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Article

Debt financing, corporate investment and the productivity of capital invested: Evidence from biggest manufacturing countries

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FINANCIAL ECONOMICS | RESEARCH ARTICLE

Debt financing, corporate investment and the productivity of capital invested: Evidence from biggest manufacturing countries

Tenkir Seifu Legesse¹, Jiqiang Tang^{2*}, Zhen Wu³ and Haifeng Guo³

Abstract: This study examines the impact of debt financing on the productivity of capital invested and the mediating role of corporate investment using data from manufacturing firms in China, Japan and the United States. We find that firms that use more debt capital are less likely to make overinvestment. It is found that overinvestment is more likely in firms that have high cash flow but low level of financial leverage. Our study also shows that companies with high debt and low cash flow have more probability of underinvestment. This is consistent with the view that financially constrained firms are more exposed to underinvestment problem. Furthermore, we documented that the use of debt financing has a positive impact on the productivity of the capital invested and that this effect is partly mediated by the investment of the manufacturing firms. This paper shades light into the present understanding of how companies use debt financing decisions to boost their investment efficiencies. The study has important management implications for corporate financial decisions as it identifies the links among corporate debt financing, investment and capital productivity.



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PUBLIC INTEREST STATEMENT

The agency cost theory claims that more use of debt financing diminishes the possibility of unwarranted spending and over investment made by management. Thus, firms with high debt in their capital structure would be more likely to invest in better projects and, hence, achieve better performance than less leveraged ones. In this article, we examine the impact of debt financing on the productivity of capital invested and the mediating role of corporate investment using data from manufacturing firms in China, Japan and the United States. Our study indicates that overinvestment is more likely in firms that have high cash flow and low level of financial leverage. In contrary, it is found that that companies with high debt and low cash flow have more chance of underinvesting. Furthermore, we documented that the use of debt financing has a positive effect on the productivity of the capital invested and that this effect is partly mediated by corporate investment.

Subjects: Finance; Business, Management and Accounting; Industry & Industrial Studies

Keywords: Corporate Financing; Corporate Investment; Capital Efficiency; Agency Cost Theory; Manufacturing Industry

1. Introduction

Agency conflict between shareholders and managers distorts a firm's financial decisions (Lin, 2017) and causes inefficient investment. According to Koussis et al. (2017), managers may sub-optimally invest in growth options and lead their firms to high agency costs. Agency cost theory suggest that the use of debt capital is important to improve organizational efficiency since the restrictive covenants in debt contracts may monitor managers' spending behaviors and forces companies to adopt more efficient managerial practices (Jensen, 1986). Constraining managers with high debt may reduce the inefficiency of marginal investments and wasteful spending managers made through asset diversion (Berger & Patti, 2006; Canarella et al., 2014; Kochhar, 2015). Mande et al. (2012) find that when corporate governance is strong, equity financing may become attractive for some firms but with decrease of corporate governance, debt financing is more desirable to mitigate agency problem. The threats caused by the managements' failure to settle debt-financing requirements are also effective motivating forces to make organizations more efficient. Thus, we predict that the use of debt capital, which we consider as the main explanatory variable in our paper, enhances the productivity of capital invested. This is because the use of borrowed funds enables firms to effectively monitor the investment behaviors of managers and mitigates over-investment of capital.

On the other hand, debt overhanging may lead to under-investment problem and may result in another form of inefficiency (Stulz, 1990). When the interests of the debtholders and the shareholders are contradicting, managers sometimes act according to the interest of the creditors. In the circumstances of excessive indebtedness or debt overhanging, managers may be forced to reject profitable projects to follow the interest of the creditors. Hence, firms shall continue borrowing up to some optimum amount of debt, to the level of their debt capacity, in order to capitalize the benefits of financial leverage. Studies have reported that the use of financial leverage improves corporate performance due to the disciplinary role of debt (Jensen, 1986; Wruck, 2004) and that excess debt causes underinvestment that leads to inefficiency (Myers, 1977; Stulz, 1990). This leads to the prediction that although the application of debt capital is beneficial for mitigating overinvestment problem, it can also humper firm's performance by inhibiting some good investments. Accordingly, this paper attempts to investigate (1) how the use of debt financing affects firm's investment; (2) whether the level of debt financing relates to corporate over-investment and under-investment levels; and (3) whether corporate investment mediates the effect of financial leverage on the productivity of capital invested.

To this end, this paper examines how the use of debt financing affects the productivity of capital invested with the mediation role of corporate investment. Here, we apply the productivity of capital invested as a measure of (inverse) agency costs to empirically test the predictions of agency cost capital structure theory. We gauge the productivity of the capital invested following Stochastic Frontier Analysis (SFA), parametric model applied to measure efficiency. We find that firms that use more debt capital mitigate over-investment and are more exposed to under-investment problem. Our finding indicates that when manufacturing firms optimize the level of their investment, the efficiency of the capital improves. Putting differently, overinvestment and underinvestment decisions made by companies impair the efficiency of invested capital. In addition, we find that the increase in corporate borrowing has a positive impact on the efficiency of the capital invested and that the effect is partly mediated by the corporate investment. This applies mainly for sub-sample of Chinese firms. The mediation role does not apply for the firms in Japan and USA.

Our study contributes to the existing body of knowledge in different ways. First, it shades light to the existing literature through an empirical analysis of the nexus among debt financing, investment,

and capital productivity using data from firms in the biggest manufacturing countries. We focus on the companies in the three biggest manufacturing countries namely: China, Japan and the United States. We concentrate on the productivity of one major sector of the economy, manufacturing. Despite the decreased importance of manufacturing in advanced countries in shares of output and employment, its role in the economy remains important, because the sector generates most technological innovations with important spillover effects to the rest of the economy. Moreover, the countries considered in this paper continue to play a major role in world production and trade of manufactured products. They account for the lion's share of the trade in manufactured goods among market economies. Thus, the choice of the countries is motivated by their leading positions with regard to global industrial economy and their reputable manufacturing experiences with high concern for efficiency. Second, although there are well established theories explaining how the use of debt affects efficiency, the mediating effect of investment has not been appropriately tested with empirical data. We show the impacts of debt financing on investment and the mediating role of investment in the financial leverage-productivity nexus. Our study applies novel approach in testing the agency cost theory. We systematically measure productivity and over (under) investments, and examine how firms' financing decisions affect their productivity with mediation effect of investment.

2. Review of literature

Berle and Means (1932) first recognized the inefficient use of funds by management in excess of profitable investment opportunities. When there is abundant free cash flow, managers have the tendency to invest it in size-increasing but unprofitable projects (D'Mello & Miranda, 2010; Deangelo et al., 2006; Denis & Osobov, 2008; GY. Wang, 2010). Moreover, Koussis et al. (2017) proved that managers may choose cash-holding policies, sub-optimally investing in growth options and leading to high agency costs. The agency cost theory suggests that firms should use more debt financing and commit part of their operating cash flows for periodic debt service payments in order to prevent managers from building unnecessary empires in their own narrow interests (Harris & Raviv, 1991; Jensen, 1986; Myers & Majluf, 1984). Constraining managers with high debt may reduce the inefficiency of marginal investments as well as the wasteful spending managers made through asset diversion, even holding the investment policy constant. The threat caused by failure to make debt service payments serves as an effective motivating force to make organizations more efficient. An increase in financial leverage reduces the free cash flow available to the managers thereby mitigates the agency cost of the firm. The funds remaining after financing all positive net present value projects cause conflicts of interest between managers and shareholders. Dividend and debt interest payments decrease the free cash flow available at discretion of managers to invest in nonvalue adding projects and to spend for perquisite consumptions.

However, with excessive level of debt, bankruptcy become chronic and financial distress costs exceeds the advantages of additional leverage (Brealey & Myers, 2011). Theories have both argued that high level of debt increases financial distress costs (Andrade & Kaplan, 1998; Warner, 1977) and that it can improve corporate performance due to the disciplinary role of debt (Jensen, 1986; Wruck, 2004). Furthermore, while debt may prevent firms from making bad investments, it may also prevent them from making good ones. Stulz (1990) predicts that firm efficiency initially increases as the level of debt increases and starts to decline after it reach the maximum point. Dube (2013) found that debt financing had a positive effect on SMEs' efficiency, noting that businesses that obtained sufficient funding from banks increased their performance. Small and medium-sized companies (SMEs) are considered to have more trouble accessing external funding than large corporations. Dube (2013) had several limitations, including mechanical correlations in its baseline model due to measurement issues, a limited scope, and weak regression analysis. Prior studies that examined the relationship between debt financing and corporate efficiency found both positive (Berger & Patti, 2006; Cai & Zhang, 2011; Margaritis & Psillaki, 2010) and negative (González, 2013; Le & Phan et al., 2017; Xu, 2012) associations between the two variables. These contrasting outcomes may be because the use of debt can have both positive and negative effects on firm performance. In our study, we focus on the link between debt financing decisions and capital efficiency with mediating role of corporate investment using data from biggest economies.

3. Hypothesis development

The agency cost theory argues that increasing the level of financial leverage reduces the possibility of unwarranted spending and mitigates over investment made by management. More use of debt finance may also mean more reliance on external capital that involves more scrutiny by fund providers, with less tolerance for unproductive investment activity and excess perquisite consumption. Thus, firms that have high debt in their capital structure would be more likely to invest in better projects and, hence, perform better than less leveraged ones. However, agency costs can also emanate from conflicts of interest between creditors and owners. According to Myers (1977), these conflicts usually occur when there is a risk of default and such conflicts create “under-investment” or “debt overhang” problems. Under debt overhanging situation, additional use of debt capital will have a negative effect on firm performance. Stulz (1990) also states that debt financing mitigates over-investment problems but can aggravate the underinvestment problem. Thus, in light of the above points, we predict that the level of debt financing determines the amount of investment that firms make; it normally reduces overinvestment but can also cause underinvestment when it is too much.

Hypothesis 1: *Citrus paribus*, the amount of investment that firms undertake depends on their level of debt financing

Hypothesis 2a: Firms that use more debt financing are less likely to make over-investment

Hypothesis 1b: Firms that use more debt financing are more likely to make under-investment

Agency conflicts are likely in cases where managers have the opportunities to take advantage of maximizing their private interests. According to the free cash flow theory, agency conflicts are more probable in situation where free cash flows are high. Managers tend to overinvest when firm holds high liquid assets readily available at the managers’ discretion. Cash holdings offer an interesting context to study the implication of agency problems (Xuan Vinh, 2018). Generally, it is probable that firms with high cash flow make overinvestment and exhibit inefficiency in their investment performance. Constraining managers with high debt may reduce the inefficiency of marginal investments and wasteful spending managers made through asset diversion (Berger & Patti, 2006; Canarella et al., 2014; Kochhar, 2015). Thus, use of debt financing monitors managers spending behaviors and can play important role for mitigating excess investments.

There is evidence that long-term investments made by cash rich firms suffer from abnormal declines in operating performance attributable to over-investment (Lamont, 1997). Some studies (Opler & Titman, 1994) also proved that companies with excess financial resources involve in more capital investments, and spend more on acquisitions, although their investment opportunities appear to be poor. Agency problems lead to investing cash flows on unprofitable projects or consuming it on organizational inefficiencies. One of the remedies, suggested by agency cost theory, is systematically increasing the level of debt capital used by the firm to constrain the manager’s investment behaviors. The use of debt financing entails reinforcements that discourage managerial financial resources wastages and it avoids over-investment (Jensen, 1986). Moreover, the use of debt capital allows the firm’s creditors to monitor firm’s investment activities more closely and systematically.

Generally, the tendency of management to carry out over-investment can be constrained by the availability of free cash flow, and debt financing can further tighten this constraint. The application of debt capital pre-commits the corporation to pay cash as interest and principal, requiring managers to meet those obligations with funds that would otherwise have been allocated to poor projects or negative NPV projects. Thus, the use of financial leverage is one of the strategies for addressing the issue of overinvestment. Companies with poor growth opportunities are expected to show a negative association between the level of debt and over-investment. On the other hand, when managers fear that investments may not produce enough cash to pay the interest and debt principle needed to

finance investment, they may underinvest. In similar view, we predict the following relationship among financial leverage, cash flows, investment, and the efficiency of capital invested.

Hypothesis 2a: *Ceteris paribus*, the efficiency of capital invested is determined by the investment decisions of the firm. Both over-investment and under-investment decisions negatively relates to the productivity of capital invested.

Hypothesis 2b: Corporate investment mediate the effects of debt financing on the productivity of capital invested.

4. Data & methods

4.1. Data

The study uses data of manufacturing companies of China, Japan and USA for the years 2007–2017. The study attempts to covers year 2007–2017 to incorporate most recent data in the analysis. The focus on the recent phenomena in the area of study makes the paper up to date and more relevant. We extracted the data from WRDS (Wharton Research Data Service), COMPUSTAT Capital IQ Global database. The firms included in the study are those with global manufacturing operations. To filter the manufacturing firms from the rest of other companies in the database, we referred their global industry code (GIC). The firms under our study are categorized in to ten subindustry sectors based on their global industrial classification. We winsorized the variables, at top 99% and bottom 1%, to avoid the effects of extreme values. Finally, our sample data contains 56,842 firm-year observations that we included in our empirical analysis. [Table 1](#) summarizes the sample data that we applied for the analysis in the current study.

4.2. Estimating the productivity of capital

To estimate capital productivity, our study applies stochastic frontier true random effect (SF TRE) model of (Greene, 2005). We represent the inputs variable by the natural logarithm of the total capital invested as reported in the balance sheet of the respective firms. The outputs variable is the natural logarithm value of gross profit generated plus the depreciation and amortization. We added back depreciation and amortization to above double counting of the input side because these items relates to capital investment. To check whether the data is normally distributed, we employee skewness/kurtosis tests for normality of both input and output factors. The result shows that there is normal distribution in the data applied for the analysis, with significant p -value for both skewness and kurtosis test. Our specification follows trans-log frontier function. We also made inflation adjustment on the value of input and output by taking year 2007 as base year and converted the values of variables to a common currency of denomination, USD. We estimated the productivity of capital invested with the equation below.

$$\ln Y_{it} = \alpha_i + \beta_k K_{it} + \beta_{kk} 1/2 \ln^2 K_{it} + U_{it} + V_{it} \quad (1)$$

$$V_{it} \sim N(0, \sigma^2_v), U_i \sim N^+(0, \sigma^2_u)$$

Where, Y_{it} is gross profit plus depreciation and amortization of firm i at time t . K_{it} is the capital invested in firm i at time t . β is unknown parameters to be estimated, α_i is firm-specific time-invariant heterogeneity, v_{it} = two-sided normal error, and u_{it} is one-sided non-negative inefficiency.

Greene's model assumes a two-sided normal error V_{it} and a half- normal random term U_{it} that represents a one-sided non-negative inefficiency term ($U_{it} \geq 0$). We estimate the model by the maximum likelihood method. Within the stochastic frontier framework and the above function, we define efficiency as follows.

Table 1. Summary of sample data

	No. of Firms	Observation			
		China	Japan	USA	Total
Material	1,273	5,625	2,859	2,956	11,440
Capital Goods	1,693	6,075	4,918	4,292	15,285
Auto Industry	341	1,287	1,291	569	3,147
Household Durable	587	1,870	1,508	1,642	5,020
Food & Bev.	463	1,585	1,249	1,285	4,119
Household Personal	136	155	306	600	1,061
Health Equip.	482	284	283	2,849	3,416
Pharmaceutical	205	1,960	0	0	1,960
Techno Hardware	1009	3,002	2,451	3,281	8,734
Semi-Conductor	326	564	501	1,595	2,660
Total	6,515	22,407	15,366	19,069	56,842

$$Y_{it} \leq \text{Exp}(f(K, it)) * \text{Exp}(V_{it}) \tag{2}$$

Theoretically,

$$\text{Eff} = \text{Observed Output/Potential Output} \tag{3}$$

$$\text{Eff} = \frac{\text{Exp}(f(K_{it})) * \text{Exp}(V_{it}) * \text{Exp}(-U_{it})}{\text{Exp}(f(K_{it})) * \text{Exp}(V_{it})} \tag{4}$$

$$\text{Eff} = \text{Exp}(-U_{it}) \tag{5}$$

Table 2 presents the parameter estimates obtained from SF TRE model regression conducted for gauging the efficiency of capital. In panel B, the table also reports the average productivity of capital in the three countries for each industrial subsector. The values of input and output variables are transformed into their natural logarithm value. Hence, it is possible to interpret the first-order coefficients in the model as elasticity of the output for changes occurred in the capital invested. The estimated second-order coefficients of the input, capital invested, is positive and significant at the 1% significance level in all industries except household and personal products industries. This indicates the sensitivity of profit generated for the change of capital invested. Output elasticity of a given input is computed from the partial derivative of the logged value of output with respect to the logged value of the input. Thus, the partial derivative of the output function in our model with respect to capital, K, gives the elasticity of the gross profit generated for change in capital invested. To check for normality of the variables included in the efficiency model, we apply skeweness and kurtosis tests. Such tests can be used as an alternative to the Jarque–Bera test in panel-data models. The result, as shown in annex B, indicates that there is normality within the data. In addition to capital productivity, there are different explanatory variable included in our study. Annex A describes measurements applied for the other variables used in the current study.

Table 2. Estimated parameters from true random-effects model

Panel A: Parameter estimates										
Frontier	Material	Capital Goods	Auto Industry	Household Durable	Food & Bev.	Household Personal	Health Equip.	Pharmaceutical	Techno Hardware	Semi-Conductor
ln(K)	-0.574*** (0.067)	-0.350*** (0.036)	-0.359*** (0.062)	-0.737*** (0.070)	-0.540*** (0.051)	-0.544*** (0.041)	-0.685*** (0.034)	-0.880*** (0.191)	-0.371*** (0.149)	-0.887*** (0.054)
ln ² (K)	0.061*** (0.004)	0.050*** (0.002)	0.049*** (0.003)	0.069*** (0.004)	0.061*** (0.003)	0.059*** (0.002)	0.071*** (0.002)	0.082*** (0.010)	0.057*** (0.008)	0.081*** (0.003)
Intercept	17.819*** (0.587)	15.916*** (0.332)	16.652*** (0.580)	20.158*** (0.655)	17.658*** (0.481)	17.709*** (0.378)	18.241*** (0.296)	20.221*** (1.770)	15.213*** (1.373)	20.472*** (0.491)
σ_u	0.417*** (0.006)	0.315*** (0.004)	0.275*** (0.008)	0.316*** (0.007)	0.330*** (0.008)	0.298*** (0.013)	0.400*** (0.008)	0.311*** (0.014)	0.424*** (0.012)	0.305*** (0.006)
σ_v	0.121*** (0.004)	0.124*** (0.003)	0.108*** (0.005)	0.095*** (0.005)	0.090*** (0.006)	0.100*** (0.008)	0.057*** (0.006)	0.200*** (0.010)	0.128*** (0.008)	0.151*** (0.004)
λ	3.445*** (0.009)	2.539*** (0.006)	2.548*** (0.011)	3.331*** (0.011)	3.672*** (0.013)	2.980*** (0.018)	6.994*** (0.012)	1.556*** (0.022)	3.311*** (0.017)	2.015*** (0.009)
Wald χ^2	11,382.840	27,069.110	5288.37	6576.31	7569.60	5607.20	19,348.77	4042.81	3204.18	12,344.28
Panel B: Mean Eff.										
China	0.583	0.677	0.712	0.674	0.627	0.656	0.613	0.751	0.719	0.664
Japan	0.667	0.735	0.741	0.658	0.698	0.603	0.610		0.763	0.685
USA	0.506	0.650	0.640	0.620	0.605	0.536	0.521		0.700	0.651
Obs.	11,440	15,285	3,147	5,020	4,119	1,061	3,416	1,960	8,734	2,660
Firm	1,273	1,693	341	587	463	136	482	205	1009	326

The average estimated capital efficiency in the entire sample is about 0.6598 (65.98%). TRE usually provides low inefficiency estimate since it does not confound heterogeneity with inefficiency (Hailu & Tanaka, 2015) and our finding suggests the same. The result also indicates that among the companies covered by our analysis, there is more variability (standard deviation of about 0.2292) in capital efficiency levels. The potential for performance enhancement is very strong in some businesses and the management should optimize the amount of capital invested in such companies. The result shows that, relative to the best practice frontier, a company that reached the average productivity level has made over (under) investment by around 34.02%. This means that the sample's average degree of inefficiency is around 34.02%. In each of the countries in the current analysis, manufacturers of technical hardware generally look relatively successful.

5. Results

In this study, we are particularly interested in analyzing the effects of debt financing on the efficiency of capital with mediating role of investment. First, we embark on examining the determinants of firm's investment amount. Then, we investigate how increase of debt capital affects overinvestment and underinvestment. Last, our study tests the mediating effects of the investment decisions for the debt-efficiency nexus.

5.1. Determinants of firm investment

The current study follows the framework of Richardson (2006) to determine the expected level of investment. According to his model, the amount of firm's investment depends on investment in the prior period ($Inv_{i,t-1}$), firm size ($Size_{i,t-1}$), the level of cash holding ($Cash_{i,t-1}$), investment opportunity or revenue growth ($Growth_{i,t}$), market return ($ROA_{i,t-1}$), and firm age. We also consider these variables in the baseline model that we applied to predict the normal level of investment. However, an attempt to include firm age variable can result in loss of large data that we use for the analysis. Thus, we excluded it from the model. In addition, because firms' investments in projects are often assigned to more than one accounting period, we include the lag of investments. Accordingly, we estimated the model below to identify the determinants of investment and the nature of their effect.

$$Inv_{i,t} = \beta_0 + \beta_1 Inv_{i,t-1} + \beta_2 Debt_{i,t-1} + \beta_3 ROA_{i,t-1} + \beta_4 Cash_{i,t-1} + \beta_5 Size_{i,t-1} + \beta_6 Growth_{i,t} + e_{it} \quad (6)$$

In the current study, we define the normal investment level as investment level predicted by the above baseline model. Researchers commonly apply Tobin's Q value (Zhong et al., 2010) and sales growth (Y. Wang, 2009; Yang & Hu, 2007) as a proxy for corporate investment opportunities. We applied the sales growth in our study. The definitions and measurements of the other variables are shown in appendix A. The results in Table 3 show a significant positive relation between new investment expenditures and prior new investments, which could be understood in the light of continued firm investment behavior and the adjustment costs of new investments (Liu & Bredin, 2010; López-de-foronda et al., 2019). The coefficients of the prior investment, growth opportunities (measured with sales growth), corporate cash holding (CF), and investment return (ROA) are positive and significant consistent with Richardson (2006). The coefficient of Size is negative and significant suggesting that the highest investments are made by firms in the fastest growing sectors that are not so intensive in fixed assets. Results under all columns of Table 3 report a negative and significant coefficient of the debt financing. This is consistent to the paper by Richardson (2006) and in line with the expectations under the current study. Increase of debt financing should lead to reduction of overinvestment according to the prediction of agency cost theory. We also performed additional estimation with GMM regression and checked that there is no problem of second order autocorrecting. To this end, the result shows that the effect of debt financing on the investment is negative under different estimations and with robustness tests.

5.2. Debt financing and over (under) investment

Overinvestment represents the extent that corporate investments are beyond a reasonable level and can be measured as the amount by which the actual corporate investment level deviates from

a normal level. Likewise, the portion that is greater than the normal level is considered as over-investment. We follow Richardson’s model to measure the over (under) investment. Based on economic determinants, we compute an expected (new) investment level or capital expenditures for each firm year. Specifically, we adopt the regression shown in column (4) of Table 3 to estimate the over (under) investment level for the empirical analysis. The residual of regressing a firm’s actual investment level, capital expenditures deflated by lag of total assets, on these economic determinants is the measure for over (under) investment. A positive residual implies that the firm invested more than expected in that year, whereas a negative residual implies that the firm invested less than expected. The model determines the optimum investment needed by assuming that the investment amount is a function of these explanatory variables. Once we determined over (under) investment level by the value of the residual, we examined whether financial leverage explains the variation in these residuals. First, we arranged the residual into three quartiles based on their values where residuals with the extreme negative values are under-investment and those with the extreme positive value are overinvestment. We considered residuals that are not that far from zero in both sides as normal. After grouping the residual based on the above procedures, we estimate the model represented by Equation (7) using panel Tobit regression. This model is used to analyze the effects of debt financing on over (under) investment levels in the firms.

$$\text{Investment}_{i,t} = \beta_0 + \gamma \text{Investment}_{i,t-1} + \beta_1 \text{Debt}_{i,t-1} + \beta_2 \text{CF}_{i,t-1} + \beta_k \sum \text{Country} + \beta_m \sum \text{Industry} + \beta_n \sum \text{Year} + e_{it} \quad (7)$$

Where $\text{Investment}_{i,t}$ refers to the level of overinvestment or underinvestment in firm “i” in the period “t”.

In the model indicated by the Equation (7), Lag of debt level ($\text{Debt}_{i,t-1}$) and Cash flow ($\text{CF}_{i,t-1}$) are used as regressors. The results in Table 4 provide interesting insights into the dual role of leverage. For firms that have underinvested, there is a positive relationship between the level of underinvestment and the level of debt although it is not statistically significant. This implies that the higher the use of debt capital the higher is the likelihood of underinvestment. The effect of excess debt on underinvestment is more pronounced in firms with low cash flow. Firms with high debt and low cash flow are more likely to make underinvestment. This is logical because such firms are expected to be financially constrained and may not have enough cash for investment. Thus, support the argument that excess use of debt capital curtails investment even under circumstances that firms have good investment opportunities (Stulz, 1990). Conversely, we document that high debt is negatively relates to the overinvestment variable suggesting that debt financing can play meaningful role in mitigating managers’ overinvestment behavior. The result also shows that firms are more likely to overinvest when they have higher cash flows and low level of debt. In general, firms with high levels of free cash flow tend to overinvest when they apply less debt than otherwise. This complies with the Jensen’s free cash flow hypothesis.

The dependent variable is represented by the regression residuals obtained from investment model shown in Table 3. Accordingly, the residuals in FE regression, Column 4 of Table 3, are applied to identify overinvestment and underinvestment conditions in the firms. We arranged the residual into three quartiles based on their values where residuals with the extreme negative values are underinvestment and those with the extreme positive value are overinvestment. We considered residuals that are not that far from zero in both sides as normal. After grouping the residuals into three quartiles, we created three dummy variables namely: Underinvestment _ dummy, Normal investment_ dummy and Overinvestment _ Dummy. Then, the absolute value of the residual is multiplied by the respective dummy variable values to determine the level of underinvestment and overinvestment.

5.3. Debt financing, corporate investment and productivity of capital

Finally, we investigate how debt financing affects the efficiency of capital and whether investment decisions plays the mediation role. We apply three steps to test the mediation effect following the

Table 3. Determinants of investment

	Expected sign of Coefficient	Dependent Var. = Investment						System GMM Full Data
		Fixed Effect Model				OLS Full Data		
		China (1)	Japan (2)	USA (3)	Full Data (4)	Full Data (5)	(6)	
Inv. $t-1$	(+)	0.234*** (0.010)	0.173*** (0.022)	0.176*** (0.024)	0.233*** (0.009)	0.523*** (0.007)	0.278*** (0.013)	
Debt $_{t-1}$	(-)	-0.029*** (0.007)	-0.019* (0.011)	-0.009** (0.005)	-0.014*** (0.004)	-0.004*** (0.001)	-0.023*** (0.007)	
Cash $t-1$	(+)	0.078*** (0.008)	0.035*** (0.008)	0.033*** (0.007)	0.061*** (0.005)	0.001 (0.002)	0.088*** (0.007)	
ROA $t-1$	(+)	0.121*** (0.008)	0.047*** (0.005)	0.054*** (0.005)	0.084*** (0.004)	0.060*** (0.003)	0.067*** (0.005)	
Firm Size $_{t-1}$	(-)	-0.031*** (0.002)	-0.006** (0.002)	-0.0013*** (0.001)	-0.027*** (0.001)	-0.002*** (0.001)	-0.062*** (0.002)	
Growth Opp. $t-1$	(+)	0.032*** (0.002)	0.010*** (0.002)	0.016*** (0.002)	0.024*** (0.002)	0.029*** (0.002)	0.019*** (0.002)	
θ_0		0.668 (0.035)	0.139*** (0.047)	0.296*** (0.029)	0.564*** (0.021)	0.070*** (0.004)	1.263*** (0.043)	
Firm effect		Yes	Yes	Yes	Yes	No	No	
Year effect		Yes	Yes	Yes	Yes	Yes	Yes	
Country effect		Yes	Yes	Yes	No	Yes	Yes	
Industry effect		No	No	No	No	Yes	No	
R ²		0.226	0.077	0.109	0.184	0.471		
F-test (χ^2)		148.999	25.647	35.720	169.665	616.048	2687.752	
AR test1							0.000	

(Continued)

Table3. (Continued)

	Dependent Var. = Investment						System GMM Full Data	
	Expected sign of Coefficient	Fixed Effect Model			Full Data	OLS Full Data		
		China (1)	Japan (2)	USA (3)				(4)
AR test2							(6)	0.182
Sargan test								0.267
Firm		2,353	1,609	2,298	6,258	6,258		6,258
Obs.		17,576	12,127	13,610	43,313	43,313		43,313

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

procedure suggested by (Baron and Kenny, 1986). First, we test whether and how corporate investment is affected by the firms' level of debt financing. We have already shown the analysis concerning this in the previous discussions with results obtained in [Tables 3 and 4](#). Next, we conduct analysis concerning the direct effect of financial leverage on the productivity of capital invested. A regression on Equation (8) is performed to examine how the level of debt financing affects and the capital efficiency. This model does not include the mediator variable.

$$EFF_{it} = \alpha_0 + \gamma EFF_{i,t-1} + \beta_1 Debt_i + \beta_2 Cash_i + \beta_3 Size_i + \beta_4 CapInt_{.i} + \beta_n \sum^{Year} + e_{it} \quad (8)$$

[Table 5](#) illustrates how the amount of corporate debt affects capital efficiency and shows that there is a positive relationship between the two. The coefficients are positive and significant for countries' sub-samples and for the entire sample. In short, the use of debt funding has been positively linked to the efficiency of capital invested in all countries. According to agency cost theory, employing debt financing decreases the likelihood of unjustified expenditures and over-investment by management. More use of debt capital also requires more reliance on external capital, which involves greater scrutiny by fund providers, less tolerance for unproductive investment operations and excessive spending of resources. Companies that use more borrowed capital in their capital structure are more likely to use funds for better investments and hence achieve higher productivity than companies that use less borrowed capital. This is because debt contracts may require more rigorous investment screening processes and decisions.

Last, we perform regression analysis of investment and corporate debt financing on capital efficiency to study whether the investment activities plays a mediation role in the agency cost theory of capital structure. The regression model for identifying the mediating effect is shown in Equation (9). If the coefficient of debt is not significant when estimating the last Equation (9), it implies that there is a complete mediation effect. If the coefficient is significant, it is necessary to judge whether there is partial mediation effect according to the coefficient values of the debt financing variable.

$$EFF_{it} = \alpha_0 + \gamma EFF_{i,t-1} + \beta_1 Investment_{.i} + \beta_2 Investment_i^2 + \beta_3 Debt_i + \beta_4 Cash_i + \beta_5 Size_i + \beta_6 CapInt_{.i} + \beta_n \sum^{Year} + e_{it} \quad (9)$$

Both [Table 5 and 6](#) present the regression results regarding the mediation effects of investment for the link between debt financing and capital productivity. We mainly estimate the baseline models represented by Equation (9) and Equation (8) using dynamic panel data regression, system GMM estimator. Our models use efficiency scores, calculated by the SF TRE model, as a dependent variable. The set of control variables includes cash holding (Cash.), firm size (size), and capital intensity (CapInt.). We also attempt to control the year effects and firm's heterogeneity using the fixed effect regression in some of the models.

Using system GMM estimator, first, we estimate the baseline models on subsample data of each country and the results have been reported in [Table 5](#). Our findings indicate that the investment level partially mediates the effects of corporate debt on the productivity of capital for firms in China. There is no observed mediation effect and corporate investment has no significant relationship with capital efficiency in the subsample of Japanese firms. The mediating effect of corporate investment is no valid for the subsample of companies in USA. It appears that corporate investment is related to capital productivity in non-linear manner and this is more pronounced for companies in USA. The result suggests that, initially, capital efficiency increases with increase of corporate investment; but above a certain investment level, the efficiency starts to decrease with additional investment. Thus, firms should conduct optimal level of investment to achieve efficient use of capital. [Figure 1](#) depicts firm capital efficiency as curvilinear function of the level of corporate investment. More specifically, the figure explain the quadratic fitted value of capital efficiency as function of the level of investment. It appears that the firms' capital productivity level

Table 4. Debt financing and over (under) investment: panel tobit regression

Dependent Variable =	Underinvestment		Overinvestment	
	(1)	(2)	(3)	(4)
Underinvestment i_{t-1}	-0.196*** (0.015)	-0.198*** (0.015)		
Overinvestment i_{t-1}			-0.109*** (0.015)	-0.106*** (0.015)
Dummy_High Debt $_{i,t-1}$	0.009 (0.017)		-0.138*** (0.015)	
Dummy_High CF $_{i,t-1}$	-0.198*** (0.015)		-0.008 (0.013)	
Dummy_High Debt $_{i,t-1}$ X Low CF i_{t-1}		0.211*** (0.023)		-0.001 (0.023)
Dummy_Low Debt $_{i,t-1}$ X High CF i_{t-1}		-0.064*** (0.020)		0.067*** (0.018)
β_0	-0.233*** (0.030)	-0.321*** (0.029)	-0.217*** (0.028)	-0.282*** (0.027)
Sigma—u	0.464*** (0.011)	0.469*** (0.011)	0.258*** (0.012)	0.260*** (0.012)
Sigma—e	1.023*** (0.007)	1.023*** (0.007)	1.023*** (0.007)	1.024*** (0.007)
Controls:				
Year effect	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Country effect	Yes	Yes	Yes	Yes
Wald χ^2	1,325.715	1240.501	1,329.042	1263.685
Right censored obs.	0	0	0	0
Left censored obs.	28,184	28,184	28,676	28,676
Uncensored obs.	14,371	14,371	13,879	13,879
Firms	6,213	6,213	6,213	6,213
Obs.	42,555	42,555	42,555	42,555

increases with increase of investment until the investment reaches an optimum level. This, implies that both underinvestment and overinvestment impair efficiency.

The results in [Table 6](#) indicate that corporate investment has a partial mediation effect for the link between debt financing and capital efficiency in the aggregate data. However, the mediation role lacks consistency under different estimations, specifically fixed effect model and system GMM. With the system GMM estimation on the full data (in [Table 6](#) column 6–10) the coefficients of debt capital are lower in the models where investment variables are inserted indicating that there is a partial mediation effect of investment for the link between the debt level and capital efficiency of the manufacturing firms. This explains how debt financing minimizes the excess investment that would have adverse

Table 5. Corporate debt financing and the productivity of capital invested: mediated by corporate investment

	Dependent Var. = Efficiency of Capital Invested (Eff)											
	China			Japan			USA					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Eff _{it-1}	0.547*** (0.015)	0.559*** (0.015)	0.565*** (0.014)	0.393*** (0.021)	0.396*** (0.020)	0.411*** (0.021)	0.471*** (0.020)	0.467*** (0.020)	0.454*** (0.020)			
Eff _{it-2}	-0.045*** (0.011)	-0.049*** (0.011)	-0.044*** (0.011)									
Investment		-0.251*** (0.057)	0.106 (0.181)		0.352 (0.215)	0.310 (0.512)		0.011 (0.167)	1.127*** (0.383)			
Investment ²			-0.871* (0.511)			-0.566 (2.730)			-3.412*** (1.134)			
Debt	0.241*** (0.037)	0.206*** (0.035)	0.212*** (0.035)	0.397*** (0.056)	0.396*** (0.059)	0.397*** (0.053)	0.276*** (0.043)	0.285*** (0.044)	0.318*** (0.042)			
Cash	-0.310*** (0.040)	-0.290*** (0.040)	-0.302*** (0.039)	-0.211*** (0.081)	-0.176** (0.084)	-0.149 (0.103)	-0.308*** (0.076)	-0.302*** (0.074)	-0.302*** (0.072)			
Firm Size	0.011 (0.009)	0.018** (0.009)	0.017** (0.008)	-0.002 (0.010)	-0.010 (0.011)	-0.010 (0.010)	-0.037*** (0.008)	-0.039*** (0.008)	-0.039*** (0.008)			
Capital Intensity	-0.173*** (0.011)	-0.163*** (0.011)	-0.157*** (0.010)	-0.480*** (0.048)	-0.418*** (0.054)	-0.344*** (0.071)	-0.177*** (0.013)	-0.160*** (0.013)	-0.159*** (0.013)			
Constant	0.183 (0.176)	0.072 (0.168)	0.064 (0.164)	0.507** (0.200)	0.638*** (0.201)	0.599*** (0.170)	1.066*** (0.167)	1.092*** (0.164)	1.054*** (0.161)			
Wald χ^2	4470.682	4616.508	4837.526	1553.909	1631.178	1481.826	1362.449	1375.942	1354.941			
AR test 1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
AR test 2	0.636	0.384	0.563	0.424	0.377	0.409	0.663	0.715	0.687			
Firm	2,353	2,353	2,353	1,611	1,611	1,611	2,555	2,555	2,555			
Obs.	17,591	17,591	17,591	13,741	13,741	13,741	16,245	16,245	16,245			

*** p < .01, ** p < .05, * p < .1

Table 6. Corporate debt financing, investment and the productivity of capital invested: mediated—moderated model

	Fixed Effect Model					System GMM				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Eff _{it-1}	0.407*** (0.008)	0.406*** (0.008)	0.404*** (0.008)	0.407*** (0.008)	0.405*** (0.008)	0.506*** (0.011)	0.513*** (0.011)	0.508*** (0.011)	0.512*** (0.011)	0.506*** (0.011)
Eff _{it-2}	-0.052*** (0.007)	-0.052*** (0.007)	-0.053*** (0.007)	-0.052*** (0.007)	-0.052*** (0.007)	-0.025*** (0.008)	-0.033*** (0.008)	-0.033*** (0.008)	-0.034*** (0.008)	-0.034*** (0.008)
Investment		0.022 (0.020)	0.335*** (0.044)	-0.097** (0.040)	0.333*** (0.044)		-0.227*** (0.053)	0.468*** (0.158)	-0.234** (0.100)	0.497*** (0.156)
Investment ²			-0.888*** (0.113)		-1.281*** (0.144)			-1.956*** (0.466)		-2.115*** (0.554)
Deb X Investment				0.291*** (0.089)					0.070 (0.225)	
Debt X Investment ²					0.972*** (0.241)					0.314 (0.781)
Debt	0.285*** (0.015)	0.285*** (0.015)	0.287*** (0.015)	0.284*** (0.015)	0.276*** (0.015)	0.225*** (0.027)	0.190*** (0.026)	0.202*** (0.026)	0.165*** (0.025)	0.189*** (0.027)
Cash	-0.346*** (0.014)	-0.346*** (0.014)	-0.344*** (0.014)	-0.343*** (0.014)	-0.341*** (0.014)	-0.352*** (0.034)	-0.325*** (0.033)	-0.338*** (0.033)	-0.341*** (0.033)	-0.346*** (0.033)
Firm Size	0.036*** (0.004)	0.036*** (0.004)	0.036*** (0.004)	0.036*** (0.004)	0.036*** (0.004)	-0.003 (0.007)	0.001 (0.007)	0.003 (0.007)	0.001 (0.007)	0.003 (0.006)
Capital Intensity	-0.162*** (0.007)	-0.162*** (0.007)	-0.163*** (0.007)	-0.162*** (0.007)	-0.163*** (0.007)	-0.183*** (0.009)	-0.167*** (0.008)	-0.164*** (0.008)	-0.165*** (0.008)	-0.162*** (0.008)
Constant	-0.287***	-0.288***	-0.290***	-0.273***	-0.278***	0.462***	0.425***	0.347***	0.451***	0.351***

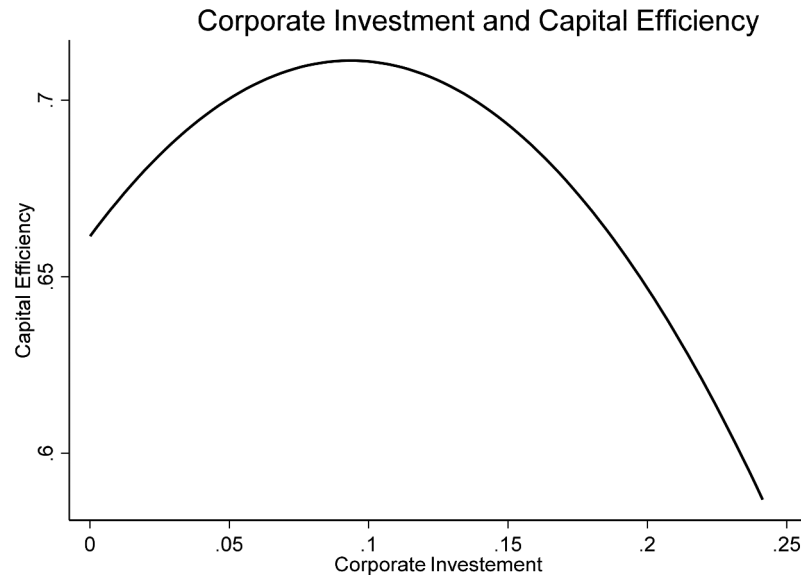
(Continued)

Table6. (Continued)

	Dependent Var. = Efficiency of Capital Invested									
	Fixed Effect Model					System GMM				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
R^2	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)	(0.134)	(0.133)	(0.131)	(0.131)	(0.129)
F-test/Wald χ^2	0.341	0.341	0.343	0.341	0.343					
AR test 1	585.861	546.928	515.677	513.551	484.629	5597.591	5645.914	5661.764	5653.422	5666.556
AR test 2						0.000	0.000	0.000	0.000	0.000
Firm	6,256	6,256	6,256	6,256	6,256	0.893	0.415	0.588	0.388	0.539
Obs.	43,330	43,330	43,330	43,330	43,330	43,330	43,330	43,330	43,330	43,330

*** $p < .01$, ** $p < .05$, * $p < .1$

Figure 1.



impact on efficiency. However, the mediating role of investment is mainly attributable to firms in China, as documented in Table 5. According to Vo (2018), companies in emerging markets are subject to precautionary motive and agency motive of holding more cash. Their study also suggests that companies in emerging economy have more exposure for agency problems because managers might subsequently use the cash reserve for their own advantages.

Generally, the results suggest that debt financing has the potential of minimizing inefficiency attributing to overinvestment. This is consistent with the prediction of agency cost theory. The availability of financial resources motivates managers to undertake unprofitable investment projects. High financial leverage can reduce agency costs since it entails restrictive monitoring of managers investment undertakings. When projects are financed by borrowed capital, the managers' tendency of overinvestment declines. This has the potential to reduce extravagant investment spending and enhances the productivity of capital invested. On the other hand, high debt financing may also cause underinvestment. This occurs when managers surrender value-adding projects due to the restriction imposed by debt contracts. Thus, leverage determines both overinvestment and underinvestment which in turn affects the efficiency of capital invested in one way or another.

6. Conclusion

This study investigated how the use of debt financing affects the productivity of capital invested and the mediating role of corporate investment. We gauge the productivity of the capital invested by employing Stochastic Frontier Analysis (SFA), parametric model to estimate productivity. We find that firms that use of more debt capital are less likely to make overinvestment but are more likely to make underinvestment when their cash flows are low. Our findings suggest that the productivity of capital invested becomes high when the manufacturing firms optimize the level of their investment. Besides, the study shows that debt financing positively affect the productivity of capital invested and that the effect is partially mediated by the investment of the manufacturing firms. Generally, our study suggests that the use of borrowed funds has the potential of minimizing agency costs attributable to investment activities. The findings also indicate that high level of debt coupled with shortage of financial resources increase the firms' chance of underinvestment. The agency cost theory suggests that the use of borrowed funds improves capital efficiency since the restrictive covenants in debt contracts may monitor managers' spending behaviors and forces companies to make more efficient investment. Our study also indicates that debt financing

increases the efficiency of capital invested by mitigating problem of overinvestment. Therefore, the results in our study are consistent with the prediction of the agency cost theory.

Our investigation focuses on companies in the three biggest economies namely China, Japan and USA. The countries considered in this paper account for the lion's share of the trade in manufactured goods among market economies. We concentrate on the productivity of capital invested in one of the major sector of the economy, manufacturing. Despite the decreased importance of manufacturing in advanced countries in shares of output and employment, its role in the economy remains important, because the sector generates most technological innovations with important spillover effects to the rest of the economy. However, our analysis lacks the data of the other sectors of the economy and the international evidence including the firms from the rest of the countries. This can be taken as the limitations of our study and future research direction. That said, this paper provides important management implication in the area of corporate finance since it explains the importance of corporate financing decisions for efficiency. We show the impacts of debt financing on corporate investment and the mediating role of investment in the financial leverage-productivity nexus. To this end, the study provides direct firm-level evidence on the interaction among debt financing, corporate investment and the level of efficiency firms achieve.

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Annex A: Definition and measurement of variables

Variable	Meaning	Definition
Debt	Level of Debt Financing	Long-term debt plus debt in current liabilities deflated by total assets as of the balance sheet date
CF	Net cash flow	Net operating cash flow deflated by lagged total assets
Investment	Investment amount	Capital expenditures deflated by lag of total assets
Size	Firm size	The natural logarithm of total assets
Cash	Cash holding	Cash balance deflated by total assets
CapInt.	Capital intensity	Net PPE over total revenue
ROA	Return on assets	EBIT divided by total assets
Growth	Sales growth	Sales growth rate (change in sales over lag of sales)
Over Investment	Investment amount exceeding the expected level	The absolute value of the residual in the investment model multiplied by overinvestment dummy value. The overinvestment dummy value becomes 1 if the residual of an observation is in the third quartile and zero otherwise.
Under investment	Investment amount less than the expected level	The absolute value of the residual in the investment model multiplied by underinvestment dummy value. The underinvestment dummy value becomes 1 if the residual of an observation is in the first quartile and zero otherwise.

To check for normality, we applied skewness and kurtosis test, with `xtsktest` Stata command, on the variables included in the model applied to estimate efficiency. This can be used as an alternative to the Jarque-Bera test in panel-data models. The result shows that there is normality within the data. We have shown the test result in the table shown below.

Annex B: Normality test for data variables used in estimating efficiency

	Observed		Bootstrap		Normal-based	
	Coef.	Std.Err.	z	$P > z$	95%Conf.	Interval]
Skewness_e	-0.055	0.020	-2.780	0.005	-0.093	-0.016
Kurtosis_e	1.039	0.163	6.360	0.000	0.719	1.359
Skewness_u	-0.158	0.025	-6.380	0.000	-0.207	-0.110
Kurtosis_u	0.669	0.083	8.060	0.000	0.507	0.832

Joint test for Normality on e: $\chi^2(2) = 48.18$ Prob > $\chi^2 = 0.0000$ Joint test for Normality on u: $\chi^2(2) = 105.76$ Prob > $\chi^2 = 0.0000$



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