How does Debt-Financing affect Productivity Growth? Firm-level Evidence from India

Abstract

This study examines the relationship between debt financing and the productivity growth for an unbalanced panel of 4540 firms manufacturing firms in India over the period: 2000-2015. Our results indicate that there exists a negative association between the use of debt and productivity, which is economically significant and robust to alternative definitions of productivity. This negative association remains significant even after accounting for the potential endogeneity of firm leverage. This finding is consistent with theoretical predictions which suggest that the agency costs of debt may lead to suboptimal investment. Going further, we test for the presence of a possible causal link between the firms' use of debt, the level of innovation-related activities and subsequent productivity changes. Our results suggest that a firm's expenditure on innovation is one of the significant channels through which an increase in the use of debt hurts productivity. We also assess the role of a potential source of firm heterogeneity by examining whether the observed effect remains stable across all firm sizes. Our results suggest that the smaller firms reduce their investments in productivity by a larger magnitude (relative to the larger firms) following an increase in the level of debt.

1. Introduction

An important development in recent years has been an increase in the availability of granular information on production activity; one, which has allowed a rigorous inquiry through new dimensions of research on the use of factor inputs. The notion of productivity in particular, which represents the efficiency with which firms convert factor inputs into output, has received considerable attention. At a macroeconomic level, it is a well-documented fact that a country's productivity assumes an important role in driving economic growth. In this regard, several studies demonstrate that total factor productivity (TFP) growth may have a larger contribution towards economic or income growth, relative to other factors such as capital accumulation. Findings from subsequent studies have further consolidated its role, as they suggest that differences in TFP explain a larger share of variation in cross-country differences in GDP per capita, compared to differences in factor accumulation. The magnitude of difference can be considerable, as Heish and Klenow (2009) find evidence of substantial gaps in the TFP between the Unites States (U.S), China and India and suggest that moving to the U.S level of efficiency can potentially improve China and India's TFP by as much as 30%-50% and 40%-60%, respectively. In view of the importance that TFP assumes as a driving force for growth, it is important to understand what causes total factor productivity to remain low in some countries?

Attempts to address this question have led to the development of a dynamic body of literature, which has evolved along two main dimensions which differ in identifying the source of variation in TFP changes. While one strand of literature examines what causes large and persistent productivity differences (within narrowly defined industries), another strand identifies the contribution of *internal* factors, or aspects which firms can use to directly impact their productivity.[1] From a macroeconomic perspective, while the reallocation of resources and the survival of inefficient firms can explain lower aggregate productivity growth, they do not entirely explain why some countries, on average, remain less productive, or, why firms in developing countries are usually less productive? The answer to this lies in understanding the contribution of firm dynamics which can play a significant role in shaping productivity.

Macroeconomic literature has long recognized that an important factor influencing growth is the level of financial development. Recent developments suggest that productivity can be a channel through which finance affects growth. A well developed financial sector reduces transaction costs and provides resources which increase the feasibility of long-term projects. These projects often support productivity-enhancing investments and subsequently improve growth prospects (Gatti and Love (2008)). A closer look into this relationship reveals that the association between finance and growth can arise from various microeconomic channels which reflect firm-level decision-making.

[1] The two sources of variation stated above are not exhaustive. Productivity differences can also arise from differences in the market environment or structure. For more information, see Syverson (2010).

A fundamental aspect of corporate decision-making is concerned with financing decisions. The association between a firm's financial resources and its undertakings can arise through at least two mediums. First, the financial resources that a firm has access to, can independently influence the level of investments it can afford to undertake. In other words, better access to financing should correlate positively with firm outcomes. Second, the composition of funds can also affect its outcomes. The firm's capital structure may affect its investment and output decisions in various ways and theories of capital structure in the corporate finance lietrature describe the mechanisms.

In their seminal paper, Modigliani and Miller (1958) argue that in a world with perfect capital markets, a firm's financial policy has no influence on firm value. However, markets in the real world are incomplete and characterized by agency problems between stakeholders; which affects the firm's relative preference for debt financing. In particular, the agency cost model and the trade-off theory outline the costs and benefits associated with the use of debt. On the one hand, the use of debt can provide interest tax-shields and minimize agency problems by limiting the amount of free cash available to managers. As debt plays a disciplinary role in this setup, the argument favors the use of more debt in the firm's capital structure. On the other hand, the costs of debt are also likely to be substantial. The use of debt can lead to problems associated with debt overhang, higher bankruptcy costs and risk-shifting behavior, which reduces the preference for debt in the capital structure. Clearly, as agency conflicts and the associated debt levels create incentives for underinvestment or overinvestment, the use of debt-financing can have direct implications on firm value.

In view of the above, a natural question then is: how does debt financing affect productivity? At discussed, the association can arise from two channels. Firstly, better access to financing allows firms to invest more in productivity-related activities. By this argument, an increase in the level of debt is expected to support productivity gains. Secondly, as the firm's use of debt-financing represents a trade-off between the costs and benefits of debt, it can influence firm outcomes in multiple ways. As noted above, to the extent that the use of debt plays a disciplinary role and minimizes agency problems, firms are likely to utilize financial resources more responsibly and direct the same towards productivity-enhancing activities. In this case, debt financing will be positively related with productivity gains. However, if a firm consistently maintains high levels of debt, the debt overhang problem is likely to intensify. This in turn can potentially reduce the firm's incentives to invest in productivity-enhancing activities or cause firms to divert resources away from such activities in order to service the buildup of debt (Coricelli et al. (2012)). In this case, higher levels of debt can be negatively related to productivity. The final impact of debt financing on productivity will depend on which of the two effects dominate.

This paper empirically examines the relationship between debt financing and productivity using a detailed sample of 4540 manufacturing firms in India for the period 2000-2015. Using the firms' leverage ratio as a measure of debt financing in a fixed-effects regression framework, we ask the following questions: what is the relationship between a firm's use of debt-financing (or

leverage) and productivity? Is the observed association between the use of debt and firm productivity significant, after accounting for the potential endogeneity of debt? Is there evidence of a possible causal link between the firm's use of debt, the level of innovative activities and subsequent productivity changes? Do sources of firm heterogeneity give rise to differential effects? In particular, is the effect of debt stable across firms of all sizes?

Our results suggest that an increase in the use of debt is associated with lower levels of productivity for the manufacturing firms in India, and this effect is statistically and economically significant. Importantly, this result holds after accounting for the endogeneity of debt. This finding is consistent with the agency costs of debt, and suggests that the debt overhang problem is likely to cause firms to divert resources away from productivity-enhancing activities. Our results also indicate that firm-level innovation is one of the significant channels through which the use of debt constrains productivity growth. Going further, we find that the effect of debt varies across firm size. In particular, we find that the smaller firms are more susceptible to under-investments in productivity, as an increase in the level of debt leads to larger declines in their productivity.

An assessment of how firm-level financing affects the productivity growth of Indian manufacturing firms is important for several reasons. First, as stated earlier, there exist large differences in productivity between manufacturing firms in developing countries like India and efficient markets like the U.S. While resource misallocation across firms can partially account for these differences, the influence of internal features in shaping productivity has not been examined in previous studies. Second, while a number of economic reforms were implemented since the Balance of Payments crisis in 1991, the efficacy of these reforms in increasing productivity is unclear. On the one hand, while Topalova (2004) finds that the manufacturing sector's productivity benefited from reduced tariffs, the overall impact of reforms is questionable. Goldar (2004) and Bosworth et al. (2006) suggest that TFP growth in manufacturing may have slowed down in the post-reform period. The contrasting observations suggest that economic reforms may not have provided the adequate impetus to support firm-level productivity. Third, the prevalence of structural bottlenecks may have further slowed down this process. According to the OECD Economic Survey (2014) , the existence of complex labor and tax regulations have reduced the incentives for firms to grow beyond a certain size and substitute capital for labor, which has affected firm productivity (Dougherty (2009) and Dougherty et al. (2011)).

Taken together, these findings suggest that structural inefficiencies or factors *external* to firms may have contributed towards increasing distortions and constraining productivity growth. In view of this, as assessment of the contribution of firm-level characteristics and in particular, the role of financial resources in influencing productivity growth will be an important step towards a comprehensive understanding of the drivers of productivity growth in India.

The remainder of the paper is organized as follows: Section 2 presents a review of literature; a description of the data and construction of variables are presented in Section 3 and Section 4 outlines the empirical specification. Sections 5 and 6 present the descriptive statistics and regression results, respectively, and Section 7 concludes.

2. Review of Literature

The theoretical mechanisms which give rise to the relationship between finance and productivity correspond to two distinct strands of literature. The first strand corresponds to the corporate finance literature on the use of debt and its implications on firm performance; and the second strand comprises of studies which identify the microeconomic channels through which firm-level credit conditions affect outcomes such as productivity. The main findings from each of these strands are reviewed in turn.

Capital structure decisions comprise one of the most fundamental issues in corporate decision-making and have been the subject of intense scrutiny. In their seminal paper, Modigliani and Miller (1958) argued that in a world with perfect capital markets, a firm's financial policy is independent to its value. Better known as the *irrelevance proposition*, this implies that a firm's capital structure has no effect on firm value.[2] This result fails to hold in real world markets which are characterized by imperfections that arise due to the presence of taxes, conflicts of interests, information problems and incentive effects of debt. The existence of such imperfections creates various incentives for the use of debt (versus equity), which can subsequently influence firm performance. In particular, the literature related to the agency cost model and the trade-off theory outline the various incentives and implications.

As managers and shareholders have more knowledge about the firm than outside investors (such as debt holders), the availability of debt as a source of external finance can affect how efficiently firm agents employ this stock of resources. Agency costs in particular, represent an important source of conflicts. According to Jensen and Meckling (1976), there are two types of agency conflicts which give rise to contrasting ways in which debt (or leverage) affects firm performance. On the one hand, using more debt can induce the threat of liquidation and limit the amount of free cash flow that managers can invest in projects which do not maximize firm value (Grossman and Hart (1982); Williams (1987); Jensen (1986); Slutz (1990)). To the extent that debt plays a disciplinary role, it can minimize the degree of conflict between managers and shareholders and thus, have a positive effect on firm performance.

On the other hand, high levels of debt can also give rise to the problem of underinvestment (Myers (1977); Slutz (1990)). If shareholders wish to reduce investment in risky projects (i.e those with negative net present value (NPV)) they may reduce the amount of paid up equity capital and force managers to raise more debt. This constrains the financial resources available to managers, which can limit the firm's ability to invest in projects with positive NPV, and thereby lead to underinvestment. Higher leverage can also aggravate the agency conflicts between the shareholders and debt holders through risk-shifting (Jensen and Meckling (1976)). In this case, since shareholders have limited liability, they may take on very risky projects at the expense of

[2] Capital structure refers to a firm's mix of debt and equity. The MM proposition states that a firm's value is determined by its real assets and not by the securities it issues. As a result, the capital structure is irrelevant as long as investment decisions are pre-determined.

debt holders. When most of these projects fail, the losses are incurred by debt holders. As such, to the extent that agency conflicts also give rise to problems of underinvestment and risk-shifting by shareholders, higher leverage can have a negative effect on firm performance. In addition to the role of agency conflicts, the negative effects of debt on performance can be realized in other ways. In this context, Myers (1977) highlights the problem of debt overhang. Debt overhang refers to situations when firms are highly indebted and face difficulties in raising funds through further borrowing. Such firms are close to financial distress and find it challenging to raise capital for new investments. As such, debt overhang is another factor which may lead to underinvestment by firms, and can subsequently translate into a negative effect of debt on firm performance.

Complementing the theoretical links described above is a vast body of empirical literature which finds evidence in support of the various mechanisms at play. Several studies have examined the association between leverage (which represents the debt ratio) and various measures of firm performance and report mixed results.[3] For example, Aivazian et al. (2005) examine the effects of leverage on firm investment for a sample of French manufacturing firms and find a negative association, a result consistent with the existence of agency costs which lead to under-investment. While most studies have examined the effects of leverage on measures such as investment or profitability, very few have considered how leverage may affect firm productivity. Nucci et al. (2005) is one of the first studies to examine this association. They employ a 2SLS-IV approach to model the relationship for a sample of manufacturing firms in Italy and find evidence of a significant negative effect within (and across) firms. In other words, they find that not only does higher leverage hurt the firms' productivity over time, firms with higher leverage report lower productivity. Moreover, they find that the association is contingent on firm-specific features like debt maturity and the share of liquid assets.[4]

While some studies document a negative relation between the use of debt and firm productivity, a selected few report a positive association. One such paper is by Margaritis and Psillaki (2010), who examine the association between capital structure, ownership structure and efficiency for a sample of French manufacturing firms in three industries. Based on a cross-sectional regression analysis, they find that leverage has a significant positive effect on firm efficiency across all industries, which supports the predictions of the agency cost model that debt can assume a disciplinary role and improve performance. Overall, their findings demonstrate a bi-directional association between leverage and firm efficiency. Finally, while most studies test for the presence of a linear relationship, Coricelli et al. (2012) argue that both effects can potentially be observed. Based on the trade-off theory, they hypothesize that while lower levels of leverage can support productivity growth, the effect is reversed as firms become more indebted. They estimate

[3] These studies have employed various measures of firm performance including firm investment, profitability and efficiency. Refer to Weill (2008) for a review of recent studies on this issue.
[4] Firms with a higher (lower) share of short-term debt (liquid assets) are seen to be less affected by leverage.

a panel threshold fixed-effects model for a sample of manufacturing firms in sixteen Central and Eastern European countries and obtain results which confirm their predictions.

In view of the existing studies on the role of firm-level financing, our study is closer to Coricelli et al. (2012), Nucci et al. (2005) and Margaritis and Psillaki (2010). Note however, that our approach also differs from the above in some ways. While we focus on the *within-firm variation* in examining the linear and non-linear effects of leverage, Coricelli et al. (2012) emphasize on the identification of a common "threshold" leverage beyond which, the effect reverses for all firms. Given that firm dynamics vary substantially across industries, we focus on the average overall effect and additionally highlight industry-specific differences, rather than determining an optimal level of leverage. In this respect, our paper is empirically closer to Nucci et al. (2005), who also account for the potential endogeneity of firm leverage by using an instrumental-variable approach. The key difference however, is on the implication of the result. While Nucci et al. (2005) estimate the effect of leverage on productivity; they are concerned with the choice between debt and equity as the preferred source of financing. Our study differs in this respect because leverage or debt -ratio represents the primary source of finance for most firms in the Indian manufacturing sector. The central question in our case is not about the suitability of debt (versus equity), but rather, about how firms utilize their resources, *given* that debt is the main source of external finance for a majority of firms. Conceptually therefore, our study is closest to Margaritis and Psillaki (2010). The distinguishing feature is that, unlike Margaritis and Psillaki (2010) who examine the association for three specific industries, we use longitudinal data spanning all manufacturing industries in India.

This paper contributes to the existing empirical literature on firm productivity in two ways. To our knowledge, this is the first study to examine the role of firm-level financing on total factor productivity growth in the Indian context. This is particularly important in view of recent findings, which suggest that financial constraints may be a factor shaping the productivity of Indian manufacturing firms.[5] Second, this is also one of the first studies, to our knowledge, which provides a perspective on the firm-level determinants of productivity in India. The insights from this study can therefore provide a useful complement to the recent work by Bollard et al. (2013), who quantify the role of macroeconomic reforms in the form of regulatory changes on the manufacturing sector productivity in India.

[5] See Hseih and Klenow (2012) and Bloom et al. (2010) for more information.

3. Data, Sample Selection and Variable Construction

3.1. Data and Sample Selection

Our sample comprises of annual firm-level information on manufacturing industries in India over the period: 2000-2015. We obtain our data from the Centre for Monitoring the Indian Economy (CMIE) Prowess Database, which provides comprehensive balance sheet information on all listed and unlisted companies (in the organized sector) across several industries of the Indian economy. As we are interested in examining the productivity growth of manufacturing firms, we limit our sample to firms which are classified under the relevant industry groups as per the National Industrial Classification (NIC 2008). We exclude firm-year observations which report missing or invalid information on sales, wages, raw material expenses, fixed assets, total assets and total debt or long-term debt. All firm-specific variables are deflated using the relevant price indices obtained from the RBI Handbook of Statistics.[6] Our final sample comprises of an unbalanced panel of 33361 observations (from 4540 firms) observed between 2000 and 2015, with an average of 7 observations per firm.

3.2 Variable Construction

3.2.1 Construction of Firm Productivity

As we are interested in studying the relationship between firm productivity and debt-financing, a central issue is the construction of a reliable estimate of firm-level productivity. While there exists various parametric and non-parametric ways of obtaining efficiency or productivity estimates, the first step typically involves estimating a production function. As productivity is not directly observable, most methods derive productivity estimates from the residuals of a production function. For our analysis, we employ a semi-parametric approach introduced by Levinsohn and Petrin (2003) to obtain firm-specific, time-varying estimates of total factor productivity (TFP). This approach has been employed in several studies including Coricelli et al. (2012) and Krishnan et al. (2015) which examine productivity dynamics and this method of estimation is seen to perform as well as non-parametric methods. This approach is described in the Appendix.

3.2.2. Other Control Variables

We next describe the firm-specific variables which are used in our regression analyses. Consistent with previous studies, we define firm leverage as the ratio of book value of total debt to the book value of total assets. We also use an alternative measure of leverage, defined as the ratio of long-term debt to total assets to check the robustness of our results.

We control for a number of firm-specific features which can potentially influence firm-level productivity. More specifically, we control for the effects of firm size, tangible assets, cash flow,

[6] Refer to Table 1 in the Appendix section for variable definitions.

firm age, ownership concentration and industry-level competitiveness.[7] *Firm size* is defined as the logarithm of firm sales or total assets. This variable is likely to be an important factor as larger firms typically have access to better technology and may even be better managed, which can lead to higher firm-level productivity (Margaritis and Psillaki (2010)). We control for a firm's *tangible assets* which is defined as the ratio of its fixed assets to total assets. Firms which are more capital-intensive are likely to use better or more efficient technology in their activities, which can potentially lead to productivity or efficiency gains (Margaritis and Psillaki (2010)). We also control for a firm's *cash flow*, which is defined is as the ratio of net cashflows from operating activities to total assets.

In addition to the above, we control for the effect of ownership concentration by defining two dummy variables which indicate the percentage of shares held by individuals classified as large shareholders. Specifically, the first dummy variable (Int_Owner) represents firms with intermediate ownership concentration, while the second variable (High_Owner) represents firms with high, or concentrated ownership.[8] We also control for the effect of firm age since productivity dynamics are likely to vary over the lifecycle of firms (Hseih and Klenow (2012)). Finally, we also account for the effect of industry-level market concentration by including the Herfindahl Index, which is calculated as the sum of squared values of each firm's market share (in sales) (at the three-digit NIC (2008) level).

[7] Most of the control variables used in our model have been identified as determinants or factors influencing firm efficiency in previous studies including Bonaccorsi di Patti (2006), Margaritis and Psillaki (2010) and Nucci et al. (2005).

[8] " Int_Owner" assumes a value of 1 for firms in which the largest shareholders have a maximum ownership ranging between 25 percent and 50 percent (and zero otherwise), whereas "High_Owner" assumes the value of 1 for firms in which the largest shareholder has as ownership share exceeding 50 percent (and zero otherwise).

4. Empirical Methodology

4.1. Empirical Specification

4.1.1 Fixed–effects regression

We next describe the empirical specification to examine the relationship between the firms' use of debt and productivity. We estimate the following equation using a fixed-effects regression:

$$Y_{it} = \alpha_1 + \beta_1 Lev_{it-1} + \beta_2 Lev_{it-1}^2 + \delta X_{it-1} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.1)$$

where Y_{it} is our measure of firm-specific productivity; Lev_{it-1} represents the debt ratio (or book value of leverage); X_{it-1} is a vector of control variables including firm size and its squared term, tangible assets, cash flows, ownership concentration, log firm age and the Herfindahl Index. As the effect of firm leverage can be non-monotonic, we include a quadratic term in eq. (4.1). Following conventional notation, i indexes firms and t indexes years in all specifications. The regression model also includes year fixed effects (λ_t) (in addition to firm fixed effects (μ_i)) to control for macroeconomic shocks and ε_{it} represents the independent and identically distributed error term. Note that all specifications of the regression model (eq. (4.1)) are estimated using one-year lagged values of explanatory variables in order to minimize potential endogeneity issues.

Drawing from our preceding discussion, firm leverage can exert a positive or negative influence ($\beta_1 \gtrless 0$), depending on the extent to which the benefits of debt outweigh the costs of debt. Most firm-specific characteristics such as tangible assets, cash flows (or internal finance), firm size, ownership concentration and industry-level competitiveness are expected to have a positive effect on firm productivity ($\delta \geq 0$).

4.2 Extending the basic model

4.2.1. Channels of Transmission

Following the estimation of our baseline model, as a next step, we try to identify a possible sequence in which the use of debt is likely to influence subsequent productivity changes. In particular, drawing from the existing literature, we examine whether the firms' expenditure on innovation is one of the channels through which the use of debt influences productivity changes. To assess whether the firms' expenditure on innovation (or equivalently, on R&D) represents a significant channel of transmission, we estimate the association in steps, following the logical sequence of the firm's decisions and outcomes. In particular, we estimate the following two equations:

$$Z_{it} = \gamma_1 + \gamma_2 \overline{Lev}_{it-1} + \gamma_3 X_{it-1} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.2)$$

$$Y_{it} = \delta_1 + \delta_2 \hat{Z}_{it-1} + \delta_3 X_{it-1} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.3)$$

where the dependent variable in eq. (4.3) represents firm-specific expenditure on R&D (our proxy for innovation); which is regressed on firm leverage (Lev_{it}) and a set of control variables which are found to influence R&D behavior. The dependent variable in eq (4.3) is the firm-specific TFP, regressed on the predicted value of R&D expenditure (from eq. (4.2)) and a set of control variables.

Taken together, while eq. (4.2) measures the relationship between the firm's use of debt and the level of innovation, eq. (4.3) measures the effect of the firm's innovation on subsequent productivity levels. If the level of innovation represents a significant channel of transmission, firm leverage is expected to have a significant effect on R&D expenses; which in turn, should be positively associated with subsequent productivity levels. In other words, the slope coefficients associated with leverage (eq. (4.3)) and predicted R&D expenditure (in eq. (4.4)) are expected to be significant ($\gamma_2 \gtrless 0$, $\delta_2 > 0$).

4.2.2 Source of Firm Heterogeneity

Firm Size

In addition to the above, we examine the role of firm characteristics in influencing the use of debt on productivity. Specifically, we examine whether the use of debt on productivity varies across firm sizes. Since the large firms are more likely to have access to alternative sources of funds, a buildup of the debt burden may not be a severe concern. Smaller firms, on the other hand, are likely to be more affected; as they lack access to alternative funding and because investment in productivity-enhancing activities is also likely to be more important for the survival of such firms. We test for this by splitting our sample into two groups representing small (and medium sized) firms and large firms and estimate the baseline model for each of these groups.[9]

5. Descriptive Statistics

We next summarize the key features of our sample, which comprises of 4540 firms across most manufacturing industries which are observed over the period between 2000 and 2015. Table 1 summarizes the variables used in our main regression.

Over the sample period, firms on average have earned revenues of approximately Rs. 900 Million, of which, the annual profit comprises of around Rs. 70 Million and the average firm holds fixed assets of nearly Rs. 460 Million. A closer look at the ratios sets these figures in perspective. While firm sales have grown at an average rate of 5 percent each year, there is considerable variation across firms. Firms hold a large share of their assets in the form of fixed

[9] We identify firms as Micro, Small or Medium-sized Enterprises (MSMEs) based on the definition outlined in the Development Act (MSMED), 2006. As per the definition (for the manufacturing sector), an enterprise is recognized as a micro enterprise if its investment in plant and machinery does not exceed Rs. 2.5 Million. The relevant range for small and medium sized enterprises is Rs. 2.5 Million-Rs.50 Million and Rs. 50 Million –Rs. 100 Million, respectively.

assets (83 percent of total assets), which may explain the relatively high level of capital-labor ratio. The Herfindahl Index is nearly 830 (or 0.0083), which suggests that firms in several industries face a relatively competitive market.[10] While nearly all firms in the sample are public limited companies (94 percent), only half of them are listed on the domestic stock exchange (NSE or BSE). In terms of the ownership concentration, a majority of the firms (78 percent) are widely held (with a maximum ownership share of under 25 percent), with only 6 percent of these firms having a concentrated ownership structure (of over 50 percent).

We next examine key financial ratios (Table 2). While firms have assumed more debt over the years, the book value of leverage has remained relatively more stable across firms, but at a comparatively high level of 0.34. A similar pattern is seen in case of the Debt/Equity ratio, which is over 3 (times) across firms in the sample. Moreover, as the interest-coverage ratio remains above 1, firms may be well positioned to meet their interest obligations. With regard to the sources of funding, it is seen that while firms mostly borrow from domestic banks to meet their financing needs (nearly 75 percent of total debt), financial institutions and corporations represent alternative sources of debt financing. Only a quarter of the firms use some form of foreign borrowing and fewer still use public borrowing. A look at the maturity structure of debt reveals that firms hold a majority of their liabilities in the form of long-term debt and nearly all borrowing is in the form of secured or collateralized borrowing.

Finally, Table 3 presents the correlation among the regressors. As seen, while there is a positive correlation between firm leverage and asset tangibility (0.19), the association with other control variables remains much lower (in the range of 0.02-0.07). Importantly, the correlation between firm leverage and cash flows (the alternative to external financing) also remains low. Overall, this suggests low correlation amongst the regressors and consequently, lesser scope of endogeneity issues plaguing the estimation.

[10] In percentage terms, the Herfindahl Index can range between 0 and 10000 (representing a monopoly).

Table 1: Summary Statistics

Variable	N. Obs.	Mean	Median	Std. Dev.	Min	Max
Sales	33361	3915.246	897.102	15000	0.076	390000
Wages	33361	239.430	49.160	1396.601	0.060	69000
Fixed assets	33361	2629.489	463.833	12000.000	2.805	390000
Raw materials	33361	1919.250	454.448	7493.446	0.055	220000
Profits	33361	494.194	67.804	2623.528	-5800.000	110000
Total assets	33361	4860.820	829.611	23000.000	2.649	700000
Total debt	33361	2129.189	278.200	12000.000	0.100	400000
Productivity (LP)	33361	3.857	2.107	10.649	0.104	189.941
Log Productivity	33361	0.555	0.745	1.181	-2.267	5.247
Productivity growth (Tornqvist)	33238	0.007	0.040	0.408	-5.278	5.965
Capital/Labor ratio	33361	11.075	5.490	38.191	0.008	4354
Raw material share	33361	0.519	0.539	0.222	0.000	7.643
Sales growth	33361	0.186	0.050	3.519	-0.998	403.122
Leverage	33361	0.348	0.342	0.205	0.000	0.999
Asset tangibility	33202	0.794	0.837	0.156	0.022	2.424
Cashflow	32577	0.004	0.001	0.048	-0.668	0.732
Profit	33361	0.095	0.096	0.094	-4.562	0.878
Herfindahl Index	33361	829.246	483.505	971.890	87.291	10000
Age	33361	30.354	24.000	35.208	-4.000	2014

Notes: Firm sales, wages, assets, raw materials, profits and debt are expressed in Rs. Million. Productivity growth based on the Tornqvist index number represents the annual percentage change in productivity. Raw material share is expressed as a percentage of total sales and sales growth represents annual percentage change in total firm sales. Capital-intensity is defined as the ratio of fixed capital to wage bill; asset tangibility is defined as the ratio of fixed assets to total assets and cash flow is defined as the ratio of net cash flow from operating activities to total assets. Leverage represents the ratio of total debt to total assets.

Table 2: Summary Statistics (Financial ratios)

Variable	N. Obs.	Mean	Median	Std. Dev.	Min	Max
Total debt (in Rs. Mln)	33361	2129.189	278.2	12000	0.1	400000
Debt (annual percent change)	33361	1.278	0.05	71.037	-0.999	11000
Leverage	33361	0.348	0.342	0.205	0	0.999
Interest coverage ratio	32645	24.075	3.006	379.061	-1500	43000
Debt/Equity ratio	31151	3.047	0.952	54.76	0	5792
Long-term debt	33361	0.554	0.574	0.302	0	1
Short-term bank borrowings	31198	0.688	0.786	0.324	0	1
Long-term bank borrowings	31198	0.312	0.214	0.324	0	1
Secured borrowing	30840	0.962	1	0.134	0	1
Sources						
Banks	31367	0.67	0.733	0.288	0	1.083
Foreign banks	5904	0.29	0.22	0.256	0	1
Financial institutions	7239	0.221	0.148	0.222	0	1
Public	3328	0.193	0.125	0.201	0	1
Corporations	13324	0.194	0.086	0.251	0	1
Other	24188	0.203	0.101	0.255	0	1

Notes: Leverage represents the ratio of total debt to total assets; interest-coverage ratio represents the ratio of EBIT to interest expenses; bank borrowing represents the share of bank debt in total debt and short-term debt represents the fraction of bank debt in the form of short-term borrowings. Sources of debt are computed as a fraction of total debt.

Table 3: Correlation Matrix

	Leverage	Asset tangibility	Cash flows	Size	Owner_inter	Owner_high	Herf Index
Leverage	1						
Asset tangibility	0.1964*	1					
Cash flows	-0.0372*	0.0379*	1				
Size	0.0209*	-0.0825*	0.0297*	1			
Owner_Inter	-0.0079	-0.0467*	0.0021	0.0985*	1		
Owner_High	-0.0691*	-0.0658*	0.0012	0.1102*	-0.1138*	1	
Herf Index	-0.0769*	-0.0228*	0.0147*	0.0318*	-0.0155*	0.0251*	1

Notes: Pair-wise Pearson's correlation coefficients reported. * indicates significance at the 5% level.

6. Results

a. Baseline Results

Table 4 presents the results from the baseline fixed-effects estimation (eq. 4.1).[11] As seen in Table 4, some firm characteristics are related to productivity and have the expected signs. Specifically, holding other factors fixed, a firm's stock of tangible assets is positively related to productivity. Cash flow is also seen to be a significant determinant, which suggests that firms are likely to use internal sources of finance to support productivity-enhancing activities. Our results also highlight that firms tend to become less productive as they get older, which can be due to lower investments or other operational inefficiencies. Interestingly, our results also suggest that the productivity levels do not vary with firm size. The degree of market concentration, however, is important, as firms in more concentrated (or less competitive) industries report higher levels of productivity.

On the role of debt financing, it is seen that an increase in the use of debt is negatively associated with firm productivity and this effect remains stable over the distribution of leverage. Our result is therefore consistent with Myers (1977) under-investment hypothesis. In other words, our result is consistent with the existence of agency costs and suggests that the prevailing levels of debt may be associated with the problems of debt overhang and risk-shifting, which may cause firms to reduce investments in productivity-enhancing activities. In terms of the magnitude of impact, a 1 percent increase in the level of firm leverage is associated with a 0.12 percent decline in firm productivity.[12] In terms of the economic significance, a 1 standard deviation increase in firm leverage can lead to a decline of 4.2 percent in average firm productivity. The deterring effect of higher leverage on firm productivity is therefore statistically and economically significant. Overall, our finding suggests that the costs of debt may outweigh the benefits of debt and thereby hurt the productivity growth of manufacturing firms in India. In light of existing studies, this result is consistent with the findings of Nucci et al. (2005) and Coricelli et al. (2012), who also report a negative relation between firm leverage and productivity growth.

[11] In all reported specifications, our choice of a fixed-effects model (versus a random-effects model) is driven by the Hausman Test.

[12] Since the model includes a quadratic term of leverage, the marginal effect (or partial derivative) of leverage is given by $\beta_1+2*(\beta_2 Lev)$, which is evaluated at the mean level of leverage (0.348) to get -0.115.

Table 4: Fixed-effects Regression (Baseline model)

	I	II	III	IV	V
Leverage	-0.091***	-0.115***	-0.116***	-0.113***	-0.176***
	(0.025)	(0.026)	(0.025)	(0.026)	(0.066)
Leverage^2					0.088
					(0.072)
Asset tangibility		0.113***	0.113***	0.108***	0.117***
		(0.031)	(0.031)	(0.031)	(0.031)
Log Size		-0.012	-0.012	-0.013	-0.000
		(0.033)	(0.033)	(0.033)	(0.033)
Log Size^2		-0.002	-0.002	-0.002	-0.003
		(0.002)	(0.002)	(0.002)	(0.002)
Cash flow			0.081**	0.077**	0.072**
			(0.033)	(0.033)	(0.033)
Owner_Inter		-0.010	-0.002	-0.010	-0.024**
		(0.013)	(0.012)	(0.013)	(0.012)
Owner_High		-0.015	-0.005	-0.016	-0.033*
		(0.018)	(0.017)	(0.018)	(0.018)
Firm age		-0.012***	-0.015***	-0.012***	-0.112***
		(0.001)	(0.001)	(0.001)	(0.019)
Herfindahl Index		0.041***	0.039***	0.041***	0.036***
		(0.010)	(0.010)	(0.010)	(0.010)
Constant	0.578***	0.768***	0.894***	0.771***	0.771***
	(0.010)	(0.128)	(0.127)	(0.128)	(0.130)
Firm and year fixed effects	Y	Y	N	Y	Y
Observations	33361	33361	33361	33361	33352
Adjusted R	0.052	0.072	0.069	0.072	0.067

Notes: Robust standard errors reported in parentheses. The dependent variable is firm productivity (using the LP method) and is expressed in natural logarithm. Firm leverage, asset tangibility and cash flows are expressed as ratios. Firm-specific ownership concentration is represented by two dummy variables representing intermediate and high ownership concentration. The base group represents firms with less concentrated ownership. Firm size, age and the Herfindahl index are expressed in natural logarithm. All explanatory variables are lagged by one time period. ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

b. Role of Innovation

Taking our result forward, we try to identify a possible sequence in which the use of debt results in subsequent productivity changes. As discussed in the literature section, while multiple firm-level factors can simultaneously contribute towards productivity improvements; we focus on the role of innovation in supporting productivity growth. In other words, we examine whether a firm's engagement in innovative activities can be one of the channels through which the use of debt influences productivity.

We demonstrate this association in two steps: we first regress firm-level R&D expenditure on firm leverage and a set of control variables; and in the second step, we regress the predicted values of R&D expenditure (from the preceding regression) on firm-level TFP and other control variables. The results from this exercise are presented in Tables 6 and 7, respectively.

Our results indicate that the use of debt influences the firm's ability to undertake innovative activities; as an increase in firm leverage is significantly associated with lower expenditure on R&D (Table 6). As such, high levels of debt appear to constrain R&D expenditure.[13] Going further, we also find that an increase in the level of (predicted) R&D expenditure is positively related to subsequent changes in firm productivity (Table 7). Our finding therefore suggests that the relationship between firm leverage and innovation (in the form of R&D) may represent an important causal link.

Taken together, our results confirm to our hypothesis that the firm's expenditure on innovation represents a significant channel through which the use of debt influences subsequent productivity changes. This finding is also consistent with Hall et al. (2009), who find that R&D expenses can lead to significant improvements in the firms' productivity.

[13] To ensure that there is no two-way causality between the level of innovation and the use of debt, we also estimate a third equation, in which we regress firm leverage on R&D expenditure (at t-1)) and other control variables (including the preceding year's sales, capital expenditure, firm size and cash flow). We find that R&D expenditure is not significantly associated with future leverage.

Table 5: Firm Leverage and R&D Expenditure (eq. (4.3))

	I	II	III
Dependent variable		*R&D expenditure*	
Leverage	-0.374***	-0.413***	-0.379***
	(0.117)	(0.109)	(0.106)
Cash holdings			-0.082
			(0.190)
Tangible assets		0.207	0.164
		(0.131)	(0.132)
Size		-0.209***	-0.198***
		(0.051)	(0.051)
Herfindahl Index		0.130***	0.127***
		(0.045)	(0.046)
Firm age		-0.144	-0.147
		(0.099)	(0.099)
Firm and year fixed effects	Y	Y	Y
N	11438	10924	10924
r2_a	0.024	0.040	0.040

Notes: Robust standard errors reported in parentheses .Reported estimates correspond to eq. (4.3). ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

Table 6: R&D expenditure and Firm Productivity (eq. (4.4))

	I	II	III
Dependent variable		*Productivity*	
R&D expenditure (predicted)	0.405***	0.401***	0.342***
	(0.049)	(0.050)	(0.049)
Asset tangibility		0.126***	0.131***
		(0.043)	(0.043)
Size		-0.064	-0.069
		(0.057)	(0.057)
$Size^2$		0.004	0.004
		(0.004)	(0.004)
Owner_Inter		-0.024	-0.023
		(0.017)	(0.017)
Owner_High		-0.013	-0.012
		(0.025)	(0.025)
Firm age		-0.007***	-0.009***
		(0.002)	(0.002)
Herfindahl Index		-0.001	0.005
		(0.013)	(0.012)
Leverage			-0.111***
			(0.038)
Firm and year fixed effects	Y	Y	Y
Obs.	9717	9702	9702
Adj-R^2	0.196	0.199	0.20

Notes: Robust standard errors reported in parentheses. The dependent variable is firm productivity (using the LP method) and is expressed in natural logarithm. ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

c. Sources of Firm Heterogeneity

Differences in Firm Size

Going further, we examine whether the effect of debt financing on productivity growth is stable and observed across all firms. In particular, we examine whether differences in firm size influence this relationship. We test for this by splitting the sample between two groups: the small and medium-sized firms (or MSMEs) and the large firms and estimate our baseline models (eq. (4.1) and (4.2)). Table 7 presents the results from this exercise.

Our results highlight two key aspects. First, an increase in the use of debt is associated with lower firm productivity and this effect is significant, regardless of differences in firm size. Second, while an increase in the degree of firm leverage appears to hurt productivity growth, the magnitude of impact varies substantially between the two groups. Specifically, our results imply that an increase in the use of debt is associated with a sharper decline in the productivity of the smaller firms. In terms of magnitude, a 1 percent increase in leverage is associated with a stronger decline of -0.15 percent in the productivity of smaller firms (relative to -0.11 percent for large firms) and difference between the two groups is statistically significant.[14]

Overall, the results from this exercise indicate that the association between firm productivity and the use of debt varies across firm size. In particular, the debt overhang problem is likely to be a more severe problem for the smaller sized firms in our sample, who appear to reduce their investments in productivity-enhancing activities by a larger magnitude, with an increase in the level of leverage.

Other Sources of Firm Heterogeneity

In addition to differences in firm size, we also verify whether the effect of firm leverage on productivity is contingent on some other potential sources of firm heterogeneity. In particular, we examine whether firms with access to equity markets exhibit a significantly different association between productivity and leverage. We also examine whether the marginal effect of leverage varies between exporting and non-exporting firms.[15] The results (presented in Table B.4, Appendix B) show that the observed effect of leverage is not significantly different for listed firms. This result implies that the problem of debt overhang which lead to underinvestment (and subsequently, lower productivity) is significant, even for firms which have access to an additional source of finance. Similarly, it is seen that the exporting firms are not likely to use debt financing in a significantly different way. Stated differently, the debt burden due to increase in firm leverage is associated with similar reductions in productivity of exporting and non-exporting firms.

[14] We obtain qualitatively similar results by classifying firms based on asset size, which are not reported for brevity.
[15] Following the conventional classification, a firm is identified as an exporter if it reports a positive value of exports in a given period. Following this classification, 3121 firms (or 69 percent of firms, representing 66 percent of all observations) are recognized as exporters over the sample period.

Table 7: Effect across Firm Size Groups

	I	II	III
Dependent variable		*Productivity*	
Firm size group	*All firms*	*Small firms (MSMEs)*	*Large firms*
Leverage	-0.113***	-0.150**	-0.109***
	(0.026)	(0.064)	(0.028)
Asset tangibility	0.095***	-0.003	0.107***
	(0.030)	(0.081)	(0.033)
Cash flow	0.073**	0.011	0.086**
	(0.033)	(0.088)	(0.034)
Owner_Inter	-0.011	-0.081*	-0.004
	(0.013)	(0.049)	(0.013)
Owner_High	-0.016	-0.118*	-0.006
	(0.018)	(0.071)	(0.018)
Firm age	-0.014***	-0.011***	-0.015***
	(0.001)	(0.003)	(0.001)
Herfindahl Index	0.044***	-0.012	0.053***
	(0.010)	(0.028)	(0.011)
Firm and year fixed effects	Y	Y	Y
Obs.	33361	5193	28168
Firms	4540	919	3621
Adj R^2	0.068	0.028	0.082

Notes: Robust standard errors reported in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

d. Accounting for Endogeneity

While the fixed-effects regression of our baseline model (eq. (4.1)) eliminates unobserved factors and minimizes simultaneity issues (as regressors are lagged by one time period), the model may still suffer from endogeneity. While the use of debt can determine the firm's ability to undertake productivity-enhancing investments, it is possible that a firm which intends to increase investments in such processes may assume more debt in the preceding years. It is also likely that when a firm becomes more productive and as a result, earns higher profits, the firm's demand or dependence on outside finance reduces in subsequent periods (Nucci et al. (2005)). Firm leverage, or the use of debt is therefore likely to be endogenously determined.

In the final step, we account for this possibility by using an instrumental variable approach (based on Two-Stage Least Squares (2SLS-IV)) to identify exogenously driven variations in firm leverage. The 2SLS-IV approach involves choosing suitable instruments for the endogenous variable, which must satisfy the preconditions of strong correlation with the endogenous variable

and no direct association with the dependent variable. We follow the existing literature on endogenous firm leverage to obtain appropriate instruments.

While the empirical literature suggests variables such as tangibility, interest expenses and asset maturities to instrument firm leverage; for the purpose of our study, we use the firms' non-debt tax shield (NDTS) and the industry-specific average debt (or leverage ratio) as the preferred instruments.[16] As highlighted by DeAngelo and Masulis (1980), NDTS, or the tax deductions from depreciation can be substitutes for the tax benefits from the use of debt and firms with greater non-debt tax shields are likely to use less debt. In this context, Huang and Song (2006), Firth et al. (2008) and Dang (2011) find evidence in favor of this theoretical prediction. Following these studies, we choose the firm's NDTS as a suitable instrument for leverage. Moreover, Bradley et al. (1984) and Grullon et al. (2006) suggest that the firms' decisions on leverage are also influenced by the industry trends, as firms in the same industry are expected to face similar cost structures. As such, we follow Grullon (2006) and Firth et al. (2008) and use the industry-specific average leverage as an additional instrument.[17]

We use NDTS and industry-specific average leverage as instruments for firm leverage and estimate our baseline model using the 2SLS fixed-effects regression. The two instruments appear as significant predictors of the leverage ratio in the first stage of regression, which are not reported for brevity. The F-test corresponding the IVs in the first stage tests for the exogeneity of the two instruments. The null hypothesis (that the instruments do not explain variation in firm leverage) is rejected at the 1% significance level (for all reported specifications). The predicted values of firm leverage from the first stage of regression are used as instruments for firm leverage in the second stage of regression. The results from the second stage of regression are reported in Table 8.

As seen, our main result remains unchanged. Holding other factors fixed, an increase in the degree of leverage is associated with lower firm productivity and this effect is statistically significant. This further substantiates our main finding, that existing levels of debt may give rise to the problem of debt overhang which causes firms to reduce investments in productivity-enhancing activities. Moreover, our additional results also hold, accounting for the endogeneity of debt: the level of firm innovation (or R&D expenditure) appears to be a significant channel through which the use of debt hurts subsequent productivity growth; and that the growth-deterring effects of firm leverage are more pronounced for the SMEs in the manufacturing industries. Our results are therefore robust to the potential endogeneity of debt.

[16] While many of these variables are good candidates for instrumenting firm leverage, most of them are likely to correlate with firm productivity (our dependent variable). For instance, while tangible assets serve as collateral and therefore correlate positively with leverage, they can independently influence production capacity and quality, which will result in a direct relation with productivity (as seen in our main model). Similarly, while interest expenses are correlated with the level of debt, higher payments in a period can cause firms to reduce their investments in productivity-enhancing activities.

[17] Several studies treat the endogeneity of firm leverage by using multiple variables (discussed above) in a 2SLS-IV setup to instrument leverage. For more information, see Firth et al. (2008).

Table 8: Baseline Model (Instrumental variable estimation (2SLS-IV)

Model spec.	*Basic model (eq. (4.1))*		*R&D exp (eq. (4.2))*		*eq. (4.1)*	
Dep. Variable	TFP-LP		R&D exp.	TFP-LP	TFP-LP	
Firm size (group)					*Large*	*Small (MSMEs)*
Leverage	-0.202	-0.265*	-1.754*		-0.093	-1.162*
	(0.143)	(0.157)	(1.037)		(0.162)	(0.621)
Tangible assets	0.084***	0.086***	0.076	0.163***	0.120***	-0.007
	(0.020)	(0.023)	(0.141)	(0.046)	(0.026)	(0.058)
Size	0.011	-0.007	-0.197***	-0.098	-0.008	-0.143*
	(0.028)	(0.032)	(0.051)	(0.062)	(0.046)	(0.082)
$Size^2$	-0.004*	-0.002		0.004	-0.003	0.016*
	(0.002)	(0.002)		(0.004)	(0.003)	(0.010)
Owner_Inter	-0.010	-0.005	0.029	-0.014	0.005	-0.051
	(0.013)	(0.013)	(0.045)	(0.018)	(0.013)	(0.049)
Owner_High	-0.019	-0.012	0.033	-0.009	0.007	-0.163**
	(0.018)	(0.018)	(0.052)	(0.026)	(0.019)	(0.075)
Firm age	-0.013***	-0.016***	-0.166	-0.013***	-0.016***	-0.014***
	(0.001)	(0.001)	(0.105)	(0.002)	(0.001)	(0.003)
Herf. Index	0.042***	0.039***	0.141***	0.014	0.047***	-0.038
	(0.009)	(0.010)	(0.046)	(0.013)	(0.010)	(0.033)
Cash flow		0.011			0.014	-0.054
		(0.037)			(0.039)	(0.120)
Cash holdings			-0.431			
			(0.301)			
R&D (predicted)				0.142***		
				(0.021)		
Obs.	38506	32740	10747	8858	27771	4964
Hausman test	0.012	0.237	2.072		0.254	0.969
(p-value)	0.912	0.616	0.15		0.614	0.325

Notes: Robust standard errors reported in parentheses. Second stage regression estimates reported.***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

Robustness checks

We check the robustness of our results in several ways. We employ two alternative measures of firm-level TFP, namely, the Tornqvist index and the Malmquist index and estimate our baseline model (eq. (4.1)).[18] We repeat this exercise using an alternative measure of firm leverage, defined as the ratio of long-term debt to the book value of total assets and the results are presented in Table B.1 (Appendix B).[19] Across all specifications, it is seen that an increase in firm leverage is associated with a decline in productivity growth and this effect is statistically significant. The role of internal sources of finance in aiding productivity changes, however, is not clear, as the sign of the coefficient varies across specifications.

Going further, we use these measures to verify a possible causal link between the firm's use of debt, the level of innovation and subsequent increases in productivity (Table B.2, Appendix B). The results based on alternative measures also confirm our hypothesis, that the firm's investment in innovative activities (in the form of R&D expenses) is likely to be one of the significant channels through which the use of debt influences subsequent productivity changes. We also examine the role of firm size using these measures and find that the smaller firms tend to reduce their productivity by a larger magnitude, following an increase in leverage (Table B.3, Appendix B).

[18] Note that while our measure of firm-level TFP using the LP method represents TFP in levels, the Tornqvist and Malmquist indices represent *changes* in productivity.

[19] A number of studies including Molina (2005) and Campello (2006) have used the ratio of long-term debt to total assets to represent firm leverage.

7. Conclusion

This study examines the relationship between firm-level financing and the productivity growth of manufacturing firms in India. Since most manufacturing firms rely on debt as a primary source of funding, we examine the relationship between firm leverage and productivity growth for an unbalanced panel of 4540 firms over the period 2000-2015. Our results suggest that there exists a negative association between leverage and firm productivity, which is statistically and economically significant. Our result implies that at the existing levels of leverage, the costs of debt (in the form of debt overhang and risk-shifting) outweigh the benefits of debt, which in turn may lead to reduced investments in productivity-enhancing activities. We test for the presence of a causal link between a firm's use of debt and subsequent productivity changes. Our results lend support to our hypothesis that the level of innovation-related activities undertaken by firms is one of the significant channels through which the use of debt influences productivity growth.

Going further, we examine whether the observed effect is contingent on firm size. We find that an increase in leverage is associated with a significantly stronger decline in the productivity of smaller firms. Finally, we examine this association for each industry in our sample and find that the negative effect of firm leverage on productivity is consistently observed across industries, though the magnitude of decline is higher among the capital-intensive industries. All our results are robust to alternative measures of productivity, firm leverage and empirical specifications.

Overall, the findings from this study provide new insights on firm-level productivity dynamics in India. Firstly, the results from our empirical analysis clearly indicate that firm-specific factors are important in shaping the productivity of manufacturing industries. In particular, a firm's use of debt financing and tangible assets appear to have significant effects on productivity. Secondly, the fact that a majority of firms may be facing constraints on further borrowing (due to high leverage) implies that most of them have a reduced scope for independently bringing about improvements in their efficiency levels, at least, in the short-run. The process therefore needs to be supported by external intervention in the form of policies which can facilitate access to resources as well as create incentives to increase efficiency levels.

One of the most important factors essential for efficiency improvements (and a result consistently observed in our analysis) is the access to the latest technologies in production, which are often embedded in the firm's fixed assets. As a majority of firms may not be in a position acquire new forms of capital, an important policy initiative will be to attract more foreign direct investment (FDI) into manufacturing industries. Foreign investments can play an important part by bringing in the necessary capital including technological know-how which can be instrumental in improving production processes. This initiative will need to be complemented by incentives provided to foreign investors for setting up utilities in India, which necessitates substantial investments in infrastructure development and a reduction of structural inefficiencies which increase production costs. In addition, the government can adopt measures to mitigate the effects of financing constraints by providing subsidies to incentivize innovation on a larger scale.

In the long run, these efforts have to be supported by the necessary regulatory reforms, particularly pertaining to tax and labor regulations, which distort incentives by encouraging firms to remain small.[20]

In this regard, the National Manufacturing Policy (2011) recognizes the significance of these deficiencies and has proposed several measures to improve infrastructure, labor productivity and regulatory procedures. The policy also emphasizes on the development of small and medium-sized enterprises (SMEs) with a focus on improving firm-level access to finance and innovation. Some of these measures include granting a priority sector status to SMEs, setting up of a stock market as well as interest-subsidies for working capital requirements. While the efficacy of these measures in alleviating financial pressures on SMEs remains to be seen, the most recent development in the form of the Goods and Services Tax (GST) bill is an important step towards reducing business costs and can be expected to improve the cost competitiveness of several industries in the following years. Eventually, the long-term implications for productivity growth will crucially depend on simplifying the current regulatory procedures and supporting a combination of industry and firm-level initiatives which promote capacity building, innovation (or technology adoption) and a competitive business environment.

[20] For more information, see Dougherty et al. (2009).

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Appendix A

A.1. Data Definitions

Variable	*Definition*
Leverage ratio	Book value of total debt/total assets
Total debt	Sum of borrowings from domestic and foreign banks, institutions, intercorporate loans, debentures, bonds and promoters
Productivity	TFP (Levinsohn and Petrin (2003)); Tornqvist TFP Index; Malmquist TFP Index
Size	log (total assets)
Tangible assets	Tangible assets (include plant, machinery and equipment)/total assets
Cash flow	Cash flow from operations/total assets
Herfindahl Index	Sum of squared market share of all firms in the industry (2-digit NIC level)
Expenditure on Innovation	Research and development expenses (current and capital account)/total assets

Measurement of Firm Productivity (Levinsohn and Petrin (2003))

Following Levinsohn and Petrin (2003), the firm-specific, time-varying estimates of TFP are obtained by estimating the following production function:

$$y_{it} = \beta_0 + \beta_1 k_{it} + \beta_2 w_{it} + \beta_3 n_{it} + \mu_{it} + \varepsilon_{it} \quad (1)$$

where y_{it} denotes firm revenue, k_{it} denotes capital or fixed assets, w_{it} represents the number of employees and n_{it} denotes expenditure on intermediate inputs. The unexplained variation in output (y_{it}) comprises of the *unobserved* efficiency term (μ_{it}) and the error component (ε_{it}). Estimating equation (1) above by Ordinary Least Squares (OLS) can be problematic as firms are likely to *choose* their factor inputs each period contingent on their contemporaneous productivity levels (which are *unobservable* to the econometrician). This may give rise to biased coefficient estimates of the production function. Levinsohn and Petrin (2003) account for this possibility and propose the use of intermediate inputs to correct the simultaneity problem.[21] Their method (referred to as the LP method, henceforth) comprises of a semi-parametric approach to obtain consistent estimates of β following which, TFP is obtained using the following equation:

$$\mu_{it} = y_{it} - \beta_1 k_{it} - \beta_2 w_{it} - \beta_3 n_{it} \quad (2)$$

We follow the LP method to obtain consistent estimates of firm-specific productivity by estimating equation (1) for each industry at the two-digit NIC level.[22] We use annual sales as our measure of firm revenue; fixed assets as a measure of capital ((k_{it}), total wage bill as a proxy for labor (w_{it}) and raw material expenses as a measure of intermediate inputs (n_{it}). All variables used are in real terms and enter the regression equation in natural logarithm.

[21] See Levinsohn and Petrin (2003) for more information on the methodology.
[22] We use the "levpet" command in Stata to obtain these estimates.

Appendix B

Table B.1: Baseline Model (Alternative measure of firm Productivity and Leverage)

	I	II	III	IV	V
Measure of Leverage	*Debt-ratio*		*Long-term debt*		
Measure of TFP (dep. var)	TFP-Tornqvist	TFP-Malmquist	TFP-LP	TFP-Tornqvist	TFP-Malmquist
Leverage	-0.118***	-0.405**	-0.115***	-0.245***	-0.374
	(0.022)	(0.167)	(0.027)	(0.031)	(4.473)
Tangible assets	0.531***	-0.705***	0.087***	0.538***	-0.579
	(0.045)	(0.155)	(0.023)	(0.044)	(0.384)
Cash flow	-0.565***	0.661**	0.024	-0.534***	0.842*
	(0.074)	(0.268)	(0.037)	(0.075)	(0.450)
Size	-0.553***	0.758**	-0.019	-0.545***	0.756**
	(0.049)	(0.319)	(0.033)	(0.048)	(0.322)
Size 2	0.023***	-0.011	-0.001	0.022***	-0.011
	(0.003)	(0.022)	(0.002)	(0.003)	(0.021)
Owner_Inter	0.021*	0.021	-0.010	0.007	0.021
	(0.012)	(0.061)	(0.012)	(0.012)	(0.066)
Owner_High	0.031**	-0.052	-0.016	0.015	-0.056
	(0.015)	(0.074)	(0.018)	(0.015)	(0.071)
Firm age	0.070***	-0.036***	-0.013***	0.010***	-0.036*
	(0.021)	(0.007)	(0.001)	(0.001)	(0.022)
Herf. Index	0.017*	0.005	0.041***	0.012	0.001
	(0.009)	(0.030)	(0.010)	(0.009)	(0.038)
Firm/year fixed effects	Y	Y	Y	Y	Y
Obs.	33038	6011	33239	33119	6006
Adj R^2	0.143	0.121	0.074	0.146	-0.185

Notes: Robust standard errors reported in parentheses. Leverage is defined as the ratio of debt to total assets in the first two specifications (columns I and II) and the alternative measure of leverage (defined as the ratio of long-term debt to total assets) is used in the remaining specifications. ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

Table B.2: Causal association between firm innovation and productivity

	I	II	III	IV
Dependent variable	*R&D expenditure*	*Firm Productivity*		
Measure of TFP		TFP-LP	Tornqvist	Malmquist
Long term debt	-0.531***			
	(0.130)			
Cash holdings	-0.017			
	(0.090)			
Tangible assets	0.131	0.087***	0.764***	-1.091***
	(0.130)	(0.030)	(0.055)	(0.313)
Size	-0.202***	0.007	-0.588***	0.883*
	(0.051)	(0.035)	(0.055)	(0.523)
Size2		-0.001	0.024***	-0.016
		(0.002)	(0.003)	(0.033)
Herf. Index	0.124***	0.024**	-0.019	0.078*
	(0.046)	(0.010)	(0.014)	(0.044)
Owner_Inter		-0.007	0.021	0.010
		(0.013)	(0.015)	(0.066)
Owner_High		-0.019	0.027	-0.057
		(0.020)	(0.021)	(0.082)
R&D expenditure (predicted)		0.203***	-0.007*	0.062***
		(0.029)	(0.004)	(0.021)
Firm and year fixed effects	Y	Y	Y	Y
Obs.	10924	32701	10865	2081
Adj R^2	0.041	0.080	0.125	0.161

Notes: Robust standard errors reported in parentheses. Columns I and II report estimates corresponding to eq. (4.3); whereas columns III-V report estimates corresponding to eq. (4.4). The predicted R&D expenditure corresponds to the fixed-effects estimation using long-term debt (from Column 1). ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

Table B.3: Effect of Firm Size

	I	II	III	IV	V	VI
	TFP-LP		TFP-Tornqvist		TFP-Malmquist	
Firm size (group)	Small	Large	Small	Large	Small	Large
Long term debt	-0.279***	-0.088***	-0.237***	-0.166***	-0.800*	0.147
	(0.073)	(0.030)	(0.083)	(0.032)	(0.473)	(0.242)
Tangible assets	-0.023	0.097***	0.578***	0.881***	-0.429**	-0.575**
	(0.081)	(0.032)	(0.103)	(0.040)	(0.217)	(0.228)
Cashflow	0.022	0.095***	-0.345*	-0.238***	0.132	1.037***
	(0.089)	(0.035)	(0.176)	(0.068)	(0.394)	(0.376)
Owner_Inter	-0.079	-0.003	0.008	0.006	0.046	0.010
	(0.049)	(0.013)	(0.052)	(0.011)	(0.054)	(0.064)
Owner_High	-0.120*	-0.005	0.100*	0.018	-0.165	-0.052
	(0.071)	(0.018)	(0.056)	(0.016)	(0.598)	(0.066)
Firm age	-0.011***	-0.015***	0.002	0.002	0.677	-0.074
	(0.003)	(0.001)	(0.004)	(0.001)	(0.746)	(0.182)
Herf. Index	-0.013	0.052***	0.019	0.029***	-0.082	0.016
	(0.028)	(0.011)	(0.025)	(0.009)	(0.061)	(0.033)
Obs.	5193	28168	5142	28096	705	5306
Adj R^2	0.032	0.081	0.027	0.062	0.195	0.107

Notes: Robust standard errors reported in parentheses. Firms are classified under the category of small and medium-sized enterprises (MSMEs) if the investment in plant and machinery is under Rs. 100 million. In each specification, firm leverage is defined as the ratio of long-term debt to total assets. ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

Table B.4. Baseline model (Alternative specifications)

	I	II	III	IV
	TFP-LP	TFP-Tornqvist	TFP-LP	TFP-Tornqvist
Leverage	-0.188***	-0.211*	-0.095**	-0.148*
	(0.046)	(0.122)	(0.037)	(0.079)
Listed*Leverage	-0.060	0.094	-0.023	0.032
	(0.055)	(0.137)	(0.018)	(0.031)
Exporter			-0.023	0.032
			(0.018)	(0.031)
Exporter*Leverage			-0.027	-0.015
			(0.040)	(0.080)
Asset tangibility	0.100***	0.964***	0.108***	0.981***
	(0.031)	(0.038)	(0.031)	(0.038)
Cash flow	0.069**	-0.226***	0.074**	-0.217***
	(0.033)	(0.063)	(0.033)	(0.062)
Size	-0.013	-0.264***	-0.010	-0.535***
	(0.033)	(0.011)	(0.033)	(0.044)
$Size^2$	-0.002		-0.002	0.021***
	(0.002)		(0.002)	(0.003)
Observations	33361	32025	33361	32025
Adjusted R^2	0.080	0.018	0.073	0.027

Notes: Robust standard errors reported in parentheses. All regressions include firm and year-fixed effects. ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.