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

Abstract

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 finance, we examine the relationship between firm leverage and productivity growth for an unbalanced panel of 4540 firms over the period: 2000-2015. Our results indicate that there exists a negative association between firm leverage and productivity and this effect is statistically and economically significant. We test for the presence of a potential causal link between firm-level leverage, innovation-related activities and observed productivity. Our results suggest that a firm's expenditure on innovation is likely to be one of the significant channels through which firm leverage influences productivity growth. We also examine whether the observed effect of leverage on productivity varies along some dimensions of firm heterogeneity and find a significant role of firm size and the maturity structure of debt in influencing this relationship. Our results suggest that an increase in leverage is associated with a significantly larger decline in the productivity of smaller firms. The negative effect of leverage is also significantly lower for firms with a relatively larger share of short-term debt. In the final step, we examine the industry-specific effects of firm leverage to account for industry-related differences.

Key words: Total factor productivity, Debt-financing, Trade-off theory, Firm-heterogeneity, Endogeneity

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 (or output per worker), compared to differences in factor accumulation.[1] The magnitude of difference can be considerable, as Heish and Klenow (2007) 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.[2] From a macroeconomic perspective, while the reallocation (or misallocation) of resources and the survival of inefficient firms are typically found to 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. In this context, recent studies have identified a range of firm-specific features including the choice of factor inputs, use of information technology (IT), innovation and financing decisions (among others) to have significant effects on firm efficiency. As such, an important step towards a more composite assessment of productivity (and why it remains low in some countries) should not only account for the role of resource misallocation across firms, but also factor in the relative contribution of firm-specific features as they are seen to influence observed levels of productivity (Syverson (2011)).

[1] Studies which find a dominant role of productivity growth in driving income growth include Klenow and Rodrigues-Clare (1997), Hall and Jones (1999), Easterly and Levine (2001) and Henry et al. (2009).

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

Macroeconomic literature has long recognized that an important factor influencing growth is the degree of financial development. In fact, recent developments suggest that productivity can be a channel through which finance affects growth. The main argument here is that 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 in fact, arise from various microeconomic channels which reflect firm-level decision-making.

One of the most fundamental aspects of corporate decision-making is concerned with financing decisions. In particular, the association between a firm's financial resources and its undertakings can arise through at least two mediums. Firstly, the financial resources that a firm has access to can independently influence the level of investment it can afford to undertake. In other words, better access to financing should typically correlate positively with firm outcomes and various studies observe these effects. Secondly, in addition to the level of financing, the firm's source of financing can also affect its outcomes. In other words, the firm's capital structure may affect its investment and output decisions in various ways and theories of capital structure (in corporate finance) 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 (or composition of funds) has no influence on firm value. However, in reality, markets are incomplete and characterized by agency problems between shareholders, debt holders and the management; which affects the firm's relative preference for debt financing. This relationship can most easily be seen in the context of the *trade-off theory*. As per the trade-off theory, a firm chooses its optimal leverage based on the relative costs and benefits 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 (Harris and Raviv (1990);Stulz (1990)). 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, all of which reduce the preference for using debt in the capital structure (Jensen and Meckling (1976); Myers (1977); Gruber and Warner (1977)). 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 firm-level financing affect productivity? At discussed, the association can arise through two channels. Firstly, if a firm has better access to financing, it can afford to invest more in productivity-enhancing activities. To this effect, an increase in the level of the firm's financial resources is likely to support productivity gains. Secondly, as the firm's use of debt-financing (or leverage) also represents a trade-off between the costs and benefits of debt, it can influence firm outcomes in multiple ways.[3] 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, firm financing (or leverage) will be positively associated with productivity gains. However, if a firm consistently maintains high levels of leverage, 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 (and) cause firms to divert resources away from such activities in order to service the buildup of debt (Coricelli et al. (2012)). In this case, firm leverage can also be associated with lower levels of productivity. The final impact of financing on productivity will therefore depend on which of the two effects dominate.

This paper empirically examines the relationship between firm-level financing (leverage) and productivity (or TFP) using a detailed sample of 4540 manufacturing firms in India for the period 2000-2015. We use the firms' leverage as a measure of financing as bank borrowings (and other forms of debt) represent the main source of funding for a majority of firms in India (Love and Martinez Peria (2005)). Moreover, since firm leverage can be affected by anticipated increases in productivity-enhancing investments, it is likely to be endogenously determined. We account for this possibility by using a Two-Stage Least Squares Instrumental Variable (2SLS-IV) approach to model the relationship. This ensures that variations in firm leverage are exogenously driven and alleviates concerns of endogeneity which can potentially influence the observed effect of leverage on TFP. We use this framework to answer the following questions: what is the relationship between a firm's use of debt-financing (i.e. leverage) and its productivity? Is there evidence of a possible causal link between firm leverage, the degree of innovative activities and productivity? Do sources of firm heterogeneity give rise to differential effects? In particular, is the effect of leverage stable across firms of all sizes; or, is the effect influenced by the firm's share of short-term debt? Does the association between leverage and firm productivity differ across industries with different relative factor intensities?

Our results suggest that there exists a significant negative association between firm leverage and productivity. In other words, an increase in leverage is associated with lower levels of productivity for the average manufacturing firm in India. This implies that firms (on average) may already be highly leveraged and as such, the debt burden (or debt overhang) may be causing firms to divert resources away from productivity-enhancing activities. We find some evidence to support our hypothesis that leverage could be affecting productivity through a decrease in the firm's innovative activities. This suggests that firm-level innovation is likely to be one of channels through which leverage constrains productivity growth. Going further, we find that the effect of leverage varies across firm characteristics. More specifically, we find that an increase in

[3] While we focus on the trade-off theory to understand the relationship between firm leverage and firm value, our empirical estimation does not entail a formal test of the same. Our understanding of factors potentially influencing leverage, however, is based on recent evidence presented by Frank and Goyal (2009), who find that capital structure decisions are largely consistent with the trade-off theory.

leverage is associated with a significantly stronger decline in productivity of smaller firms. Our results also indicate that the decline in productivity (associated with higher leverage) is significantly lower among firms with a relatively larger share of short-term debt. 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.

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 (Hseih and Klenow (2007)). 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 manufacturing productivity benefited from reduced tariffs (as a consequence of trade liberalization), 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 adequate impetus to support firm-level productivity improvements. Third, the prevalence of structural bottlenecks may have further slowed 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 as well as 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 variables are presented in Section 3 and Section 4 outlines the empirical specification of our regression model. Sections 5 and 6 present the descriptive statistics and regression results, respectively, and Section 7 concludes.

1. **Review of Literature**

This paper examines the relationship between firm leverage and productivity for a sample of manufacturing firms in India. The mechanisms which give rise to this relationship correspond to two distinct strands of literature. While the first strand corresponds to the corporate finance literature on leverage and its effects on firm performance, 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 therefore been the subject of intense scrutiny. In their seminal paper, Modigliani and Miller (1958) (MM theory, henceforth) 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 (or source of finance) has no effect on firm value.[4] This result however, fails to hold in a market characterized by imperfections which arise due to the presence of taxes, conflicts of interests, information problems and incentive effects of financial leverage. Subsequent work has incorporated the role of these imperfections and proposed two theories relating to optimal capital structure, namely, the *trade-off theory* and the *pecking order theory.* Essentially, these theories vary in the relative importance that is assigned to the source of market imperfections and consequently, in the relative preference for a certain form of financing. This paper in particular relates to the strand of corporate finance literature which examines the effects of financial leverage (or debt ratio) on firm performance in the context of the trade-off theory.

The *trade-off theory* is one of the main theories on how firms choose their capital structure and in turn, how their capital structure affects firm value or performance. According to this theory, each firm chooses its optimal capital structure (optimal leverage/debt ratio) by evaluating the costs and benefits of financial leverage. On the one hand, while using more debt provides greater interest tax shields for firms (which increases firm value), on the other hand, it also increases the costs of financial distress.[5] Finally, it is this trade-off between tax benefits and costs of distress that determines the optimal leverage or debt ratio. While decisions on capital structure or optimal leverage are central to firm value maximization and have been an independent subject of intense empirical investigation, there is more to the significance of observed levels of leverage.[6] Due to

[4] Capital structure refers to a firm's mix of debt and equity. The basic idea of the MM proposition is 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.

[5] Financial distress occurs when firms find it increasingly difficult to repay their borrowings/debt. In extreme cases, this can even lead to bankruptcy.

[6] There is a substantive body of literature which has empirically examined the determinants of corporate leverage (and tested the validity of the trade-off theory versus the alternative pecking order theory). For instance, Rajan and Zingales (1995) find that firm-level debt ratios are influenced by four factors, namely, firm size, profitability, asset tangibility and market-to-book values. Their findings seem to be consistent with the presence or validity of both

the presence of market imperfections, the leverage or optimal debt ratio *chosen* each period can affect the incentives of agents (who maximize firm value) in various ways, which in turn can aggravate the costs of distress and thereby have significant implications for firm performance. As the trade-off theory recognizes the sources leading to financial distress (in addition to determining the optimal capital structure), a parallel strand of literature relating to the trade-off theory empirically measures the *effects of leverage* on various dimensions of firm performance. This paper in particular relates to this segment of research.

As managers or shareholders have more knowledge about the firm and its operations than outside investors (such as debt holders), the availability of debt as a source of external finance can affect how efficiently firm agents choose to employ this stock of financial resources.[7] In this regard, agency costs represent an important source of conflicts. According to Jensen and Meckling (1976), there can be two types of agency conflicts which can give rise to contrasting ways in which firm leverage affects value or 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 or shareholders' value (Grossman and Hart (1982); Williams (1987); Jensen (1986); Stulz (1990)). To the extent that leverage plays a disciplinary role in this process, it can minimize the degree of conflict between managers and shareholders and thus, have a positive effect on firm performance.

On the other hand, higher leverage may also give rise to the problem of underinvestment (Myers (1977); Stulz (1990)). If shareholders wish to reduce investment in risky projects (i.e. those with negative present value), 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 scope of investing in plausible projects with positive present value, and thereby lead to underinvestment by firms. Moreover, 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 (with can yield higher prospective profits) at the expense of debt holders. Under these circumstances, 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 identified above, the negative effects of leverage 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 difficulty in raising funds through further borrowing. Such firms are close to financial distress

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theories. In contrast, Frank and Goyal (2009) find that the empirical evidence on U.S. firms is relatively more consistent with versions of the trade-off theory.

[7] One of the reasons why debt potentially affects the incentive structure is because it is obtained from agents who have incomplete information about the firm's operations (vis-à-vis the *insiders*). It also arises as a consequence of an asymmetric liability structure (against debt holders) in the event of a default or bankruptcy.

and find it challenging to raise capital for new investments as the returns on these investments accrue to existing debt holders and not the new investors. As such, debt overhang is another factor which may lead to underinvestment by firms, which can subsequently translate into a negative effect of leverage 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 described by the *trade-off theory*. To this effect, several studies have examined the association between leverage and various measures of firm performance and report mixed results.[8] 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 leading 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 or efficiency. Indeed, as firms become more efficient at converting factor inputs into output, they are likely to gain a cost advantage along with quality improvements, which can subsequently lead to higher profits and greater market valuation over time.[9] A number of studies therefore consider productivity as a measure reflecting firm value.[10]

Nucci et al. (2005) is one of the early studies which examine the link between productivity and external financing. In particular, they employ a two-stage least squares (2SLS - Instrumental Variable) approach to model the relationship between leverage and total factor productivity for a sample of manufacturing firms in Italy. Based on their model, they find evidence of a significant negative effect within (and across) firms. Moreover, they find that the association is contingent on firm-specific features like debt maturity and the share of liquid assets.[11] These results are interpreted as evidence that market-based (equity) finance may be important in raising aggregate productivity in Italy.

While leverage appears to have a negative effect on productivity in some studies, a selected few report a positive association. One such paper which documents this effect 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.[12] 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

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[8] These studies have employed various measure of firm performance including firm investment, profitability and efficiency. Refer to Weill (2008) for a review of recent studies on this issue.

[9] See Dwyer (2001) for more information on how firm productivity can lead to better market valuation (measured by Tobin's Q).

[10] The positive association between plant-level productivity and firm value is also documented by Balasubramanyan and Mohan (2010).

[11] Firms with a higher (lower) share of short-term debt (liquid assets) are seen to be less affected by leverage.

[12] Margaritis and Psillaki (2010) rely on a non-parametric measure of productive efficiency (based on distance functions) to represent firm's agency costs, as opposed to other measures of financial performance or productivity.

leverage can assume a disciplinary role and improve performance. Overall, their findings demonstrate a bi-directional association between leverage and firm efficiency. They also emphasize on the need to account for industry dynamics in modeling capital structure and its effects.

Finally, while most studies test for the existence of a linear relationship and emphasize on either a positive *or* a negative effect of firm leverage, Coricelli et al. (2012) argue that both effects can potentially be observed. In other words, the effect of leverage can vary over its distribution. 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. After reaching a certain threshold, the costs of debt outweigh the benefits of debt and can result in a negative effect on productivity growth. They estimate a panel threshold fixed-effects model for a sample of manufacturing firms in sixteen Central and Eastern European countries between 1999 and 2008 and obtain results which confirm their predictions. The estimated *threshold leverage* is interpreted as the optimum debt ratio for firms in these countries.

While the preceding discussion outlines how firm leverage affects performance by influencing incentives, a second strand of literature identifies other microeconomic channels through which firm leverage (or more generally, credit conditions) can influence outcomes such as productivity. The rationale shared by a majority of these studies is that access to credit can limit the firm's ability to engage in activities which give rise to productivity gains. Recent studies in this line of literature suggest a significant role of factor inputs and innovation-related activities in shaping productivity.

While labor and capital are central to a firm's production process, they can also affect productivity if there are differences in quality that input measures fail to capture (Syverson (2011)). Recent studies have found that the quality of labor and capital can have significant effects on firm productivity. For example, Ilmakunnas et al. (2004) use matched worker-plant data on Finnish firms and demonstrate that productivity is positively associated with the workers' education and age. Van Biesebroeck (2003) examines the productivity of auto assembly plants which adopt "lean" technologies (which represent new capital and production practices). They find that shifting to this form of capital is significant in improving labor productivity growth. In other work, Doraszelski and Jaumandreu (2009) examine productivity growth for a sample of Spanish firms and find that research and development (R&D) expenditure explains significant variation observed in productivity growth.[13] While these studies demonstrate that factor inputs and innovative activities can improve productivity outcomes, several others document how tough credit conditions affect some of these factors which influence productivity. In this context, an important contribution is made by Aghion et al. (2010), who suggest that tight

[13] As noted by Syverson (2011), R&D is one of the observable components of a firm's engagement in innovative activities. For more information on the role of innovation, see Hall et al. (2008), who examine the links between R&D intensity, innovation and productivity of SMEs in Italy.

credit conditions can affect a firm's productivity-enhancing investments (and hence, productivity) by raising the *liquidity risk* of such expenditure.

They present a two-period overlapping generations growth model with credit markets and endogenous investment and productivity. The distinctive feature of this model is that entrepreneurs engage in two types of investments, a short-term investment and a long-term, productivity-enhancing investment.[14] Under complete markets, the short-term investment is procyclical whereas the long-term component of investment remains counter-cyclical.[15] As the endogenous component of productivity growth is counter-cyclical, it mitigates volatility. However, the transmission changes when firms are faced with tighter credit constraints. Specifically, tighter credit constraints increase the *liquidity risk*, which makes long-term investment (and consequently, productivity growth) more procyclical, thereby increasing the variation in productivity and output.[16] They empirically validate these predictions for a sample of countries by showing that R&D investment and growth become more sensitive to exogenous shocks in the presence of tighter credit constraints.

Evidently, access to finance can affect productivity in various ways. Interestingly however, only a few studies have empirically examined this issue. Among them, Gatti and Love (2008) examine this issue for a sample of Bulgarian firms and find that access to a credit line (or overdraft facility) is significantly and positively associated with TFP. Krishnan et al. (2014) examine how an exogenous increase in the supply of credit affects productivity. Using a sample of U.S firms, they find that the increase in firms' access to finance (as a result of bank deregulation) led to higher TFP.[17] Chen and Guariglia (2013) examine this issue for a sample of Chinese manufacturing firms for the period 2001-2007 and find that productivity is significantly constrained by the availability of internal finance.[18]

In view of the existing studies on the role of firm-level finance, our study is empirically closer to Coricelli et al. (2012), Margaritis and Psillaki (2010) and Nucci et al. (2005). However, it is worth noting that our approach also differs from these studies in important 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 existence of a common "threshold" leverage beyond which, the effect reverses for all firms. Given that firm dynamics can vary substantially across industries

[14] Long-term investments can represent various undertakings such as starting a new business, adopting a new technology, acquiring new skills and (or) engaging in research and development activities.

[15] This happens as the demand for long-term investment is relatively less procyclical (as it takes longer to complete).

[16] Liquidity risk refers to the risk that long-term investment may be disrupted by unknown liquidity shocks. Productivity in this situation becomes procyclical due to an increase in procyclicity of demand for long-term investment and by increasing the success probability of this investment during booms than in recessions.

[17] The observed effect is higher among financially constrained firms, which may have stalled investing in productivity-enhancing activities as they faced tighter credit conditions prior to the deregulation.

[18] In addition to the studies discussed here, some studies examine the effect of financial constraints on productivity. However, since these studies typically rely on a synthetic measure of constraints and not firm leverage, they are less relevant in the context of this study. For more information, see Ferrando and Ruggieri (2015) and Levine and Warusawitharana (2016).

(within the manufacturing sector) and more so, across countries with distinct institutional features, the "optimal leverage" or debt-ratio is unlikely to be the same across industries or, across countries. Our empirical approach therefore focuses on the average (overall) effect and additionally highlights industry-specific differences, rather than determining a common optimal level of leverage.

In this regard, our paper is empirically closer to Nucci et al. (2005), who also identify exogenously-driven variations in firm leverage using an instrumental-variable approach. The key difference in this context is with regard to the interpretation 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 in view of the manufacturing firms in our sample, not only does firm leverage represent the use of debt; it represents the primary source of finance for most firms. The central question, therefore, is not about the suitability of debt, but rather, about how firms utilize their resources, *given* that debt is the main source of external finance for a majority of these firms. In this regard, our study is conceptually closer to Margaritis and Psillaki (2010). However, while Margaritis and Psillaki (2010) focus on the cross-sectional association in three industries, our sample comprises of longitudinal data spanning all manufacturing industries in India. Moreover, by adopting an instrumental-variable approach to tackle the endogeneity of leverage, we are able to mitigate concerns of reverse causality and observe the average association over a longer horizon.

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 association between firm leverage and total factor productivity in the Indian context. This is important not only because of the theoretical mechanisms discussed earlier, but also because recent findings suggest that financial constraints or credit conditions may be a factor influencing the productivity of manufacturing firms in India.[19] Furthermore, while the recent empirical literature on productivity includes two significant contributions by Hseih and Klenow (2007, 2012) who examine plant-level productivity of Indian manufacturing firms (in the context of resource misallocation) and document firm-dynamics, only a limited number of studies examine productivity trends in the context of firm-specific determinants.[20] This paper also contributes to this line of literature. Finally, in addition to examining the role of external finance, we also account for various sources of firm and industry-level heterogeneity which can potentially give rise to differential effects. By accounting for these possibilities, our study tries to present a composite perspective on the true effects of leverage on the productivity of manufacturing firms in India.

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

[20] Following Hseih and Klenow (2007, 2012), a few studies have examined the role of economic reforms in influencing the productivity growth of manufacturing plants in India. For more information, see Bollard et al. (2013) (for the contribution of economic reforms) and Arnold et al. (2012) (for the role of service-sector reforms).

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). As such, our sample comprises of firms which are classified under the industry groups ranging between NIC-10 and NIC-33.[21] 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. We also exclude highly indebted firms by excluding observations for which the debt-to-asset ratio (or book value of leverage) is greater than or equal to 1.[22] All firm-specific variables are deflated using the relevant price indices obtained from the Reserve Bank of India (RBI) Handbook of Statistics. Our final sample comprises of an unbalanced panel of 33361 observations (from 4540 firms) 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 in this analysis is the construction of a reliable estimate of firm-level productivity. While the relevant literature has developed various parametric and non-parametric ways of obtaining efficiency or productivity estimates, the first step typically involves the estimation of a production function. As productivity (or efficiency) is not directly observable, most parametric (and semi-parametric) methods derive productivity estimates from the residuals of an estimated 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 increasingly been employed in several studies including Coricelli et al. (2012) and Krishnan et al. (2015) which examine productivity dynamics and the estimates from this method are seen to perform as well as those from other non-parametric methods.

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[21] We exclude firms engaged in the production of coke and petroleum products (NIC code 19) and those engaged in the Gems and Jewelry industry (NIC code 321).

[22] This amounts to restricting the sample's debt ratio to the [0,1] range, which implies that the sample comprises of only those firms which report positive debt level but not excessively indebted or close to bankruptcy over the sample period.

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 and consequently, biased estimates of firm productivity. Levinsohn and Petrin (2003) account for this possibility and propose the use of intermediate inputs to correct the simultaneity problem.[23] 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.[24] 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.[25] The firm-level TFP obtained from eq. (2) is then trimmed at the 1st and 99th percentiles of the distribution to exclude the effect of outliers in our main regression model.

Alternative measures of Productivity/Efficiency

a. Tornqvist Index Number

While we rely on productivity estimates obtained from the LP method as our primary measure of firm-level productivity, we check the robustness of our results by estimating our model using two *alternative measures* of productivity. The first of these measures is the well-known *Tornqvist Index number* which is computed as the *change in total factor productivity* using an additive version of the Cobb-Douglas production function. As observed by Caves et al. (1982) and Syverson (2011) (among others), an advantage of this approach is that it is intuitively plausible and does not require estimating the parameters in eq. (1) using regression techniques. This measure has subsequently been employed in several studies including Brandt et al. (2012)

[23] See Levinsohn and Petrin (2003) for more information on the methodology.
[24] We use the "levpet" command in Stata to obtain these estimates.
[25] We use the total wage bill to represent labor as most firms over the sample period do not report information on the number of employees.

to verify results obtained from alternative measures. The basic idea is that a cost-minimizing firm will optimize by equalizing the relative factor price to the elasticity of substitution allowed by the existing production technology. Consequently, factor shares can be used to account for factor substitutability.

Our alternative measure of productivity is therefore obtained by calculating the Tornqvist index number as follows:

$$TFPQ_{it} = (y_{it} - y_{it-1}) - \bar{s}_{it}\,(w_{it} - w_{it-1}) - (1 - \bar{s}_{it})(k_{it} - k_{it-1}) \qquad (3)$$

where $\bar{s}_{it} = (s_{it} + s_{it-1})/2$ represents the labor share in output (and estimated by the average share of labor in output in the current and preceding year), $(1 - \bar{s}_{it})$ represents the share of capital in output (assuming constant returns to scale) and y_{it}, w_{it} and k_{it} represent firm-specific output, labor and capital, respectively. The productivity estimate thus obtained using the Tornqvist index number represents the change in productivity of firm i in year t, over the previous year.

b. Malmquist Productivity Index

In addition to the Tornqvist Index number, we use the *Malmquist Productivity Index* as a second measure of total factor productivity change. Pioneered by Malmquist (1953), this index is a popular alternative to many of the parametric and semi-parametric approaches and has been used in a number of studies to examine productivity dynamics. The Malmquist Index is based on a non-parametric framework which uses data envelopment analysis (DEA) to evaluate productivity (or efficiency) change between two production units, or between two time periods (of the same production unit).[26]

Following Fare et al. (1994), we estimate an output-based Malmquist Index (assuming Constant Returns to Scale (CRS) technology) for firm i in year t+1 as:

$$M_i\big(y_{i,t+1}, x_{i,t+1}; y_{i,t}, x_{i,t}\big) = \left[\frac{d^t(x_{it,+1}\ y_{it+1})}{d^t(x_{it}\ y_{it})}\ \frac{d^{t+1}(x_{it,+1}\ y_{it+1})}{d^{t+1}(x_{it}\ y_{it})}\right]^{1/2} \qquad (4)$$

where $x_{it} = (k_{it}, w_{it})$ is the input vector of capital and labor (of firm i); $y_{it} = (Y_{it})$ is the corresponding output vector; $d^t(x_{it}, y_{it})$ and $d^{t+1}(x_{it+1}, y_{it+1})$ represent the distance functions of

[26] DEA refers to a linear-programming technique which uses information of a firm's input and output quantities to construct a production frontier relating to the sample data points. The so called "frontier" is obtained as the solution to a sequence of linear programming problems corresponding to each entity or firm in the sample. The measured efficiency of a firm reflects the distance of the corresponding observation or data point from this frontier. Intuitively, a firm's efficiency indicates the degree of its efficiency relative to the best-practice or best-performing firm in that particular industry. For more information on DEA in the context of Malmquist Index, refer to Coelli and Rao (2005).

production in periods t and t+1, respectively.[27] Equation (4) thus represents the productivity of firm i in year t+1 relative to its production in year t ($y_{it,}x_{it}$). The TFP index in equation (4) is then obtained by estimating the four components of distance functions using linear programming techniques. We obtain our estimates of the Malmquist Productivity Index as outlined in eq. (4) using the "malmq" command available in Stata 12.[28]

3.2.2. Other Control Variables

In this subsection we discuss the construction of the other firm-specific variables which are used in our regression analyses. As we are interested in examining the effect of firm financing on productivity gains, our main variable of interest is the firms' use of debt financing, since it is known to be the primary source of funds for a majority of firms in India (Love and Martinez Peria (2006)). To this effect, we consider two alternative definitions of the book value of leverage.[29] Our primary measure of leverage is defined as the ratio of book value of total debt (short-term and long-term) to book value of total assets. Additionally, we use an alternative measure of leverage, defined as the ratio of long-term debt to total assets to check the robustness of our results. These are widely accepted measures representing the degree of a firm's debt-financing and have been used in various studies including Aivazian et al. (2005), Margaritis and Psillaki (2010), Coricelli et al. (2012) and Campello (2006) which examine the role of external finance in the context of firm performance.

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, asset tangibility, cash flows, firm age, ownership concentration and industry-level competitiveness.[30] *Firm size* is defined as the logarithm of firm sales or total assets. This variable is likely to have a significant influence 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. Once again, 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)).

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[27] Distance functions represent the firm's production technology (with multiple inputs and (or) multiple output) without imposing any behavioral objectives such as profit maximization or cost minimization and can be defined as input-based or output-based functions (Ceolli and Rao (2005). A value of $M_{i,t}$ greater than 1 denotes an improvement in TFP over the previous year, whereas a value less than 1 denotes a decline.

[28] Since the Malmquist Index (for panel datasets) can only be estimated for a balanced panel of firms, we are able to obtain this index for only a sub-sample of firms in our original data set. More specifically, the index is estimated for a sample of 1509 firms (across all manufacturing industries) over a period of five years between 2010 and 2014.

[29] We are unable to consider the market value of leverage as an alternative measure since nearly 50 percent of all firms in our sample are not listed in the domestic stock market.

[30] 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).

We also control for a firm's *cash flows*, which is defined is as the ratio of net cashflows from operating activities to fixed capital or total assets. The motivation for considering the effect of cash flows on firm productivity arises on two accounts. Firstly, the extensive literature on financial constraints and firm behavior views cash flows as an indicator of the availability of internal sources of finance (Chen and Guariglia (2013)). When the supply of external funds such as debt falls short (in some periods), firms may need to depend on available cash flows as an alternative to bridge the deficit and support production-related activities. It is therefore possible that firms employ their internal finance (cash flows) in conjunction with external funds such as debt to finance production and hence, productivity-enhancing activities. Secondly, there is empirical evidence that the firms' cash flows have significant implications for real activities such as capital investment, accumulation of inventory and employment decisions, all of which can potentially shape a firm's productivity or efficiency gains. More importantly, a number of studies including (Brown at al., 2012; Brown and Petersen, 2011) go on to provide evidence of significant effects of the firms' cash flows on research and development-related activities, which have sizeable implications for observed levels of firm efficiency. In view of this evidence, it is therefore important to gauge the effect of cash flows on firm productivity.[31]

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. More 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. The former variable (Int_Owner) assumes a value of 1 for firms in which the largest shareholders has a maximum ownership ranging between 25 percent and 50 percent and zero otherwise, whereas the latter assumes the value of 1 for firms in which the largest shareholder has as ownership share exceeding 50 percent. From a theoretical perspective, a concentrated ownership structure is expected to be associated positively with firm efficiency. This is because shareholders of such (concentrated) firms may be more capable of monitoring and aligning the management objectives, which can potentially reduce agency conflicts and result in improved firm performance (Jensen and Meckling (1976), Margaritis and Psillaki (2010)).

We also control for the effect of effect of firm *age* since productivity dynamics are likely to vary over the lifecycle of firms (Krishnan et al. (2014), Hseih and Klenow (2012)). It is therefore important to control for this source of potential non-linearity in assessing the impact of firm leverage. Finally, we also account for the effect of industry-level *market concentration* by

[31] In addition to the variables discussed above, it is possible that aspects such as sales growth, profitability and export behavior may influence a firm's incentives to invest in productivity-enhancing activities. Note however, that since these variables are also key indicators of firm performance (similar to productivity), they are likely to be responsive to changes in leverage and our (other) control variables. Since this can lead to serious endogeneity issues in our model, we decide to exclude them from the baseline specifications. When we examine their effects in unreported regressions (using one and two-period lagged terms), we find that the marginal effect of leverage remains qualitatively unchanged.

including the Herfindahl Index, which is calculated as the sum of squared values of each firm's market share (in sales) at the annual three-digit NIC (2008) level. The intuition behind incorporating the effect of industry concentration is that firms in a more concentrated (or less competitive) industry are more likely to engage proactively in investing in productivity-enhancing activities in order to gain market share (Krishnan et al. (2014)). As such, firm-level productivity on average, may be positively associated with the degree of industry-specific market concentration.

4. Empirical Methodology

4.1. Empirical Specification

4.1.1 Fixed–effects regression

We next describe the empirical specification we adopt to examine the relationship between the firms' level of external finance and productivity. We begin with a fixed-effects regression framework to examine this relationship which is described by the following equation:

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

where Y_{it} is our measure 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* (log sales) and its squared term*, tangible assets* (ratio of fixed assets to total assets), *cash flows* (cash flows to fixed capital or total assets), *ownership concentration,* log *firm age* and the *Herfindahl Index* (at the three digit NIC level). As the effect of firm leverage can be non-monotonic, we account for this possibility by including 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 (i.i.d) 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 in the system and standard errors are clustered at the firm level.

Drawing from our discussion earlier, firm leverage can exert a positive or negative influence ($\beta_1 \gtrless 0$), depending on whether the benefits of debt (in a disciplining capacity) dominate the costs of debt (debt overhang or risk-shifting) or vice-versa. Most firm-specific characteristics such as asset tangibility, cash flows (or internal finance), firm size, ownership concentration and industry-level competitiveness are expected to have a positive effect on firm productivity ($\delta \geq 0$).

4.1.2. Fixed-effects Instrumental Variable (FE-2SLS) approach

An issue with estimating eq. (4.1) using a fixed-effects approach is that the regression can potentially suffer from endogeneity problems. While a firm's level of debt can affect its ability to innovate (and subsequently, its productivity), it is possible that firms which intend to increase investment in productivity-enhancing activities assume more debt in preceding years to support such investments. Moreover, if a firm becomes more productive, it is likely to generate higher profits, which in turn can reduce the use of (or dependence on) debt in subsequent periods (Nucci et al. (2005)). The causal association may therefore be bi-directional.

To account for this possibility, we use an instrumental variable approach (based on Two-Stage Least Squares (2SLS)) to identify exogenously driven variations in firm leverage. This approach involves identifying a variable which correlates strongly with the endogenous variable but is uncorrelated with the dependent variable. In the context of our model, we use the interest expenses incurred each year (normalized by total assets) to instrument leverage. Our choice of this variable as a suitable instrument requires a detailed explanation.

As stated above, a suitable instrument for an endogenous variable is one which satisfies the two conditions of high correlation with the endogenous variable and no direct association with the dependent variable. Our choice of interest expenses as the instrument variable is based on economic theory as well as the two preconditions. As firms assume more debt (short-term or long-term), they have to set aside more resources each year to make the interest payments associated with debt. As such, there is clearly a positive association between the level of debt (leverage) held by firms and the amount of interest expenses incurred each period on servicing their debt. Moreover, since interest payments due each period are unconditional on how firms perform in the financial year, there is no systemic relation between the firm's interest payments and productivity (a measure of performance). As such, given the theoretically strong association with leverage and no direct association with firm performance or productivity, interest expenses can therefore be considered as a valid instrument for firm leverage.[32]

Before proceeding with the empirical specification, it is important to understand why we cannot consider other candidate variables as instruments. Perhaps the most frequently used variable to instrument leverage is a firm's asset tangibility and the argument put forward is based on its role as collateral. When creditors extend finance, they are likely to request for collateral in exchange for loans, which typically comprises of a firm's fixed assets as they are transferable in the event of liquidation (Campello (2006)). As such, a firm's asset tangibility is likely to correlate positively with its leverage. Moreover, since the tangibility of assets does not systematically affect performance parameters such as sales, it is often regarded as a suitable instrument for leverage in studies on various measures of firm performance.[33] Note however, that this argument fails to hold for our model. While the association with leverage is theoretically strong; asset tangibility, which represents the access to fixed capital is also theoretically associated with productivity. As noted earlier, firms with more fixed capital may also have better technology which can *potentially* affect its productivity. As this association defies one of the preconditions, a

[32] The correlation between the variables also verifies this association. While the correlation between firm leverage and interest expenses is 0.65, the correlation with the firm productivity is expectedly low, at 0.06.
[33] Studies which have used asset tangibility to instrument firm leverage include Campello (2006) and Aivazian et al. (2005).

firm's asset tangibility cannot be regarded as a valid instrument while examining productivity dynamics.[34]

To account for the fact that leverage may be endogenously determined, we proceed by reporting the results from a fixed-effects instrumental variable (2SLS-IV) approach, which involves estimating the following equation:

$$Y_{it} = \alpha_1 + \beta_1 \overline{Lev}_{it-1} + \overline{Lev}^2_{it-1} + \delta X_{it-1} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.2)$$

where $\overline{Lev}_{it}$ represents the predicted values of leverage using interest expenses (in the 1st stage of regression).[35] This specification includes all other control variables from the main equation (4.1)) and the results from this approach are reported *in addition* to the ones from the main fixed-effects model.

4.2 Extending the basic model

4.2.1. Role of Innovation

The first stage of our empirical analysis estimates equations (4.1) and (4.2) to observe the effect of leverage on firm-productivity. While this captures the effect of firm leverage on observed productivity gains, there are multiple sources or firm characteristics which facilitate the process and lead to productivity improvements. In particular, the firms' quality of factor inputs and the tendency to innovate are among some of the factors which are seen to contribute towards this process. While it is not possible to uniquely characterize the contribution of each these channels (as they are likely to be complementary), an important extension of the basic empirical model can be to formally test whether the effects of external financing on productivity are realized through at least one of these channels.

As a next step therefore, we specifically examine how external financing affects a firm's tendency to innovate, which in turn is expected to correlate with productivity improvements. To this effect, we estimate the following equations:

$$Z_{it} = \gamma_1 + \gamma_2 \overline{Lev}_{it-1} + \gamma_3 X_{it-1} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.3)$$

$$Y_{it} = \delta_1 + \delta_2 Z_{it-1} + \delta_3 X_{it-1} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4.4)$$

[34] In addition to asset tangibility, while one can consider annual tax savings (or tax shields) as an instrument for leverage (as the interest is tax-deductible), we are unable to consider this variable as most firms report incomplete or missing information on the same.

[35] The instrument for the quadratic term of leverage is obtained following Wooldridge (2002). In particular, we regress firm leverage on interest expenses (the excluded instrument) and all exogenous regressors (from our basic specification eq. 4.1) and obtain the predicted leverage. The squared term of the predicted leverage is then used as an instrument for the endogenous quadratic term.

where the dependent variable in eq. (4.3) represents firm-specific expenses on innovative activities and the right-hand side variables are the same as in previous specifications.[36] The dependent variable in eq. (4.4) is our measure of firm-level TFP whereas the independent variable Z_{it} represents the firm's innovative activities (along with a set of control variables). Taken together, while eq. (4.4) measures the relationship between innovation and productivity, eq. (4.3) measures the effect of firm leverage on innovation. Obtaining a significant slope coefficient in each of these equations ($\delta_2>0$, $\gamma_2 \gtreqless 0$ (depending on whether $\beta_1 \gtreqless 0$)) can therefore provide some evidence of causality by showing that debt-financing affects productivity (at least) by influencing its ability to undertake innovative activities.

4.2.2 Sources of Firm Heterogeneity

a. Firm Size

In addition to the above, we examine the role of certain firm characteristics in influencing the effect of leverage on productivity. More specifically, we examine whether the effect of leverage on productivity varies across firm sizes. Since larger firms may be at a more mature stage in their lifecycle, they may have access to more debt (relative to smaller firms) and likely channelize their funds towards other activities. Smaller firms, on the other hand, may display a stronger association between the variables as investing in productivity-enhancing activities is likely to be more important for the survival of such firms. We test for these possibilities 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.[37]

b. t Maturity Structure of Debt

Finally, we extend our basic model to understand whether the maturity structure of debt assumes a significant role in this process. To this effect, we examine whether firms with a larger share of short-term debt experience a differential impact of leverage on firm productivity. The theoretical argument for this hypothesis is based on two important (and mutually exclusive) theories on the choice of liability maturity structure, namely, the *contracting-cost hypothesis* and the *signaling hypothesis* (Barclay and Smith (1995)). The contracting-cost hypothesis considers the firm's future capital investment as a real option (Baum et al. (2007)). The argument can be traced back

[36] As the Prowess database on Indian firms does not directly identify (or classify) expenses related to innovative-activities, our measure of the firm's innovative activities is the sum of variables which are likely to represent the extent of innovation. Specifically, a firm's investment in innovative activities is defined as the sum of research and development expenses, intangible assets, royalties and information technology-related expenses. Data limitations on this category of expenses also mean that we are unable to classify our proxy of innovation-related expenses as representing product *or* process innovation.

[37] 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.

to Myers (1977), who suggests that firms with more growth options in their investment decisions are more likely to maintain shorter maturity debt. When debt matures before the implementation of investment decisions, it is unlikely to result in sub-optimal decisions. Moreover, holding shorter term debt reduces potential problems of under-investment associated with long-term debt.[38] As under-investment eventually erodes firm performance, this theory posits a negative association between maturity and performance.

The signaling hypothesis also posits an inverse relationship as a larger share of short-term debt is perceived as an indicator of the firm's low credit risk. In this context, Diamond (1991) observes that highly rated firms often prefer short-term debt due to lower refinancing risks associated with the same. In recent years, a number of studies including Schiantarelli and Jaramillo (1996), Schiantarelli and Sembenelli (1999), Nucci et al. (2005) and Baum et al. (2007) have empirically tested these hypotheses and have arrived at conflicting conclusions on the real effect of short-term debt on performance measures such as profitability and productivity.

In view of these theories, we formally test whether firms with more short-term debt in their capital structure exhibit a stronger association with productivity. To this effect, we add an interaction term in the baseline models (eqs. (4.1) and (4.2)) and estimate the following equation:

$$Y_{it} = \alpha_1 + \beta_1 Lev_{it-1} + \theta_1 HighSTDebt_{it-1} + \theta_2 Lev_{it-1} * HighSTDebt_{it-1} + \delta X_{it-1} + \varepsilon_{it} \quad (4.5)$$

where *HighSTDebt* is a binary variable which is equal to 1 for firms which have a higher share of short-term debt. In any given period, a firm is considered to hold relatively *more* short-term debt if its value is above the median value of short-term debt of the entire sample (over the sample period).[39] The interaction term in eq. (4.5) therefore represents the difference in the effect of leverage on productivity for firms with more short-term debt. To further substantiate the result from estimating eq. (4.5), we repeat the same exercise, with the exception that the binary variable (in each iteration) represents firms with short-term debt shares in the top 30th percentile, 20th percentile and 10th percentile of the distribution.[40] If the contracting-cost and signaling hypotheses are valid for our sample of manufacturing firms, we expect the slope coefficient associated with the interaction term to be positive ($\theta_2 > 0$).

[38] This arises due to conflicts of interest between debt holders and equity holders as long-term debt creates more flexibility for the latter to reject projects with positive net present value and engage in risk-shifting behavior (discussed in the Literature Review Section).

[39] We also split the sample based on the firms' average short-term debt relative to the industry-specific median level and obtain qualitatively similar results.

[40] The approach outlined here has been adopted in previous studies such as Nucci et al. (2005) and Johnson (2003) (among others) to test for the effect of debt maturity structure on firm performance.

5. Descriptive Statistics

In this section, we present the summary statistics pertaining to our sample of manufacturing firms in India. As stated earlier, our sample comprises of 4540 firms across most manufacturing industries which are observed over the period between 2000 and 2015. Table 5.1 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. For instance, while firm sales have grown at an average rate of 5 percent each year, there is considerable variation across firms in the sample. This variation is partly reflected in the profitability figure, which suggests an average annual profit of 9 percent but subject to variation. Firms hold a considerable share of their assets in the form of fixed assets (nearly 83 percent of total assets on average), which may explain the relatively high level of capital-labor ratio (nearly 5.5 times) observed in the sample. Moreover, the average firm is close to 30 years old, which suggests that many of the firms are likely to be at a stable phase of their lifecycle. The Herfindahl Index (at the 3 digit NIC level) is nearly 830 (or 0.0083), which suggests that firms across several industries face a relatively competitive market.[41] 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).

As a next step, we examine some key financial ratios (Table 5.2) which highlight important features of the manufacturing firms in our sample. Firstly, while firms on average have assumed more debt over the years (with an average annual growth rate of 5 percent), book leverage (or debt ratio) has remained relatively more stable across firms but at a comparatively high level of 0.34 over the same period. A similar pattern is seen in case of the Debt/Equity ratio, which is (on average) over 3 (times) across firms in the sample. A comparison of these ratios across listed and unlisted firms reveals that debt financing is an important source of external finance for all firms, that is, the dependence on debt for external finance is not limited to unlisted firms.[42] These figures clearly highlight the significance of debt as a chief source of financing for a majority of firms in Indian manufacturing industries. Moreover, as the interest-coverage ratio remains above 1 for most firms over the sample period, firms are on average, 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 external financing needs (nearly 75 percent of total debt), financial institutions and corporations are considered as alternative sources of debt financing used by a

[41] In percentage terms, the Herfindahl Index can range between 0 and 10000 (representing a monopoly).
[42] Refer to Table A.1 in the Appendix.

large number of manufacturing firms. Importantly, only a quarter of the firms in the sample use some form of foreign borrowing (1334 firms), and fewer still use public borrowing (778 firms), which is indicative of the underdeveloped debt market in India. A look into the maturity structure of debt reveals that firms hold a majority of their obligations in the form of short-term debt (nearly 70 percent), and nearly all of this borrowing is in the form of secured or collateralized borrowing.[43]

As the firms in our sample belong to a wide range of industries which differ substantially in terms of relative capital intensities (among other factors), the use of external financing is also likely to vary across these segments. As a next step therefore, we examine the distribution of financial ratios across the sectors, which are presented in Table 5.3. This distribution reveals some important patterns in the data. While leverage is expectedly higher in capital-intensive sectors like Chemicals and Electrical Equipments, it also remains relatively high (and above the sample average of 0.34) in traditional (labor-intensive) sectors like Textiles, Apparels and Food products (around 0.38 to 0.40). Importantly, the fact that leverage remains at nearly 0.24 even in technology or knowledge-intensive sectors like Pharmaceuticals and Computers indicates that debt financing assumes an important role in supporting businesses across a wide spectrum of manufacturing industries.[44]

As a next step, we summarize the productivity trends observed for the firms in our sample. As discussed in the previous section, we use the Levinsohn-Petrin method to obtain time-varying estimates of total factor productivity for firms in each industry (at the two-digit NIC level) and this measure is summarized in Table 5.4. While the average productivity differs substantially across industries, there are some notable differences in the variability observed within each industry. In particular, while intra-industry variance in productivity is lower (on average) in industries like Textiles, Apparels and Chemical, it is considerably higher in many of the capital-intensive and knowledge-intensive industries including Pharmaceuticals and Computers. A look at how productivity has changed over time provides a clearer picture. As seen in Table 5.5, while firms in the Textiles, Chemical and Electrical equipments industries appear to have become more productive over time (as firm productivity has grown at an average rate of over 4 percent per year), firms in the Pharmaceuticals, Transport equipments and Computer-related industries appear to have had more modest increases (if any) in productivity. This feature can be partially responsible for the dispersion in productivity observed across all firms, which appears to have

[43] Since our sample spans over a long period, it is possible that some of the trends observed above are likely to have varied over time. We therefore also examine how these ratios have evolved over the years (refer to Table A.2 in the Appendix) and find that most ratios remained relatively stable over the entire sample period. The only exception observed is with regard to the composition of debt, where the share of bank borrowing has consistently increased from 56 percent to nearly 70 percent of total best by 2014.

[44] A similar pattern is observed in case of the debt-equity ratio, which remains above 1 across all sectors (though lower in magnitude in knowledge-intensive sectors). As observed in the overall trend, borrowing from domestic banks comprise the bulk of total debt, and the maturity structure indicates that most of this debt is in the form of short-term borrowing.

increased over time (Table 5.6).[45] Importantly, the summary statistics based on our *alternative* measure of productivity (the Tornqvist index number) are broadly in line with these patterns.[46] Taken together, these trends suggest that not only do substantial differences in productivity exist *between* industries in our sample, firm and industry-specific features are likely to give rise to significant (and asymmetric) variation in firm-level productivity observed *within* each of these industries.

Finally, a possible concern with a regression analysis using firm-specific variables can be regarding the potentially high correlation between the regressors, which can lead to biased and inconsistent estimates. In the final step therefore, we ascertain the magnitude of this problem by examining the correlation between the regressors in our model (discussed in a subsequent section), which are reported in Table 5.7. As seen in Table 7, while there is a positive correlation between firm leverage and asset tangibility (0.19), its correlation 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 considerably low (-0.037). Overall, these figures are encouraging as they provide evidence of low correlation amongst the regressors and consequently (relatively) lesser scope of endogeneity issues plaguing the estimation.

[45] While an increase in dispersion in firm productivity (within industries) would probably indicate the survival of inefficient firms across industries, we refrain from arriving at this conclusion as our estimates are based on an unbalanced panel data set, which allows firm entry/exit over the sample period.

[46] Refer to Table A.3 in Appendix A.

Table 5.1: 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
Cash flow	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 is exchange as an annual percentage change. 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; 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 5.2: 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
Short-term debt	31198	0.688	0.786	0.324	0	1
Long-term debt	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 5.3: Financial ratios (Industry-level distribution)

Industry	N. Obv.	Capital intensity	Leverage	Interest coverage	Debt/ Equity	Bank borrowing	Short -term
Food products	*3597*	10.044	0.372	11.053	3.360	0.689	0.715
Beverages	*963*	19.716	0.367	7.806	2.418	0.681	0.678
Tobacco products	*204*	5.939	0.251	9.173	0.823	0.652	0.709
Textiles	*3936*	12.981	0.448	5.557	3.303	0.725	0.581
Wearing apparel	*217*	6.196	0.354	4.615	4.124	0.717	0.730
Leather products	*296*	6.560	0.318	6.798	1.765	0.752	0.796
Wood products	*259*	7.765	0.374	87.981	1.740	0.630	0.766
Paper products	*1163*	16.265	0.400	21.947	2.929	0.654	0.587
Printing	*78*	24.702	0.337	29.327	1.740	0.617	0.685
Chemical products	*4542*	11.014	0.330	33.528	1.802	0.630	0.704
Pharmaceuticals	*2682*	7.468	0.292	63.478	1.388	0.669	0.730
Rubber and plastics	*2299*	10.040	0.364	10.105	2.884	0.654	0.719
Non-metallic minerals	*1536*	16.638	0.353	17.945	2.090	0.611	0.594
Base metals	*3907*	17.252	0.374	17.540	2.297	0.671	0.681
Fabricated metal	*995*	6.645	0.371	18.378	2.209	0.722	0.709
Computers	*897*	5.452	0.279	20.286	7.849	0.712	0.759
Electrical equipment	*1621*	12.345	0.296	23.674	4.456	0.656	0.765
Machinery and equipment	*2035*	4.113	0.237	45.384	1.628	0.669	0.765
Motor vehicles	*129*	8.287	0.251	20.466	1.634	0.527	0.648
Other Transport	*2087*	4.740	0.295	37.728	5.423	0.655	0.674
Furniture	*51*	2.971	0.289	14.106	2.389	0.640	0.850
Other	*67*	4.552	0.361	4.392	1.119	0.704	0.740

Notes: Capital-intensity is defined as the ratio of fixed capital to wage bill; leverage represents the ratio of total debt to total assets; interest-coverage ratio represents the ratio of EBIT to interest expenses; debt/equity ratio is defined as the ratio of total debt to equity capital; 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. The industries represent the set of all manufacturing industries classified under the two-digit NIC (2008) level.

Table 5.4: Productivity estimates in log form (based Levinsohn-Petrin method)

Industry	N. Obs.	Mean	Std. Dev.	Pct. 25	Median	Pct. 75
Food products	3597	1.726	0.51	1.432	1.642	1.905
Beverages	963	0.603	0.788	0.076	0.476	0.982
Tobacco products	204	3.24	0.915	2.446	3.481	3.873
Textiles	3936	1.573	0.365	1.393	1.525	1.689
Wearing apparel	217	4.123	0.747	3.687	4.216	4.73
Leather products	296	-0.966	0.682	-1.469	-1.046	-0.611
Wood products	259	1.449	0.448	1.24	1.451	1.677
Paper products	1163	-0.675	0.554	-1.052	-0.72	-0.356
Printing	78	1.41	0.487	1.236	1.469	1.67
Chemical products	4542	1.006	0.419	0.784	0.927	1.117
Pharmaceuticals	2482	0.224	0.637	-0.197	0.182	0.577
Rubber and plastics	2299	-0.415	0.614	-0.792	-0.391	-0.045
Non-metallic minerals	1536	-0.318	0.661	-0.767	-0.362	0.032
Base metals	3907	0.929	0.441	0.707	0.824	0.999
Fabricated metal	995	1.824	0.34	1.633	1.824	2.003
Computer, electronics and optical	897	-0.83	0.796	-1.39	-0.933	-0.428
Electrical equipment	1621	-0.657	0.662	-1.085	-0.735	-0.369
Machinery and equipment	2035	-0.037	0.522	-0.364	-0.072	0.251
Motor vehicles	129	-0.593	0.262	-0.797	-0.634	-0.473
Other Transport equipment	2087	-1.403	0.657	-1.848	-1.506	-1.095
Furniture	51	0.413	0.742	-0.212	0.334	0.736
Other Manufacturing	67	4.473	0.405	4.269	4.505	4.727

Notes: Summary statistics correspond to firm-level and time-varying productivity estimates obtained from the Levinsohn-Petrin (LP) method, expressed in natural logarithm. The industries represent the set of all manufacturing industries classified under the two-digit NIC (2008) level.

Table 5.5: Productivity growth (Levinsohn-Petrin method)

Industry	N. Obs.	Mean	Std. Dev.	Pct. 25	Median	Pct. 75
Food products	3597	0.042	0.61	-0.102	-0.005	0.09
Beverages	963	0.261	6.028	-0.134	-0.02	0.115
Tobacco products	204	0.017	0.301	-0.108	0.003	0.082
Textiles	3936	0.044	0.891	-0.068	-0.004	0.067
Wearing apparel	217	0.128	0.528	-0.112	0.033	0.221
Leather products	296	0.031	0.527	-0.095	-0.013	0.07
Wood products	259	0.03	0.289	-0.104	0	0.101
Paper products	1163	0.055	1.659	-0.082	-0.018	0.045
Printing	78	0.074	0.327	-0.059	0.017	0.102
Chemical products	4542	0.033	1.546	-0.075	-0.012	0.056
Pharmaceuticals	2482	0.019	0.585	-0.115	-0.03	0.063
Rubber and plastics	2299	0.007	0.49	-0.086	-0.016	0.048
Non-metallic minerals	1536	0.028	0.441	-0.106	-0.014	0.081
Base metals	3907	0.04	0.791	-0.075	-0.01	0.055
Fabricated metal	995	0.024	0.251	-0.067	0.003	0.077
Computer, electronics and optical	897	0	0.288	-0.129	-0.011	0.09
Electrical equipment	1621	0.053	1.002	-0.093	-0.017	0.059
Machinery and equipment	2035	0.039	0.793	-0.092	-0.017	0.067
Motor vehicles	129	-0.008	0.131	-0.074	-0.018	0.021
Other Transport equipment	2087	-0.024	0.175	-0.097	-0.025	0.035
Furniture	51	0.019	0.255	-0.119	0.042	0.137
Other Manufacturing	67	0.023	0.365	-0.12	-0.016	0.107

Notes: Summary statistics correspond to the annual percentage change in firm-level productivity estimates obtained from the Levinsohn-Petrin (LP) method. The industries represent the set of all manufacturing industries classified under the two-digit NIC (2008) level.

Table 5.6: Dispersion in Productivity (Levinsohn-Petrin method)

Measure of Dispersion	2002	2006	2010	2014
Standard deviation	0.2380	0.2538	0.2423	0.4921
Inter-quartile range ($75^{th} – 25^{th}$)	0.2400	0.2810	0.2847	0.4762

Notes: Estimates of standard deviation and inter-quartile range represent the dispersion of firm-level log TFP (based on Levinsohn-Petrin method) and industries are weighted by their value-added shares.

Table 5.7: Correlation Matrix

	Leverage	Asset tangibility	Cash flow	Size	Herf Index
Leverage	1				
Asset tangibility	0.1964*	1			
Cash flow	-0.0372*	0.0379*	1		
Size	0.0209*	-0.0825*	0.0297*	1	
Herf Index	-0.0769*	-0.0228*	0.0147*	0.0318*	1

Notes: Pearson's correlation coefficients reported. * indicates significance at the 5% level. Leverage represents the ratio of total debt to total assets; asset tangibility is defined as the ratio of fixed assets to total assets; cash flow is defined as the ratio of net cash flow from operating activities to total assets and firm size is defined as the log of sales.

6. Results

a. Baseline Results

Table 6.1 presents the results from the baseline fixed-effects regression (eq. 4.1) for firm productivity and Table 5.2 reports the results from the instrumental variable regression (eq. 4.2). As the estimates are similar in magnitude, the discussion will focus on the IV-estimates.[47] As seen in Table 6.2, selected firm characteristics have a significant association with firm productivity and most of them have the expected signs. More specifically, holding other factors fixed, a firm's stock of tangible assets (on average) has a significant positive association with productivity, which suggests that physical capital is important for productivity gains. Cash flow is also seen to be positively associated with productivity, which suggests that firms (on average) are likely to use internal sources of finance to support productivity-enhancing activities. The results also highlight that firms tend to become less productive as they get older, which can potentially reflect lower investments or (and) other operational inefficiencies. Moreover, it is seen that firm productivity (on average) is not significantly different for firms with concentrated ownership and does not tend to increase with firm size. The degree of market concentration however, appears to be associated with productivity gains. In particular, it is seen that industries with relatively more concentrated (or less competitive) market structure have higher productivity, which is consistent with the idea that firms in such industries are likely to engage more proactively in productivity-enhancing activities to gain market share. Overall, our results are in line with prior expectations and hence consistent with the evidence from previous studies (Nucci et al. (2005), Margaritis and Psillaki (2010), Chen and Guarglia (2013), Krishnan et al. (2015)).

Coming to our variable of interest, it is seen that firm leverage has a negative association with productivity and this is significant at the 1 percent level. In particular, the associated coefficient of -0.163 implies that, holding other factors fixed, a 1% increase in firm leverage (from it's the mean level) is associated with a 0.16% decline in firm productivity.[48] With regard to the economic significance of this result, the coefficient of -0.163 implies that a one standard deviation increase in firm leverage will lead to a decrease in firm productivity of approximately 4.4%-6% of its mean for all firms.[49] Thus, the effect of leverage on firm productivity is statistically and economically significant.[50] The insignificant coefficient on the quadratic term

[47] In all reported specifications, our choice of a fixed-effects model (versus a random-effects model) is driven by the Hausman Test. In particular, the χ^2 test-statistic corresponding to the baseline eq. (4.1) is 504.81 (with a p--value of 0.00) and same for the instrumental variable regression (eq. (4.2)) is 268.30 (with a p-value of 0.00). In both cases therefore, the fixed-effects version of the model is preferred and yields consistent slope estimates.

[48] 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 the mean level of leverage (0.348) to obtain -0.1634. The respective coefficient for the fixed-effects model is -0.120 and the decline due to a one standard deviation increase in leverage is 4.2% of average productivity.

[49] The decline of 4.4% refers to the specification of the model excluding the quadratic term of leverage (Table 2).

[50] Moreover, the magnitude of the negative effect of leverage does not vary significantly between firms which have access to equity markets and those which don't. This result is reported in the robustness section.

implies that this effect does not vary significantly over the distribution of leverage. Overall, this result implies that for the firms in our sample, high levels of debt (on average) may aggravate the problems of debt overhang or (and) risk-shifting, which may cause firms to reduce investments in productivity-enhancing activities. In other words, the costs of debt (on average) appear to outweigh the benefits of debt and thereby hurt productivity growth of manufacturing firms in India.

Our result compares in interesting ways with relevant studies. In particular, Margaritis and Psillaki (2007, 2010) find a significant positive effect of leverage on efficiency for a sample of firms in New Zealand and Sweden and conclude that their results are in line with the predictions of the *agency cost hypothesis*. Their findings contrast sharply with our result, which is consistent with Myers (1977) in that debt can negatively affect firm value. While the divergence in the observed effect can reflect *real* differences in the role of leverage across the samples, it can potentially arise due to other reasons. A primary reason can be the sample and nature of analysis. While our study examines the (average) association observed over a period of 15 years, Margaritis and Psillaki (2007, 2010) use only two years of data and report results from a cross-sectional analysis. The lack of the time series component in their sample may exclude important information on the impact of changes in firm leverage, which is observed over time.[51]

In contrast, our result is consistent with the findings of Nucci et al. (2005) and Coricelli et al. (2012). In particular, while Nucci et al. (2005) observe a significant negative effect of leverage across firms, Coricelli et al. (2012) find that leverage tends to hurt productivity growth only beyond a certain threshold level (of 0.4). Thus, the negative effect is observed only for a certain range of leverage. Note however, that this is not necessarily inconsistent with our result. In the context of manufacturing firms in our sample, since the average manufacturing firm is already highly leveraged (at an average of 0.34 over the entire sample period), assuming more debt obligations only increases the debt burden and is therefore seen to hurt productivity-enhancing investment across the relevant levels of leverage.

[51] Additionally, unlike most firms in India, since a larger share of firms in developed countries have access to equity markets, relatively lesser dependence on debt for external financing can potentially reduce underinvestment problems in the presence of high debt.

Table 6.1: 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	Y	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 time-varying 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. Column 3 reports estimates of eq. (4.1) excluding year effects. All explanatory variables are lagged by one time period. ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

Table 6.2: Second stage results of Baseline model (Instrumental Variable Regression)

	I	II	III	IV	V
Leverage	-0.110*	-0.123**	-0.190***	-0.119**	-0.359***
	(0.059)	(0.058)	(0.059)	(0.058)	(0.129)
$Leverage^2$					0.281
					(0.184)
Asset tangibility		0.123***	0.124***	0.118***	0.105***
		(0.030)	(0.030)	(0.030)	(0.032)
Size		-0.011	-0.011	-0.012	-0.039
		(0.035)	(0.035)	(0.035)	(0.042)
$Size^2$		-0.002	-0.002	-0.002	0.000
		(0.002)	(0.002)	(0.002)	(0.003)
Cash flow			0.077**	0.078**	0.075**
			(0.033)	(0.033)	(0.034)
Owner_Inter		-0.006	0.001	-0.006	-0.013
		(0.012)	(0.012)	(0.012)	(0.012)
Owner_High		-0.011	-0.003	-0.011	-0.011
		(0.017)	(0.017)	(0.017)	(0.017)
Firm age	-0.014***	-0.012***	-0.015***	-0.012***	-0.016
	(0.001)	(0.001)	(0.001)	(0.001)	(0.034)
Herfindahl Index		0.041***	0.038***	0.041***	0.037***
		(0.010)	(0.009)	(0.010)	(0.010)
Firm and year fixed effects	Y	Y	Y	Y	Y
N	32135	32135	32135	32135	32135
Hausman test	5.247	4.275	0.537	4.556	3.836
(p-value)	0.022	0.0387	0.4636	0.0328	0.1469

Notes: Robust standard errors reported in parentheses. The dependent variable is firm productivity (using the LP method) and is expressed in natural logarithm. Results from the first stage of regression are omitted for brevity. Firm leverage, asset tangibility and cash flows are expressed as ratios. Firm-specific time-varying 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. Column 3 reports estimates of eq. (4.2) excluding year effects. All explanatory variables are lagged by one time period. The Hausman test (row a) is a specification test for the endogeneity between firm leverage and productivity and the corresponding p-value is reported in row (b). ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

b. Role of Innovation

In the next step, we try to identify a possible causal link between firm-level financing and productivity. To this effect, we examine whether a firm's engagement in innovative activities is one of the channels through which firm leverage influences productivity. As discussed earlier, the level of innovative activities undertaken by firms can have direct and sizeable effects on subsequent productivity levels. We demonstrate this association in two steps: we first regress firm-level productivity on our measure of innovation (expenditure on innovative activities); and in the second step, we regress this measure of innovation on leverage and other control variables. The results from this exercise are presented in Tables 6.3a and 6.3b, respectively.[52]

Evidently, the level of innovative activities undertaken by firms has a positive influence on productivity or efficiency improvements, as an increase in this variable (on average) is significantly positively associated with an increase in productivity (Table 6.3a). Importantly, it is seen that firm-level debt financing may be a crucial factor associated with innovation activities, as an increase in leverage is associated with a significant decline (of nearly 0.4 percent) in a firm's (average) expenditure on these activities (Table 6.3b).[53] This suggests that the leverage-innovation relationship may be an important causal link. Taken together, our results lend support to the possibility that at least one of the channels through which an increase in firm leverage (or the buildup of debt burden) can hurt productivity is by discouraging firm-level investment in innovative activities.

One of the limitations of this part of our analysis is that several firms report missing information on innovation-related expenses. The estimation is therefore based on a subset of the firms from our original sample. Note however, that this does not introduce a substantial bias in our sample as firms which do provide this information are distributed across all industries (and not limited to the capital-intensive and knowledge-intensive industries such as Pharmaceuticals and Chemicals industries).

[52] We focus on fixed-effects estimates reported in Table 5.3 as the Hausman test for the endogeneity of firm leverage is rejected for this specification (eq. 4.3), implying that leverage may be considered as an exogenous variable.

[53] A more definitive assessment of the causal association would require the inclusion of leverage in the first regression of innovation on productivity. Note however, that we are unable to implement this for two reasons. Firstly, the association between innovation and leverage implies that they cannot be simultaneously incorporated as regressors in the same equation, even if leverage appears as an endogenous variable. This will require instrumenting innovation (in addition to leverage), data for which is unavailable. Secondly, given that firm financing can potentially affect productivity through multiple channels, the effect of leverage on productivity may remain significant even after controlling for innovation. Hence, including leverage and innovation simultaneously is unlikely to deliver a more robust result than the one reported in Table. 5.3a.

6.3a. Firm Productivity and Innovative activities

	I	II	III
Dependent variable		Firm Productivity	
Innovative activities	0.014***	0.015***	0.014***
	(0.005)	(0.005)	(0.005)
Owner_Inter		-0.006	-0.002
		(0.022)	(0.021)
Owner_High		0.002	0.007
		(0.034)	(0.034)
Asset tangibility			0.157***
			(0.047)
Size			-0.040**
			(0.016)
Firm age	-0.019***	-0.019***	-0.017***
	(0.002)	(0.002)	(0.002)
Herfindahl Index		0.046***	0.045**
		(0.018)	(0.018)
Constant	0.876***	0.586***	0.704***
	(0.079)	(0.139)	(0.177)
Firm and year fixed effects	Y	Y	Y
Observations	13662	13662	13545
Adj R^2	0.095	0.097	0.105

Notes: Robust standard errors reported in parentheses .Reported estimates correspond to eq. (4.4). ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

Table 6.3b: Role of Innovative activities

	I	II	III	IV
Dependent variable	Innovative activities (IN_{it})			
	Fixed-effects		IV	
Leverage	-0.404***	-0.389**	-0.871***	-0.545*
	(0.154)	(0.154)	(0.307)	(0.301)
Asset tangibility		-0.479***		-0.624***
		(0.171)		(0.176)
Size		-0.379***		-0.462***
		(0.125)		(0.130)
$Size^2$		0.023**		0.033***
		(0.010)		(0.010)
Owner_Inter		0.201***		0.278***
		(0.072)		(0.069)
Owner_High		0.133		0.242***
		(0.094)		(0.090)
Herfindahl Index		-0.087		-0.083
		(0.053)		(0.052)
Constant	-3.871***	-1.469**		
	(0.096)	(0.668)		
Firm and year fixed effects	Y	Y	Y	Y
Observations	13662	13540	14605	13065
Adjusted R^2	0.045	0.055		
Hausman test[a]	n.a	n.a	1.411	0.052
(p-value)[b]			0.2349	0.8194

Notes: Robust standard errors reported in parentheses. The dependent variable is firm productivity (using the LP method) and is expressed in natural logarithm. Columns 1-2 present estimates from the fixed-effects regression (eq. (4.1)) and columns 3-4 present results from IV estimation (eq. (4.2)). Results from the first stage of regression are omitted for brevity. Firm leverage, asset tangibility and cash flows are expressed as ratios. Firm-specific time-varying ownership concentration is represented by two dummy variables representing intermediate and high ownership concentration. The base group represents firms with less concentrated ownership. All explanatory variables are lagged by one time period. The Hausman χ^2 test (row a) is a specification test for the endogeneity between firm leverage and productivity and the corresponding p-value is reported in row (b). ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

c. Sources of Firm Heterogeneity

Going further, we examine whether the impact of leverage on productivity varies along some dimensions of firm heterogeneity. We first examine whether differences in firm size influence this relationship, by splitting the sample between two groups: small and medium sized firms (MSMEs) and large firms and estimate our baseline models (eq. (4.1) and (4.2)). Table 6.4 presents the results from this exercise.

Examining this relationship for the two groups of firms highlights two key aspects. Firstly, firm leverage is seen to be negatively associated with productivity, and this effect is significant (at the 1% level) regardless of differences in firm size. Secondly, while high levels of leverage appear to hurt productivity, the magnitude of impact varies substantially across the two groups. Expectedly, the results imply that the negative effects of higher leverage on productivity are more pronounced for the smaller sized firms. As seen in Table 6.4, a 1 percent increase in leverage is associated with a stronger decline (of -0.23 percent) in the productivity of smaller firms and difference between the two groups is significant (at the 5% level).[54] This effect is also economically significant as a one standard deviation increase in leverage will lead to a decline in productivity of nearly 5.4 percent of its mean of small firms.

Overall, the results from this exercise imply that the association between firm productivity and leverage varies across firm size. Smaller sized firms in our sample appear to reduce investments in productivity-enhancing activities by a larger magnitude, with an increase in the level of leverage.[55]

Going further, we examine whether differences in the debt maturity structure can be another source of heterogeneity in firm behavior. As the firm's share of short-term debt varies constantly with changes in its level of total debt and is hence endogenously determined, we examine its effect by estimating eq.(4.5), which includes an interaction term to capture any differences in the effect of leverage for firms with a higher share of short-term debt. The coefficient of leverage in this model therefore represents the marginal effect of leverage of firms with relatively *lower* share of short-term debt. The results are presented in Table 6.5.[56]

The results clearly indicate that the effect of leverage on firm productivity is contingent on, or influenced by the firm's debt maturity structure. In particular, the results reported in column 2 (Table 6.5) imply that an increase in the level of leverage is associated with a significantly less decline in productivity for firms which have a higher share of short-term debt. To further verify

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[54] The difference in the coefficients of leverage between the two groups is statistically significant (the χ^2 test-statistic is equal to 4.77 (with a p-value of 0.0289)).

[55] A concern with classifying firms under one of the two groups is that some firms may have increased investments in fixed assets over the sample period and transitioned from being an MSME to a large firm. To account for this, we repeat this exercise by estimating the model for only those firms which do not change status over the sample period and the results are similar in magnitude to the ones reported in Table 6.5.

[56] Table 5.6 present the results from the fixed-effects regression. The corresponding results from the instrumental variable regression are reported in Table B.5 in Appendix B.

that this effect is valid and consistently significant, we estimate this model using interaction terms which represent different levels of the distribution of firms (columns 3-5, Table 6.5).[57] The results obtained clearly demonstrate that the decline in the negative effect of leverage is consistent and robustly observed across all specifications. Importantly, this exercise also highlights that while the observed effect is distinctively lower for firms with higher shares of short-term debt, the net effect continues to remain negative (and significant at the 5% level). As such, this implies that even though the degree of effect varies across firms, the debt burden of high leverage is consistently associated with lower productivity across all manufacturing firms. Our results are consistent with the findings of Nucci et al. (2005) and Baum et al. (2007) and support the predictions of the contracting-cost and signaling hypotheses, which posit that holding shorter term debt reduces conflicts of interest among stakeholders and problems of under-investment which affect firm performance. Consequently, higher levels of leverage may hurt investment in productivity-enhancing activities to a lesser extent in firms which assume more short-term debt.

Table 6.4: Role of firm size.

	Small and medium firms (MSMEs)		Large firms	
	FE	IV	FE	IV
Leverage	-0.224***	-0.239**	-0.138***	-0.114*
	(0.058)	(0.100)	(0.026)	(0.067)
Asset tangibility	-0.031	0.009	0.122***	0.118***
	(0.074)	(0.077)	(0.031)	(0.031)
Cash flow	-0.019	-0.014	0.084***	0.085***
	(0.068)	(0.068)	(0.031)	(0.031)
Owner_Inter	-0.044	-0.024	-0.004	-0.002
	(0.033)	(0.033)	(0.012)	(0.012)
Owner_High	-0.054	-0.024	0.003	0.003
	(0.037)	(0.032)	(0.017)	(0.017)
Firm age	-0.006**	-0.006**	-0.015***	-0.015***
	(0.003)	(0.003)	(0.001)	(0.001)
Herfindahl Index	-0.004	0.003	0.044***	0.041***
	(0.021)	(0.020)	(0.010)	(0.010)
Constant	1.198***		0.534***	
	(0.157)		(0.073)	
Firm/year fixed effects	Y	Y	Y	Y
Observations	8834	7968	24527	23873
Adj-R^2	0.010		0.101	
Hausman test		4.332		4.708
(p value)		0.0374		0.030

Notes: Robust standard errors reported in parentheses. Columns 1 and 3 correspond to estimates from eq. (4.1) and columns 2 and 4 present IV-estimates from eq. (4.2). ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

[57] Examining the marginal effect across the segments of the distribution of leverage allows us to verify whether the effect (reported in column 2, Table 5.6) is only limited to a specific range of leverage.

Table 6.5: Role of the debt maturity structure.

	I	II	III	IV	V
Leverage	-0.113***	-0.114***	-0.112***	-0.109***	-0.106***
	(0.026)	(0.026)	(0.025)	(0.025)	(0.026)
Leverage*highST50		0.023*			
		(0.014)			
Leverage*highST30			0.051***		
			(0.019)		
Leverage*highST20				0.077***	
				(0.025)	
Leverage*highST10					0.115***
					(0.042)
Asset tangibility	0.108***	0.112***	0.111***	0.112***	0.114***
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
Cash flow	0.077**	0.075**	0.075**	0.076**	0.075**
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
Herfindahl Index	0.041***	0.036***	0.036***	0.035***	0.036***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Constant	0.771***	0.772***	0.773***	0.771***	0.768***
	(0.128)	(0.129)	(0.129)	(0.129)	(0.129)
Firm/year fixed effects	Y	Y	Y	Y	Y
Observations	33361	33352	33352	33352	33352
Adj-R^2	0.072	0.067	0.068	0.068	0.068

Notes: Robust standard errors reported in parentheses. Column 1 presents estimates from eq. (4.1) and columns 2-5 present estimates corresponding to eq. (4.5) for firms with short-term debt in the top 50th percentile, 30th percentile, 20th percentile and 10th percentile of the distribution, respectively. ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

d. <u>Industry-level Results</u>

While the preceding discussion highlights the average effect of firm leverage on productivity observed across all firms in the sample, industry-level differences can be an additional source of heterogeneous response. Since the Indian manufacturing sector is highly diversified and produces a wide range of commodities which vary substantially in their production processes and use of human capital, fixed capital as well as knowledge-based capital, industries within the sector are likely to vary in their average productivity and their dependence on external financing. It can therefore be expected (*a priori*) that external finance such as debt may assume a differential role in each industry.

In the final stage of our analysis, we account for this source of heterogeneity by examining the impact of leverage on firm productivity for each industry (at the two-digit NIC level) in our sample. To this effect, we estimate our baseline models (eqs. (4.1) and (4.2)) for each industry; however, we only report the coefficient of leverage (β_2) due to space constraints. Table 6.6 presents the results.[58]

The results from this exercise highlight some noteworthy features of our sample. Primarily, even though industries have distinctive characteristics, a common issue faced by the majority of them is that firms are (on average) highly leveraged and the associated debt burden is one of the factors constraining productivity growth. This implies that our baseline result represents the true effect of leverage for the majority of firms and is not driven by a particular industry. Importantly, it is seen that existing leverage may give rise to problems of debt overhang and under-investment in capital-intensive industries (such as Electrical equipment, Computers) as well as the more traditional labour-intensive industries such as Textiles. This demonstrates that the rising costs of debt can have direct implications on the firm's productivity-enhancing investments regardless of differences in relative factor-intensities.

In terms of the magnitude of impact, while a 1 percent increase in leverage (holding other factors fixed) is associated with declines in the range of 0.14 percent to 0.34 percent in sectors like Textiles and Beverages, the average decline is stronger in relatively more capital-intensive sectors like Pharmaceuticals, Electrical equipments and Computers and ranges between 0.27 percent and 0.34 percent.[59] In particular, the productivity of firms manufacturing Transport equipments appears to be most sensitive to changes in leverage, as an increase in leverage by 1 percent is on average, associated with a significant decline of nearly 0.4 percent in firm productivity. The only exception is observed in case of the Chemical Industry, where the costs

[58] As we find no evidence of non-linear effects of leverage on productivity, we report the results from eq.(4.1) and (4.2) after excluding the quadratic term. While the effects of firm-specific factors vary across industries, a firm's tangible assets and size are found to be statistically significant for most industries.

[59] While the coefficient of leverage in the Machinery and equipments industry does not appear significant at the 5% level, it is marginally significant as the p-value associated with the t-statistic is 0.10.

(or benefits) of debt appear to have no direct influence on firm productivity.[60] This result indicates that the productivity of firms in this industry may be influenced by unobserved firm-level factors which are not accounted for in our model.[61] A more likely possibility is that factors outside firm-level decision-making play a more decisive role in shaping productivity in this industry.[62]

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[60] The results suggest that access to finance is unlikely to be a significant factor affecting productivity gains, as the latter is not sensitive to changes in internal finance. The level of tangible assets is the only firm-specific variable (other than firm age) to be associated with higher firm productivity.

[61] In unreported regressions, it is seen that firm-level productivity (in the Chemical industry) is not sensitive to changes in the level of innovative activities. Moreover, the effect of leverage is not significant even after controlling for innovative activities in the regression model. As such, productivity changes are unlikely to be as a direct consequence of firm-level decisions including investments in innovation.

[62] The Chemical industry is one of the oldest and most important industries in India in terms of its contribution towards manufacturing output and exports. Importantly, it assumes a significant role as a supplier of key raw materials to several other industries. In recent years, this industry has benefitted from various government policies designed to improve its efficiency and international competitiveness. In particular, one of the most important developments has been to allow 100 percent foreign direct investment (FDI) in this sector, which has led to substantial foreign investments since 2009 (FICCI Report (2013)). While a detailed analysis of the implications of FDI is beyond the scope of this paper, it is possible that regulatory changes may have assumed a central role in shaping productivity improvements of firms in this industry.

Table 6.6: Industry-level Results

Industry	N	Leverage (β_2)	Std. Err
Food products	3597	-0.223***	0.080
Beverages	963	-0.343**	0.168
Tobacco products	204	0.337*	0.167
Textiles	3936	-0.138*	0.073
Wearing apparel	217	-0.417**	0.173
Leather products	296	-0.177	0.333
Wood products	259	-0.264	0.254
Paper products	1163	-0.183**	0.086
Printing	78	-0.052	0.352
Chemical products	4536	-0.065	0.053
Pharmaceuticals	2482	-0.267***	0.103
Rubber and plastics	2299	-0.117	0.090
Non-metallic minerals	1536	0.060	0.101
Base metals	3906	-0.174***	0.067
Fabricated metal	995	-0.209**	0.096
Computers	897	-0.335**	0.163
Electrical equipment	1621	-0.275***	0.099
Machinery and equipment	2035	-0.162	0.101
Motor vehicles	129	0.092	0.155
Other Transport equipment	2087	-0.396***	0.097
Furniture	51	-0.441	0.621
Other Manufacturing	137	-0.232	0.209

Notes: Robust standard errors reported in parentheses. Reported estimates represent the co-efficient associated with leverage from the baseline eq. (4.1). All regressions include firm-specific control variables, time and year-fixed effects. ***, **, * 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 (4.2)).[63] We repeat this exercise using an alternative measure of firm leverage, defined as the ratio of long-term debt and the book value of total assets and the results are presented in Table B.2 (Appendix B).[64] Across all specifications, it is seen that, holding other factors fixed, 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 of productivity and leverage to verify whether they indicate the existence of a causal link between firm leverage, innovation and subsequent increases in productivity. The results (presented in Table B.3 in Appendix B) demonstrate that the association between a firm's innovation activities and productivity gains is robust to alternative measures and is statistically significant. The results provide further evidence that investment in innovative activities is likely to be one of the significant channels through which a firm's leverage influences productivity changes. We also verify whether the identified sources of firm heterogeneity (firm size and debt maturity structure) influence the effect of leverage using alternative measures. The results (presented in Tables B.4 and B.5 in Appendix B) clearly suggest that there is a significantly higher decline in the productivity of smaller firms associated with an increase in leverage. Moreover, firms with a relatively higher share of short-term debt observe a smaller decline in productivity associated with changes in leverage. Finally, the results from the industry-level analysis using the Tornqvist index (reported in Table B.6 in Appendix B) are broadly in line with the main trends in that higher leverage is associated with lower productivity growth across most industries (with the exception of the Chemical industry), though the magnitude of effect tends to vary.

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.[65] We also examine whether the marginal effect of leverage varies between exporting and non-exporting firms.[66] The results (presented in Table B.7) show that the observed effect of leverage

[63] 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.
[64] 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.
[65] In unreported regressions, we also examine whether the effect of leverage is influenced by the firm's ownership concentration and find that the marginal effect of leverage does not vary significantly across firms with low, intermediate and high equity ownership concentration.
[66] 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.

is not significantly different for listed firms. This result implies that problems of debt overhang which lead to underinvestment (and subsequently, lower productivity) can be significant, even for firms which have access to an additional source of finance. Similarly, it is seen that 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.[67]

[67] Our main regression model does not include firm-level exports as an explanatory variable due endogeneity issues between productivity and exporting behavior. Notwithstanding this limitation, in unreported regressions, we include export-intensity as one of the regressors (lagged by one time period) and find that our results remain qualitatively unchanged. The coefficient associated with the export variable suggests that an increase in the firm's exports (on average) is not associated with a significant increase in productivity.

7. Conclusion

This study examines the relationship between firm-level financing and 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. This 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 innovation-related activities and observed productivity. Our results from this exercise lend support to our hypothesis that a firm's tendency to innovate, or real expenditure on innovation is likely to be one of the significant channels through which firm leverage or debt-financing influences productivity growth.

Going further, we examine whether the observed effect is contingent on certain firm characteristics such as firm size and the debt maturity structure. We find that an increase in leverage is associated with a significantly stronger decline in the productivity of smaller firms. Moreover, our results indicate that the decline in productivity is significantly lower for firms with a relatively larger share of short-term debt. We also 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. Finally, 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.[68]

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.[69] 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 for small enterprises as well as making provisions for interest-subsidies to meet 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 subsequent 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.

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[68] For more information, see Dougherty et al. (2011).

[69] Some of these measures include the setting up of National Investment and Manufacturing Zones (NIMZ), which are large-scale industrial units with simplified compliance norms (and various financial incentives) designed promote manufacturing activities. The NMP (2011) has also identified investment in skill development as a priority to address the shortage of skilled labor. Moreover, the NMP (2011) has proposed several measures to reduce the compliance burden, including a single-window electronic clearance and greater cooperation between the central and state government institutions to expedite processes. For more information, see the Department of Industrial Policy and Promotion (DIPP) Report (2011) on the NMP.

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Appendix A

A.1. Summary statistics: Financial ratios (Listed and unlisted firms)

	Listed firms				Unlisted firms			
Variable	N	Mean	Mdn	S.D.	N	Mean	Mdn	S.D.
Debt (% change)	11183	0.938	0.053	20.798	22178	1.449	0.049	85.864
Leverage	11183	0.348	0.343	0.207	22178	0.347	0.341	0.204
Interest coverage	10940	23.169	2.925	462.143	21705	24.531	3.043	329.346
Debt/Equity ratio	10317	3.219	1.054	47.34	20834	2.963	0.914	58.085
Sources								
Banks	10409	0.693	0.766	0.285	20958	0.659	0.715	0.289
Foreign banks	1482	0.291	0.209	0.271	4422	0.29	0.221	0.25
Financial institutions	1541	0.207	0.133	0.219	5698	0.225	0.153	0.222
Public	444	0.212	0.13	0.234	2884	0.19	0.125	0.196
Corporations	4690	0.232	0.126	0.269	8634	0.173	0.071	0.238

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.

A.2. Summary statistics (Distribution of Financial ratios over time)

	2002		2006		2010		2014	
Variable	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Total debt	989.848	4770.468	1126.635	4040.171	2213.568	10811.830	4039.417	21141.720
Leverage	0.371	0.215	0.338	0.198	0.338	0.200	0.344	0.209
Interest coverage	9.675	78.094	25.245	187.969	22.104	177.205	17.195	129.871
Debt/Equity ratio	5.350	105.629	3.128	70.239	2.173	11.452	3.215	35.805
Sources								
Banks	0.568	0.282	0.673	0.282	0.719	0.279	0.696	0.288
Foreign banks	0.263	0.269	0.302	0.241	0.294	0.256	0.267	0.263
Financial institutions	0.281	0.219	0.205	0.217	0.192	0.236	0.122	0.197
Public	0.205	0.195	0.190	0.197	0.182	0.206	0.196	0.229
Corporations	0.159	0.218	0.192	0.248	0.211	0.267	0.195	0.255

A.3. Productivity change (Tornqvist index)

Industry	N. Obs.	Mean	Std. Dev.	Pct. 25	Median	Pct. 75
Food products	3571	0.01	0.405	-0.139	0.036	0.186
Beverages	950	0.024	0.515	-0.167	0.045	0.219
Tobacco products	202	-0.023	3.78E-01	-0.16	0.028	1.52E-01
Textiles	3931	0.002	0.404	-0.134	0.039	0.179
Wearing apparel	216	0.094	0.438	-0.118	0.081	0.295
Leather products	295	0.004	0.307	-0.131	0.04	0.176
Wood products	258	0.051	0.385	-0.147	0.074	0.213
Paper products	1162	-0.013	0.4	-0.109	0.035	0.154
Printing	78	0.08	0.56	-0.088	0.036	0.159
Chemical products	4530	0.015	0.389	-0.114	0.05	0.183
Pharmaceuticals	2475	-0.012	0.401	-0.146	0.024	0.154
Rubber and plastics	2296	0.019	0.35	-0.096	0.053	0.178
Non-metallic minerals	1526	0.029	0.414	-0.097	0.057	0.193
Base metals	3899	0.007	0.471	-0.176	0.044	0.215
Fabricated metal	991	-0.001	0.422	-0.177	0.023	0.204
Computer, electronics and optical	889	-0.016	0.417	-0.182	0.034	0.193
Electrical equipment	1612	0.01	0.441	-0.172	0.041	0.206
Machinery and equipment	2024	-0.001	0.399	-0.158	0.028	0.201
Motor vehicles	129	0.027	0.49	-0.139	0.033	0.19
Other Transport equipment	2086	-0.003	0.308	-0.134	0.019	0.15
Furniture	51	0.003	0.332	-0.087	0.018	0.176
Other Manufacturing	67	0.004	0.303	-0.109	0.038	0.153

Notes: Summary statistics correspond to the Tornqvist TFP Index, which represents the log difference in firm-level productivity (eq. 3.3). The industries represent the set of all manufacturing industries classified under the two-digit NIC (2008) level.

Appendix B

Table B.1: First stage Instrumental Variable regressions (2SLS-IV)

	I	II	III	IV
Interest expenses	3.315***	3.362***	3.058***	3.357***
	(0.174)	(0.180)	(0.155)	(0.180)
Asset tangibility		-0.022	-0.019	-0.020
		(0.014)	(0.014)	(0.014)
Cash flow			-0.023**	-0.033**
			(0.014)	(0.014)
Size		-0.024**	-0.023	-0.024
		(0.010)	(0.010)	(0.010)
$Size^2$		0.001	0.001	0.001
		(0.0010)	(0.0010)	(0.0010)
Owner_inter		-0.009*	-0.003	-0.009
		(0.005)	(0.005)	(0.005)
Owner_high		-0.022***	-0.019***	-0.022***
		(0.007)	(0.007)	(0.007)
Firm/year-fixed effects	Y	Y	N	Y
Observations	32135	32135	32135	32135

Notes: Robust standard errors reported in parentheses. The dependent variable is firm leverage which is instrumented using interest expenses as a ratio of total assets. Firm leverage, asset tangibility and cash flows are expressed as ratios. Column 3 reports first-stage estimates of eq. (4.1) excluding year effects. ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

Table B.2: Baseline Model (Alternative measure of firm Productivity and Leverage)

	I	II	III	IV	V
	Debt-asset ratio		Long-term debt ratio		
Alternative Productivity measure	Tornqvist	Malmquist	LP	Tornqvist	Malmquist
Leverage	-0.095*	-0.634*	-0.162**	-0.166*	-1.097*
	(0.052)	(0.368)	(0.079)	(0.092)	(0.644)
Asset tangibility	0.970***	0.230*	0.116***	0.961***	0.244*
	(0.038)	(0.129)	(0.030)	(0.038)	(0.132)
Cash flow	-0.232***	0.218	0.086***	-0.225***	0.219
	(0.062)	(0.293)	(0.033)	(0.062)	(0.289)
Size	-0.526***	0.788**	-0.015	-0.529***	0.773**
	(0.043)	(0.311)	(0.035)	(0.043)	(0.314)
$Size^2$	0.021***	-0.015	-0.002	0.021***	-0.015
	(0.003)	(0.021)	(0.002)	(0.003)	(0.021)
Owner_Inter	0.036***	0.015	-0.005	0.036***	0.017
	(0.012)	(0.062)	(0.012)	(0.012)	(0.064)
Owner_High	0.057***	-0.074	-0.012	0.055***	-0.076
	(0.015)	(0.075)	(0.017)	(0.016)	(0.077)
Herfindahl Index	0.018**	-0.003	0.041***	0.019**	-0.011
	(0.009)	(0.031)	(0.010)	(0.009)	(0.031)
Firm/year fixed effects	Y	Y	Y	Y	Y
Observations	32034	6015	32135	32034	6015
Hausman test	24.058	4.088	7.139	14.086	4.158
(p value)	0.000	0.0432	0.010	0.000	0.0414

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.3: Causal association between firm innovation and productivity

	I	II	III	IV
Dependent variable	Innovative-activities		Productivity Index	
	FE	IV	Tornqvist	Malmquist
Leverage (Long-term debt)	-0.553***	-0.945*		
	(0.164)	(0.525)		
Asset tangibility	-0.504***	-0.661***		
	(0.172)	(0.181)		
Size	-0.374***	-0.472***		
	(0.126)	(0.131)		
$Size^2$	0.022**	0.033***		
	(0.010)	(0.010)		
Owner_Inter	0.196***	0.272***	0.000	-0.091
	(0.072)	(0.070)	(0.018)	(0.057)
Owner_High	0.127	0.236***	0.028	-0.113*
	(0.093)	(0.090)	(0.026)	(0.061)
Herfindahl Index	-0.088*	-0.088*	0.023*	0.007
	(0.053)	(0.052)	(0.013)	(0.042)
Innovative activities			0.035***	0.063***
			(0.005)	(0.017)
Firm/year fixed effects	Y	Y	Y	Y
Observations	13540	13065	13637	2829
Adjusted R^2	0.056		0.020	0.008
Hausman test	0.366			
(p value)	0.5451			

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. (4.3). ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

Table B.4: Effect of Firm Size

	Small and medium firms (MSMEs)			Large firms		
Productivity measure	TFP-LP	TFP-Tornqvist		TFP-LP	TFP-Tornqvist	
Leverage		-0.387**			-0.246***	
		(0.155)			(0.071)	
Long-term debt	-0.520**		-0.840**	-0.142*		-0.413***
	(0.224)		(0.345)	(0.083)		(0.120)
Asset tangibility	-0.018	0.394***	0.354***	0.117***	1.047***	1.020***
	(0.079)	(0.075)	(0.077)	(0.031)	(0.044)	(0.044)
Cash flow	-0.001	-0.172*	-0.149	0.091***	-0.302***	-0.286***
	(0.071)	(0.104)	(0.110)	(0.032)	(0.080)	(0.080)
Owner_Inter	-0.020	-0.001	0.006	-0.002	0.005	0.006
	(0.032)	(0.031)	(0.032)	(0.012)	(0.012)	(0.012)
Owner_High	-0.021	-0.012	-0.006	0.003	0.021	0.018
	(0.032)	(0.040)	(0.042)	(0.017)	(0.018)	(0.019)
Herfindahl Index	0.000	0.022	0.017	0.043***	0.031***	0.033***
	(0.020)	(0.020)	(0.021)	(0.010)	(0.010)	(0.010)
Firm/year fixed effects	Y	Y	Y	Y	Y	Y
Observations	7968	7908	7908	23873	23833	23833
Hausman test	5.184	17.555	12.411	0.031	45.97	37.531
(p value)	0.0228	0.000	0.000	0.8611	0.000	0.000

Notes: Robust standard errors reported in parentheses. Columns 1 and 3 correspond to estimates from eq. (4.1) and columns 2 and 4 present IV-estimates from eq. (4.2). 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 debt to total assets, or as the ratio of long-term debt to total assets. ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

Table B.5: Effect of Short-term debt

	I	II	III	IV	V	VI	VII	VIII
	TFP-LP				TFP-Tornqvist Index			
Leverage	-0.159***	-0.122**	-0.120**	-0.118**	-0.113**	-0.085	-0.081	-0.251***
	(0.060)	(0.058)	(0.058)	(0.058)	(0.054)	(0.052)	(0.053)	(0.062)
Leverage_ HSD50	0.073*				0.102***			
	(0.040)				(0.023)			
Leverage_ HSD30		0.038*				0.112***		
		(0.023)				(0.029)		
Leverage_ HSD20			0.071**				0.103***	
			(0.027)				(0.032)	
Leverage_ HSD10				0.099**				(0.055)
				(0.046)				
Asset tangibility	0.110***	0.116***	0.116***	0.118***	0.971***	0.972***	0.980***	0.873***
	(0.030)	(0.030)	(0.030)	(0.030)	(0.038)	(0.038)	(0.038)	(0.038)
Cash flow	0.080**	0.079**	0.079**	0.075**	-0.033***	-0.033***	-0.217***	-0.040***
	(0.033)	(0.032)	(0.032)	(0.033)	(0.010)	(0.010)	(0.062)	(0.011)
Size	-0.013	-0.010	-0.009	-0.010	-0.535***	-0.533***	-0.530***	-0.092***
	(0.035)	(0.035)	(0.035)	(0.035)	(0.045)	(0.044)	(0.044)	(0.032)
N. Obv.	32135	32073	32087	32097	31954	31965	31979	31987
Hausman test	11.492	6.524	4.651	4.909	72.251	36.134	30.478	54.47
(p value)	0.003	0.034	0.097	0.086	0.000	0.000	0.000	0.000

Notes: Robust standard errors reported in parentheses. Columns I-IV (V-VIII) present instrumental-variable estimates using TFP-LP (Tornqvist TFP Index) as the dependent variable and correspond to eq. (4.5)) for firms with short-term debt in the top 50^{th} percentile, 30^{th} percentile, 20^{th} percentile and 10^{th} percentile of the distribution, respectively. ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

Table B.6: Industry Results (Tornqvist TFP Index)

Industry	N	Leverage (β_2)	Std. Err
Food products	3442	-0.346**	0.149
Beverages	862	-0.573	0.369
Tobacco products	202	0.219	0.222
Textiles	3801	-0.379*	0.201
Wearing apparel	201	-0.785	0.751
Leather products	286	0.414*	0.222
Wood products	258	0.261	0.233
Paper products	1162	0.300**	0.136
Printing	1162	0.300**	0.136
Chemical products	4412	-0.044	0.120
Pharmaceuticals	2368	-0.457*	0.272
Rubber and plastics	2296	0.199**	0.088
Non-metallic minerals	1484	-0.181	0.274
Base metals	3755	-0.591***	0.229
Fabricated metal	991	-0.066	0.111
Computers	889	-0.241*	0.142
Electrical equipment	1544	-0.700*	0.398
Machinery and equipment	2024	0.043	0.101
Motor vehicles	129	-0.728	0.612
Other Transport equipment	2086	0.165**	0.078
Furniture	51	0.487	0.362
Other Manufacturing	137	-0.089	0.362

Notes: Robust standard errors reported in parentheses. Reported estimates represent the co-efficient associated with leverage from the baseline eq. (4.1). All regressions include firm-specific control variables, time and year-fixed effects. ***, **, * indicate significance at the 1%, 5% and 10% level, respectively.

Table B.7. 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.