of High-tech Firms

	(1)	(2)	(3)	(4)	(5)
DT	−0.065	−0.002	−0.181	−0.147	−0.132
	(−0.12)	(−0.00)	(−0.36)	(−0.30)	(−0.13)
CASH	0.055*	0.056*	0.088**		
	(1.76)	(1.77)	(2.38)		
DEBT	0.015	0.017	0.008		
	(0.85)	(0.95)	(0.47)		
SALES		0.001***	0.001***		
		(6.63)	(6.40)		
DEBT × CASH			0.003***		
			(2.74)		
Controls	Yes	Yes	Yes	Yes	Yes
Observations	819	819	819	410	409

Notes. The Table shows the response of the firms to the tax credit. The left-hand side variable is the change in R&D expenditure (scaled by total assets) over 2008–9. In the last two columns, the sample is restricted to firms with values of CASH respectively, below and above the median for high-tech firms. Estimated models include a full set of dummies for region, sector (two-digit level), size and legal form of firms as well as firm founding date and total personnel costs scaled by lagged total assets. Standard errors are robust to spatial correlation at regional level and heteroscedasticity. t-statistics in parentheses. Statistical significance is denoted as follows: *p > 0.1, **p < 0.05, ***p < 0.01.

becomes negative when the proportional growth rate is considered. We thus conclude that a short-run fiscal stimulus is irrelevant to affecting R&D by high-tech firms.

There is some evidence that recipient high-tech firms mainly saved the tax credit. We have estimated (1) for different left-hand side variables and found that in 2009 recipient firms increased the current financial assets and the provision for risks (see columns (2) and (4) in Table 13). Adding up these two items together, there is a relative increase of roughly 1 percentage point of total assets relatively to the non-recipients.[16]

4. What Did the Firms Spend the Tax Credit on?

R&D expenditure we consider may be related to in-house or outsourcing activities. However, in 2008 all firms in the sample only realised in-house R&D, outsourcing became a valid alternative during the economic crisis as it allowed operating costs to be reduced. Not least for what concerns our investigation, the tax-credit rate for R&D projects realised together with universities and/or public research agencies rose to 40%. While total expenditure in our sample increased by 0.4 percentage points during 2008–9, a small reduction characterised the in-house expenditure, whose share fell to 85%. This is confirmed within the sub-groups of traditional and high-tech firms. In-house expenditure dropped from 4.78 to 4.63 percentage points among traditional firms and from 13.61 to 13.45 among high-tech firms.

When the two components of R&D are analysed separately, we find again that liquidity drives the response to the fiscal stimulus among the traditional firms.

[16] However, results not reported do not signal any differential variation of these balance-sheet items for the treated traditional firms, whatever the level of liquidity.

Table 13

Did High-tech Firms Save the Tax Credit?

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
DT	0.121	0.416***	−0.573	0.467***	0.350*	−0.974	1.233***
	(0.02)	(2.89)	(−1.28)	(3.14)	(1.96)	(−1.55)	(3.96)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	819	819	819	819	819	819	819

Notes. The variable DT is a dummy that equals 1 in the case of assignment of the tax credit. The left-hand side variable is: the 2008–9 percentage difference of liquidity divided by total assets in 2008 (column (1)); the 2008–9 percentage difference of the ratio of financial assets to total assets (column (2)); the 2008–9 percentage difference of the ratio of total debt to total assets (column (3)); the 2008–9 percentage difference of the ratio of the sum of amortisation, depreciation, write-downs, accruals for provisions and other accruals to total assets (column (4)); the 2008–9 percentage difference of the ratio of earning/loss due to extraordinary and non-recurring operations to total assets (column (5)); the 2008–9 percentage difference of the ratio of total purchases of raw materials and services to total assets (column (6)). In column (7) the outcome variable is the sum of outcome variables in columns (2), (4), and (5). Estimated models include a full set of dummies for region, sector (two-digit level), size and legal form of firms as well as firm founding date and total personnel costs scaled by lagged total assets. Standard errors are robust to heteroscedasticity and spatial correlation at regional level. t-statistics in parentheses. Statistical significance is denoted as follows: *p < 0.1, **p < 0.05, ***p < 0.01.

Recipient and non-recipient firms with values of CASH below the median as well as non-recipients with values of CASH above the median dropped in-house R&D by about 0.25 percentage points of total assets. Contrarily, recipient firms with high values of CASH increased it by 0.12 points. As already noticed for the total expenditure, the disctinct behaviour of recipients is strengthened if the sample is further restricted according to values of debt. In this case, the average change of in-house expenditure becomes +0.39 and −0.67 percentage points for recipients and non-recipients, respectively.

Table 14, panel (*a*) and (*b*), makes clear the relevance of liquidity across traditional firms in a more formal way.[17] Even allowing for the controls, changes of in-house and outsourcing R&D are statistically different across recipients and non-recipients only when the sample of high liquidity firms is considered. In particular, the point estimates for the recipient firms imply that about two-thirds of the total effect of the fiscal stimulus is due to more in-house R&D.

In-house expenditure is the sum of current and capital expenditure. In 2009, 46% of the total expenditure of traditional firms consisted of expenditure for skilled workers (researchers and technicians); about the same share was due to other current expenditure and roughly 8% of the total to capital expenditure. Data for these components at firm level are less reliable than the aggregate ones. This said, results by components of R&D are quite interesting. Regarding traditional firms, the impact of the tax credit becomes economically and statistically insignificant if we look at skilled workers expenditure. The entire effect estimated above for high liquidity firms is related to the rest of the in-house expenditure. Part (*c*) of Table 14 also reveals that in 2009 treated high-tech firms strongly reduced operating costs related to skilled

[17] To save on space we only report results by splitting the sample according to CASH.

Table 14

In-house and Outsourcing Activities

	(1) In-house R&D	(2) Outsourcing	(3) Skilled workers	(4) Other in-house
Part (*a*): traditional firms with high liquidity				
DT	0.331*	0.214***	−0.039	0.370***
	(2.01)	(3.15)	(−0.45)	(2.92)
Controls	Yes	Yes	Yes	Yes
Observations	921	921	921	921
Part (*b*): traditional firms with low liquidity				
DT	0.070	0.037	−0.099	0.169*
	(0.50)	(1.03)	(−1.11)	(1.75)
Controls	Yes	Yes	Yes	Yes
Observations	922	922	922	922
Part (*c*): high-tech firms				
DT	−0.690	0.712***	−0.854**	0.163
	(−1.36)	(3.91)	(−2.43)	(0.30)
Controls	Yes	Yes	Yes	Yes
Observations	819	819	819	819

Notes. Columns (1) and (2) show evidence on the effect of the fiscal stimulus on the two components of total R&D, that is in-house and outsourcing expenditure. In columns (3) and (4) evidence is reported relative to, respectively, in-house R&D expenditure for skilled workers and the rest of in-house expenditure. The outcome variable is the 2008-09 change in R&D scaled by total assets. The variable DT is a dummy that equals 1 in case of assignment of the tax credit. Estimated models include a full set of dummies for region, sector (two-digit level), size and legal form of firms as well as firm founding date and total personnel costs scaled by lagged total assets. Standard errors are robust to heteroscedasticity and spatial correlation at regional level. t-statistics in parentheses. Statistical significance is denoted as follows: *p < 0.1, **p < 0.05, ***p < 0.01.

workers – by 0.8 percentage points – and increased expenditure to finance outsourcing activities by roughly the same amount. Although we do not have information on the external partners of high-tech firms, this result is easily explained given the much higher tax-credit rate related projects realised with universities and public research agencies.

To summarise, evidence on the type of R&D expenditure confirms the role of liquidity as a driving force for the response to the economic stimulus by traditional firms and also suggests that the bulk of the overall effect was driven by higher demand for goods and services.

5. Evidence on Firm Performance after the Fiscal Stimulus

We close the empirical investigation with an assessment of whether firms that received the tax credit had better performance in the medium run, relative to the non-recipients. To investigate this issue, we distinguish between two sub-periods: the three years immediately after the fiscal stimulus (2010–2), when firms in Italy as well as in other countries experienced huge drops in sales and earnings due to the economic crises, and the period of partial recovery in the following three years (2013–5). We should expect any change in the firm performance to fade and disappear over a multi-year horizon if the fiscal stimulus only determined a transitory effect.

For almost all firms considered above we have assembled data relative to measures of returns on assets, returns on sales, and productivity over 2006–15. We adopt the following difference-in-differences regression model for panel data:

$$\Delta\text{PERFORMANCE}_{i,t} = \alpha + \gamma\text{DT}_i + \beta\text{DTPOST}_{i,t} + \theta Z_{i,t} + \varepsilon_{i,t}, \quad (3)$$

where the left-hand side variable is the firm i change in the measure of performance at time t, DT is the binary treatment variable, DTPOST has values equal to 1 for treated firms since 2010 and 0 otherwise, while Z is the label for the controls including a full set of dummies taking into account differences in location, production sector and legal form, as in the previous exercises, as well as region-specific trends to allow for differences in business cycles across regions and year-specific dummies to control for nation-wide variations in firm performance. As usual, the firm-specific fixed effect is filtered out by taking the first difference of the outcome variable. Based on the above model, we carry out two distinct exercises to compare the change in performance during 2007–9 with that during 2010–2 or 2010–5 respectively. In particular, both exercises are performed for high-tech firms and traditional firms with either low or high liquidity, as identified previously. Since only recipient firms with high liquidity increased R&D after the fiscal stimulus, this allows any effect of the fiscal stimulus as such to be disentangled from the effect driven by the larger R&D expenditure. Standard errors used to evaluate the statistical significance are now also robust to serial correlation at firm level given the multiple-year data structure. The main conclusions, however, do not depend on this choice.

Table 15 shows the results relative to the change in earnings before interest, tax, depreciation and amortisation (EBITDA) and after-tax earnings, both scaled by the book value of total assets, and returns on sales. Estimates of the coefficient attached to DT for traditional firms suggest that during the three years 2007–9 recipients and non-recipients of the tax credit performed similarly on average, irrespective of the available liquidity. Just after the fiscal stimulus the difference in performance depends, instead, on the specific sample: recipient firms with high liquidity performed clearly better than the non-recipient ones. The average difference in EBITDA between the two groups of firms is about 1 percentage point of total assets (see column (1) of panel (*a*)). The magnitude of the difference does not change by using the after-tax earnings or the return on sales as outcome variable (see columns (2) and (3)). [18] After the spike, however, before and after-tax earnings of treated firms with high cash revert to the values of the corresponding control group. The estimate of β when we compare 2007–9 with 2010–5 amounts to only half of the previous estimate (see the last three columns of panel (*a*)). Evidence not reported shows that such estimates become insignificantly different from zero when we compare 2007–9 with 2013–5.

No difference is found according to the treatment identifier across traditional firms with low liquidity and high-tech firms (see part (*b*) and (*c*) of the Table). Since for these firms, we also found unresponsiveness to the tax credit, we conclude that the fiscal stimulus affected the firm performance only if it pushed R&D expenditure higher.

[18] Unfortunately data on employment are available for a much lower number of observations. For this restricted sample, it follows that during 2010–2, recipient firms increased the earnings per employee relative to the non-recipients by about 3,000 euro.

Table 15

Firms' Performance after the Fiscal Stimulus

	(1)	(2)	(3)	(4)	(5)	(6)
	Sample 2007–12			Sample 2007–15		
	EBITDA	EARNINGS	ROS	EBITDA	EARNINGS	ROS
Part (*a*): traditional firms with high liquidity						
DTPOST	1.103***	0.996***	0.969***	0.559**	0.504**	0.608*
	(3.70)	(3.33)	(2.76)	(2.35)	(2.01)	(1.93)
DT	−0.265	−0.240	−0.301	−0.254	−0.209	−0.309
	(−1.24)	(−1.30)	(−1.10)	(−1.27)	(−1.24)	(−0.91)
Observations	5,242	5,242	5,103	7,704	7,703	7,457
Part (*b*): traditional firms with low liquidity						
DTPOST	−0.113	−0.0486	0.276	−0.139	−0.133	0.233
	(−0.23)	(−0.06)	(0.88)	(−0.38)	(−0.25)	(0.89)
DT	−0.172	−0.155	−0.257	−0.239	−0.234	−0.264*
	(−0.60)	(−0.57)	(−1.37)	(−0.99)	(−0.77)	(−1.68)
Observations	4,988	4,988	4,892	7,289	7,289	7,078
Part (*c*): high-tech firms						
DTPOST	0.649	2.844	1.049**	−0.0460	0.481	0.528
	(1.07)	(0.99)	(2.08)	(−0.10)	(0.23)	(1.30)
DT	−0.0979	0.125	−0.522	−0.0587	0.0795	−0.473
	(−0.28)	(0.21)	(−1.52)	(−0.17)	(0.13)	(−1.62)
Observations	4,504	4,504	4,236	6,591	6,591	6,152

Notes. The variable DT is a dummy that equals 1 in case of assignment of the tax credit in 2009; DTPOST is a dummy that equals 1 during 2010–5 if DT equals 1. EBITDA is the first difference of earnings before interests, taxes, depreciation and amortisation divided by total assets (as a percentage); ROS is first difference of returns on sales, that is earnings before interests and taxes divided by total revenues (as a percentage) EARNINGS is first difference of earnings after taxes divided by total assets (as a percentage). All specifications include the founding date, a full set of dummies for region, sector, calendar year, and legal form of the firms and region-specific trends. Standard errors are robust to heteroscedasticity and two-way correlation, allowing for spatial correlation at regional level as well as time correlation at firm level. The panel is unbalanced because of missing observations. Firms with low (below the median) and high (above the median) liquidity are identified according to the 2009 values of CASH for traditional firms. t-statistics in parentheses. Statistical significance is denoted as follows: *p > 0.1, **p < 0.05, ***p < 0.01.

6. Conclusions

The widespread resort to fiscal stimulus at the onset of the recent crisis has provided new evidence at the household level on whether countercyclical fiscal policy matters. We contribute complementary evidence at the firm level by investigating the effect of the R&D tax credit supplied to Italian firms in 2009. Among traditional firms, liquidity is found to be the key dimension to identify who is affected by the economic stimulus. Recipients firms with relative large cash holdings raised R&D expenditure quite a lot, even more if they were heavily indebted. In particular, the economic stimulus led to larger expenditure unrelated to the hiring of skilled workers. Recipients with small amounts of cash instead behaved like the corresponding group of non-recipient firms. High-tech firms changed the composition of total R&D expenditure in favour of outsourcing activity and to the detriment of employment. In line with their tendency to smooth R&D through time, we did not find, however, differences between recipients

and non-recipients regarding the total amount of spending. Finally, we found that when the tax credit pushed more R&D it also induced a strong transitory effect on the firm performance.

It is of course rather difficult to provide a general equilibrium scrutiny of the attempt to stimulate R&D. A simple back of the envelope calculation may, however, be useful for a broad assessment. The main direct cost of the tax credit we analysed consists in the corresponding drop in the tax revenue by half a billion euro. Since at that time, high-tech firms counted for less than 2% of the total number of firms in Italy and R&D outsourcing expenditure was 15% of the total, the average elasticity of 1, estimated for traditional firms, implies more R&D expenditure in 2009 by a bit less than half a billion euro. If the higher R&D in 2009 also induced some increase in R&D in the following years we may conclude that by reducing the tax revenue by one euro the government encouraged more R&D by roughly the same amount.

Some may argue that an economic stimulus for R&D did not drive larger expenditure among high-tech firms. The public policy we studied is a short-term subsidy supplied in bad times. 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 also explains why we found a strong role for liquidity, which is absent in related studies on the relationship between R&D and its price.

Appendix A. Data Description

In the following, we report the definitions of the main variables used in the econometric models. For more details, see the online Appendix B.

ΔR&D: change over 2008–9 of the ratio (times 100) between total R&D expenditure and total assets. Total R&D expenditure consists of expenditure related to activities realised employing firm's personnel and equipment (in-house expenditure), plus expenditure realised by other firms, universities or public research agencies (outsourcing).

CASH: ratio (times 100) between the sum of:

(*i*) 2008 liquidity – cash, bank accounts, checks;
(*ii*) 2009 earning/loss due to extraordinary and non-recurring operations;
(*iii*) 2009 financial income and expenses; and
(*iv*) 2009 adjustments to the value of financial assets, and 2008 total assets.

DEBT: the 2008 value of the ratio (times 100) between total debt and total assets. Total debt includes total bank liabilities, bonds, other current and non-current liabilities.

SALES: percentage growth over 2008–9 of total revenue from sales and services (scaled by contemporaneous total assets).

EBITDA: first difference of earnings before interests, taxes, depreciation and amortisation divided by total assets (times 100).

ROS: first difference of earnings before interests and taxes divided by total revenues (times 100).

EARNINGS: first difference of earnings after taxes divided by total assets (times 100).

DT: Dummy equals to 1 for recipients of the tax credit in 2009.

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Additional Supporting Information may be found in the online version of this article:

Appendix B. Data Descriptions.
Data S1.

References

Acconcia, A., Corsetti, G. and Simonelli, S. (2014). 'Mafia and public spending: evidence on the fiscal multiplier from a quasi-experiment', *American Economic Review*, vol. 104(7), pp. 2185–209.
Acconcia, A., Corsetti, G. and Simonelli, S. (2015). 'The consumption response to liquidity-enhancing transfers: Evidence from italian earthquakes', CEPR discussion paper 10698.
Agarwal, S., Liu, C. and Souleles, N.S. (2007). 'The reaction of consumer spending and debt to tax rebates-evidence from consumer credit data', *Journal of Political Economy*, vol. 115(6), pp. 986–1019.
Almeida, H., Campello, M., Laranjeira, B. and Weisbenner, S. (2009). 'Corporate debt maturity and the real effects of the 2007 credit crisis', National Bureau of Economic Research. https://doi.org/10.3386/w14990 (last accessed: 14 May 2017).
Alti, A. (2003). 'How sensitive is investment to cash flow when financing is frictionless?', *Journal of Finance*, vol. 58(2), pp. 707–22.
Auerbach, A.J. and Gorodnichenko, Y. (2012). 'Measuring the output responses to fiscal policy', *American Economic Journal: Economic Policy*, vol. 4(2), pp. 1–27.
Auerbach, A.J. and Hines, J. (1988). 'Investment tax incentives and frequent tax reforms', *American Economic Review*, vol. 78(2), pp. 211–16.
Barro, R.J. and Redlick, C.J. (2011). 'Macroeconomic effects from government purchases and taxes', *Quarterly Journal of Economics*, vol. 126(1), pp. 51–102.
Becker, B. (2015). 'Public R&D policies and private R&D investment: a survey of the empirical evidence', *Journal of Economic Surveys*, vol. 29(5), pp. 917–42.
Bloom, N., Griffith, R. and Van Reenen, J. (2002). 'Do R&D tax credits work? Evidence from a panel of countries 1979–1997', *Journal of Public Economics*, vol. 85(1), pp. 1–31.
Bronzini, R., de Blasio, G., Pellegrini, G. and Scognamiglio, A. (2008). 'The effect of investment tax credit: evidence from an atypical programme in Italy', Bank of Italy, Economic Research and International Relations Area.
Bronzini, R. and Iachini, E. (2014). 'Are incentives for R&D effective? Evidence from a regression discontinuity approach', *American Economic Journal: Economic Policy*, vol. 6(4), pp. 100–34.
Brown, J.R., Fazzari, S.M. and Petersen, B.C. (2009). 'Financing innovation and growth: cash flow, external equity, and the 1990s R&D boom', *Journal of Finance*, vol. 64(1), pp. 151–85.
Bruinshoofd, A. and de Haan, L. (2005). *Financing the New Economy: Are ICT Firms Really that Different?* Amsterdam: De Nederlandsche Bank.
Campello, M., Giambona, E., Graham, J.R. and Harvey, C.R. (2011). 'Liquidity management and corporate investment during a financial crisis', *Review of Financial Studies*, vol. 24(6), pp. 1944–79.
Cantabene, C. and Nascia, L. (2014). 'The race for R&D subsidies: evaluating the effectiveness of tax credits in italy', *Economia e Politica Industriale*, vol. 41(3), pp. 133–58.
Cantabene, C., Nascia, L. and Perani, G. (2011). 'Valutazione degli effetti di politiche di sostegno alla spesa per r&s delle imprese: il caso del credito di imposta per r&s in Italia, 2007–2009', Presented at the conference 'Analisi dei dati di impresa per la conoscenza del sistema produttivo italiano: il ruolo della statistica ufficiale'. http://www.istat.it/it/files/2011/11/presentazione_Cantabene_Nascia_Perani.pdf (last accessed: 14 May 2017).
Cingano, F., Manaresi, F. and Sette, E. (2013). 'Does credit crunch investments down? New evidence on the real effects of the bank-lending channel', Money and Finance Research group (Mo.Fi.R.) – University Politecnica Marche – Department of Economic and Social Sciences.
Cleary, S. (1999). 'The relationship between firm investment and financial status', *Journal of Finance*, vol. 54 (2), pp. 673–92.
Cummins, J.G., Hassett, K.A. and Hubbard, R.G. (1994). 'A reconsideration of investment behavior using tax reforms as natural experiments', *Brookings Papers on Economic Activity*, vol. 25(2), pp. 1–74.
Duchin, R., Ozbas, O. and Sensoy, B.A. (2010). 'Costly external finance, corporate investment, and the subprime mortgage credit crisis', *Journal of Financial Economics*, vol. 97(3), pp. 418–435.
Fazzari, S.M., Hubbard, R.G. and Petersen, B. (1988). 'Financing constraints and corporate investment', *Brookings Papers on Economic Activity*, vol. 1988(1), pp. 141–95.
Gross, D.B. and Souleles, N.S. (2002). 'Do liquidity constraints and interest rates matter for consumer behavior? Evidence from credit card data', *Quarterly Journal of Economics, MIT Press*, vol. 117(1), pp. 149–85.

Guiso, L., Sapienza, P. and Zingales, L. (2004). 'Does local financial development matter?', *Quarterly Journal of Economics*, vol. 119(3), pp. 929–69.
Hadlock, C.J. and Pierce, J.R. (2010). 'New evidence on measuring financial constraints: moving beyond the KZ index', *Review of Financial Studies*, vol. 23(5), pp. 1909–40.
Hall, B.H. (1993). 'R&D tax policy during the 1980s: success or failure?', *Tax Policy and the Economy*, vol. 7, pp. 1–36.
Hall, B.H. and Lerner, J. (2010). 'The financing of R&D and innovation', in (b. Hall and N. Roseberg, eds.), *Handbook of the Economics of Innovation*, vol. 1, pp. 609–39, Amsterdam: Elsevier.
Hall, B. and Reenen, J.V. (2000). 'How effective are fiscal incentives for R&D? A review of the evidence', *Research Policy*, vol. 29(45), pp. 449–69.
Himmelberg, C.P. and Petersen, B.C. (1994). 'R&D and internal finance: a panel study of small firms in high-tech industries', *Review of Economics and Statistics*, vol. 76(1), pp. 38–51.
Hines, J., Hubbard, R.G. and Slemrod, J. (1993). 'On the sensitivity of R&D to delicate tax changes: the behavior of us multinationals in the 1980s', in (A. Giovannini, R.G. Hubbard and J. Slemrod, eds.), *Studies in International Taxation*, pp. 149–94, Chicago, IL: University of Chicago Press.
Jappelli, T. and Pistaferri, L. (2014). 'Fiscal policy and MPC heterogeneity', *American Economic Journal: Macroeconomics*, vol. 6(4), pp. 107–36.
Johnson, D.S., Parker, J.A. and Souleles, N.S. (2006). 'Household expenditure and the income tax rebates of 2001', *American Economic Review*, vol. 96(5), pp. 1589–610.
Kaplan, S.N. and Zingales, L. (1997). 'Do investment-cash flow sensitivities provide useful measures of financing constraints', *Quarterly Journal of Economics*, vol. 112(1), pp. 169–215.
Kashyap, A.K., Lamont, O.A. and Stein, J.C. (1994). 'Credit conditions and the cyclical behavior of inventories', *Quarterly Journal of Economics*, vol. 109(3), pp. 565–92.
Mian, A. and Sufi, A. (2014). 'House price gains and US household spending from 2002 to 2006', Working Paper, National Bureau of Economic Research.
Misra, K. and Surico, P. (2014). 'Consumption, income changes, and heterogeneity: evidence from two fiscal stimulus programs', *American Economic Journa: Macroeconomics*, vol. 6(4), pp. 84–106.
Moyen, N. (2004). 'Investment-cash flow sensitivities: constrained versus unconstrained firms', *Journal of Finance*, vol. 59(5), pp. 2061–92.
Nakamura, E. and Steinsson, J. (2014). 'Fiscal stimulus in a monetary union: evidence from US regions', *American Economic Review*, vol. 104(3), pp. 753–92. https://doi.org/10.1257/aer.104.3.753 (last accessed: 14 May 2017).
Nickell, S. (1981). 'Biases in dynamic models with fixed effects', *Econometrica*, vol. 49(6), pp. 1417–26.
Parisi, M. and Sembenelli, A. (2003). 'Is private R&D spending sensitive to its price? Empirical evidence on panel data for Italy', *Empirica*, vol. 30(4), pp. 357–77.
Parker, J.A., Souleles, N.S., Johnson, D.S. and McClelland, R. (2013). 'Consumer spending and the economic stimulus payments of 2008', *American Economic Review*, vol. 103(6), pp. 2530–53.
Ramey, V.A. (2011). 'Can government purchases stimulate the economy?', *Journal of Economic Literature*, vol. 49(3), pp. 673–85.
Shapiro, M.D. and Slemrod, J. (2003). 'Consumer response to tax rebates', *American Economic Review*, vol. 93 (1), pp. 381–96.
Shapiro, M.D. and Slemrod, J. (2009). 'Did the 2008 tax rebates stimulate spending?', *American Economic Review*, vol. 99(2), pp. 374–79.
Surico, P. and Trezzi, R. (2015). 'Consumer spending and property taxes: evidence from the 2011 Italian imu', mimeo. Finance and Economics Discussion Series 2015–57, Board of Governors of the Federal Reserve System (U.S.).
Wilson, D.J. (2009). 'Beggar thy neighbor? The in-state, out-of-state, and aggregate effects of R&D tax credits', *Review of Economics and Statistics*, vol. 91(2), pp. 431–6.
Zúñiga-Vicente, J.Á., Alonso-Borrego, C., Forcadell, F.J. and Galán, J.I. (2014). 'Assessing the effect of public subsidies on firm R&D investment: a survey', *Journal of Economic Surveys*, vol. 28(1), pp. 36–67.