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The Evaluation of the Effectiveness of Tax Expenditures: a Novel Approach

An application to the regional tax incentives for business investment in Italy

by

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ABSTRACT

This study evaluates the regional tax incentives for business investment in Italy and addresses the following questions: (i) how much additional investment was stimulated by the government intervention; (ii) has the public financing displaced (part of) the private financing; (iii) to what extent would the outcomes on firm performance have not been achieved without the public support? The methodology consists of applying the matching approach in order to select a sample of firms composed of both recipients and non-recipients such that for each subsidised firm a comparable unsubsidised counterpart is found, which is similar in every respect except for the tax benefit. An empirical model of firm's investment behavior has then been estimated in order to obtain the tax-price elasticity and to test the sensitivity of investment decisions to the availability of internal funds by taking into account the dynamic structure underlying capital accumulation. This new approach to evaluate tax expenditures allows us to deal with the problem of the endogeneity of firms' participation decisions as well as to account for the different channels through which tax incentives operate. Finally, the impact of the investment tax credit on TFP levels is identified by modelling the productivity dynamics at the firm level.

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EXECUTIVE SUMMARY

In many OECD countries including Italy, investment incentive schemes traditionally represent the main policy tool targeted to equalising economic opportunities in different regions. The report offers a contribution to the debate on whether such provisions are economically justified. We use a particularly rich micro dataset on regional tax incentives for business investments in Italy to address the following questions: How are public funds allocated among firms? How much additional investment was stimulated by the government intervention? Or does public financing displace private financing? To what extent would the outcomes (*i.e*. total factor productivity) have not been achieved without public support?

To answer the first question above we explore how allocation outcomes are related to some observed firm characteristics and whether the regional tax incentive alleviates obstacles to firm's growth. As for the second issue, the methodology consists of applying the matching approach in order to select a sample of firms composed by both recipients and non-recipients such that for each subsidised firm a comparable unsubsidised counterpart is found, which is similar in every respect except for the tax benefit. We then estimate an empirical model of firm's investment decisions with the aim of recovering the tax-price elasticity and testing the sensitivity of investment decisions to the availability of internal funds by taking the dynamic structure underlying capital accumulation into account. The third question is tackled by analyzing the determinants of productivity dynamics at the firm level.

The report highlights the benefits of the intervention scheme examined here, but also its limits in achieving policy objectives. The distributional effects of providing a tax-based incentive that is easy to claim for the recipient as it can be deducted from all tax and social security liabilities, are positive in that many categories of firms were reached by this provision. These included SMEs and credit-constrained firms that would have certainly encountered higher hurdles in accessing external funds in the counterfactual situation of no public support. Nonetheless, the program does not exactly correspond to a payable tax credit. This paper shows that, a large share of the credit accrued was carried forward each year by a large number of firms. The effective incentive effect for firms that did not have enough tax and social security liabilities to benefit from the full value of the tax credit was somewhat lower, on the order of an average of 4.4 percent, relative to the aid intensities set by law. Our results also show that the efficacy of the provision in distributional terms depends on the total spending. After the program was downsized in the second half of year 2002, the more

needy categories of firms were less likely to receive the public support than in the early intervention period. This suggests that a large amount of resources provided through the tax system were absorbed by firms that claimed the credit as an additional source of finance available for investments.

Firms' response to policy intervention aimed at reducing the marginal cost of capital is likely to be quite substantial. Our findings imply that a 10 per cent reduction in the user cost is expected to stimulate additional investment spending by as much as 8.6 per cent. However, this is not the full effect because of the income effects induced by financing constraints. For credit-rationed firms, the resulting increase in cash flow could induce a further rise in investment outlays over and above the pure substitution effect. In this respect, our results show that the public support was quite effective in reducing the investment sensitivity to the availability of internal funds for credit-constrained firms.

On the other hand, if the provision had been permanent instead of temporary the responsiveness of companies would probably have been much lower. The investment elasticity to changes in the other components of the user cost of capital (not subject to temporal deadline) is in fact equal to -0.47. Temporary investment incentives can have a larger short-run impact on investment than permanent investment incentives by encouraging inter-temporal substitution effects. In the present context, the tax credit on lagged areas was suddenly introduced at the end of year 2000, thereby the delay in investment spending is likely to be meaningless. However, investments could have been anticipated prior to the expiration of the provision, probably from when the budgetary restrictions were abruptly imposed during the second intervention year. More generally, our findings suggest that substitution possibilities incorporated into production technologies are limited; hence investment incentives have a narrow impact on the long run capital accumulation.

On the issue of output additionality, our results show that attaining the tax bonus has had differential impacts across different categories of firms. The fiscal incentive raised productivity growth at a significant rate in low-productivity firms, whereas only a small productivity improvement is observed for subsidized companies which were already near the leaders in productivity. Given that the intervention in lagged areas was motivated by the presence of significant gaps in infrastructure and in social economic conditions with the rest of the country, we argue that the provision results in a quite insufficient support for firms to compete in outside markets. Finally, by computing the benefit generated by the intervention, measured as the resulting increase in the production level, we find that this amount does not actually outweigh the budget resources allocated over

the observation period. Admittedly, this measure should be taken with caution. As a matter of fact, the number of post-intervention years available in our data set is limited.

INTRODUCTION

Tax expenditures are defined as revenue decreases due to preferential tax provisions for example special exemptions, exclusions, allowances, deductions, credits, deferrals, reduced tax rates or other forms of tax offsets, that shield certain taxpayers from exposure to prevailing tax rules. Such provisions are policy tools analogous to government outlays, hence the term 'tax expenditures' (henceforth TE). TE are a common channel for financing public policies that may parallel direct expenditures in the support of a broad range of activities, from social welfare to environmental and industrial policy objectives.

The main advantages of TE are the greater flexibility in operative terms which results in a faster provision of resources to beneficiaries, and the absence of government interference with the choice of projects. The literature acknowledges that tax expenditure programs may be more effective than direct subsidies in stimulating individual behavior to accomplish policy objectives. The implementation of discretionary mechanisms is more complex due to the need of a lot of information to select agents and projects. Also, they involve more government bureaucracy that may undermine the certainty about times and ways of receiving the funds by applicants. In turn this implies that TE are more *cost-efficient* than direct expenditures since they involve lower administrative costs.

In practice the political cost for a government that decides on a tax provision is lower than a corresponding direct spending program since it falls outside the budgetary framework. Therefore, the cost of TE is largely hidden and subject to less bureaucratic control than direct spending programs to the detriment of the transparency of the tax system. Unlike direct outlays that may require an annual appropriation, the setting of a ceiling and are subject to scrutiny, most TE are open-ended authorized or blurred within the tax structure, while the effective cost in terms of revenue losses is included in the budget law at most for the first year, and their effectiveness has rarely been evaluated.

Starting from Surrey's seminal work (1967) that emphasized the importance of taking into account the amount of government spending through the tax system on the growth of public spending, many OECD countries produce annual TE reports to assess the magnitudes of revenue forgone. This can make an important contribution to transparency and convey important information about the government's fiscal activity. However, only a few countries include TE in the budget ceiling for spending, analyse the possible effects of individual tax expenditure programs on future revenue or examine their impact in terms of equity and efficiency.

Most criticisms of tax provisions concern in fact distributional effects and efficiency issues. For instance, it is often recognized that TE tend to benefit the wealthier while direct expenditures tend to benefit the poorer. In particular, consider non-refundable tax credit schemes, which many governments have applied: for those taxpayers that are tax-exhausted it is not possible to take advantage of them; therefore the more needy agents are excluded. For those who benefit, the amount of tax saving usually increases with the amount of the tax base. It follows that a tax relief which is introduced to stimulate an activity temporarily and then, as often happens, becomes a structural component of the tax system may alter the redistributive design of the system itself. The unfair allocation of the benefit to higher-income persons may reduce the level of progressiveness of the tax structure as defined by the statutory tax rate schedule. This is the case for example for TE in the form of exclusions or deductions from the tax base. Analogously, tax provisions that are targeted to a limited group of beneficiaries may violate the principle of horizontal equity, if taxpayers with similar incomes face different tax liabilities depending on whether they benefit from the tax relief. On the other hand, in the presence of differences in needs, or better in the contributing capacity among taxpayers the use of TE may restore the principle of horizontal equity. However, many TE are often a response to various interest groups rather than to actual needs. Therefore, the tax system can result in a wide range of effective tax rates even within the same income class. This implies a substantial unfair treatment of equal individuals and also a loss of efficiency by altering market signals. In addition, what if the tax incentive were not effective to influence individuals' behaviour? Or what if the targeted taxpayers would have taken the same decisions even in absence of the provision?

It is clear that the tightening of the tax base implies higher nominal tax rates in order to raise a given amount of tax revenue with relevant consequences in terms of tax competition among countries. With public debt rising rapidly in most OECD countries, the interest to adopt specific base broadening policies is likely to increase.

The objective of investigating base broadening opportunities in OECD countries that might allow a reduction in statutory tax rates and may improve the efficiency of the economy and/or the distribution of after-tax income underlies the WP2's tax policy project 'the choice between base broadening and tax incentives'. The report aims at contributing to WP2's programme of work by focusing on the effectiveness analysis of selected tax expenditures that are designed to sustain firm's investment. The report discusses the choice of a proper evaluation strategy and provides an application of the proposed

approach to the assessment of a regional tax credit for business investment in Italy.

Chapter 1 of the paper discusses evaluation issues and methods, reviews the empirical evidence on the effectiveness of fiscal incentives, and illustrates the proposed evaluation approach of selected tax expenditures that are designed to modify investment behaviour of firms.

Chapter 2 of the paper describes the structure of the incentive programme for investment in disadvantaged areas introduced in Italy by Law 388/00 in 2001, and focuses on the determinants of the demand for public support. The analysis is based on a particularly rich database obtained by integrating different data sources, comprising confidential corporate tax return data which includes variables from the regional tax incentive, company accounts, the administrative register of firms, information on national business groups, as well as information from the administration of other incentive programmes targeted to the same areas.

Chapter 3 deals with the analysis of the impact of the regional tax credit on firms investment's decisions. The methodology consists of applying the matching approach in order to select a sample of firms composed by both recipients and non-recipients such that for each subsidised firm a comparable unsubsidised counterpart is found, similar in every respect except for the tax benefit. Then, an empirical model of firm’s investment decisions is estimanted in order to infer the tax-price elasticity and test the sensitivity of investment responses to the availability of internal funds by taking into account the dynamic structure underlying capital accumulation.

Lastly, Chapter 4 of the paper investigates the effects of the provision on production and productivity. A measure of output additionality is obtained through the estimation of a dynamic behavioural model of the TFP growth at the firm-level.

1 EVALUATING THE EFFECTIVENESS OF SELECTED TAX EXPENDITURES

This chapter provides a general framework for the evaluation of tax expenditures that are designed to modify investment behaviour of firms. Examples of this category of tax expenditures are favourable tax treatments which results in reductions in tax liabilities for certain subsets of taxpayers and/or investment outlays, like R&D tax credits or accelerated depreciation allowances for investments in machinery, equipment and buildings, tax incentives targeted to specific groups of firms (*e.g.* SMEs) or lagged territorial areas, and any other tax treatment that makes the after-tax cost of the investment considerably lower than other forms of investment.

Different empirical methods have different advantages and limitations in relation to the diverse issues that can be raised in evaluating these specific policy tools. In order to overcome this problem, we suggest a more comprehensive approach on the effectiveness evaluation of tax-based subsidies, one that is based on the use of a combination of evaluation methods. Section 1.1 presents an extended list of issues that should be considered in the evaluation of the effects of selected tax expenditure. Section 1.2 focuses on the main methodological approaches developed in the evaluation literature and introduces the proposed approach. Section 1.3 undertakes a survey of the existing literature on the effectiveness of fiscal incentives. Finally, section 1.4 outlines the research carried out in this study.

1.1 Evaluation Issues

The questions that an evaluation study should answer concern the success of the policy with regard to the policy objectives and the effects on the behaviour of beneficiary firms. A first question to investigate is how resources are allocated among firms, and to analyze whether the resulting outcomes are consistent with the policy goals. Tax incentives, even those deemed as simplifying the access to the provision may create additional complexity and add to compliance and tax administration costs. In particular, in order for firms to claim tax deductions a full record of revenues and costs would normally be required. Assembling and verifying this data may be difficult and time consuming. Consider, for example, a provision targeted to sustain firms that are likely to face market imperfections in financing their R&D activities. The presence of complexity in the access to the provision may discourage the

participation of small firms which also encounter higher hurdles relative to large firms in accessing external funds. On the other hand, targeted tax relief may create unintended scope for tax-planning and benefit non-targeted taxpayer groups. Testing specific hypotheses about the firms` participation status (*e.g*. firm size and financial structure) can shed light on the existence of unexpected barriers in reaching the desired population of firms.

Another set of questions concern the assessment of *additionality*: How much additional input was stimulated by the government intervention, or does public financing displaces private financing (*input additionality*)? To what extant outputs (e.g., revenues, profits, market share, patents, products & services) would not have been achieved without public support (*output additionality*)? Do temporary incentives affect individual behaviour even after the grants have expired? Does public financing significantly modify firm behaviour and strategy (e.g., type of research, degree of collaboration, and management of innovation processes - *behavioural additionality*)?

The main objective of any tax-based investment incentive is to stimulate private investment by reducing the effective price of capital goods. Input additionality is thus a central question. In particular, the empirical analysis should measure for every euro of tax cut to what extent the firm invest in the targeted activities over and above the level of investment that would have been realized without the scheme. Firms' response to the government intervention crucially depends on the investment demand elasticity to tax-price changes. If such response were low it would take a large fiscal relief to produce a significant impact. Investment displacement may occur if input prices significantly increase as a consequence of the implementation of the policy.[1] In addition, tax breaks may operate through an income effect, the so called cash flow effect. The tax benefit reduces the tax liability of the firms: the increase in the after tax income is then available for additional capital investment but it can also be used in non-equipment activities, for instance raising dividends, marketing expenditures or replace more conventional sources of investment funds. Yet, it is conceivable that a consistent tax refund would alleviate financial constraints for firms that are more dependent on external finance. One economic justification for subsidized funding to SMEs, especially to innovative

1 For example, when the number of firms receiving the tax-subsidy is significant compared to the total and the input supply curve is inelastic, the input prices may increase thus lowering the rates of return from the investment and vanishing the effect of the public support (see David and Hall, 1999). Among the few studies that explore the link between investment tax policy and capital-goods prices, Goolsbee (1998) finds that investment incentives lead to immediate increases in the prices of capital in the United States. On the other hand, Hasset and Hubbard (1998) provide evidence suggesting that investment incentives are not dissipated in changes in capital-goods prices in most industrialized countries, including the United States.

SMEs, is rooted in the belief that some form of capital market imperfections exists that may inhibit investment in firms more exposed to credit rationing. Thus, an analysis of the effect of public support to investment activities need to ascertain whether firms view the government support as a substitute source of financing, cheaper than funds raised on financial markets although not a proper stimulus to undertake further projects or, alternatively, subsidized firms invest the released funds in unexploited investment opportunities that were not profitable using more costly external finance (Hall, 2002).

The next issue concerns the link between the subsidized investment and the economic performance of the firm undertaking them. Ultimately, the success of the scheme relies on the achievement of higher sales/profit/market share though the innovation of products or processes. The assessment of output additionality is quite complex since outcomes are in general delayed and it may be difficult to distinguish the subsidized investment returns from other factors affecting profitability.

A complete evaluation of an incentive scheme requires understanding business decision processes and capturing changes in strategies resulting from the government intervention. Behavioural additionality is a very recent field of evaluation analysis that originated from the recognition that more traditional formulation of additionality are inaccurate in the case of large firms. This approach is based on the collection of questionnaire, interview or a combination of the two, for this reason it will not be considered here (see OECD, 2006).

1.2 Empirical Methods of Evaluation and the Choice of a Proper Evaluation Strategy

The empirical answer to the question of whether the government intervention stimulates or displaces private investment in either R&D or physical assets implies dealing with the issue of what would have occurred in the absence of the policy. The problem arises because the programme has been implemented and what would have occurred in its absence is not observable, that is at any point in time a firm either participates or not in the programme, but never both. In the evaluation literature the causal effect of a policy instrument, the so called *treatment effect*, is defined as the difference between the value observed on a target variable after the intervention and the value that would be observed for the same variable in the *counterfactual* situation of no intervention. It follows that the evaluation problem concerns the inference of a valid counterfactual on the basis of the available information.

All evaluation methods are based on comparisons between recipients and not-recipients of the provision. The evaluation aim is making the comparison group 'comparable' to the treatment group in every respect except for the treatment. In the presence of systematic difference between recipient and not-recipient firms, a simple comparison of the mean impact of the programme may lead to biased results. This is a common situation in policy experiments in which the participation in the programme differs from random assignment. In general, the access mechanism to the scheme may be a source of selection into treatment. In the context of concern here, think for example of tax provisions that may be used only by firms that are not tax exhausted. Firms unable to use the credit may be less likely to undertake investment projects than firms that use the credit in the absence of the provision. Also, self-selection decisions may arise since firms at least partly choose whether to participate or not to the programme. Firms that get a good investment opportunity are more likely to apply for the credit, but they would also be more likely to carry out the project in the absence of the support.

The literature on the econometrics of evaluation provides several econometric approaches to identify treatment effects in non-experimental setting (see Blundell and Costa Diaz, 2000, for a survey). The choice of the appropriate evaluation approach crucially depends on the type of data available and the policy parameters of interest. Simulation studies show that no universally valid estimator exists (Heckman *et al*., 1999). The reminder of this section is devoted to discuss different evaluation strategies that can be appropriate in the analysis of tax incentives to private investment and to show that.

Denote the potential outcome of a target variable by Y_i^1 for firm *i* that receives the credit and Y_i^0 for the non-recipient firm. Let D_i indicate access to the scheme such that D_i =1 for the recipients and D_i =0 to the non-recipients. In the context of concern here, one may be interested to evaluate the impact of a policy on a well defined set of outcome variables that might include the investment expenditure, as well as an indicator of firm's performance, like sales, profits, market shares or total factor productivity. The evaluation analysis aims at decomposing Y_i^1 into two distinct parts, Y_i^0 and $\Delta_i = E\left[Y_i^1 - Y_i^0 \mid D_i = 1\right]$, corresponding to the outcome that would have been occurred regardless of the policy and the effect induced by the policy. Note that this can be regarded as a missing data problem, in the sense that we need to use the available observations to impute the relevant information unobserved. In the presence of selection into treatment $E\left[Y_i^0 \mid D_i = 1\right]$ cannot be simply calculated as arithmetic

mean of the non recipients, because $E[Y_i^0 \mid D_i = 1] \neq E[Y_i^0 \mid D_i = 0]$. Suppose that the selection into treatment is completely determined by a set of exogenous variables $(X = x_i)$ that can be observed by the researcher and conditioning on these variables the assignment into treatment is random (*conditional independence assumption* - CIA), then $E[Y_i^0 \mid D_i = 0, X = x_i]$ can be used as a measure of counterfactual for the recipients (Rubin, 1977).

Consider the following specification of the outcome function for recipients and non-recipients:

$$Y_i^1 = g(X_i) + D_i\alpha + u_i \qquad (1.1)$$

$$Y_i^0 = g(X_i) + u_i$$

where $g(X_i)$ is a function of the set of observables *X* and u_{it} is a stochastic error term. Assume that the treatment effect is additive, the coefficient of D_i measure the impact of the programme (*average treatment effect* - ATE). Specific flexible functional forms can be chosen to approximate $g(X_i)$ which can be interpreted as a control function for self-selection bias. Conventional regression methods can be used to estimate the parameter of interest α by imposing common parameters for recipients and non-recipients on $g(X_i)$ or, which is the same, by pooling the observations for both states. In this setting the OLS estimator is consistent for α.

If CIA holds participation decisions are being based on observables alone. However, this assumption cannot be tested. Rosenbum and Rubin (1983) pointed out that a large number of control variables is required to ensure the validity of CIA. They show that when the vector X has a high dimension, it can be condensed into a summary statistic, the so-called propensity score. This measure is the probability of being treated conditional on the covariates, $\Pr(D_i = 1 \mid X = x_i)$.

Methods based on propensity score look attractive because they are parsimonious. The propensity score can be estimated using flexible binary models (e.g. logit, probit) or fully non-parametric models (Heckman, Ichimura and Todd, 1997). In the first case the estimated propensity score can be regarded as a first stage estimation and included in the behavioural response equation as an additional regressor in place of the numerous control variables. The advantage of this approach is that it leads to more robust estimates of the treatment effect compared with other methods (Haussman, 2001).

Estimates of propensity scores can be used in a very different way to match firms with similar propensity scores (*matching estimator*). The goal of the

matching approach is to find for each treated firm a similar untreated counterpart with the same X-realisation. The basic idea of the matching approach is to reproduce the 'natural' experiment setting where the treatment is randomly distributed between groups of identical subjects. The method of matching assumes that given a set of conditioning variable *X*, within each 'stratum' defined by $X = x_i$ the counterfactual distribution of the participants is the same as the observed outcome distribution of the non-participants. This implies that within each stratum recipient and non-recipient firms can be compared directly and the impact of the programme can be computed by averaging over all pairs of firms. Analogously to the parametric set-up, when the vector X has high dimension the comparison group may be chosen using the propensity score by defining a criterion of proximity.

Combining matching with difference-in-differences (diff-in-diffs) has become an increasingly popular estimation strategy to measure the treatment effect. The impact of the policy is evaluated by comparing the outcome of interest (for example, the investment outlay) before and after the policy intervention and between the treatment group and the control group. However, if the outcome variable under study is serrially correlated conventional diff-in-diffs standard errors may grossly understate the standard deviation of the estimated treatment effects leading to serious overestimation of *t*-statistics and significance levels (Bertrand, Duflo and Mullainathan, 2004). As a consequence, alternative estimation methods such as GMM estimation of dynamic panel data models could be more efficient.

The main difference between regression and matching is the weighting scheme used to take the average of the treatment effects in each stratum: regression gives more weights to cells in which the proportion of treated and untreated is similar, while matching gives more weights to cells in which the proportion of treated is high. [2] The crucial advantage of the matching approach is that there is no need to make assumption about the functional form of the selection function. Because the aim is to select a dataset allowing for a controlled experiment, in general this evaluation method rests on strong data requirements. A possible drawback is that it might be difficult to assign a non-participant firm with similar propensity scores to each participant firm. This is likely to occur if the group of non-recipient firms is not wide enough compared to the recipients. The loss of information may be critical in the case of heterogeneous response that is when the expected impact of participation differs across firms. It is possible then that the estimated impact does not represent the mean impact of the programme. Another potential problem is that

2 See Angrist (1998) for some interesting examples of the difference between regression and matching.

the more detailed is the relevant information needed to select potential candidates for the control group, the harder it is to find a similar control unit. Most importantly, the method of matching is not suitable when CIA is violated.

If failure of the CIA is suspected one has to turn to instrumental variables estimation (IV) of the policy impact (Wooldridge, 2002). Provided that valid instruments for treatment are available this method guarantees the required randomness in the assignment rule. The instrument is assumed to be unrelated with the outcome except through participation, thus the relationship between the instrument and the outcome identifies the treatment effect. The identification of α is not affected if some exogenous variables in X are not available. Yet, it has to be remembered that in finite samples the IV estimate is biased in the same way as the OLS estimate, and the weaker the instrument the closer the IV bias to the OLS bias.

Another option is the traditional econometric approach to the selection problem which allows for selection on the basis of unobserved components of outcomes (Heckman *et al*., 1999). The Heckman selection estimator is more robust than the IV estimator, but it imposes more restrictions on the structure of the model. In particular, it assumes that the outcome model is additively separable in the regressors and the unobserved characteristics. The procedure is in two-step: in the first, the part of the unobservables that is correlated with the participation decisions D_i is estimated; this is precisely what is missing from the outcome model (1) when the assignment to treatment is not random. In the second step the outcome equation is estimated including among the regressors the error term of the participation equation in order to control for the component of the selection process that is correlated with the error term.

As Heckman (2004) pointed out, the modern literature on evaluation policy aims at essentially identifying the sign and magnitude of the causal effect in question, not the full range of parameters pursued in structural econometrics. This limits severely the possibility to extend the evaluation results to different contexts, either in order to forecast the impact of the same policy to a different population or to design a new policy, or again to predict *ceteris paribus* changes in other conditioning variables. On the other hand, the structural simulation approach, which has long been used in policy analysis, requires estimating a behavioural model grounded in economic theory which is usually not an easy task. This is particularly true in firms' behaviour analysis. Structural investment models, such as q-models and Euler equations, have not had much success in empirical testing (see Bond and Van Reenen, 1998, for a survey). In certain contexts, to recover all structural parameters may be even unnecessary, so that an empirical rather than a structural approach may be preferable.

However, the straight application of the counterfactual analysis developed in the evaluation literature in labour market econometrics to the assessment of investment incentives appears not a suitable evaluation strategy. As argued in the previous section, a tax-based subsidy may affect investment decisions through different channels. These include a direct effect, through the input price, and an indirect one through the cash flow. Trying to measure the distinct effects associated with each channel, instead of the overall effect, would improve our knowledge on the policy impact on business behaviour. This requires extending the evaluation framework depicted above in several directions.

First, most commonly evaluation studies incorporate the participation in the programme through an indicator function. This implies that the identification of the policy effect relies on the variability of the access to the scheme over time and across firms. However, it is unlikely that the magnitude of the subsidy is the same for all the recipient firms (think for example of differences in the usability of the credit due to the tax status of the firm), so that the evaluation results are likely to be relatively imprecise. A better approach consists of accounting for the benefit in terms of the variation of the user cost of capital, a measure that captures the marginal cost of the investment taking into account tax rules, interest rates, depreciation rates and other type of subsidies. The advantage of this method is that the response to policy changes corresponds to the elasticity of the investment demand to the marginal cost of capital. The model of firm decision turns out to be better grounded in economic theory and the heterogeneity in the amount of the benefit as well as in tax burden faced by firms may be very useful in identifying the parameter of interest. In addition, the estimated elasticity can be used to predict the effect of a tax break, even in the absence of information on the usability of the tax subsidy at the firm level or in the case where the policy has never been implemented (Hall and Van Reenen, 2000).

Second, to identify whether a positive indirect effect takes place one should test if recipient firms are less conditioned by factors such as financial constraints or firm size compared *ceteris paribus* to non-recipient firms.

Third, short-term effects may differ from the long-term effects, and then a dynamic version of the model should be considered provided that longitudinal data is available. Introducing a dynamic structure in the empirical model may modify substantially the sign and the significance of the estimated relationship between public support and investment decision (see Capron and Van Pottelsberghe, 1997; Lach, 2000). The time pattern of estimated effects may suggest the presence of substantial adjustment cost in capital accumulation or some type of constraints that may alter temporarily the firms' response to the intervention (for example highly inelastic supply of either capital or skill labour),

or a possibly outward shift in the marginal rate of return schedule that may originate by the opening of new technological opportunities taking the form of higher project returns.

This requires making an effort in structural modelisation as argued also by David *et al*. (2000). One viable solution could be applying the matching estimator as a method to reduce differences between recipients and non-recipients and then use the selected sample to infer the impact of the policy on the outcome variable by estimating an empirical model of firm's behavior to recover the complete set of the parameters of interest. This approach has not been exploited in evaluation analyses yet, but as shown by Blundell *et al*. (2000) the combination of parametric and non-parametric techniques is likely to improve the evaluation results significantly.

The next section focuses on recent applications in the evaluation of both capital subsidies and R&D incentives with the intent of providing useful and relevant insights to our study.

1.3 Empirical Evidence on the Effectiveness of Fiscal Incentives

The impact of tax changes that affect the incentive to invest has been a major concern of an extensive literature on the determinants of firm investment decisions pioneered by Hall and Jorgenson (1967). Investment tax credits or accelerated depreciation allowances have been the rule rather than the exception in most OECD countries since World War II in an effort to stimulate economic growth. Despite economic theory predicts that the marginal user cost of capital should be a key parameter in analyzing fiscal policies, the supporting evidence on this topic is mixed. Some panel studies find substantial estimates of the tax price elasticity ranging from -0.5 to -1.0.[3] By contrast, other econometric studies suggest that investment is only modestly responsive to price as the user cost elasticity mostly lies between zero and -0.4 (Auerbach and Hasset, 1990; 1992, Kopcke, 1982; Chirinko *et al*., 1999).[4] It is the object of this section to briefly summarize the recent evolution of the literature, and to

3 See Hasset and Hubbard (1997) for a survey.

4 It is also worth recalling the works of House and Shapiro (2006) and Cohen and Cummins (2006) that, evaluating a temporarily accelerated depreciation allowances in the U.S., provide contrasting evidence. In particular, by applying a general equilibrium setup, House and Shapiro (2006) show that capital expenses benefited substantially from the favourable tax treatment. Using a difference-in-differences specification, Cohen and Cummins (2006) challenged this result, by suggesting that the bonus was largely ineffective.

highlight to what extent recent advances in evaluation methods have contributed to improving the knowledge in this field.

A large strand of the literature on the effectiveness of public funds in increasing investment spending in private firms focuses on government subsidies for R&D. Hall and Van Reenen (2000) offer an authoritative review of the literature on the impact of fiscal incentives for R&D. They claim that tax has an impact on R&D activities. Most of the studies for U.S. and several other countries using firm level data estimate the tax price elasticity of total R&D spending on the order of unity, although there is a noticeable degree of variations around this. These findings suggest that a reduction of the cost of R&D causes an increase in the quantity of R&D of the same percentage. Some recent results reported for Italy by Parisi and Sembenelli (2003) and for France by Mairesse and Mulkay (2004) using firm-level panel data suggest that the elasticity of R&D with respect to its price could in fact be even larger.

Within this strand of literature the most compelling evidence is based on the quasi-experimental approach of estimating the response of R&D demand to its user cost using reduced form behavioural models. In general, the applications based on this approach implicitly assume that fiscal incentives are fully available to all eligible firms, and the evaluation strategy lies on variations in the generosity of the scheme between different firms and, also changes over time.[5] A few caveats are in order, however. Few studies control for the simultaneity between the investment level and the tax price faced by the firm by using instrumenting techniques due to the difficulties of finding appropriate instruments to identify the endogenous variable.[6] In addition, few panel studies exploit the full variability of prices among different firms that emerges in many ways from the structure of the credit or from the tax system as a potential source of identification of the tax price elasticity.

Evaluation analyses based on the comparison of differences in outcomes between tax credit users and un-users are scarse. Indeed, even when the tax-based subsidy is basically available to every firm, a fair proportion of companies might be reluctant to apply for the credit owing to the considerable extent of

5 An advantage of the quasi-experimental approach is that the response induced by a tax rebate can be still inferred on the basis of a user cost variable that does not incorporate the measure of the tax subsidy when the information set does not include the post-intervention years (see for example Parisi and Sembenelli, 2003).

6 As already stated, identification problems may arise if a firm's access to the scheme or variation in generosity of the scheme is related to the firm's characteristics, such as its tax exhaustion position, the amount of foreign income, etc., that are correlated both with the investment level and the tax price faced by the firm, then ordinary regression estimates are biased and the estimated user cost of capital elasticity tends toward zero. In this situation, instrumental variable estimation could be more appropriate, although at the expense of estimate precision.

bureaucracy involved in filling out the necessary forms, or simply because the use of the credit may increase the probability of audits of a firm's accounts by the taxation authorities. In some cases, incentive schemes do not even apply automatically to all eligible firms either because they are discretionary or subject to budget constraints. In such circumstances it may be questioned whether those companies that undertook the investment without applying for the credit can represent a suitable control group in order to identify the causal effect of the policy. Czarnitzki *et al.* (2004) address this concern by explicitly investigating whether performance of R&D tax credit recipients differs from that of non-recipient firms conducting R&D and whether the higher performance can be attributed to the effect of R&D tax credits. They apply the matching approach on cross-sectional data for a representative sample of Canadian manufacturing firms and find that R&D tax credits have a positive impact on the firm's decision to conduct R&D and also that R&D activities induced by the fiscal incentive lead to additional innovation output, measured both in terms of number and of sales of new products.

Conversely, a number of studies use the most recent developments in evaluation methods in the effectiveness evaluation of direct subsidies. Reviewing this literature is useful for highlighting the progress achieved in the direction of improving the empirical evidence, in particular, in an evaluation field where investment displacement is more likely to arise, compared with tax-based subsidies, in addition to the form of crowding out operating through the input market effect. David *et al*. (2000) and Klette *et al*. (2000) in their surveys point to the shortcomings of the extant literature and the difficulties in finding conclusive results regarding the sign and the magnitude of the relationship between public grants for R&D and private R&D expenditure.[7] Later studies that carefully control for potential selection biases arising from non-random assignment of subsidies to firms by using different methods still provide heterogeneous results, although most of them find evidence that the hypothesis of complete crowding out effects between public and private funds can be rejected.[8]

Wallsten (2000) estimates simultaneous equation models of the award allocation process and demonstrates that, controlling for the endogeneity of grants, public R&D subsidies in the US have a strong crowding out effect on private R&D spending, and no impact on employment. Busom (2000) analyzes

7 This finding is also confirmed by the meta-analysis of Garcia-Quevado (2004).

8 Unfortunately, the empirical evidence is not strictly comparable, with only few exceptions. Studies differ widely in terms of period and country coverage, and extend over different periods. In some cases, the restrictions of the available information may impose severe limits on addressing the issues of selection and endogeneity bias. This makes it difficult to trace a relationship between methods used and results.

the probability of participation in a program granting R&D subsidies in Spain by implementing Heckman's parametric selection models on a sample of Spanish firms in 1988. She finds that public funding stimulates more effort on R&D expenditure and employment for the majority of firms in her sample, but for 30% of beneficiary firms complete crowding out effect cannot be ruled out. Gonzales, Jaumandreu and Pazo (2005) focus on the modelling of firms' decisions about performing R&D and the associated level of R&D effort using a representative sample of Spanish manufacturing firms observed for the period 1990-99. They argue that the impact of R&D subsidies on firms' decisions regarding R&D remain relatively modest and controversial. Some small firms would stop carrying out R&D projects if subsidy were eliminated, thus proving that market failures do matter. However, subsidies only induce a modest increase in R&D investments in firms that would have performed innovative activities even in the absence of the intervention. Although there is no evidence of funding crowding out, public funds are detected going mainly to firms whose engagement in formal R&D is not affected by subsidies. Analogously, Lach (2002) suggests differential effect according to firm size of the R&D subsidies using panel data on a sample of Israeli companies. Large firms get subsidies for projects that would have been undertaken even in the absence of the subsidies, while small companies use the subsidy to fund projects that would not have been undertaken without them.

On the other hand, Hussinger (2003) applying selection models shows that public funding increases firm's R&D expenditures in the German manufacturing sector. Similar results are also achieved by other studies for Germany that employ matching estimators (Czarnitzki and Fier, 2002; Almus and Czarnitzki, 2003). Czarnitzki and Licht (2006) extend previous analysis to examine the input and output additionality of public R&D subsidies in Western and Eastern Germany. They find a large degree of additionality in public R&D grants with regards to innovation input measured as innovation expenditures, as well as with regards to innovation output measured by patent applications. Also, Ebersberger and Lehtoranta (2008) in Finland show that the public R&D funding has a significant positive effect on the innovation inputs and innovation outputs based on the propensity score matching technique. Koga (2005), using a sample of Japanese high-technology start-ups over the years 1995-1998, suggests a positive relationship between R&D subsidies and company-financed R&D particularly in mature firms.[9]

9 However, this analysis suffers from limitations of the dataset which is very poor in terms of observations (200 firms) and does not include the amount of the R&D subsidy.

In what follows, we briefly review those studies that have investigated the impact of regional development policies, which is the main focus of our study. In spite of the fact that in many countries regional development policies absorb the main amount of resources allocated to manufacturing activities, evidence on the effects of such policies in triggering capital assets is rather limited. Harris and Trainor (2005) attempt to examine the effects of different policy instruments, both capital grants and tax incentives, directed to manufacturing firms in Northern Ireland. Using detailed micro-level panel data (1983-1998) comprising both recipient and non-recipient plants, they focus on TFP effects and employ an appropriate panel estimator involving instrumental variables, in order to take into account the potential endogeneity of grants. They conclude that the results are fairly mixed, showing that public support does appear to have had different impact across different industries. Interestingly, they reveal that capital grants were more likely to have a positive impact on TFP as opposed to other grant-aid. Bronzini and de Blasio (2006) evaluate the impact of an investment grant program that was the main policy instrument for reducing territorial disparities in Italy over the second half of the '90s. By comparing subsidized firms with firms whose applications were rejected and using the diff-in-diffs approach they find that financed firms substantially increase their investments in comparison with the pool of rejected application firms. However, their results suggest the presence of intertemporal substitution effects. Firms appear to have anticipated investment projects originally planned after the post-intervention period to take advantage of the incentives. In fact, beneficiary firms significantly slow down their investment activities in the years following the program. Also, the evidence suggests that financed firms displace their non-financed competitors. Bronzini *et al*. (2008a, 2008b) focus on the same provision analyzed in this report to estimate the impact of the programme eligibility by comparing both subsidized and non-subsidized firms located in eligible areas to firms located in non-eligible areas. The treatment group is matched with a comparable control group using the propensity score matching and the exact matching. They adopt a difference-in-differences framework and find that the programme has been effective in stimulating investment. They conclude that, differently from other investment tax credit programmes implemented elsewhere in the world, the provision is not restricted to profitable firms with tax liabilities, thus representing a source of finance that alleviates the sensitivity to the availability of internal resources in credit-constrained firms. However, they do not explicitly investigate this issue.

1.4 The Outline of the Study

The discussion above has highlighted that different methods have strengths and weakness with respect to the questions of interests in evaluation analyses and that there is no single method that can be used to address all issues and investigate all aspects of the scheme. This problem can be tackled through the use of a combination of evaluation methods. The empirical literature provides a number of applications based on the combination of the matching estimator and the difference-in-differences approach. In section 1.1.2 we have suggested another evaluation strategy that we argue can be particularly suited in evaluating tax-based subsidies targeted to spur investment activities. This study offers an application of the proposed approach to the analysis of regional tax incentives for business investments in Italy. The research program is described in what follows of this section.

The tax subsidy examined here was enacted in December 2000 to enhance investments in tangible and intangible capital goods realized in disadvantaged areas mainly located in Southern Italy. The magnitude of the support varies by region and firm size, being higher in relatively less developed regions and for SMEs. In addition, the credit could be used to offset almost any tax and social security liabilities in order not to restrict the benefit to profitable firms. The tax bonus was temporary in that it could be received on investment outlays realized by the end of year 2006. Just under two years from its introduction, the incentive program, which was originally quite generous, became financially unsustainable, so that the budget ceiling was drastically cut, the automatic mechanism stated in the original norm was substituted with a monitoring procedure and the credit accrual was staggered over time. The provision was subsequently reintroduced in 2007, with minor changes with respect to the norm in force up to 2006. Specifically, the incentive is still temporary and supposed to stay in place until 2013. However, the budget was further downsized with respect to the previous period of application. Applications presented in only few months have exhausted the total amount of resources allocated. It is therefore important to make an effort to evaluate the effectiveness and the outcomes generated by the policy tools adopted insofar in order to favour its reorganization.

The study provides an attempt to answer several evaluation issues following the lines of research discussed in section 1.1. As the tax subsidy was subject to a budget ceiling, not all the eligible firms benefited from the scheme, therefore the appropriate question to raise in assessing this provision is: who applied for the tax credit? More specifically, we test whether small firms and other types of firms, that usually encounter higher hurdles than large firms in

achieving external funds, had access to the scheme, and whether the discontinuity over time in the administration of the provision had an impact on this.

Indeed, a large share of the population of eligible firms had no access to the tax benefit, as we will show in chapter 2. With the use of this information we will construct a proper counterfactual exercise with the aim of reducing differences between tax credit users and un-users. The selected sample, which includes both groups of firms, is used to estimate a model of investment behaviour and recover the tax-price elasticity as a measure of additional investment stimulated by the government intervention. As discussed earlier, this approach has the advantage of allowing one to account for the other channel through which the incentive to invest is affected indirectly, the 'income effect' induced by financing constraints, and also the dynamic structure underlying capital accumulation. Most interestingly, using this framework the problem of selection bias can be addressed through a double strategy. If the matched approach fails to fully eliminate the selection into treatment, it is possible to tackle this issue with the estimation of the behavioural model using instrumental variable techniques. On the other hand, after the implementation of the matching estimator, the selection bias is likely to be less severe, thus increasing the probability of success of the instrumental estimation.

Given that the incentive was known to last for some years, we check whether it had larger effects than lasting changes to investment incentives. To do this, we decompose the user cost in the user cost without the tax credit and the differential component that accounts for the tax offset, and compute the corresponding investment responses. We also test whether substitution and income effects differ amongst different types of firms, and whether the public financing helps to alleviate firms' financing constraints.

Finally, the same dataset is used to verify the success of the scheme in improving the productivity of recipients in comparison to non-recipients. We compute several measures of the total factor productivity at firm level and investigate the link between subsidised investments and economic performance of firms undertaking them through a descriptive analysis of the distribution of the total factor productivity both before and after the intervention. Further, we estimate a dynamic behavioural model of the TFP growth at firm-level in order to quantify the productivity improvement.

A distinctive feature of this study is the use of a particularly rich micro dataset that relies on many different data sources covering the whole population of eligible firms over a fairly long period of time, including three pre-intervention years (1998-2000) and five post-intervention years (2001-2005). The information on the administration of the incentive scheme is drawn from

confidential corporate tax return data and includes data on the access to the regional tax bonus, the tax year of accrual of the tax bonus, the investment outlays, the credit used to offset tax liabilities and the residual amount that is carried forward. These observations are then integrated with other data sources on Italian corporations by matching observations for the fiscal legal unit on the basis of a common identifier. Specifically, we draw information from company accounts and national business groups,[10] from business and employee registers, as well as information from the administration of other incentive programmes targeted to the same areas. The final dataset allows for the computing of a large set of variables, including key variables that relate to the effects of the scheme, such as capital stock, financial sources, revenue, value added, user of capital, and, also, other basic characteristics of the firms, such as firm size, firm age and firm ownership. The construction of the sample used in estimation from archives covering the universe of companies ensures an extensive coverage of the production structure in targeted areas, thus increasing confidence when extrapolating the empirical results to the regional economy at large.

2 WHO RECEIVED THE TAX CREDIT?

From the second half of the 1990s, government grants and area-based initiatives (i.e. territorial agreements, area-based contracts, etc.) have been the main tools of intervention used for reducing territorial disparities in Italy. However, these forms of interventions have not by and large been successful in attracting investments, especially FDI, thus suggesting that these policies have not contributed to overcome the fundamental problems that inhibit investment in lagged areas in Italy.[11]

As soon as the EU Commission allowed Member Countries to use tax incentives instead of monetary ones to spur new investments in less developed areas of Europe at the end of year 2000, a further tool was introduced for firms that realized investment in disadvantaged areas in Italy - a tax credit of up to

10 Source: Cerved Business Information spa.

11 As mentioned in section 1.3, see Bronzini and de Blasio (2006) for an evaluation of the effectiveness of government grants over the years 1993-2001.

65% of the investment outlays.[12] Differently from government grants that require long lasting competitive auctions, fiscal incentives drastically reduce times and costs of the administrative procedure, entail less interference in the marketplace and avoid the need for political intermediation.[13]

The next paragraph presents the structure of the tax credit on investment in lagged areas. Paragraph 2.2 offers some statistics on the distribution of tax benefits and computes a measure of the effective incentive effect, whereas paragraph 2.3 is devoted to investigating the determinants of the allocation mechanism of public funds across firms.

2.1 THE CREDIT ON INVESTMENT IN DISADVANTAGED AREAS

The tax credit to private investments in disadvantaged areas was introduced at the end of year 2000 (Law 388/00) and was set to expire in 2006. The credit was based on the amount of new investments realized in targeted territorial areas (art. 87, par. 3, let. *a*) and *c*) of the European Community Treaty). Beneficiaries are not allowed to benefit from other provisions, such as grants set up for the same policy goal of reducing territorial disparities (Law 488/1992) or other tax relieves targeted to different policy objectives but related to the same investment goods (for example Law 383/2001, art. 4). Differently from conventional tax credits, the provision is not restricted to profitable firms. In fact, beneficiaries firms are allowed to use the bonus to offset almost all direct and indirect taxes[14] and, also, social security liabilities.

12 Law no. 266/97 requires the Government to carry out systematic monitoring and evaluation of the provisions targeted to enterprises. These activities have to be reported and submitted, for checking, to Parliament. The aims are to identify the most effective intervention tool and improve the design of proper policies, which have become important issues on the policy agenda in the present context of decreasing financial resources which are available to foster economic activities. The evaluations conducted by the Ministry of Economic Development focus on input and result additionality, users' satisfaction and selection mechanisms using both surveys and econometric analysis on a firm-level (see "Relazione sugli incentivi di sostegno alle attività economiche e produttive", Ministry of Economic Development, www.sviluppoeconomic.gov.it).

13 These features appear to be important requirements for a policy tool targeted to supporting economic development in lagged areas, particularly in cases where business environment is characterized by the presence of strong personal relationships, often "improper" relationships that give rise to significant transaction costs, as in Southern Italy.

14 These include the corporate income tax - called IRPEG until 2003 and renamed IRES since the tax reform in 2004, a value-added tax levied on business activities (IRAP) and indirect tax liabilities on consumption (IVA).

The extent of the relief varies according to investment location and firm size (see Table 1). For 100 euro of investment outlays, the tax cut ranges from 8 euro that can be claimed by a large firm located in targeted territorial areas in Northern and Central Italy, up to 65 euro due to a small firm or a medium-sized firm in Calabria.

Table 1 **Aid intensities by targeted territorial areas and firm size, years 2000-2006**

	Small Firms	Medium firms	Large firms	
Areas in derogation *ex* art. 87.3 *a*)				
Calabria	65%	65%	50%	(*)
Campania	50%	50%	35%	(*)
Basilicata	50%	50%	35%	(*)
Puglia	50%	50%	35%	(*)
Sicilia	50%	50%	35%	(*)
Sardegna	50%	50%	35%	(*)
Areas in derogation *ex* art. 87.3 *c*)				
Abruzzo	30%	30%	20%	
Molise	30%	30%	20%	
Northern and Central Italy	18%	14%	8%	

Note: (*) After 07/08/02 the percentage of aid intensities are reduced to the extent of 85% (Law 138/2002).

Investment goods covered by the benefit include both physical and intangible capital with some restrictions which are listed in Table 2. In particular, it is worth noting that R&D expenses directly supported by the firm are not allowed, whereas eligible investments include patents, licences and rights of usage of intellectual property when purchased from other firms.

Table 2 **Investment goods admitted and non-admitted to the tax credit**

Investment goods admitted		Investment goods non-admitted
Physical capital - Equipment and real estate (Acquisition and realization)	Intangible goods (only if purchased from other firms)	
Acquisition and realization of new plants	Patents	Tangible investment goods that are pure costs (advertising, R&D, start-up expenditures, etc.)
Completion of interrupt works	Licences of exploitation of patented technical knowledge	Furniture and ordinary office machines (excluding computer and telephonic and electronic systems)
Enlargement or advancement of existing plants	Non-patented technical knowledge	Means of transport devoted to the transportation for third parties (only for the transport sectors)
Restarting of existing plants	Rights of usage of intellectual works	

The credit accrues with the purchase or realization of the capital goods, even through financial leasing, and is computed by applying the aid percentage to the value of net investments by subtracting from the cost of the new investment goods the amount of sales, displacements and depreciation of the capital stock belonging to the same categories of investment goods admitted to the favourable tax treatment and to the same productive unit where the investment is carried out.

The incentive mechanism was substantially revised in 2002. Law 138/2002 reduced the aid intensities to 85 percent of the tax benefit set by art. 87, par. 3, let. *a*) and the economic sectors admitted to the provision are reduced with the exclusion of the transport sector. Instead, it is abolished the prohibition of cumulating between the benefit and the provision introduced by art. 4 Law 383/2001, namely the non-taxation of profit reinvested, the so called "Tremonti-bis". Most importantly, the automatic mechanism stated in the original norm was substituted with a monitoring procedure in order to limit the access to the benefit within the authorized ceiling. Finally, Law 289/2002 cut the budget ceiling to roughly one third of the initial amount (2 billion euro) and scheduled the usage of the credit to be staggered over time; in particular three distinct cases were considered:

1. firms that attained the right to the tax support through the automatic mechanism before August 2002 were allowed to use the credit up to 10 percent in year 2003 and to 6 percent in the subsequent years;
2. beneficiaries that are selected by the new monitoring procedure after August 2002 were allowed to use the credit up to 35 percent of its whole amount in 2003 and, respectively, up to 70 and 100 percent in the two subsequent years;
3. firms that apply later than the first of January 2003 are allowed to use the credit exclusively within the second year from the time of application and have to respect lower and upper limit of usage, respectively, set equal to 20 and 30 percent in the first year, and to 60 and 70 percent in the following year, with the penalty of losing the contribution; also the benefit was conditioned on the realization of the investment in each year at least at the lower bounds of the credit usage.

It has to be underlined that the credit could be used without time limitation in case 1) and 2), so that it could always be carried forward when a firm was tax exhausted, whereas in case 3) the credit should be used within the second tax year subsequent to the period of application. In particular, in this latter case if the recipient firm realized in each year the minimum level of investment equal to the lower bounds of credit usage but was not able to use the credit due to insufficient tax and social security liabilities, the share of the credit unused is

lost; conversely if the credit accrued at an higher extent than the upper bound of utilization, it can always be carried forward even though, as already mentioned, no longer than the second year subsequent to the time of application. Therefore, the share of the credit not used within such deadline is lost. Table 3 summarizes the evolution of ITC regulation.

Table 3 **The evolution of the ITC regulation, Law 388/2000 and subsequent modifications**

Application	Credit utilization restrictions	Credit carry forwards	
before August 2002	$c_t \leq k_t * C$		Yes
	$\overline{c}_{t+1} = 10\%C$	If $c_t < \overline{c}_t$	Yes
	$\overline{c}_{t+i} = 6\%C$	If $c_{t+i} < \overline{c}_{t+i}$	Yes
From August to December 2002	$\overline{c}_t = 35\%C$	If $c_t < \overline{c}_t$	Yes
	$\overline{c}_{t+1} = 35\%C$	If $c_{t+1} < \overline{c}_{t+1}$	Yes
	$\overline{c}_{t+2} = 30\%C$	If $\sum c_{t+i} < C$	Yes
After January 2003	*Lower limit*		
	$\underline{c}_t = 20\%C$	If $c_t < \underline{c}_t$	No
	$\underline{c}_{t+1} = 60\%C$	If $c_{t_i} \geq \underline{c}_{t_i}$	Yes
	$\underline{c}_{t+2} = C - (c_t + c_{t+1})$	If $\sum c_{t+i} < C$	No
	Upper limit		
	$\overline{c}_t = 30\%C$	If $c_t > \overline{c}_t$	Yes
	$\overline{c}_{t+1} = 70\%C$	If $\sum c_{t+i} < C$	NO

Note: c_t is the credit used in period t, k_t is the fraction of the investment project realized in period t, and C is the total amount of the credit due to a pluri-annual investment project. After August 2002 k_t is fixed by law and starting from January 2003 upper and lower limit of credit usage are envisaged; in particular, $\overline{c}_t$ ($\underline{c}_t$) is the maximum (minimum) amount allowed to be claimed in period t provided that the credit is accrued.

2.2 THE INCENTIVE EFFECT CONSIDERING CREDIT CARRY FORWARDS

The restrictions imposed on the credit utilization significantly reduce the incentive effect of the credit. If we define the effective credit rate as the sum of the discounted stream of credit benefit, a firm located in Molise with positive tax and contribution liabilities that received the credit after January 2003 will have

an incentive effect rate ranging from 28.66 and 29 points, corresponding to the lower and the upper limit of credit usage, compared to the statutory credit rate of 30 percent, provided the investment is completely realized in the year of application and assuming a nominal after-tax discount rate of 5 percent. The limits imposed on credit carry forwards further contribute to reducing the incentive effect of the credit.

It is worth noting that although the credit is not restricted to firms with taxable income, since it is allowed to offset any payment due to the central administration, a large share of the benefit accrued was carried forward each year by a large number of firms (see Table 4). Credit carryovers reduce the tax benefit to an extent that depends on interest rates and expectation on future tax liabilities and, therefore, affect the user cost of the investment in different ways for different firms.

Table 4 **Investment Tax Credit, summary statistics years 2000-2005**

		2000	2001	2002	2003	2004	2005
ITC accrued	N. of firms	121	16878	10293	3256	2740	2215
	Mean (€)	576,075	131,343	92,708	203,881	186,490	231,323
ITC carry forward	N. of firms	61	15078	13513	12774	12338	11142
	Mean (€)	154,839	100,765	77,836	93,804	95,238	89,950

Source: Corporate Tax return data (Table RU) manifold years.

The aid intensities can be corrected for the usability of the credit with the aim of computing a proxy of the effective incentive effect. Specifically, it is possible to compute an effective credit rate, as already defined, as the sum of the discounted stream of credit benefit. Our measure is based on the observed distribution over time of credit usage at the firm level coming from the tax files over the observation period. Given this information set, this measure corresponds to an ex-post rate as opposed to an ex-ante rate that, instead, can be obtained as a function of expected tax liabilities and investment expenditures (Altshuler, 1989). We argue that this measure would better capture the heterogeneity of the incentive effects of the provision than the aid intensities set by law.

Overall, roughly 14,000 different firms[15] received the credit during the period 2001-2005, in most cases (75%) for one year, while 18.5 percent of them received the credit for two years, and the remaining for three or more years. On average, the tax credit reduced the investment spending by roughly 48.5 percent. The average effect of the tax cut was slightly higher in 2001 and 2002, but it declined to 42 percent in subsequent years, as a result of the reduction of the aid intensities. For the companies that were not able to use the credit at the time it was accrued, the effective credit rate was on average 4.4 percent lower than the aid intensities.

Finally, Table 5 shows the distribution of the regional tax credit by economic sector and firm size. The population of firms consists of all corporations located in the target territorial areas that also filed tax forms (for simplicity we disregard areas in Northern and Central Italy given their marginal role both in terms of allocated resources and number of beneficiary firms). Only 5.42 percent of all eligible firms received the credit over the years 2001-2005. Manufacturing and commercial firms accounted for the bulk of total credit claimed (over 60% percent). Also firms in the top quartile of the sales distribution were the heaviest users of the regional credit.

Table 5 Distribution of the regional tax credit by economic sector and firm size

	Composition of the population (in %)	Recipient firms (in %)	Percentage of the total credit (in %)
Non financial sectors	100	5.42	
Manufacturing	19.22	19.20	30.59
Traditional Industries	*9.22*	*5.37*	*11.21*
Medium Technology Industries	*7.87*	*7.90*	*17.80*
Advanced Technology Industries	*2.10*	*5.92*	*1.58*
Construction	23.96	4.49	19.83
Trade	32.98	6.16	34.98
Transportation	5.01	2.61	3.92
Private Services	18.86	4.97	10.67
Firm size			
SMEs	75	4.67	65.48
Large firms	25	7.85	34.51

Source: Corporate Tax return data (Table RU) manifold years.

15 Firms that loose the tax credit or that incompletely fill in the required information on the realised investment are eliminated from the sample. Also few observations are discarded due to outliers in the aid intensity measure.

2.3 THE ALLOCATION OF THE REGIONAL TAX CREDIT AMONGST FIRMS

As a first step in assessing the effectiveness of the investment tax credit we consider the determinants of public funds allocation. In particular, the aim of this section is to ascertain whether the regional tax credit supported investment for firms that would otherwise not have undertaken such activities.

As stated above, applications for the fiscal bonus were satisfied according to the chronological order within the authorized ceiling. Hence, the distribution of resources across firms is mainly the outcome of application choices made by firms. Assuming that firms were aware of the existence of the incentive scheme[16], we can expect that all firms that found an investment to be profitable even in the absence of the incentive would have applied for the credit. For all other firms, the decision of both undertaking the investment and applying for the credit implies taking into account some key factors, in particular *i*) the cost of, and the expected return of, investment projects considering the tax offset, *ii*) the cost of applying for the tax credit and *iii*) the likelihood of obtaining the credit. Following Blanes and Busom (2004), we investigate how the probability of applying for the tax credit is associated to some observable firm characteristics.

It is worth noting that what we observe is the allocation outcome. Our database allows us to distinguish among firms that realized the investment project and received the tax credit, firms that undertook investments but did not receive the tax credit (in such cases we don't know whether the firm applied or not) and firms that did not realize investments at all. As it is standard in the literature, we expect that the likelihood of undertaking an investment increases with firm size and the availability of internal funds, and decreases with the cost of external finance. Thus, for firms that received the tax credit, we expect that firm size and financing constraints might have been less severe than for non-recipient firms.

In addition, we can expect that the likelihood of both undertaking investments and applying for the incentive would have been related positively to the tax liabilities of the firm. In general, in the presence of a tax credit, a firm that is taxable is likely to have a higher investment incentive than a firm that is non taxable. We expect that this holds also in the present context. Indeed, by adding all the tax and social security liabilities of companies in our database (with the exception of indirect tax liability on consumption (IVA) - not available) about 25 percentage of all eligible firms turn out to have a null amount of tax

16 Indeed, a survey carried out at the end of 2001 revealed that almost 30% of the firms were not aware of the existence of the tax provision (Ministero delle Attività Produttive, 2002).

and social security liabilities. Thus, even though the tax bonus was allowed to be offset against almost all tax and social security liabilities of the firm, it seems relevant to control for differences in the incentive effect of the tax bonus that may be associated to the presence of tax and social security liabilities. Along the same line of reasoning, we distinguish whether the firm was profitable or not.

We estimate a multinomial logit model on the categorial variable Status, taking value 0 for firms that did not realize investment, 1 for firms that undertook investments but did not receive the tax credit and 2 for firms that realized investment projects and received the tax credit. Conditioning variables comprise firm size (measured by the sales distribution, firms in the top quartile are considered large firms), cash flow divided by total capital, interest rate on loans, total tax liabilities of the firm as a percentage of value added, and whether the firm holds net operating losses. We also include an additional variable indicating whether the firm is a start-up to capture differences in the investment incentive associated to the different stages of the life cycle of the firm. Finally, sector and region dummies are added in order to account, respectively, for technological opportunities that may vary across economic sectors and for the location of the firm and the degree of the aid intensity. As far as sector dummies are concerned, we distinguish traditional industries (Food, Textiles and Clothes, Wood, Leather, Paper, Furniture), medium technology industries (Metals, Machinery, Chemical, Rubber and Plastics, Non metallic minerals and Metal products) and advanced technology industries (Office equipment and electronics, Car Industry and Other transportation).

The model is estimated by distinguishing the first intervention year (2001) and subsequent years 2003-2005 to verify to what extant the discontinuity in the program administration that took place during year 2002 has had an impact on the allocation outcome. It is worth recalling that the most important adjustment consists in a strong reduction of the budget ceiling (from 2 billion euro in 2001 to roughly one third of this amount in the following years). Table 6 shows the marginal effect that changes in each explanatory variable has on the probability of being in each of the three possible states. All variables enter significantly and with the expected sign. Overall, the results show that financing conditions have the highest impact on the probability of undertaking investments. Referring to the estimates for the first intervention year, the first column shows that the probability of not doing investment decreases with firm size and the availability of internal funds, while it increases the higher the cost of debt finance is. Besides, newborn firms were more likely to do investments than mature firms. Comparison of the marginal effects on the likelihood of both doing investments and applying for the credit (column 3) to those on the probability of doing invest-

Table 6 The allocation of regional tax credit among firms, Marginal Effects from a Multinomial Logit Estimation

	Year 2001			*Years 2003-05*		
	Status=0 $I_t=0$	*Status=1* $I_t>0$ & *RTC=0*	*Status=2* $I_t>0$ & *RTC>0*	*Status=0* $I_t=0$	*Status=1* $I_t>0$ & *RTC=0*	*Status=2* $I_t>0$ & *RTC>0*
Firm size	-0.107*	0.143*	-0.035*	-0.077*	0.071*	0.006*
	(0.009)	(0.009)	(0.005)	(0.005)	(0.005)	(0.001)
Cash flow	-0.259*	0.269*	-0.010*	-0.273*	0.282*	-0.009*
	(0.008)	(0.007)	(0.004)	(0.005)	(0.005)	(0.001)
Interest rate	0.404*	-0.556*	0.152*	0.415*	-0.449*	0.034*
	(0.037)	(0.041)	(0.019)	(0.025)	(0.025)	(0.003)
Tax liabilities	0.245*	-0.382*	0.137*	0.258*	-0.272*	0.014*
	(0.008)	(0.008)	(0.003)	(0.005)	(0.005)	(0.001)
Operating loss position	0.033*	0.004	-0.037*	0.057*	-0.055*	-0.001*
	(0.003)	(0.004)	(0.019)	(0.002)	(0.002)	(0.000)
1 if start-up	-0.196*	0.086*	0.110*	-0.215*	0.211*	0.004*
	(0.003)	(0.004)	(0.003)	(0.002)	(0.002)	(0.003)
Small firms * Tax liabilities	-0.095*	0.179*	-0.083*	-0.062*	0.066*	-0.004*
	(0.010)	(0.011)	(0.006)	(0.006)	(0.006)	(0.001)
Medium-Tech Industries	0.051*	-0.051*	0.000	0.064*	-0.062*	-0.001*
	(0.006)	(0.006)	(0.003)	(0.004)	(0.004)	(0.000)
Advanced-Tech Industries	0.029*	-0.051*	0.021*	0.041*	-0.048*	0.007*
	(0.006)	(0.006)	(0.003)	(0.004)	(0.004)	(0.000)
Constructions	0.043*	-0.052*	0.008*	0.037*	-0.038*	0.001
	(0.010)	(0.011)	(0.005)	(0.007)	(0.007)	(0.001)
Transportations	0.065*	-0.067*	0.001	0.070*	-0.069*	-0.000
	(0.004)	(0.004)	(0.001)	(0.002)	(0.003)	(0.000)
Private services	0.046*	0.008*	-0.054*	0.024*	-0.018*	-0.006*
	(0.007)	(0.007)	(0.002)	(0.005)	(0.005)	(0.000)
Abruzzo	0.112*	-0.066*	-0.045*	-0.030	0.014	0.016
	(0.020)	(0.019)	(0.006)	(0.022)	(0.024)	(0.017)
Basilicata	0.064*	-0.132*	0.067*	-0.039	-0.058	0.098
	(0.021)	(0.020)	(0.016)	(0.034)	(0.039)	(0.067)
Calabria	0.037	-0.141*	0.104*	-0.027	-0.058	0.085
	(0.019)	(0.018)	(0.016)	(0.031)	(0.039)	(0.058)
Molise	0.069*	-0.095*	0.027*	-0.022	-0.001	0.023
	(0.018)	(0.018)	(0.009)	(0.022)	(0.023)	(0.015)
Puglie	0.104*	-0.109*	0.005	-0.016	-0.005	0.021
	(0.023)	(0.022)	(0.012)	(0.024)	(0.026)	(0.022)
Sardegna	0.063*	-0.117*	0.053*	-0.014	-0.035	0.049
	(0.018)	(0.017)	(0.012)	(0.024)	(0.028)	(0.031)
Sicilia	0.087*	-0.121*	0.034*	-0.019	-0.017	0.037
	(0.020)	(0.018)	(0.011)	(0.024)	(0.027)	(0.029)
Obs. in each category	35,727	56,696	13,023	138,353	207,256	6,267

Notes: standard errors are in brackets, * significant at 5%-Level. Industries groups are as follows: Traditional Industries (Food, Textiles and Clothes, Wood, Leather, Paper, Furniture), Medium Technology Industries (Metals, Machinery, Chemical, Rubber and Plastics, Non metallic minerals and Metal products) and Advanced Technology Industries (Office equipment and electronics, Car Industry and Other transportation).

ment without public money (column 2) enables to highlight the distributional impact of the incentive scheme. The evidence supports the hypothesis that the incentive scheme reduced obstacles to firm growth. Note that the effect of firm size reduces noticeably, passing from a positive and significant value (0.14) in column 2 to a value slightly below zero (-0.035) in column 3, suggesting that in the first intervention year the tax bonus reached a considerable number of small and medium-sized firms, thus reducing the influence of firm size on investment decisions. Analogously, the tax credit substantially mitigated the impacts of financing conditions. The availability of internal funds and the cost of debt finance result in a much lower impact on the likelihood of doing investments in column 3 than in column 2, suggesting that firms with low cash flow and/or that experienced high cost of external funds were more likely to undertake the investment in the presence of public support than otherwise. In addition, start-up firms were more likely to apply for the credit than mature firms. In terms of geographical distribution, firms located in Calabria, the less developed region among the eligible areas, were more likely to apply by about 0.10 points than firms located in Campania (that is the omitted region with the highest number of companies) probably as a result of the higher aid intensity. Furthermore, firms belonging to advanced technology industries were more likely to apply than firms belonging to traditional industries (i.e. the benchmark group).

As expected, the tax position of the firm played an important role on participation decisions of the firms. Specifically, the likelihood of applying for the benefit increased by almost 0.14 points for firms with tax and social security liabilities. However, small firms and very small firms were somewhat less likely to apply for the tax bonus than larger firms even in the presence of tax and social security liabilities (up to 0.08 points). On the other hand, non profitable firms were less likely to undertake investment activities. The presence of net operating losses reduces the likelihood of applying for the credit by 0.04 points.

The estimates of the same model for the years 2003-2005 have almost an identical interpretation to those obtained for the first intervention year. However, the program is found to have a much lower impact on SMEs and credit-rationed firms as a consequence of the severe restrictions imposed on the provision of public funds. The last column on Table 6 shows the marginal effects on the probability of doing investment and applying for the credit. The effect of size is still lower than the effect of size had on the probability of doing investment without public support (column 5), but differently from estimations for the first intervention year, the influence of size remains positive and significant, suggesting that after the revision of the incentive program larger firms were somewhat more likely to undertake investments and apply for the credit than SMEs, although the magnitude of the effect is small. Analogously, firms with

lower cash flow and subject to higher cost of external finance had a lower probability to access the benefit than in the first intervention year.

To sum up, by comparing recipient firms with eligible non-recipient firms, we find that small and medium-sized firms and credit-constrained firms were more likely to undertake investments in the presence of the incentive than otherwise. The same holds true for start-up firms and those firms located in Calabria, the less developed region amongst the eligible areas. However, smaller firms - even those holding tax and social security liabilities - were somewhat less likely to apply for the tax bonus than larger firms. These findings are somewhat attenuated after the cut to the financing of the provision in 2002.

Overall, these results suggest that the program was quite an effective means to reach the categories of firms that needed the incentive the most, although at the expense of a great amount of budget resources that very soon turned out to be unsustainable. After the support was scaled back, the needier categories of firms were less likely to receive the tax-based subsidy than before. This suggests the conclusion that a large share of funds allocated through automatic mechanisms is absorbed by firms that need the public support the least, so that downsizing the program may severely compromise the possibility of the success of the incentive itself.

3 ASSESSING THE IMPACT OF THE REGIONAL TAX CREDIT ON FIRMS' INVESTMENT DECISIONS

This chapter is devoted to answer the question on whether additional investment was stimulated by the incentive scheme. First, we apply the matching procedure to construct a sample comprising firms that received the credit and eligible firms that did not received the credit. We then discuss the empirical framework adopted to assess the potential impact of the tax subsidy on firms' investment choices which relies on the estimation of the tax price elasticity. Finally, we provide descriptive statistics of a panel data set from around 10,000 Italian companies over the period 1998-2005 and present the empirical analysis.

3.1 The Construction of the 'Control' Group: the Matching Approach

To evaluate the causal effect of the tax credit, we need to select a comparison group as similar as possible to recipient firms in terms of observable characteristics. As argued in section 1.2, it is possible to use the outcomes of non-recipient firms to infer the counterfactual situation of no intervention provided that (*i*) all the relevant differences between beneficiaries and non-beneficiaries firms are captured in their observable attributes (*Conditional Independence Assumption*), (*ii*) participants and non-participants to the intervention scheme with the same characteristics are observed (*Common Support*).

Rosenbum and Rubin (1983) suggest using the conditional probability of participation in the program for purposes of stratification. This is the so-called *propensity score*, computed as $p(Z_i) \equiv \Pr(i \in treated \mid Z_i = z_i)$. This procedure relies on the analysis of the probability of applying for the credit analogous to the one presented in the previous chapter. Specifically, it requires the estimation of a binary choice model (probit or logit) on a set of covariates, then matching can be performed on $p(Z_i)$ by defining a criterion of proximity, thus reducing a potentially high dimensional matching problem to a one dimensional problem.

We use the matching procedure as implemented by Becker and Ichino (2002) which, after the estimation of the probit model, iteratively splits the sample in equally spaced intervals of the propensity score and tests that within each interval the means of each characteristic do not differ between treated and control units, that is to say whether the balancing property is satisfied. [17] Our purpose is to select a counterfactual for each tax credit user by reducing differences between recipients and non-recipients over the pre-intervention years.

The control group is drawn from the population of companies located in the disadvantaged areas that did not obtain the tax benefit, although eligible. Firms that benefited from other sources of public funds during the years of application of the Law 388/00 are eliminated (in particular firms that obtained grants through Law 488/1992 and tax relief on investment spending according to Law 383/2001, art. 4). After the integration of the different data sources, as described in section 1.4, including confidential corporate tax return data, company accounts and business archives, and after discarding observations

17 See, also, Leuven and Sianesi (2003).

showing null values for the capital stock or the turnover (except in the case of newborn firms), the dataset comprises in total roughly 60,000 companies with roughly 10,300 recipient firms. The matching procedure is executed with reference to observations in the tax year 2000, which is the only pre-intervention year available with complete information. In particular, the propensity score is estimated for all firms that accrued the tax benefit over the period 2001-2005 and also were active in 2000.

The variables Z_i used for the estimation of the propensity score include some indicators of the firm's productive structure (labour cost over capital assets, sales as a percentage of capital assets, gross operating margin as a percentage of value added), other indicators of the financial structure and firm ownership (cash flow divided by total capital, debt ratio, interest rate on loans, whether the firm belong to a group of companies), firm size (measured, as above, by the sales distribution, firms in the top quartile are considered large firms), firm age (whether the firm is newborn or mature) and an indicator of the ability of the firm to claim the benefit (tax and social securities liabilities[18] as a percentage of value added).

The procedure has been implemented on separate clusters obtained by partitioning the database by economic sector (2-digit) and firm size in order to reduce somewhat differences across firms. This strategy also ensures that the matched firm is drawn from the same economic sector as the subsidized one and the same firm size. Moreover, in order to obtain the balancing properties to be satisfied in several cases, we further disaggregate the information set on the basis of firm age by distinguishing between new born firms and mature firms.

After the matching is performed, each recipient firm is associated with a similar firm except for the tax subsidy according to the value of the function of the propensity score. Since the propensity score is a continuous variable, exact matching will rarely be achieved and a certain distance between firms belonging to the two groups need to be allowed. In particular, we apply the *nearest neighbour* method of matching without replacement. The adopted procedure provides about 10.078 matches, therefore a large information set that may allow us to test the effectiveness of public support to business investment in lagged areas for different categories of firms.

18 As said, these include the corporate income tax, IRAP and Social Security liabilities; IVA is not available.

3.2 The Empirical Model of the Firm's Investment Behaviour

The empirical model used for estimation of the firm's investment behaviour is the following reduced form specification of the investment rate:

$$\frac{I_{i,t}}{K_{i,t-1}} = (1-\alpha)\frac{I_{i,t-1}}{K_{i,t-2}} + \beta \mathrm{X}_{i,t} - \gamma \ln(C)_{i,t} + \eta_i + \lambda_t + \nu_{i,t} \qquad (3.1)$$

where the subscripts *i* and *t* respectively indicate the i^{th} company (*i* =1, 2, …, N) and year *t* (*t*=1, 2, …, T). $I_{i,t}$ represent the net investment realised in year *t* and $K_{i,t-1}$ is the stock of capital measured at the end of t-1, $\ln(C)_{i,t}$ is the contemporaneous value of the user cost of capital, γ is the response of the investment rate to its price and the adjustment parameter α measures the speed of adjustment.[19] In addition, the regression model include a vector of control variables, $X_{i,t}$ which is listed below, a firm specific-fixed effects η_i to account for individual time invariant unobserved characteristics influencing the investment decisions, and a full set of time dummies λ_t to capture a certain degree of dependency over time across firms of the investment behaviour. Parameters to be estimated are (1-α), β and γ. Finally, $\nu_{i,t}$ is the orthogonal error term.

Equation (3.1) provides an empirical approximation to the intertemporal adjustment process that has generated the data (Bond and Van Reenen, 2005). To control for the presence of unobserved firm-specific effect and to allow for potential endogeneity of the regressors an instrumental approach is required. In particular, we address the concern that the investment level and the tax price faced by the firm are simultaneously chosen. We consider GMM estimators that uses lagged values of the regressors as instruments.

Control variables $X_{i,t}$ introduced in the econometric specification are:

1. the lagged cash flow to capital ratio,[20] a positive coefficient would indicate excess sensitivity of the investment decisions to the availability of internal funds;
2. the lagged sales to capital ratio, a positive coefficient would suggest the presence of imperfect competition in the product market;
3. a variable defined as the deviation of real GDP from its trend in year t in order to capture time varying common across-firms aggregate shocks;
4. sector dummies in order to remove sector-related shocks from the errors;

19 The closer α is to 1 the faster the speed of adjustment.
20 The specification of cash flow relative to the existing capital stock is to avoid units problems.

5. the squared of the lagged investment rate to capture non-linearity in the adjustment process.

Notice that in the presence of imperfect capital markets, the cash flow variable may capture the "income" effect of the policy induced by financing constraints. Therefore, including cash flow in the specification of the investment model (3.1) allows one to infer the pure "substitution" effect arising from changes in the tax price variable, instead of the composite effect, and the estimated user cost elasticity can be interpreted as the long run impact of user cost changes on the desired capital stock, holding cash flow constant. Income effects on investment spending through cash flow operate in the short run.

The user cost of capital is calculated following the formulation pioneered by Hall and Jorgenson (1967) and King and Fullerton (1984). As known, the user cost of capital can be interpreted as the rental price of capital. It represents the policy variable in the investment model (3.1) since policy instruments, like favourable tax treatments (such as tax credits) or direct incentives to the purchase of capital goods, depreciation allowances and corporate tax rate enter explicitly in its computation. Omitting firm and time indices the user cost of capital can be expressed as follows:

$$C = \frac{(1 - \tau A - f\kappa)(\rho + \delta - \pi)}{(1 - \tau)} \tag{3.2}$$

where τ is the effective marginal tax rate on corporate profits, A is the present value of depreciation allowances, and τA is the tax benefit on the investment depreciation, $f\kappa$ is the share of realized investments that benefit of the tax credit multiplied by the amount of the credit for a unitary investment (κ), ρ is the financial cost of capital, δ is the economic depreciation rate and π is the rate of inflation on investment price. The financial cost of capital can be expressed for simplicity as $\rho = \phi r_L (1 - \tau) + \frac{(1 - \phi) r_B}{(1 - z)}$ where ϕ is the debt ratio, r_L the interest rate on loans applied to the firm, r_B is the interest rate on a safe investment that is to say the opportunity cost of retained earnings and z is the tax rate on capital gains.

In order to assess the specific effect of the tax credit on investment, the user cost of capital can be split into two components: the rate of the user cost of capital without the tax credit (ω) and the differential effect of the tax credit on the user cost of capital (ψ). Following Mairesse and Mulkay (2003), equation (3.2) can be rewritten as:

$$C=\left[\frac{(\rho+\delta-\pi)}{(1-\tau)}-\frac{\tau A}{(1-\tau)}(\rho+\delta-\pi)-\frac{f\kappa}{(1-\tau)}(\rho+\delta-\pi)\right] \qquad (3.3)$$

Define:

$$\omega=\frac{(\rho+\delta-\pi)}{(1-\tau)}-\frac{\tau A}{(1-\tau)}(\rho+\delta-\pi), \text{ and}$$

$$\Omega=\frac{(\rho+\delta-\pi)}{(1-\tau)}-\frac{\tau A}{(1-\tau)}(\rho+\delta-\pi)-\frac{f\kappa}{(1-\tau)}(\rho+\delta-\pi),$$

it follows that the logarithm of the user cost of capital can be decomposed linearly into two components, the rate of the user cost in the absence of the incentives and the percentage reduction of the rate of the user cost of capital due to the tax incentives:

$$\ln(C)=\ln(\omega)+[\ln(\Omega)-\ln(\omega)]=\ln(\omega)+\ln(\psi). \qquad (3.4)$$

In principle, this approach allows us to estimate the differential response of firms to different specific component of the user cost, and to address more precisely the question on the impact of different tax provisions on investment behaviour. In this instance, it is relevant to distinguish the effect of tax credit from other changes of the user cost of capital given that the incentive provided by Law 388/00 is of temporary nature. That is to say, it is possible that firms might have anticipated investment projects in order to benefit from the tax provision.

Replacing the user cost of capital by its two components from equation (3.4) the empirical model (3.1) becomes:

$$\frac{I_{i,t}}{K_{i,t-1}}=(1-\alpha)\frac{I_{i,t-1}}{K_{i,t-2}}+\beta\mathrm{X}_{i,t}+\gamma_1\ln(\omega)_{i,t}+\gamma_2\ln(\psi)_{i,t}+\eta_i+\lambda_t+\nu_{i,t} \qquad (3.5)$$

The most relevant aspects of the computation of the user cost of capital derive from the availability of corporate tax return data. In particular, the computation of the user cost of capital takes into account:

- the possibility for the firm to opt for accelerated depreciation in the case of firms that are fully taxable, otherwise it is assumed that the ordinary depreciation rate[21] is applied;
- the effective tax credit computed at the firm-level, in particular for companies that were not able to fully use the credit at the time it accrued this measure is corrected by a discounted factor (see section 2.2);
- the marginal tax rate (MTR) has been approximated by a taxable income dummy, which takes the value of the statutory tax rate if taxable income is positive and a value of zero otherwise.

The MTR is defined as the present value of current and expected future taxes paid on an additional unit of income earned today. It can be computed by taking into account the interdependence of the various features of the tax code and the managers' expectations of the future stream profits generated by the investment. It follows that the effective MTR is quite difficult to calculate. On the other hand, in the presence of tax asymmetries of the tax system, due to carry-back or carry-forward tax treatment of net operating losses, it is clear that the fiscal burden on the investment return depends on the firm's tax status. Therefore, the statutory tax rate is inappropriate to approximate the effective MTR. An easy way to calculate proxy for the MTR is the taxable income dummy (Graham, 1996). [22] As defined above, it captures the cross-sectional and inter-temporal variations in the firm's effective tax status and can be very useful in the analysis of the link between tax structure and investment behaviour. The empirical literature on investment behaviour has usually disregarded the implication of tax asymmetries using the statutory tax rate as a proxy for the MTR. A few studies addressing this issue (Devereux, 1989; Devereux *et al*. 1994; Arachi and Biagi, 2005) provide unconclusive evidence in support of its relevance for firm's decisions. It is worth noting that these latter studies share the feature that the company's tax status is assessed by using accounting data. Since financial statements do not perfectly measure taxable income, the implicit MTR may be distorted. In contrast, the advantage of using tax return data is that taxable income is accurately measured, and this should allow a more precise

21 Before 2008 in Italy, a firm was allowed to accelerate the write-off of the capital good up to two times the rate of the ordinary depreciation for the first two periods from its purchase, such that for instance an investment can be completely deduced in only three fiscal years instead of five. The 2008 tax reform abolished accelerated depreciation allowances.

22 Another alternative to the MTR is the thrichotomous variable equal to i) the top statutory tax rate if the firm has neither a net operating loss carryforward nor negative taxable income, ii) one-half the top statutory tax rate if the firm has either a net operating loss carryforward or negative taxable income but not both, and iii) zero if the firm has negative taxable income and a net operating loss carryforward.

identification of the relationship between the user cost of capital and investment demand.

3.3 Descriptive Statistics

We use an extensive panel of firm data extracted from the integrated database described in section 1.4, that contains 9,964 corporations located in the main targeted territorial areas in Central and Southern Italy. The sample used is the one selected using the procedure described in section 3.1 by matching tax credit users and un-users. After computing the main variables used in the investment model and in the productivity analysis (see chapter 4), we excluded observations that appeared to contain substantial outliers.[23] The data set consists of three pre-intervention years (from 1998 to 2000) and five post-intervention years (from 2001 to 2005). The panel data is unbalanced to avoid that the analysis reflects the impact of the tax credit on stable firms (and continuously sampled over our time period). The number of observations drops to 7,852 in the first year and to 8,781 in year 2005. In particular, about 1,200 firms exit from the sample over the 2003-2005 period, most of them because of closure.

Table 7 depicts the composition of the sample used in estimation. Even though the adopted selection procedure was not specifically addressed to the construction of a representative sample, it is worth underlying that the selected sample reproduces the main features of the firm population in Southern Italy. In particular, most of the corporations belonging to our sample are small or very small enterprises, correspondingly our database is not biased toward large firms as commonly used microeconomic data sources.

Table 8 reports descriptive statistics of the main variables used in the econometric analysis for the two groups of subsidized and not subsidized firms over the 1998-2005 period. [24] Firms' characteristics, such as employment, age and ownership, and other variables like cash flow rates, sales over capital, and user cost of capital without the tax credit, are quite similar on average across the two groups. However, the investment rate is larger for recipient firms than for unrecipient firms, probably as a result of the public support received through

23 Specifically, firms were discarded if the investment rate exceeded 1 (except in the case of new born firms), if the revenue was negative, or if the value added was negative for more than four periods, or cash flow to the capital stock fell in the last centile of the empirical distribution. Also, we require that at least five consecutive annual observations were available for the firms included in the final sample. Further, firms not forming one of a pair, either the treated or the untreated counterpart, were excluded.

24 See data appendix for details on the calculation of the variables.

Table 7 Composition of the selected sample, year 2000

Sector Classification	*Number of Firms*	*Share (in %)*
Mining and Quarrying	93	0.93
Food, Beverage and Tobacco	217	2.18
Textiles	42	0.42
Clothing	203	2.04
Leather and Leatherwear	72	0.72
Wood products	89	0.89
Paper	51	0.51
Printing	79	0.79
Petroleum Refineries	26	0.26
Chemicals	57	0.57
Rubber Products and Plastic	85	0.85
Nonferrous Metal	251	2.52
Iron and Steel Production	46	0.46
Metal Devices	338	3.39
Machinery	166	1.67
Office Sets and Information Systems	31	0.31
Electrical Products	114	1.14
Communication Devices	25	0.25
Precision and Optical Goods	30	0.30
Road Vehicles	18	0.18
Other Means of Transport	17	0.17
Furniture and other Manufacturing	98	0.98
Building	1,880	18.87
Trade of Vehicles	413	4.14
Wholesale Trade	1,949	19.56
Retail Trade	1,305	13.1
Hotels and Restaurants	398	3.99
Transportation	83	0.82
Other Transportation Activities	188	1.89
Real Estate	155	1.56
Renting	48	0.48
Private Services	448	4.50
Refuse Disposal	870	8.73
	79	0.79
Size (Number of Employees)		
<30	9,282	93.16
30-99	564	5.66
100-249	96	0.96
250-500	13	0.13
>500	9	0.09
Firms	9,964	100.00
Observations	74737	
Obs./firm	7.50	

the tax credit. The percentage of reduction of the user cost of capital due to the tax credit is around 0.14 points on average over the intervention years (2001-2005).

Table 8 Summary statistics (1998-2005)

Variables	Recipient firms			Non-recipient firms		
	Mean	St. Dev.	Median	Mean	St. Dev.	Median
Employment (n. of employees)	13	35.944	6	13	85.574	5
Age (years)	11	37.765	7	12	46.465	8
1 if belongs to a business group	0.069	0.255	-	0.072	0.260	-
Investment/Capital	0.539	1.462	0.104	0.337	1.297	0.033
Lagged investment/Capital	0.609	1.551	0.129	0.376	1.365	0.039
Cash Flow/Capital	0.491	0.538	0.298	0.440	0.533	0.231
Sales/Capital	1.504	1.480	1.208	1.515	3.387	1.103
User cost without incentives	0.072	0.030	0.075	0.073	0.032	0.076
User cost with incentives	0.062	0.032	0.064	-	-	-

Further, it is useful to show the composition of financing sources for the two groups of firms during the intervention years. Table 9 displays that internally generated fund was the main firms' source of finance covering, on average, almost half of investment outlays. The second most important source was new equity with a share around 25 percent, followed by bank finance covering around 20 percent of the flow-of-funds. There are no noticeable differences in the composition of sources of finance among the two groups, except for the fact that the share of own resources (either new equity or internal funds) is larger for not subsidized firms. Fiscal subsidies covered on average a modest share of subsidized firms' investment spending - slightly above 5 percent for recipient firms.

Table 9 Sources of investment finance of recipient and non-recipient firms, 2001-2005

	Total Sample	Number of employees			
		<30		≥30	
		SF	NSF	SF	NSF
Sources of finance (in % of total finance)					
New equity	25.9	24.8	27.8	17.2	26.8
Cash flow	47.7	49.1	52.9	39.3	39.5
Bank debt	19.7	14.9	16.7	32.7	31.8
Fiscal subsidies	2.7	5.5	0	6.2	0
Other sources	4.0	5.7	2.6	4.6	1.9
Importance of sources of finance					
Share of firms with no bank finance (in %)	36.8	39.7	40.1	16.3	18.7
Share of firms with bank finance > 50% (in %)	19.2	18.1	19.0	28.31	26.6
Share of firms with cash flow > 50% (in %)	34.9	35.6	34.3	34.3	36.2
Share of firms with fiscal subsidies > 50% (in %)	-	5.1	-	5.6	-

Notice, on the other hand, that there is considerable diversity in the way small firms financed their investment in comparison with larger firms. The share of bank debt was much lower for small firms than for firms with more than 30 employees. As shown at the bottom of Table 9, this is mainly due to the fact that small firms were more likely not to borrow at all. This is consistent with what is argued in the literature on small business finance in Italy. The limited financial exposition of small firms is mainly due to the fact they do not use external finance to grow, thus reducing their investment activities. The empirical analysis will try to ascertain whether public funds reduced the sensitivity of the investment to internal resources, in particular for small firms.

3.4 Econometric Results

We report alternative estimates of the dynamic econometric investment equation (3.5) in table 10. As expected in the presence of firm-specific effects, ordinary least squares (OLS) appears to give an upwards-biased estimate of the coefficient on the lagged dependent variable, whilst within-groups appears to give a downwards-biased estimate of this coefficient.

Our preferred econometric results are obtained using the GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). This combines a system of equations in first differences using suitably lagged levels of endogenous variables as instruments, as in the basic first-differenced GMM estimator (Arellano and Bond, 1991), with equations in levels for which lagged differences of endogenous variables are used as instruments. Both first-difference GMM and system GMM estimators provide estimates for the coefficient on lagged investment ratio that fall into the credible range. The reported GMM regressions are two-step estimation with corrected errors (Windmeijer, 2005). Instruments used are collapsed second-lag instruments of the lagged values of all right-hand side variables (Roodman, 2008). The validity of lagged levels dated t-2 as instruments in the first-differenced equations are not rejected by both the Sargan test and the Hansen test of over identifying restrictions. Also, the validity of lagged levels dated t-2 as instruments on the first-differenced equations, combined with lagged first-differences dated t-1 as instruments in the levels equations, are not rejected by both Sargan and Hansen test. The Difference Hansen statistic that specifically tests the additional moment conditions used in the levels equations accepts their validity.

The signs of the lagged independent variables and of the main additional control variables are as expected and significant at the conventional confidence levels. The first order term of the lagged investment rate is positive, suggesting

Table 10 Investment equation: OLS, Within Groups and GMM results, panel data 1998-05

Dependent variable: I_{it}/K_{it-1}	*OLS LEVELS*	*WITHIN GROUPS*	*GMM DIF t-2*	*GMM SYS t-2*
Lagged Investment/Capital	0.045**	-0.449**	0.033**	0.033**
(I_{it-1}/K_{it-2})	(*0.004*)	(*0.003*)	(*0.005*)	(*0.005*)
Lagged Cash Flow/Capital	0.00004*	-0.00005	0.003**	0.003**
(CF_{it-1}/K_{it-2})	(*0.00001*)	(*0.0004*)	(*0.001)*	(0.001)
Lagged Sales/Capital	0.018**	0.040**	0.0034**	-0.004
(Y_{it-1}/K_{it-1})	(*0.003*)	(*0.004*)	(*0.0008*)	(*0.020*)
User cost of capital without tax incentives	-0.108**	-0.156**	-0.152**	-0.170**
($\ln\omega_{it}$)	(*0.010*)	(*0.013*)	(*0.030*)	(*0.033*)
Differential effect of the tax credit	-0.313**	-0.311**	-0.313**	-0.309**
($\ln\psi_{it}$)	(*0.015*)	(*0.014*)	(*0.019*)	(*0.021*)
GDP gap	0.085**	0.060**	0.031*	0.109**
	(*0.013*)	(*0.004*)	(*0.017*)	(*0.048*)
Time and Sector dummies	YES	YES	YES	YES
Constant	NO	NO	NO	NO
N-obs.	51.643	51.643	51.643	51.643
AR(1) (*p*-value)			0.000	0.000
AR(2) (*p*-value)			0.176	0.187
Sargan test (*p*-value)			0.287	0.790
Hansen test (*p*-value)			0.437	0.662
Dif-Hansen (*p*-value)				0.365

Note: standard errors are in brackets, ** significant at 5%-Level; * significant at 10%-Level. Instruments used are collapsed second-lag instruments of the lagged values of all right-hand side variables in the first difference equations and collapsed first-lag instruments of the lagged values of all right-hand side in the levels equations.

a regular adjustment process toward the long run target.[25] Also, the value of the coefficient of the lagged dependent variable (0.033) indicates that the adjustment process toward the target is quite fast (α=1-0.033=0.967). The coefficient of lagged cash flow to capital is found positive and significant, but the magnitude is small suggesting that the sensitivity of investment decisions to financing constraints do not matter much for firms belonging to our sample.[26] We will return later on this issue. The coefficient of sales to capital ratio is not significant and close to zero, therefore is not consistent with the presence of

25 The coefficient of the squared of the lagged investment rate, not shown here, is not significantly different from zero, suggesting that the adjustment process is linear. Also, we add the debt to capital ratio which is found to be not significant, suggesting that there is no evidence of sensitivity to bankruptcy costs.

26 After the financial crisis that affected the bank system in Southern Italy in the '90s, official statistics indicate that the availability of bank credit to SMEs returns to a consistent growth in the past years. However, the incidence of credit-rationed firms in Southern Italy was still twice the value observed in the rest of the country. For instance, on the basis of a ISAE-ANBP survey carried out in 2003, the percentage of strong-rationed firms (weak-rationed firms) was roughly 10.2% (19.3%) in Southern Italy while it was around 6.8% (10.6%) in Central-Northern Italy.

imperfect competition. In addition, the coefficient of the GDP gap affects the investment rate positively, as expected, implying that positive macro shocks stimulate capital accumulation.

Our findings show that the user cost of capital is an important determinant of firm's investment behaviour. The value for the coefficient on the user cost without the tax credit is negative and significant (-0.15). The corresponding long run elasticity of investment is -0.42 evaluated at the means level and is very significant. This estimate is larger in comparison to the evidence provided by the literature on this topic when using Italian data[27], although much lower than the value of unity. The coefficient for the residual component of the user cost of capital that accounts for the differential effect of the tax credit (ψ) is equal to -0.31 and significantly different from the coefficient on the user cost without the tax credit. It is important to note that the estimated impact of the tax credit is invariant with the estimation method, implying that the policy variable does not appear endogenous. We interpret this evidence as an indirect test of the ability of our matched procedure to properly reduce differences amongst recipient and non-recipient firms.

The estimated long run elasticity of investment demand is -0.86 and strongly significant, twice as high as the elasticity of the user cost of capital without the incentive. The larger impact of the tax bonus with respect to changes in the other components of the user cost (not subject to temporal deadline) is likely due to the limited duration of the incentive.[28] As known, a temporary investment tax subsidy is expected to influence the timing of when investment is realized, encouraging firms both to postpone investment right after the provision is introduced and to anticipate investment spending when the provision is close to the end. Given that the tax credit on lagged areas entered in force suddenly at the end of year 2000, the delay in investment spending is likely to be meaningless. Indeed, inter-temporal substitution effects should be more substantial prior to expiration. In particular, the budgetary restrictions abruptly imposed during the second intervention year might have induced acceleration in investment ever since then. Our results seem to substantiate such hypothesis.

Looking at the effect of the tax bonus on firms' investment behaviour, it is worthwhile to remark that the value of the elasticity is on the order of unity. This means that for each euro of tax cut, we observe almost one euro (0.86) of additional investments over and above the investment level that otherwise

27 For instance, Arachi and Biagi (2005) find a value for the elasticity of investment with respect to the user cost of capital equal to -0.2.

28 See e.g., Auerbach (1989).

would have been undertaken. Thus, there is no "additionality" (that occurs when the investment outlays, compared to what firms would have done in the absence of the tax-subsidy, increase more than the incentive amount).

We explore the possibility that responses to the policy may vary according to firm size. Table 11 compares estimates of the same specification used in table 10 for the sub-sample of small firms (with less than 30 employees) and for larger firms. The sample split is achieved by assigning each firm to the different sub-samples according to the number of employees in the pre-intervention year (2000). Inspection of Table 11 reveals that results for small firms are very similar to those obtained for all firms.

Table 11 **Subsample results (GMM-SYS t-2)**

Dependent variable: I_{it}/K_{it-1}	***All firms (i)***	***Small firms (ii)***	***Larger firms (iii)***
Lagged Investment/Capital (I_{it-1}/K_{it-2})	0.033** (*0.005*)	0.032** (*0.005*)	0.117** (*0.047*)
Lagged Cash Flow/Capital (CF_{it-1}/K_{it-2})	0.003** (0.001)	0.003** (0.001)	0.009 (0.011)
Lagged Sales/Capital (Y_{it-1}/K_{it-1})	-0.004 (*0.020*)	-0.004 (*0.020*)	0.001 (*0.094*)
User cost of capital without tax incentives ($\ln\omega_{it}$)	-0.170** (*0.033*)	-0.170** (*0.033*)	-0.113 (*0.092*)
Differential effect of the tax credit ($\ln\psi_{it}$)	-0.309** (*0.021*)	-0.312** (*0.021*)	-0.196* (*0.106*)
GDP gap	0.109** (*0.048*)	0.106** (*0.048*)	0.127 (*0.167*)
Time and Sector dummies	YES	YES	YES
Constant	NO	NO	NO
N-obs.	51.643	49,932	1,711
AR(1) (*p*-value)	0.000	0.000	0.002
AR(2) (*p*-value)	0.187	0.243	0.260
Sargan test (*p*-value)	0.790	0.887	0.245
Hansen test (*p*-value)	0.662	0.787	0.392
Dif-Hansen (*p*-value)	0.365	0.489	0.459
Elasticity of investment w.r.t. the user cost of capital evaluated at the mean level			
User cost of capital without tax incentives ($\ln\omega_{it}$)	-0.472** (*0.092)*	-0.464** (*0.092)*	-0.554 (*0.453*)
Differential effect of the tax credit ($\ln\psi_{it}$)	-0.857** (*0.058*)	-0.852** (*0.058*)	-0.955* (*0.515)*

Note: standard errors are in brackets, ** significant at 5%-Level, * significant at 10%-Level. Instruments used are collapsed second-lag instruments of the lagged values of all right-hand side variables in the first difference equations and collapsed first-lag instruments of the lagged values of all right-hand side variables in the levels equations; (ii) includes a direct indicator of expected profitability in order to test whether the significance of the cash flow variable is really due to the presence of important financing constraint.

As far as larger firms are concerned, capital accumulation seems characterized by a slower adjustment process (α=0.883) than in small firms (α=0.968), while the effects arising from changes in the user cost are less precisely estimated. The user cost of capital without tax incentives is no longer significant. The response to the temporary tax credit is significant only at the 10% level. Yet, it is worth noticing that the corresponding elasticity is much closer to unity (-0.955) than in smaller firms (-0.852), suggesting that partial crowding out is less likely to occur in the subgroup of larger firms. On the other hand, lagged cash flow is found to be insignificant for the sub-sample of larger firms, consistently with the hypothesis that large firms are less likely to face financing constraints than small firms.

We further investigate the importance of financing constraints in small firms. As previously stated, lagged cash flow has quite a low impact on the investment behaviour of small and medium-sized firms in the sample we have examined. One interpretation is that financing constraints do not matter much for SMEs in our sample. An alternative interpretation is that financing constraints enter the investment process in a way which has not been captured by the cash flow variable, which instead could proxy information about current expectations of future profitability (Bond *et al*., 2004).[29]

We test the robustness of our finding to measurement errors by explicitly introducing an alternative indicator in the regression model of expected profitability. If cash flows contain information about expected profitability, we can expect this financial variable to become less significant by adding a direct measure of future expected profitability. In that case, the cash flow variable doesn't provide a correct measure to test for the presence of financing constraints. Column (i) of Table 12 includes a proxy for expected future profitability in our investment model for small firms.[30] After controlling for this variable, the lagged cash flow, that was highly significant in columns (ii) of Table 11, remains marginally significant, suggesting that we cannot exclude a certain degree of collinearity between our indicator of expected profitability and lagged cash flow. However, the indicator of expected profitability is statistically not significant, even when we omit lagged cash flow from the investment model

29 Literature provides several arguments on this topic. Kaplan and Zingales (1997, 2000) address the concern that firms facing a higher premium cost for external funds need not show greater sensitivity to changes in cash flow, though this is an open question (Fazzari, Hubbard and Peterson, 2000). For example, Becker and Sivadasan (2006) show that cash flow sensitivity is lower in countries with better-developed financial markets than in countries which rank relatively low in terms of financial development indicators, such as Italy.

30 This measure is obtained as a forward-looking indicator of expected profitability, as described in the data appendix.

(column (ii) of Table 12). This suggests that cash flow, although subject to caveats discussed above, can be interpreted as reflecting financial constraints.

Table 12 Financing constraints in small firms (GMM-SYS t-2)

Dependent variable: I_{it}/K_{it-1}	***(i)***	***(ii)***	***(iii)***	***(iv)***
Lagged Investment/Capital (I_{it-1}/K_{it-2})	0.033** (*0.000*)	0.034** (*0.006*)	0.031** (*0.005*)	0.029** (*0.005*)
Lagged Cash Flow/Capital (CF_{it-1}/K_{it-2})	0.003* (*0.0017*)		0.003** (*0.001*)	0.003** (*0.001*)
Indicator of expected profitability ($E\Pi_t$)	-0.092 (0.333)	-0.000 (0.233)		
CF_{it-1}/K_{it-2} *treated			0.038** (0.006)	
$(CF_{it-1} + RTC)/K_{it-2}$*treated				0.004** (0.002)
Lagged Sales/Capital (Y_{it-1}/K_{it-1})	0.019 (*0.081*)	-0.002 (*0.062*)	0.001 (*0.020*)	-0.004 (*0.020*)
User cost of capital without tax incentives ($\ln\omega_{it}$)	-0.185** (*0.064*)	-0.160** (*0.035*)	-0.188** (0.*034*)	-0.169** (0.*030*)
Differential effect of the tax credit ($\ln\psi_{it}$)	-0.320** (*0.035*)	-0.324** (*0.033*)	-0.325** (*0.021*)	-0.310** (*0.021*)
GDP gap	0.122* (*0.073)*	0.111* (*0.066)*	0.197** (*0.039*)	0.103** (*0.039*)
Time and Sector dummies	YES	YES	YES	YES
Constant	NO	NO	NO	NO
N-obs.	49,932	49,932	49,932	49,932
AR(1) (*p*-value)	0.000	0.000	0.000	0.000
AR(2) (*p*-value)	0.268	0.150	0.148	0.273
Sargan test (*p*-value)	0.877	0.028	0.781	0.853
Hansen test (*p*-value)	0.807	0.337	0.656	0.721
Dif-Hansen (*p*-value)	0.730	0.185	0.361	0.421

Note: robust standard errors are in brackets, ** significant at 5%-Level, * significant at 10%-Level. Instruments used are collapsed second-lag instruments of the lagged values of all right-hand side variables in the first difference equations and collapsed first-lag instruments of the lagged values of all right-hand side variables in the levels equations.

As said above, our main interest in this issue is to test whether the tax credit helped in particular credit-constrained firms, by reducing the sensitivity of investment decisions to the availability of internal funds for such firms. This could be the case, since by analyzing the probability of applying for the credit we have shown that financially constrained firms were more likely to apply for the credit (section 2.3). In particular, we asked whether recipient firms were more likely to face financing constraints than non-recipient firms and if so whether the tax benefit mitigated somewhat the impact of such constraints to firm growth. In Column (iii) of Table 12 we add to our preferred specification (column (i) of Table 11) an interaction term that captures the differential impact

of lagged cash flow on the treated firms. The coefficient on this latter term is found to be significant and the magnitude is much higher than the effect of lagged cash flow on the whole sub-sample. This confirms the evidence provided in section 2.3, that firms that applied for the tax bonus were more likely to be credit constrained. Finally, column (iv) of Table 12 reports estimates of the same specification except that now we include an interaction term that adds the available cash flow and the amount of the tax credit for treated firms. The effect of this variable is significant and much lower than in column (iii), suggesting that that the tax credit was quite effective in reducing the sensitivity to internal finance in credit-constrained firms.

We measure that the increase in investment spending in credit constrained firms due to the income effect is about 0.09 points. By adding the income effect to the substitution effect, the overall impact of the tax relief in small firms is approximately equivalent than in larger firms (0.95). Therefore, our results show that even though there is no additionality, no displacement of the received public support takes place.

In summary, our findings suggest that the tax credit played a positive role in fostering investments in lagged areas. The elasticity of investment to the tax bonus is quite high, although slightly below unity. This means that for each euro of tax cut, we observe almost one euro of additional investments over and above the investment level that otherwise would have been undertaken. In addition, the support somewhat reduced the sensitivity to the availability of internal funds for credit-rationed firms.

However, firms' investment response can be explained at least partially by inter-temporal substitution effects due to the temporary nature of the incentive that might have led firms to anticipate investments before the time of expiration to take advantage of the incentive. In fact, the investment elasticity to changes in the user cost of capital without the tax incentive is much lower than to the temporary tax credit. This implies that the substitution possibilities offered by firms' production technologies are limited and, correspondingly investment incentives have a much narrower impact on the long run capital stock.

Our results are not always consistent with those found by Bronzini et al. (2008a, 2008b). As a matter of fact, both studies reach the conclusion that recipient firms activate investment outlays higher than non-recipient ones, however Bronzini et al. (2008a, 2008b) are unable to measure the presence and degree of additionality. Their results are drawn by specifying the policy variable in binary form (tax credit users, vs. tax credit unusers), a type of setting that only permits to check for the presence of total crowding out, but not to distinguish, as in the present context, whether the increase in the investment outlays effectively exceeds the grant amount or not. Further, our estimates

decompose the impact of the tax credit into the substitution effect and the income effect. In particular, it has been shown that the support somewhat reduced the sensitivity to the availability of internal funds for credit-rationed firms.

In addition, Bronzini et al. (2008a, 2008b) fail to find evidence that the investment boost attributable to the provision is due to time substitution. The empirical strategy adopted in this paper allows us to argue that firms' investment response can be explained at least partially by inter-temporal substitution effects due to the temporary nature of the incentive that might have led firms to anticipate investments before the time of expiration to take advantage of the incentive. In fact, the investment elasticity to changes in the user cost of capital without the tax incentive is much lower than to the temporary tax credit. This implies that the substitution possibilities offered by firms' production technologies are limited and correspondingly investment incentives have a much narrower impact on the long run capital stock.

4 THE REGIONAL TAX CREDIT AND TOTAL FACTOR PRODUCTIVITY GROWTH

In this chapter we examine productivity dynamics at firm-level, namely the evolutionary process in which some firms thrive while other lag, with the aim of investigating whether the availability of public resources makes subsidized firms more productive than the unsubsidized counterpart. In particular, we measure growth in productivity generated by the capital incentives through the estimation of a dynamic behavioural model of the TFP growth at a firm-level.

4.1 Productivity Growth: a dynamic representation

Following Griffith *et al.* (2006), we model productivity dynamics at firm-level by encompassing some observed stylized facts on productivity dispersion and evolution: persistence in productivity levels at firm-level over time, heterogeneity in productivity levels across firms as well as convergence towards the technological frontier. Within this framework, the level of TFP at firm-level, lnA_{it}, can be expressed as a function of its prior level (A_{it-1}), an individual

specific factor (γ_i) to reflect productivity differentials and the distance from the current frontier in the sector *j*, $ln(A^F_j / A_i)$, to capture convergence:

$$\ln A_{it} = \ln A_{it-1} + \gamma_i + \lambda \ln\left(\frac{A_j^F}{A_i}\right)_{t-1} + u_{it} \qquad (4.1)$$

where λ is a parameter that measures the speed of convergence and u_{it} is a stochastic error. This specification imposes that the rate of productivity catch-up depends on relative, rather than absolute, levels of productivity. By re-arranging terms and incorporating an additional determinant - changes in the current technological frontier $\Delta ln A^F_j$ - the following Error Correction Model (ECM) representation is obtained:

$$\Delta \ln A_{it} = \beta \Delta \ln A_{jt}^F + \lambda \ln\left(\frac{A_j^F}{A_i}\right)_{t-1} + \delta Treated * Post + \gamma_i + T_t + \varepsilon_{it} \qquad (4.2)$$

where $\Delta \ln A_{it}$ represents the growth rate in TFP of firm *i* in year *t*. This formulation clarifies the relationship between non-frontier and frontier TFP in terms of technological transfer. The first term ($\Delta ln A^F_j$) provides a flexible representation of the TFP growth rate, by allowing TFP growth in the frontier to have a direct effect on TFP growth in non-frontier firms. The second term ($\ln(A_j^F / A_i)_{t-1}$) corresponds to the size of the technological gap (the distance between the firm performance and the technological frontier). The larger this gap, the greater the potential growth in non-frontier firms associated with the technological transfer. It follows that, while parameter β represents the short-run transitory effect, coefficient λ, that is expected to be of positive sign, expresses the speed of technological transfer through the error correction feedback and therefore captures the intensity of the long-run relationship.[31]

The impact of the investment tax credit on TFP levels is then captured by implementing the differences-in-differences identification strategy, as the differential TFP growth rate between tax credit users and un-users over the period following the credit accrual. Specifically, we incorporate a dummy variable which is an interaction term between an indicating variable equal to 1 if the firm has received the tax bonus (*Treated*) and another binary variable set to 1 for the period after the achievement of the incentive (*Post*). A full set of time, sector and region dummies is also included to control for common shocks to technology and macroeconomic fluctuations, and to account for different

31 This formulation corresponds to the one used in the Tax and Growth study.

degrees of economic development across regions. The residual component ε_{it} is an idiosyncratic error.

4.2 Results and Interpretation

We compute different indexes of TFP in order to check the sensitivity of our results to the choice of the methodology. One measure of TFP is obtained, using the index number approach (Caves *et al*. 1982), as the residual rate of production growth not explained by the growth in the factor input use. Alternatively, the TFP can be computed as the residual from the estimation of firm-level production function. In particular, we apply the estimator proposed by Levinshon and Petrin (2003), henceforth referred to as LP (see the methodological appendix for further details).

The growth of total factor productivity in our estimation sample ranges between 1.6% and 1.9% per annum, respectively on the basis of the index approach and the LP procedure, at the median of the entire distribution over the 1998-2005 sample period (Table 13). The standard deviation on TFP growth is 0.33, which shows that there is considerable variation in growth rates. The logarithm of TFP gap is on average 0.44 amongst firms within two-digit sectors, which implies that non-frontier firms have productivity levels that are on average 55% (62% LP estimates) lower than frontier firms. The TFP gap provides a measure of the potential for productivity catch-up for non-frontier firms. The table shows that there is a substantial variation in the size of such distance. The TFP level of the technological frontier is measured as averaged TFP of the 5% most productive firms in sectors *s* and year *t*. Growth in TFP in frontier firms is 0.2% on average (0.4% LP estimates).

Table 13 **Productivity results: descriptive statistics**

Variable	*Median*	*Mean*	*St. dev.*
	Divisia index		
ΔTFP_{ijt}	0.016	0.023	0.338
$TFPGAP_{ijt-1}$	0.426	0.443	0.202
ΔTFP_{Fijt}	0.003	0.002	0.014
	Levinsohn-Petrin estimator		
ΔTFP_{ijt}	0.019	0.026	0.336
$TFPGAP_{ijt-1}$	0.461	0.485	0.222
ΔTFP_{Fijt}	0.005	0.004	0.026

Note: The sample includes about 67,000 observations of non-frontier firms.

Figure 1 plots the distribution of TFP levels estimated using both the Divisia index and the LP methodology for treated firms and the control group. In particular, the sample is split in pre-intervention years (1998-2000) and post-intervention years (2001-2005). As we can see, the density distribution for the two groups quite overlap in the pre-intervention years, whereas the distribution for treated firms moves slightly to the right (in the sense of the stochastic dominance of the first order) in the post-intervention years. In particular, the density distribution of the treated group turns out to be more concentrated around the median than the density of the control group. The Kolmogorov-Smirnov test of the equality of distributions confirms that the distribution of TFP levels for firms that received the credit contains larger values than the control group. Most importantly, this holds on the basis of both productivity measures.

Figure 1 - Distribution of TFP levels across treated and untreated firms

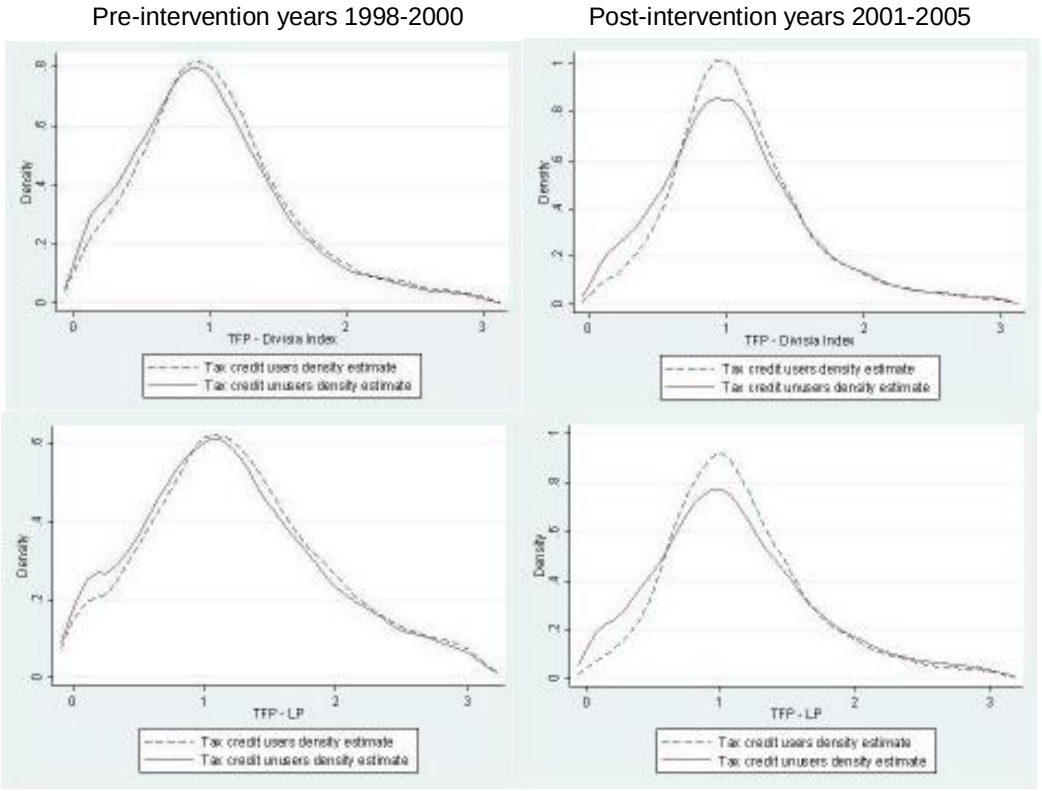

Table 14 reports the frequency of companies that transit between quintiles of their 2-digit sector TFP distribution by distinguishing treated and untreated firms. The rows of the transition matrix report the proportion of firms by quintile in year 2005 and by each quintile of the TFP distribution in the pre-intervention year 2000. For example, the first row shows that of the treated companies that were in the bottom quintile of their sector's TFP distribution in year 2000, five years later 39% of those that survived remained in the bottom quintile, 25% moved up to the second quintile, 15% to the third, 8% to the fourth and 12% to the fifth quintile. This transition matrix confirms basic findings related to productivity dispersion and growth uncovered by the recent literature using microdata. Specifically, it shows that the estimation sample is characterized by a high degree of persistency in productivity levels at both extremes of the TFP distribution, accompanied by a significant degree of heterogeneity in intra-firm productivity (as assumed by the catching-up model discussed above). For the purpose of our concern here, this transition matrix also confirms that the main distance in performances between treated and untreated firms are concentrated amongst less productive firms as shown by the kernel density plot. Recipient firms that were in the lower quintiles in 2000 are more likely to move upward within the productivity distribution than the control ones or, which is the same, less likely to lag (quintile 2).

Table 14 **Transition matrix**

Quintile of TFP Distribution, year 2000		*Quintile of TFP distribution, year 2005*					
		1	2	3	4	5	Total
1	Treated	**39.48**	25.09	14.98	7.73	12.72	100
	Untreated	**43.73**	19.39	10.96	6.53	19.39	100
2	Treated	18.63	**32.44**	26.45	11.88	10.60	100
	Untreated	25.80	**27.18**	19.61	12.04	15.37	100
3	Treated	11.41	22.39	**28.96**	23.90	13.35	100
	Untreated	13.44	20.51	**24.33**	23.52	18.19	100
4	Treated	8.66	13.56	22.32	**31.29**	24.16	100
	Untreated	9.72	12.44	19.08	**30.09**	28.67	100
5	Treated	9.96	9.96	11.65	23.40	**45.02**	100
	Untreated	12.03	9.82	10.97	18.09	**49.09**	100

Note: the table shows the frequency of firms by quintile of the TFP distribution within their 2-digit sectors in year 2000 and 2005, in particular only firms that are present in both periods are included. Productivity measures are computed with the index approach. Quintiles are sorted in increasing order, i.e. quintile 1 is the bottom quintile

The relationship between the assignment of the tax bonus and changes in the productivity distribution is then investigated by estimating model (4.2). The results are reported in table 15. We estimate the model applying the GMM estimator developed by Blundell-Bond (1998). In particular, we instrument the TFP gap term using lagged value of the variables to correct for potential measurement errors in TFP. Column (1) of Table 15 reports the basic specification of the model (equation 4.1). As expected, the correlation between the firm's TFP growth rate and the distance to the technological frontier (in their 2-digit sector) is positive and significant. In column (2) we add the growth rate of TFP in the frontier as in the ECM representation (equation 4.2). This specification allows for a more flexible long-run relationship between frontier and non-frontier TFP. The frontier growth rate enters with a positive and significant coefficient. This implies that firms in industries where the frontier is growing faster also experience faster growth.

Table 15 TFP growth at the firm level and the impact of the investment tax credit

dep var: ΔTFP_{ijt}	(i) All firms	(ii) All firms	(iii) All firms	(iv) Far from Leaders	(v) Close to Leaders
ΔTFP_{Fjt}		0.190** (*0.034*)	0.140** (*0.062*)	0.164 (*0.141*)	0.319** (*0.045*)
$TFPGAP_{ijt-1}$	0.255** (*0.076*)	0.259** (*0069*)	0.156 (*0.128*)	0.222 (*0.201*)	0.447** (*0.093*)
Treat*Post			0.023 (*0.016)*	0.172** (*0.076*)	0.035** (*0.013*)
Year dummies	Yes	Yes	Yes	Yes	Yes
2-digit sector dummies	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes	Yes
Sargan test	0.014	0.000	0.515	0.121	0.044
Hansen-J test	0.175	0.113	0.582	0.653	0.101
N. obs.	59,200	59,200	59,200	28,234	30,014

Note: Robust standard errors are in parenthesis. ** denote significance at 5%-Level; * denote significance at 10%- Level. Instruments used are: in the first-differenced equations TFPGAPijt-3, TFPGAPijt-4, and in the levels equations: ΔΔTFPGAPijt-2. The test of serial correlation suggests that there is first order serial correlation in the disturbance term, but no second order serial correlation is detected. Also, the set of instruments used is appropriate based on the Hansen-J test.

Further, we try to incorporate other possible determinants of TFP dynamics of firms in Southern Italy such as age, as a proxy for experience and managerial skills, whether the firm belongs to a business group, and an index of

proximity to credit rationing in the region where the firm operates. This index is obtained as the ratio between the amounts used of bank loans over the amount authorized at a regional level.[32] For values close to 1, this index indicates that firms located in the region are more exposed to the risk of credit rationing.[33] A positive coefficient on age is expected, meaning that mature firms are more efficient and able to raise external funds than newborn firms; a positive coefficient on the variable indicating the firm belongs to a business group would suggest that business groups represent a form of organization which allows them to overcome, at least partially, the drawbacks implied by the small size of Italian firms; and a negative coefficient on the index of proximity to credit rationing would imply that the conditions of the credit market are an important determinant of firm growth. However, including these additional explanatory variables provides unsatisfactory results. The parameters on the frontier growth rate and on the gap term remain positive and significant, the supplementary variables enter with the expected sign but their effects are not precisely estimated (these results are omitted here).

The specification in column (3) accounts for the impact of the investment tax credit on TFP growth rates. The coefficient on the variable *Treated*Post* represents the differential TFP growth rate on the treated averaged over the entire period after the firm received the incentive. The coefficient enters positively, but is not precisely estimated. In addition, the gap term becomes insignificant. This suggests that, when trying to identify the causal effect of the tax credit, a misspecification problem became apparent; that is, the parameters of the model turn out to be unstable over the whole sample. As shown by the descriptive analysis of the TFP distribution, the distance between TFP levels of recipient and non-recipient firms tend to be higher for low-productivity companies. Also, the degree of persistency in productivity levels is higher at the bottom and top quintile of the TFP distribution. We split the sample in firms far from, and near to, the technological frontier firms in the industry. The division is based on the median value of the productivity gap in each industry in the pre-intervention year 2000. Column (4) and (5) confirm that the effectiveness of the regional tax credit varies in the two sub-samples and the coefficients on the variable Treated**Post* are now strongly significant in both sub-samples. Notice also that the other parameters of the model vary considerably in the two estimates. In firms far from leaders, the TFP growth rate in the frontier and the

32 Source: Bank of Italy.

33 This index ranges between 0.75 and 0.87 over the observation period and is higher in several regions such as Calabria, Campania, Sardinia and Sicily, than in the rest of the targeted territories covered in the estimation sample.

gap term have the expected sign but are not significant, confirming that the bottom side of the TFP distribution is characterized by a high degree of persistency in productivity levels and that the catching-up is weak. Indeed, the differential growth in productivity in firms that received the credit with respect to the control group was fairly high over the post-intervention years, roughly 17% per annum. On the other hand, firms near the TPF frontier seem to be more sensitive to changes in the current technological frontiers; also, the convergence effect is stronger. For high-productivity companies, the magnitude of the extra increase in productivity of firms that received the credit appears quite substantial as well, equal to 3.5% per annum.

We also tried to recover the impact of tax subsidies on productivity in SMEs and larger firms, but again, as for the whole sample, such estimates are not clear-cut. Interestingly, it thus appears that the distribution of productivity growth rates according to firm size do not correspond to the ranking of the distribution itself so that, for instance, less productive firms do not generally coincide with smaller firms.

Further, to answer the question on whether the investment credit is efficient under an economic point of view, in the sense that the cost is counterbalanced by an almost equivalent increase in the value added in the targeted areas, we use our estimation results to gauge the overall impact of the investment credit on the level of production through a simulation exercise. As a whole, setting the tax bonus to zero, the value added in recipient firms would have been some 1.3 percent lower during the 2001-2005 period. There are wide variations across firms, however. Our results suggest that the public support was a quite significant driving force for low-productivity firms, while it had a moderate effect in high-productivity firms. The value added loss would have been on average 3 percent in firms far away from the TFP frontier compared to barely 0.5 percent in firms already near the frontier throughout the post-intervention years.

Comparing the increase in production level induced by the tax credit to the budget resources allocated, we find that the overall output additionality corresponds approximately to the 48 percent of the total amount of credit claimed by firms belonging to the sample used here. These estimates should be judged with caution considering that the effects of additional investment generated by the tax bonus on the level of production likely comes with delays and are of unknown length, thereof our observation period is relatively short for a complete assessment.

One argument to explain the small gains from public support in high-productivity firms could be that they already belong to the productivity frontier. On the other hand, the incentive schemes to lagged areas are justified by the

objective gap in the degree of economic development, arising from differences in infrastructural, social and economic conditions between targeted regions and the rest of the country. What emerges from our results is that the policy tool under exam has supported companies in the process of improving their own competitive positions within local productive systems but, taken as a whole, the enhancement doesn't appear to be substantial enough so as to reduce the gap with respect to external areas. This can be explained by the fact that over the period considered here the prevailing competitive model rests on production cost and price minimization. Although the incentive scheme comprises a wide variety of investment profiles, including the purchase of patents and rights of usage of intellectual property, the effort made by firms to adopt development paths oriented to quality and innovation, is meaningless. For less productive firms, the public support represented a precious source of finance, in many circumstances a substitute to bank loans, to undertake investment that contributed significantly to recuperate production efficiency. However, for firms already close to the local production frontier, the possibilities of realising efficiency gains could arise to a greater extent from the adoption of development paths oriented to quality and innovation and to sustaining internalization strategies.

5 POLICY CONCLUSIONS

The conclusions reached in this study go beyond those obtained by standard applications of well known statistical techniques. Taken as a whole, our findings suggest that providing a tax-based subsidy targeted to the accumulation of capital is not an optimal tool for regional policy aiming at fostering local development. What we learned from the Italian experience highlights that a tax credit automatically administered and not restricted to profitable firms represents an important support for SMEs, credit-rationed firms and low productivity firms. However, the increase in investment outlays, compared to what firms would have done in the absence of the fiscal stimulus, does not overcome the tax bonus amount. In addition, the programme exerts a much lower impact on productivity growth in firms near the local leaders in productivity. On the other hand, deadweight losses associated to a universalistic support are unsustainable particularly in the current recessive macroeconomic conjuncture. The report also underlines the implications of the

provision on the timing of investments, which should instead be decided by firms on the basis of financial and economic profitability perspectives in order to avoid distortions in the optimal allocation of resources. It is also worth underling that the administration of the tax incentives should not increase the uncertainty and difficulties in forecasting the path of the user cost of capital with sudden modifications of the program in force.

This study suggests the need to address public effort more selectively to the fostering of risk-taking in innovative business also in the context of policy interventions for reducing territorial disparities: unintended “windfall gains” should be avoided and resources should be reallocated from inefficient firms to business activities with greater potential for economic growth. In particular, the tools for innovative finance, usually absent in lagged regions such as in Southern Italy, should be enhanced in order to spur the adoption of advanced competitive strategies based on quality and innovation.

In the context of regional policies, the choice between lowering the rate and broadening the base is a real option provided local authorities are allowed to introduce differentiated tax regimes. For example in the EU countries, the most recent Community jurisprudence has legitimated selected forms of differentiated tax regimes provided decisions are taken by regional governments autonomously without seeking compensations through transfers from central revenues. To benefit firms in lagged areas, differentiated regimes should be introduced asymmetrically and the reduction in the tax burden should be proportional to the differential in net benefits arising from the location of business activities in territories characterized by a lower degree of economic development.

METHODOLOGICAL APPENDIX

Measurement of Total Factor Productivity

As it is standard in the existing empirical literature, one measure of relative total factor productivity is obtained using the index number approach (Caves *et al*., 1982)

$$\Delta TFP_{it} = \Delta \ln Y_{it} - \sum_{z=1}^{Z} \tilde{\alpha}_{it}^{z} \Delta \ln x_{it}^{z} \qquad \text{(A.1)}$$

where *Y* denotes value added, x^z is use of factor z, $\tilde{\alpha}_{it}^{z}$ is the Divisia share of total cost ($\tilde{\alpha}_{it}^{z} = \left(\alpha_{it}^{z} + \alpha_{it-1}^{z}\right)/2$, where α_{it}^{z} the share of factor z in total cost at time *t*) and *Z* is the number of input factors. The Divisia index of factor inputs is derived as a weighted sum of growth rates, where the weights are the shares. By imposing $\sum_z \tilde{\alpha}_{it}^{z} = 1$, constant returns to scale are assumed.

The distance between the firm performance and the technological frontier can be computed straightforwardly. Define the measure of relative TFP, evaluated relative to a common reference point - the geometric mean of all other firms in the same industries -, as follows

$$MTFP_{it} = \ln\left(Y_{it} / \bar{Y}_{jt}\right) - \sum_{z=1}^{Z} \sigma_{it}^{z} \ln\left(x_{it}^{z} / \bar{x}_{jt}^{z}\right) \qquad \text{(A.2)}$$

where $\bar{Y}$ and $\bar{x}_j^z$ are geometric mean of value added and the use of factor *z* for all firms in the same industry over all years and $\sigma_i^z = \left(\alpha_i^z + \bar{\alpha}_j^z\right)/2$ is the average of the factor share in firm *i* and the geometric mean factor share in industry *j*. Again, we impose constant return to scale ($\sum_z \sigma_i^z = 1$). Denote the frontier level of TFP relative to the geometric mean $\mathrm{MTFP}_{\mathrm{jt}}^{\mathrm{F}}$. Subtracting $\mathrm{MTFP}_{\mathrm{jt}}^{\mathrm{F}}$ from $\mathrm{MTFP}_{\mathrm{it}}$, we obtain a superlative index of the productivity gap between a firm and the technological frontier in a sector-year. This is denoted by $\mathrm{TFPGAP}_{\mathrm{it}}$ and is the empirical counterpart to $\ln(A_j^F / A_i)_t$ in the section 4.1 above.

A parametric measure of total factor productivity can be computed as the residual from the estimation of firm-level production function. Denoting by f_{jt} a

generic production function for industry *j* and by A_{it} a time dependent index of technological progress or TFP, we are interested in estimating the production function $Y_{it} = A_{it} f_{jt}(x_{it})$. We assume a logarithmic Cobb-Douglas (Hicks neutral) technology in labour inputs and capital (L, K) of the form

$$\ln Y_{it} = \alpha_j \ln L_{it} + \beta_j \ln K_{it} + \varepsilon_{it} \qquad \text{(A.3)}$$

where the error term ε_{it} comprises two unobservable components, the productivity term, A_{it}, and the random component. While this letter is independent from input choices, the same does not hold for the productivity component. Potential endogeneity between input levels and productivity arises because firms may observe productivity shocks (that are unobserved for the econometrician) and respond by varying the input use accordingly. Estimators ignoring this correlation (such as OLS) will yield inconsistent results. Levinsohn and Petrin (2003) show the conditions under which intermediate inputs can be used as a proxy for these unobservable shocks, as an extension of the estimator proposed by Olley and Pakes (1996). The LP approach can be readily implemented with no additional data requirements, since intermediate inputs are typically subtracted from a value-added production function. Also, intermediate input proxies do not suffer from the truncation bias induced by investment proxy, as in the Olley and Pakes' estimator, which requires firms to have non-zero levels of investment[34].

A common drawback of these estimators is the assumption that the underlying production function is Cobb-Douglas, whereas it would be preferable to assume a more flexible technology. The index number approach may be preferable from this point of view, since it can be shown that formulation (4.1) is consistent with a *translog* production function which provides an arbitrary close local approximation to any underlying production technology. However, it relies on a number of other potentially critical assumptions, including constant return to scale and perfect competition on factor markets[35].

Our TFP measures are obtained allowing the production frontier to vary across two-digit sectors and time.

34 In addition, intermediate inputs may respond more closely to productivity shocks than investment, because adjustment costs associated with intermediate inputs are lower. The Levinsohn-Petrin procedure is available for Stata users, see Petrin, Poi and Levinsohn (2003).

35 These requirements imply that factor shares contain information on its marginal physical productivity, and therefore provide the correct weight for the factor input when measuring productivity.

DATA APPENDIX

The main variables we use in the analysis are listed below.

The *investment ratio* is computed as the ratio of investment to the replacement cost value of the stock of capital at the beginning of the period. Investment spending is measured as purchases minus sales of tangible and intangible assets. In particular, investment spending is inferred from changes in the book values of tangible and intangible assets in each period. Given that the reported net book value of assets subtracts the fiscal depreciation allowed for tax purposes rather than commercial depreciation, the capital stock is corrected by taking into account the economic depreciation. This correction lowers the value of accumulated depreciation and thus increases the net book of assets.

The *stock of capital* at current replacement cost is obtained by using the perpetual inventory method, which is based on the assumption that the rate of utilization of capital goods is constant over time. The starting value of the capital stock is drawn from the net book of tangible fixed capital and intangible assets in the first year, adjusted for the previous year's inflation, and then subsequent values are calculated recursively as follows:

$$p_t^I K_t = (1-\delta) p_{t-1}^I K_{t-1} \frac{p_t^I}{p_{t-1}^I} + p_t^I I_t \qquad \text{(A.1)}$$

where p_t^I is the price of investment goods, K_t is the capital stock, I_t is real investment and δ is the economic depreciation rate. In particular, this measure of capital stock is obtained by aggregating across different types of capital goods. Price indices and economic depreciation rates for different types of capital goods are drawn from the national accounts on gross investments by owner branch (Istat, 2002)[36].

The *cash flow* is computed from after tax profits plus depreciation.

The indicator of expected profitability is defined as follows:

$$E\Pi_{it} = \frac{\hat{\Pi}_{i,t+1}}{p_t^K (1-\delta) K_{i,t-1}} \qquad \text{(A.2)}$$

where $\hat{\Pi}_{i,t+1}$ is approximated with profit before tax at time t+1 and the denominator is the replacement cost value of the stock of capital that the firm inherits from the previous period. Equation (A.2) provides a measure of expected profitability for the following year.

36 These statistics were recently revised according to OECD guidelines provided in "Measuring Productivity, OECD Manual", OECD, Paris, 2001.

Following are the parameters and data sources used in the calculation of the user cost of capital:

$$C = \frac{(1-\tau A - f\kappa)(\rho + \delta - \pi)}{(1-\tau)}$$

where $\rho = \phi r_L (1-\tau) + \frac{(1-\phi) r_B}{(1-z)}$ is the financial cost of capital.

Symbol	*Definitions*	*Sources*
A	depreciation allowances for type of capital	Fiscal
τ	effective marginal tax rate on corporate profits	Corporate tax return data
f	Proportion of realized investments that benefit of the tax credit	CERVED - Company accounts data Corporate tax return data
k	Marginal effective credit rate	Corporate tax return data
δ	Economic depreciation	OECD
ϕ	Debt ratio	CERVED - Company accounts data
r_L	Interest rate on loans	Bank of Italy
r_B	Interest rate on safe investments	Bank of Italy
π	Inflation rate	ISTAT
z	Tax rate on capital gains	Fiscal

Firm size is measured by the sales distribution; firms in the top quartile are considered large firms.
Firm age is the number of years from the setting up of the firm, as an indicator of informationally opaque firms.
Firm ownership, we distinguish independent firms from firms belonging to a business group.

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