

# Is firm's productivity related to its financial structure? Evidence from microeconomic data

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## Abstract

The theoretical literature on corporate finance points to an equilibrium relationship between the firm's share of intangible assets and its financial structure. Firms undertaking innovative activities typically hold specialized equipment and a large share of immaterial assets, such as patents, research knowledge, project specific human capital. Hence, more innovative firms tend to have a different capital structure from less innovative ones. Ultimately, differences in the propensity to innovate are likely to translate into different total factor productivity (TFP) levels. In this paper, we rely upon a detailed dataset for a panel of Italian firms in order to study the empirical relationship between firms' capital structure and their TFP. In particular, we identify variations in firms' financial structure induced by factors that do not directly affect the share of intangibles in their total assets and we test whether these exogenous variations determines changes in firms' productivity. The empirical results show a negative relationship between leverage and productivity, consistent with theories of firms' financial structure based on bankruptcy costs, conflicts of interest between equityholders and debtholders and control rights. Our findings

have strong policy implications, suggesting that interventions favoring market finance may have substantial effects on aggregate productivity.

## 1 Introduction<sup>1</sup>

The relationship between the real and the financial sector of the economy has been a central issue in the literature, going back at least as far as Bagehot (1873). The last decade has witnessed a resurgence of interest in this topic, both at the theoretical and, to a larger extent, at the empirical level. A major achievement of this renewed research effort is a conclusive answer to the question of causality. A number of recent papers have shown that more developed financial systems foster economic growth, owing to their ability to allocate the available resources to more productive tasks.<sup>2</sup>

A parallel issue studied in the literature is whether bank- or market-based financial systems are better at allocating the available economic resources. On the theoretical side the debate is widely open. Some authors have argued that markets and venture capitalists are better in financing riskier and, when successful, more profitable and productive projects. Other have emphasized the importance of financial intermediaries in overcoming the information problems that characterize financing decisions. On the empirical side, the available evidence does not provide a clear answer to the question.<sup>3</sup>

This paper takes a different route from previous literature and attempts to answer the question of what financial systems allocate most efficiently the available economic resources by analyzing the relationship between a firm's capital structure and its productivity. The rationale is the following: firms undertaking innovative activities typically hold specialized equipment and a large share of immaterial assets, such as patents, research knowledge, project specific human capital. At the same time, the theoretical literature on corporate finance points to an equilibrium relationship between the firm's share of intangible assets and its financial structure. Hence, more innovative firms tend to have a different capital structure from less innovative ones. Ultimately, differences in the propensity to innovate are likely to translate into

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<sup>2</sup>For a reputed opposite view, see Robinson (1952).

<sup>3</sup>the next section briefly discuss this issue; additional references are in Levine (2004).

different TFP levels (Griliches and Lichtenberg, 1984). Financial systems more capable of providing the type of funding used by firms with a higher productivity should therefore also guarantee higher aggregate productivity.

The relationship between a firm's leverage and its share of immaterial assets is not obvious, because many different mechanisms link a firm's financing choice and its propensity to innovate. On the one side, theories emphasizing bankruptcy costs, conflicts of interest between equityholders and debtholders and control rights suggest that firms holding larger portions of immaterial assets are less likely to be reliant on debt finance (Jensen and Meckling, 1976; Hart, 1995). On the other side, theories based on agency costs and informational asymmetries suggest that equity financing is subject to severe underpricing in firms holding more intangibles (Myers and Majluf, 1984), favoring the use of debt over that of equity financing (i.e., a higher leverage).

The alternative theoretical predictions lend themselves to the empirical scrutiny. In this paper, we rely upon a detailed dataset for a large panel of Italian firms in order to study the relationship between firms' financial structure and their productivity. In particular, we concentrate on exogenously driven variations of the firm's financial structure in order to avoid the endogeneity problems that would otherwise affect a regression of TFP on leverage.<sup>4</sup>

Our results show that firms with lower leverage have a higher level of total factor productivity. This can be seen as indirect evidence that market-based financial systems drive to higher levels of real economic activity. Moreover, we lend some empirical support to the view that the better performance of less leveraged firms descends from their stronger ability to invest in more productive, but also more opaque, activities, in particular research and development. Our results have important policy implications, as they imply that interventions favoring market finance may have substantial effects on aggregate productivity.

The remaining of the paper is organized as follows. In the next section we present the theoretical and empirical background of our framework, reviewing the major results of the literature related to our research. Section 3 presents the empirical model adopted in the econometric analysis. Section 4 describes the data used in the empirical analysis and the methodology for

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<sup>4</sup>A further strength of our analysis is that of overcoming the potential aggregation bias that is likely to plague the existing studies, based mostly on data at the country and industry levels.

estimating firms' productivity. The results of the basic specification and of the robustness checks are presented in section 5. Section 6 concludes.

## 2 Background

Two major strands of economic literature are related to the issues discussed in this paper: the one studying the relationship between financial development and the performance of the real economy, and that on the determinants of firms' financial structure.

A number of theories have been proposed in order to explain how the development of the financial system may affect the performance of the real economy. Mainly, they hinge on the degree of efficiency of financial markets in channelling funds from sectors in financial surplus to sectors in deficit, focusing, for example, on the ability of financial intermediaries to evaluate investment opportunities (Grenwood and Jovanovic, 1990; King and Levine, 1993) or to provide liquidity in front of illiquid investment (Bencivenga and Smith, 1991).

Empirically, the positive correlation between financial development and real economic growth is a firmly established fact. The most recent literature has gone one step further, showing that there is a substantial causal relationship going from financial development to economic growth (see, e.g., Jayaratne and Strahan, 1996; Rajan and Zingales, 1998), and that this is mainly the result of a more efficient allocation of financial resources than of higher rates of saving and capital accumulation (Wurgler, 2000; Beck et al., 2000).

The question of whether bank-based or market-based financial systems are more efficient in allocating the available resources is more debated. From a theoretical point of view, authors such as Allen and Gale (2000) argue that financial markets are better at financing projects on which the investors' opinions are more heterogeneous, such as R&D investment; others stress instead the role of financial intermediaries in overcoming the information problems that characterize financing decisions, as emphasized in the seminal contribution of Diamond (1984). On the empirical side, no clear evidence has been provided showing the supremacy of one system or the other (see, e.g., Levine, 2000; Beck and Levine, 2002; Demirguc-Kunt and Maksimovic, 2002).<sup>5</sup>

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<sup>5</sup>To our knowledge, the only paper finding evidence of differences between the two

The second strand of literature related to the analysis presented in this paper is that on the determinants of firms' financial structure. Indeed, if the Modigliani-Miller indifference theorem applied, there would be no reasons why a financial system should be preferred to another. However, the literature on firm's capital structure has uncovered a large number of channels through which differences in firms' funding sources affect their investment and output decisions.<sup>6</sup> With respect to the analysis presented in this paper, this extensive literature can be classified into three major classes, depending on whether the analysis focuses, respectively, on bankruptcy costs, agency problems, or asset control.<sup>7</sup>

Bankruptcy cost theories are based on the idea that the loss incurred by debtholders in case of default is lower if the firm has a larger share of tangible assets, that can be more readily sold in the market (Jensen and Meckling, 1976). Hence, more innovative firms, having a larger share of intangibles, are less likely to be financed with debt.

Theories based on agency problems have considered different types of conflicts of interest. Harris and Raviv (1990) and Stulz (1990) study the effects of the conflicts between equityholders and managers: because the latter hold less than the full residual claim, they have an incentive to look for personal benefits, like consuming 'perquisites' such as large offices or corporate jets. In order to control for this problem, equityholders can increase the firm's share of debt, therefore limiting the amount of free cash available to managers. Clearly, it will be easier for managers to divert resources for their personal uses when they are dealing with more opaque projects, as it is typically the case for innovative firms. If this is the case, equityholders should require, for such firms, a higher leverage.

A further type of conflict is that between insiders (managers or entrepreneurs) and outsiders. Because the former are better informed about the financial prospects of the firm, the latter may interpret the choice of is-

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types of financial systems is Tadesse (2000), who shows that bank-based systems are more growth enhancing if the overall financial sector is underdeveloped, while the opposite is true for more developed financial systems.

<sup>6</sup>The dimension of this literature is witnessed by the already large number of surveys available on this issue. See, among the others, Harris and Raviv (1991), Shleifer and Vishny (1997), Zingales (2000) and Myers (2001).

<sup>7</sup>An additional class of models is based on the role of the different tax costs of debt and equity financing. Although these models have no major implications for the relationship between firms' financial structure and productivity, they provide the theoretical background for some set of instruments used in the empirical analysis (see section 3).

suing new equities – which dilute the insiders’ control – as a negative signal on the firm’s future prospects, and therefore underprice them. Under these assumptions, Myers and Majluf (1984) show that the firm’s optimal strategy implies the use of equities as the last source of finance, after internal funds and debt. Because for innovative firms it is more likely that information asymmetries are substantial, they should also have a higher share of debt financing.

Finally, since the seminal works of Jensen and Meckling (1976) and Myers (1977), the conflict of interest between debtholders and equityholders has also been analyzed. The basic idea in this literature is that equityholders, as residual claimants, have an incentive to take on riskier projects than what would be optimal (to ‘go for broke’). Because debtholders anticipate this behavior, the value of debt is underpriced, reducing the incentive for equityholders to use it as a source of finance. Clearly, if innovative firms are more likely to face riskier investment opportunities, their debt issues should suffer even more from underpricing, forcing firms to make a larger use of equity financing.

The last class of theories emphasize the role of control rights, building on the seminal works of Aghion and Bolton (1992) and Hart (1995). The basic idea is that firms’ optimal capital structure is the result of the trade-off between the marginal cost of diluting the control rights by issuing new equities and the marginal cost of debt in case of default. Because the latter increases with the share of intangibles, these theories predict that innovative firms are less likely to use debt financing.

In summary, a first class of theories – based on bankruptcy costs, on conflicts of interest between equityholders and debtholders and on control rights – predict that more innovative firms have lower leverage; a second class, based on conflicts of interest between managers and shareholders and between insiders and outsiders, predict the opposite.

The empirical literature on the determinants of capital structure has searched for the effect of a number of firms’ characteristics on their capital structure. Titman and Wessels (1988) find that firms with higher growth opportunities – as measured by the growth rate of total asset, capital expenditure over total assets and R&D expenditures over total sales – have lower debt financing, consistent with the first class of theories discussed above. Titman and Wessels (1988) and Bradley et al. (1984), similarly find that firms with more unique products – proxied by the sales expenses over total sales (a measure of marketing and advertising costs), the number of voluntarily

quitting employees (a measure of the specificity of the human capital employed in the firm) and R&D expenses – are less likely to use debt financing. provide empirical evidence in favor of this hypothesis. Among the other variables that have been found to positively affect the equilibrium share of debt financing are also size (Warner, 1977; Smith and Warner, 1979), earnings’ volatility (Marsh, 1982; Bradley, Jarrel and Kim, 1984), and the probability of bankruptcy (Castanias, 1983). Finally, in partial contrast with Bradley et al. (1984), Aghion et al. (2004) find that firms with no R&D expenses and with high R&D expenses have a large share of new equity financing, while firms with positive but low R&D expenses have a larger share of debt financing.<sup>8</sup>

Two papers empirically investigate the relationship between labor productivity and financial structure. Nickell and Nicolitsas (1995), studying a sample of UK firms, find some evidence of a a small positive effect of debt pressure on labor productivity. They interpret this result as consistent with the hypothesis of Jensen (1986) that if managers lose more than shareholders in the event of bankruptcy, a higher debt position may cause a reduction in investment and an increase in efforts to raise efficiency which, in turn, determines a positive link between debt and productivity. Schiantarelli and Sembenelli (1997), studying a different sample of UK firms and a sample of Italian firms, find instead a positive relationship between labor productivity and leverage and a negative relationship between labor productivity and debt maturity.

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<sup>8</sup>A parallel strand of literature, starting with the seminal contribution of Fazzari et al. (1988), studies how firms fund new investment. The existence of a positive relationship between corporate investment and cash flow has been interpreted by many as evidence consistent with the hypothesis that financial constraints affect firms’ investment policies. Recently, Kaplan and Zingales (1997 and 2000) have argued instead that ”investment-cash flow sensitivities are not valid measures of financing constraints”, providing empirical evidence that investment-cash flow sensitivities do not increase monotonically within the degree of financing constraints, as measured by a variety of firm specific, mainly balance-sheet indicators. The debate on this issues is still open. However, as Hubbard (1998) argues, ”while there is relatively widespread agreement on the role of financial frictions in the investment decisions of some firms, there is less agreement on the magnitude of that role”.

### 3 The empirical specification

As shown in the previous sections, theories of capital structure point to an optimal relationship between the intensity of innovative activities and the financial structure. There are, however, different theoretical views on the equilibrium relationship between the capital structure and the extent to which firms innovate. These views lend themselves to the empirical scrutiny, which may shed light on the merits of competing models of corporate finance.

Our estimation framework will be as follows. First, we identify variations in firms' financial structure induced by factors that do not directly affect their productivity. Second, we investigate whether the exogenous variations in leverage induce firms to change their propensity to innovate and, as a consequence, their productivity.

The reason for considering exogenously driven variations of the firm's financial structure is that a straight regression of TFP on leverage would be subject to serious endogeneity problems. Indeed, the equilibrium relationship that we described above implies that a firm with a certain leverage is bound to a given level of intangibles (and hence of TFP). At the same time, however, a firm wishing to innovate by increasing its share of immaterial assets is bound to change its leverage. Causality may therefore run in both directions.<sup>9</sup>

In light of these problems, in order to pin down the implications for productivity of a firm's financial structure, we adopt the following instrumental variable specification:

$$LTFP_{it} = \alpha + \beta LEV_{it} + Z_{it}\gamma + \eta_i + \varepsilon_{it} \quad (1)$$

where  $LTFP_{it}$  is the natural logarithm of the total factor productivity of firm  $i$  at time  $t$  and  $LEV_{it}$  is the leverage of firm  $i$  at time  $t$ ; the regression include a set of control variables ( $Z_{it}$ ), represented, among others, by time (calendar year), size and geographical (provinces) dummies.  $\eta_i$  reflects the fixed latent heterogeneity and  $\varepsilon_{it}$  is a random error that is assumed to be independently and identically distributed (i.i.d.) with mean zero and variance  $\sigma_\varepsilon^2$ . We estimate the above equation using the between-group estimator, that ignores the over time variation of firms' characteristics, and the fixed-effect instrumental-variable estimator, which only accounts for within-firm variation in TFP.

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<sup>9</sup>A more specific potential bias, determining a negative relationship between leverage and productivity, owes to the fact that firms with a higher TFP are likely to generate higher profits and cash-flows, and therefore make lesser use of debt.



In order to instrument leverage, we selected the following variables: a) a tax variable summarizing the taxation components of each firm's user cost of capital; b) an indicator of regional financial development. Our choice of instruments, of course, requires a detailed explanation.

With regard to the first instrument, we recall that a variety of tax policy instruments are included in the user cost formula. Because the source of investment financing is not neutral with respect to tax policy, the firm's capital structure is likely to depend on the tax variables summarized in the user cost formula. Fortunately, we had access to a detailed dataset constructed at the Bank of Italy where information on all the fiscal-related components of the user cost is set to the appropriate firm-specific value (see De Mitri, Marchetti and Staderini, 1998). The large heterogeneity across firms in their tax positions makes this information a potentially relevant instrument.

In principle, one could object that the user cost of capital or the cost of financing, which is its major component, are themselves powerful and valid instruments for our regression. The argument would be that variation in the cost of financing, induced by either changes in the cost of debt or in the cost of equity, is likely to affect the firm's capital structure without being driven by other factors that influence productivity. The firm's leverage, however, directly enters the definition of the cost of financing (and, thus, of the user cost of capital), as being the weight for the cost of debt. Therefore, the relationship between leverage and the cost of financing largely owes to the fact that the former is simply part of the definition of the latter and, as such, cannot be a valid instrument. On the contrary, the tax variables included in the definition of the cost of capital are likely to affect the firm's financial structure to a significant extent, without, however, being influenced by the latter and, thus, potentially, by productivity. In the empirical estimation, we did not include in the instruments set the whole variety of taxes and fiscal-related components reflected in the user cost formula. In particular, we employ taxes on firms' assets and, for fixed effect regressions, also tax exemptions. When a more comprehensive fiscal instrument is used, which includes all tax policy instruments, the estimation results of our empirical analysis remain qualitatively very similar to those documented in the paper. In that case, however, the appropriate statistical tests would point to a failure of the hypothesis of instruments exogeneity.

The second instrument we used is an indicator of local financial development at the regional level. This measure is drawn from a recent study of Guiso et al. (2004), who construct such indicator consistently with the

notion that more developed financial markets grant individuals and firms an easier access to external funds. In particular, using Italian data on individuals' access to credit, they estimate the probability that a household is denied credit or discouraged from applying for it, conditionally on a number of individual characteristics and other controls. In their linear probability model, they insert a set of 19 regional dummies; the parameter estimates of these dummies provide a measure of the extent to which a region is financially developed. We believe that the degree of local financial development is likely to represent a somewhat relevant exogenous determinant of a firm's capital structure. Moreover, considering that firm's TFP has a large idiosyncratic component and that we include in our empirical specification other region specific control variables, it is unlikely that there are omitted factors in the estimating equation that drive region-wide financial development and also foster firm-level productivity, thus affecting the exogeneity of this instrument.

Before turning to the estimation results, we first describe the data used in the empirical analysis and the measure we derived for firm-level productivity.

## 4 The data

### 4.1 Data description

Estimation is conducted on a representative sample of high quality data on over 40,000 firms for the period 1982 - 1998. Data are drawn from balance-sheet information compiled by the Company Account Data Service (CADS, Centrale dei Bilanci). Firm-level TFP measures are constructed by applying the Olley and Pakes (1996) methodology. The latter allows to control for the simultaneity between technology and input demand, as well as for the self-selection in the data induced by the higher probability that firms endowed with more capital survive after a bad productivity realization (Cingano and Schivardi, 2004). Data on the firm-specific taxation component of the user cost of capital, constructed within a project developed by Banca d'Italia (see De Mitri et al., 1998), were kindly made available by the authors. This information at the microeconomic level is drawn from CADS data as well as from the Bank of Italy's Survey of Investment in Manufacturing (SIM) and the Credit Register (CR), a statistical source maintained by a special unit of the Bank of Italy (Centrale dei Rischi), that provides detailed data

on bank-firm contracts. In computing the user cost of capital, De Mitri et al. (1998) followed the Hall-Jorgenson approach, as adapted by Auerbach (1983) to firms that use both equity and debt finance.

The CADS supplies balance-sheet indicators at nominal value. We deflate both value added and investments using the appropriate two-digit deflators, derived from the National Institute for Statistics's (NIS) National Accounts. The capital stock at firm level was obtained from the book value of investment using the permanent inventory method, accounting for sector specific depreciation rates from NIS's National Accounts data. The initial capital stock was estimated using the deflated book value, adjusted for the average age of capital estimated from the depreciation fund. We take care of outliers by excluding firms with values of value added per worker or value added per unit of capital below the first or above the last percentile of the distribution. This procedure does not introduce systematic biases in the results, while improving their stability.

## 4.2 Measuring firm-level productivity<sup>10</sup>

We use the estimation approach proposed by Olley and Pakes (1996). Production takes place through a Cobb-Douglas technology using capital and labor, with parameters  $\alpha$  and  $\beta$ , subject to an unobserved (to the econometrician) productivity shock  $\omega$ . In logs, the production function is

$$y_t = \alpha k_t + \beta l_t + \omega_t + \eta_t \quad (2)$$

where  $\eta$  is a random shock uncorrelated with the other variables. For simplicity, the theoretical model assumes that capital is irreversible (the estimation method works independently from this assumption); moreover, capital is a predetermined variable at  $t$  so that it is independent from  $\omega_t$ , while labor can adjust to the productivity shock. The firm also decides whether to continue production or shut down, in which case it collects a salvage value  $\Phi$ . The dynamic programming problem of the firm is represented by the Bellman equation:

$$V(k_t, \omega_t) = \max\{\Phi, \max_{i_t, l_t}[\pi(k_t, l_t, \omega_t) - c(i_t) + E(V(k_{t+1}, \omega_{t+1}))]\} \quad (3)$$

$$\text{s.t. } k_{t+1} = (1 - \delta)k_t + i_t, F_\omega(\omega_{t+1}|\omega_t) \quad (4)$$

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<sup>10</sup>This section is taken from Cingano and Schivardi (2003).

where  $\pi$  is current profit,  $c(\cdot)$  is the cost of investment and  $F_\omega(\omega_{t+1}|\omega_t)$  is the probability distribution of  $\omega_{t+1}$  given  $\omega_t$ , assumed to be stochastically increasing. The dynamic programming problem delivers three policy functions: a continuation function  $\chi(k_t, \omega_t) = \{0, 1\}$ , an investment function  $i(k_t, \omega_t) \geq 0$  and an employment function  $l(k_t, \omega_t)$ . The continuation decision takes the form of a threshold value  $\underline{\omega}(k)$  for the productivity shock below which it is optimal to exit.

The continuation decision and the input choices depend on the capital stock and the unobservable productivity shock. This implies that OLS estimation of (2) has two sources of bias. First, the labor input is correlated with  $\omega$ ; second, it can be shown that  $\underline{\omega}(k)$  is decreasing in  $k$ , which induces a selection issue: the higher the capital stock the more likely it is that firms remain in the market even with low realizations of  $\omega$ . This implies that if selection is not accounted for the capital coefficient will be downward biased, because of the negative correlation between  $\omega$  and  $k$ .

Olley and Pakes propose a procedure to correct for both biases. For the simultaneity bias they approximate the unobservable  $\omega$  with a non-parametric function of investment and current capital stock. In fact, the investment function is invertible so that there exists a function relating the productivity shock to the stock of capital and investment:

$$\omega_t = h(i_t, k_t) \tag{5}$$

Given that the shape of  $h(\cdot)$  depends on the functional forms of the primitives and in general has no analytical representation it is approximated by a polynomial series in  $i$  and  $k$ . The coefficient of the labor input is therefore consistently estimated by OLS on:

$$y_t = \beta l_t + \phi(i_t, k_t) + \eta_t \tag{6}$$

where

$$\phi(i, k) = \alpha k + h(i, k) \tag{7}$$

Define the estimated value  $\hat{\phi} = y - \hat{\beta}l - \hat{\eta}$ .

To estimate the capital coefficient we need to account for selection. To do so, in a first step we estimate a probability of survival as a function of  $(i_t, k_t)$  via a probit estimation of the continuation decision in a power series

of  $i$  and  $k$ . Define the estimated probability as  $\hat{P}$ . We can now introduce a Heckman-type correction in the estimation of the capital coefficient. In fact,

$$E(y_{t+1} - \beta l_{t+1} | k_{t+1}, \chi_{t+1} = 1) = \beta k_{t+1} + E(\omega_{t+1} | \chi_{t+1} = 1, \omega_t) \quad (8)$$

Using the definition of conditional expectation and (5), it can be shown that the conditional expectation of  $\omega_{t+1}$  can be expressed as a function of  $P$  and  $h$ , say  $g(P, h)$ . Using (7), the estimating equation therefore becomes

$$y_{t+1} - \beta l_{t+1} = \beta k + g(\hat{P}, \hat{\phi} - \alpha k) + \xi_{t+1} + \eta_{t+1} \quad (9)$$

where  $\xi$  is the innovation in  $\omega$ . The last step therefore requires the non-linear estimation of equation (9), where the unknown function  $g$  is replaced by a power series in  $\hat{P}$  and  $\hat{\phi} - \alpha k$ .

We implement the procedure using polynomial approximations of the fourth degree in all stages to approximate  $h, P$  and  $g$ . Results are stable when going from a third to a fourth degree, an indication that the polynomial approximations are sufficiently accurate. In terms of results, we find that the simultaneity bias does not affect the estimation of the labor coefficient to a large degree, while selection is very important for the capital coefficient. This is the same pattern observed by Olley and Pakes with data from the telecommunications equipment industry in the US.

Descriptive statistics of all variables used in the empirical analysis are reported in table 1.

## 5 The empirical results

### 5.1 Baseline specification

The results of our baseline regression are reported in Table 2. They show that firms with lower leverage are on average more productive. In particular, when we use the two-stage least squares between estimator, which focuses on average firm values, the estimated coefficient associated to leverage is -1.332 with a standard error of .037 (panel A). We also used the two-stage least squares within (fixed effect) estimator, which exploits the time-series instead of the cross-section variability of the data. In this case, also, the effect of leverage on TFP is estimated to be negative and equal to -.154 (with a standard error of .013; panel C).

Similar results are obtained including a number of additional controls. Although in these cases the coefficients of leverage are lower in absolute value than in the previous cases (respectively 0.863 for the between estimator and 0.110 for the within estimator; panels B and D), they remain negative and significantly different from zero.

This finding lends support to the view that firms which are less reliant on debt finance tend to hold a larger portions of immaterial assets and, thus, to undertake more innovative activities. Ultimately, this translates into a higher total factor productivity. Thus, according to our finding, a firm which is less leveraged – for reasons independent from its growth opportunities – is more likely to conduct innovative projects which increase growth opportunities and lead to a larger TFP.

The estimated coefficient associated to the between-group specification simply reflects the cross-sectional differences between firms with low and high leverage. On the contrary, the within groups or fixed effects estimates of equation (1) exploits the within-firm variation in leverage. In this latter case, the negative estimated coefficient suggests that, for the same firm, an increase in leverage is associated with a lower TFP. The fact that this estimated coefficient is of a smaller size (in absolute value) with respect to the one from the between specification indicates that the cross-sectional differences across firms in the financial structure play a more important role in explaining productivity.

In the estimation of equation (1), also the control variables enter significantly. This is confirmed by the value of the Wald tests (not reported) for the joint significance of the calendar year dummies (in the within estimation) and of the industry dummies (in the between estimation). Moreover, we also constructed a Hausman test to discriminate between a fixed-effect and a random-effect model. The test rejects the hypothesis of orthogonality of the random effects and the regressors, indicating that the random-effect estimator would be inconsistent (the value of the test is 1301.6 with a p-value of .00). In order to ascertain relevance of our instrument set, for both the between- and the fixed-effect specification, we conducted a simple test. This test for power of the instruments is simply a Wald-type test of the joint significance of instruments in the first stage panel regression. In both cases, the p-value of this test is .00. Finally, in order to test the exogeneity of the instruments, we run a Hausman test of over-identifying restrictions, which leads in both cases to the rejection of the null hypothesis of instruments' endogeneity at the 5 per cent level or more.

## 5.2 Other tests

In order to grant more generality to our analysis and to establish a closer link between the theoretical motivation of this study and the empirical framework, we also investigate two parallel issues. First, we test whether the firm's financial structure is indeed an explanatory factor for the intensity of firm's innovative activities (and whether the way these respond to leverage is qualitatively similar to the way firm's productivity responds). Second, we directly verified whether the relationship between TFP and the extent of innovative activities is indeed positive and statistically significant.

In order to tackle the first issue, we run a panel regression identical to (1), also instrumented,<sup>11</sup> where the dependent variable, however, is no longer the *TFP* but the degree of firms' innovative activities. The latter variable is approximated by the share of intangible over total non-financial assets. Because our new dependent variable,  $IMM_{it}$ , is a share, whose values, of course, range between 0 and 1, we consider the logistic transformation of  $IMM_{it}$  and use this as dependent variable. The latter, thus, becomes  $\ln(\frac{IMM_{it}}{1-IMM_{it}})$ .<sup>12</sup> In Table 3, we report the estimation results of this regression, for which we continue to use both the between-effect and the fixed-effect instrumental variable estimator. Consistently with our a priori, the estimated effect of leverage on the share of intangible assets is of the same sign of the effect of leverage on productivity. Moreover, not only is the estimated effect negative but it is also statistically significant. With the between-group estimator, the coefficient estimate of leverage is -3.000 with a standard error of .194 while, when fixed-effects are allowed for, the estimate is -.174 with a standard error of .048.

So long as we consider the share of intangibles a good proxy for the firm's propensity towards innovative activities, these findings indicate that less leveraged firms tend to be more innovative. How these differences in leverage have also implications for the firm's performance was already examined in the previous section. However, we add here another piece of evidence by testing that the relationship between our measure of performance (TFP) and the extent to which a firm innovates is indeed positive and statistically

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<sup>11</sup>We include as instruments the full set of tax policy determinants of the user cost of capital, since in this case the test of over-identifying restrictions permits to reject the hypothesis of endogeneity at the usual confidence levels.

<sup>12</sup>Not to lose the boundary observations in the logistic transformation we have added (subtracted) 0.05 to  $IMM_{it} = 0$  ( $IMM_{it} = 1$ ), as suggested by Amemiya (1985).

significant. To do so, we simply run a panel regression of firm's *TFP* on the share of immaterial over total non-financial assets. The estimation results, presented in table 4, point to a positive and strongly significant relationship. The estimated parameter ranges from .922 (with a standard error of .199) in the between-effect specification to .111 (with a standard error of .007) in the fixed-effect specification.

### 5.3 Sample splits

Our finding that less leveraged firms have on average a higher productivity might be analyzed in greater detail by testing for the presence of non linearities in the relationship between financial structure and total factor productivity. The argument in favor of these non linearities is that there are a number of firms' characteristics that may uncover a degree of difference across firms in the sensitivity of TFP to leverage. A natural way to address this issue is by splitting the entire sample of firms according to each of these characteristics and investigating whether the estimated effect of leverage on TFP varies across the two groups of firms and is magnified by the presence of this characteristic.

The first hypothesis we test is whether the negative TFP-leverage relationship is weaker for firms with a higher share of short-term bank debt. The rationale for this hypothesis is that conflicts of interest between equityholders and debtholders are less important in the case of short-term bank debt, which allows banks to exert a stronger control on firms' activities.

Table 5 presents the results from estimating equation (1) on two different sub-samples: the first one refers to firms having a share of short-term bank debt above the sample median of the firms' average ratios. The second sub-sample refers to firms with a share of short-term bank debt which is less than (or equal to) the median across firms of their average shares. We find that the effect of leverage on productivity is always negative, but it is much higher for firms with a low share of short-term bank debt. If one considers the between-group specification, the estimated coefficient associated to leverage is -1.612 (with a standard error of .057) in the sub-sample of firms with less short-term bank debt. On the contrary, the estimated effect is -1.213 (with a standard error of .050) in the other sub-sample. Similar results are obtained when the fixed-effect estimator is used. In this case, the estimates of the parameters for leverage are, respectively, -.202 and -.124, with standard errors of, respectively, .022 and .017.



Another investigation deals with the role of liquid assets in shaping the relationship between leverage and productivity. Arguably, if a firm has to decide whether to undertake projects with high-growth potentials and has a large share of liquid assets, it can catch the opportunities by relying to a significant extent on the internal funds available. Hence, for these firms the capital structure may be less crucial than it would be for other firms and no matter whether the firm's leverage is high or low, the performance enhancing activities can be undertaken thanks to the resources associated with positive and large cash flow. Our empirical results seem to lend support to this view. In Table 6, we report the results from estimating equation (1) for two groups of firms: one is comprised of those with a share of liquid over total assets greater than the median across firms of the each firm's average share. The other group of firms is comprised of those with a share of liquid over total assets which is less than (or equal to) the sample median. When we use the between-group estimator, the coefficient of leverage is -1.269 with a standard error of .054 for firms with a large share of liquid assets; by contrast, the estimated effect is -1.307 with a standard error of .058 for less liquid firms. Similarly, the results with the fixed-effect estimator point to a negative effect of leverage in both sub-samples, which is, however, much larger for firms with a lower share of liquid assets: the estimated coefficients are -.163 (with a standard error of .018) in this group of firms and it is -.096 (with a standard error of .021) in the group of more liquid firms.

## 6 Conclusions

Differences in TFP are a major determinant of the asymmetries in country's economic performance. The dichotomy between productivity and capital formation (in the broad definition of human and physical capital and knowledge) as the main driving forces of economic growth is a central theoretical issue. Recent contributions, including Prescott (1998), Hall and Jones (1999) and Easterly and Levine (2001), argue that the bulk of cross-country differences in the level or growth rate of GDP per capita is not explained by factor accumulation but by TFP.<sup>13</sup>

Our empirical findings document that exogenous factors affecting a firm's financial structure have substantial effects on its allocation of capital between material and immaterial assets and, ultimately, on its productivity. These

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<sup>13</sup>On this issue, see also Young (1995)

results are found considering both a between-group estimator, which simply reflects the cross-sectional differences between firms with low and high leverage, and a fixed-effect estimator, which exploits only within-firm variations. Moreover, we provide two additional sets of results, supporting our interpretation of the causation effect running from a firm's financial structure to its share of intangibles, its propensity to innovate and, ultimately, its productivity. First, we show that there is a negative and significant causal relationship from a firm's leverage to its share of intangibles. Second, we show that there is a positive and significant relationship between the share of intangibles and a firm's productivity. Finally, we find that the negative relationship between leverage and productivity is non-linear, depending on some firm-specific characteristics. In particular, we document that the negative relationship is stronger for firms with a lower share of short-run bank debt and with lower liquid over total assets.

These results lend support to the theories of firms' financial structure based on bankruptcy costs, conflicts of interest between equityholders and debtholders and control rights, which predict that less leveraged firms have a higher share of immaterial assets and, as argued above, a higher TFP. Some caution is, however, necessary in deriving macroeconomic implications from our empirical findings. This owes to the large heterogeneity in firms' productivity and the massive and continuous reallocation of outputs and inputs across firms and within sectors (Davis and Haltiwanger, 1999; Baily et al. 1992; Bartelsman and Doms, 2000). Indeed, the overall performance of an economy depends not only on the average productivity of its firms, but also on the relative shares of production of efficient and inefficient firms, a feature that is in turn related to firms' entry and exit. However, Bartelsman and Doms (2000) show that the contribution of productivity growth at the plant level to average total factor productivity is in any case substantial, in the order of fifty per cent (and suggest that, at the firm level, it is likely to be even larger). Our results have, therefore, important policy implications, suggesting that interventions favoring market finance may indeed be beneficial for aggregate productivity.

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Table 1  
Descriptive statistics

Variable	N observations	Mean	Median	Standard deviation
Log(TFP)	240,836	2.400	2.403	0.573
Leverage	240,836	0.504	0.535	0.266
Tax on assets	193,706	0.003	0.000	0.005
Tax exemptions	193,706	0.002	0.000	0.009
Liquid assets	240,836	0.066	0.026	0.094
Immaterial assets	240,753	0.095	0.029	0.156
Cash-flow	240,836	0.144	0.146	0.213
Long-run bank debt	229,387	0.203	0.080	0.267
Short-run bank debt	223,698	0.754	0.885	0.304
Financial development	220,985	0.317	0.297	0.095

Legend: TFP is total factor productivity computed through the Olley and Pakes' method; leverage is defined as debt over total assets; tax on assets is a firm-specific tax rate on firm's assets; tax exemptions is a firm-specific rate of tax exemption; liquid assets are a share over total assets; immaterial assets are a share over total non-financial assets; cash-flow is as a share of value added; long-run bank debt is a share over total financial liabilities; short-run bank debt is a share over total bank debt; financial development is an index of the region's financial development (see Guiso et. al, 2004).



Table 2  
The effect of leverage on firm's productivity  
Panel data estimation

Dependent variable: $\log(TFP_{it})$	Between effects IV	Between effects IV	Fixed effects IV	Fixed effects IV
	Panel A	Panel B	Panel C	Panel D
<i>Leverage<sub>it</sub></i>	-1.332***(0.037)	-0.863***(0.032)	-0.154***(0.013)	-0.110***(0.012)
<i>Immaterials<sub>it</sub></i>		1.107***(0.019)		0.153***(0.007)
<i>Cash-flow<sub>it</sub></i>		0.620***(0.022)		0.398***(0.004)
<i>Long run bank debt<sub>it</sub></i>		-0.375***(0.015)		0.037***(0.003)
<i>Liquid assets<sub>it</sub></i>		-0.018(0.048)		0.324***(0.011)
<i>Firm size 2</i>		0.239***(0.009)		-0.008***(0.003)
<i>Firm size 3</i>		0.230***(0.009)		-0.013***(0.003)
<i>Firm size 4</i>				-0.005***(0.003)
<i>Firm size 5</i>		0.152***(0.009)		-0.012***(0.003)
<i>Constant</i>	3.357***(0.105)	2.827***(0.086)	2.579***(0.008)	2.532***(0.008)
Over-identifying restrictions	0.44 (p-value = 0.51)	0.11 (p-value = 0.74)	6.13 (p-value = 0.05)	5.21 (p-value= 0.07)
N. observations	27,029	27,024	177,679	177,629

Legend: The sample period is 1982-1998. Parameter estimates are reported with standard errors in brackets. The instrument set includes tax components of the user cost of capital (tax on firms' assets and, for fixed effect regressions, also tax exemptions) plus the indicators of financial development at the regional level (see discussion in the text). Leverage is defined as debt over total assets; immaterials is the share of immaterial over non-financial total assets; cash-flow is as a share of value added; lung run bank debt is a share over total financial liabilities; liquid assets are a share over total assets; firm size 2-5 are dummy variables obtained from quintiles in the distribution of the number of employees. In choosing the fixed-effects vs random-effects estimators, we used the value of the Hausman test. Over-identifying restrictions is a Hausman test on the exogeneity of instruments, distributed as a  $\chi^2$  with degrees of freedom equal to the number of over-identifying restrictions. The between-effect specification includes geographical (province) and industry dummies while the fixed-effect specification includes calendar year dummies.

\*\* significant at the 5-percent level.

\*\*\* significant at the 1-percent level.

Table 3  
The effect of leverage on firm's intensity of innovative activities  
Panel data estimation

Dependent variable: $\ln\left(\frac{IMM_{it}}{1-IMM_{it}}\right)$	Between effects IV	Fixed effects IV
Leverage <sub>it</sub>	-3.000*** (0.194)	-0.174*** (0.048)
Constant	-0.766*** (0.130)	-2.001*** (0.027)
Over-identifying restrictions	0.20 (p-value = 0.90)	4.98 (p-value = 0.08)
N. observations	28,480	177,228

Legend: The sample period is 1982-1998. Parameter estimates are reported with standard errors in brackets. The dependent variable is the logistic transformation of the share of immaterial over total non-financial assets,  $IMM_{it}$ . The instrument set includes tax components of the user cost of capital and the indicators of financial development at the regional level (see discussion in the text). Leverage is defined as debt over total assets. In choosing the fixed-effects vs random-effects estimators, we used the value of the Hausman test. The fixed-effect specification includes calendar year dummies while the between-group specification includes industry dummies.

\*\*significant at the 5-percent level.

\*\*\*significant at the 1-percent level.

Table 4  
 Productivity and the firm's intensity of innovative activities  
 Panel data estimation

Dependent variable: $\log(TFP_{it})$	Between effects	Fixed effects
Immaterials <sub>it</sub>	0.922*** (0.199)	0.111*** (0.007)
Constant	2.301*** (0.034)	2.543*** (0.003)
N. observations	28,525	177,473

Legend: The sample period is 1982-1998. Parameter estimates are reported with standard errors in brackets. Immaterials is the share of immaterial over total non-financial assets. In choosing the fixed-effects vs random-effects estimators, we used the value of the Hausman test. The fixed-effect specification includes calendar year dummies while the between-group specification includes industry dummies.

\*\*significant at the 5-percent level

\*\*\*significant at the 1-percent level.

Table 5  
 Non-linearity in the effect of leverage on productivity:  
 The role of short-term bank debt  
 Panel data estimation

Dependent variable: $\log(\text{TFP}_{it})$	Sub-samples: Firms with	
	more short term bank debt	less short term bank debt
	(a) Between effects IV	
Leverage <sub>it</sub>	-1,213*** (0.050)	-1.612*** (0.057)
Constant	3.331*** (0.156)	3.462*** (0.137)
N. observations	15,134	11,895
	(b) Fixed effects IV	
Leverage <sub>it</sub>	-0.124*** (0.017)	-0.202*** (0.022)
Constant	2.612*** (0.011)	2.533*** (0.013)
N. observations	104,460	73,219

Legend: The sample period is 1982-1998. The sample splitting criterion is the following: a firm is identified as having more short-term bank debt if its share over total bank debt is larger than the median across firms of the firms' time averages. Conversely, a firm is identified as having less short-term bank debt if this share is less than (or equal to) the median across firms of these time averages. The instrument set includes tax components of the user cost of capital (tax on firms' assets and, for fixed effect regressions, also tax exemptions) plus the indicators of financial development at the regional level (see discussion in the text). Leverage is defined as debt over total assets. In choosing the fixed-effects vs random-effects estimators, we used the value of the Hausman test. The between-effect specification includes geographical (province) and industry dummies while the fixed-effect specification includes calendar year dummies.

\*\*significant at the 5-percent level.

\*\*\*significant at the 1-percent level.

Table 6  
 Non-linearity in the effect of leverage on productivity:  
 The role of liquid assets  
 Panel data estimation

Dependent variable: log(TFP <sub>it</sub> )	Sub-samples: Firms with	
	higher liquid assets	lower liquid assets
	(a) Between effects IV	
Leverage <sub>it</sub>	-1.269*** (0.054)	-1.307*** (0.058)
Constant	3.425*** (0.140)	3.262*** (0.154)
N. observations	12,066	14,963
	(b) Fixed effects IV	
Leverage <sub>it</sub>	-0.069*** (0.021)	-0.163*** (0.018)
Constant	2.593*** (0.011)	2.549*** (0.012)
N. observations	69,625	108,054

Legend: The sample period is 1982-1998. The sample splitting criterion is the following: a firm is identified as having more liquid assets if its share over total assets is larger than the median across firms of the firms' time averages. Conversely, a firm is identified as having less liquid assets if this share is less than (or equal to) the median across firms of these time averages. The instrument set includes tax components of the user cost of capital (tax on firms' assets and, for fixed effect regressions, also tax exemptions) plus the indicators of financial development at the regional level (see discussion in the text). Leverage is defined as debt over total assets. In choosing the fixed-effects vs random-effects estimators, we used the value of the Hausman test. The between-effect specification includes geographical (province) and industry dummies while the fixed-effect specification includes calendar year dummies.

\*\*significant at the 5-percent level.

\*\*\*significant at the 1-percent level.