# External debt as a mode of financing Innovation Spending in India: Listed State owned enterprises versus Private sector enterprises

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***Abstract***

*The current study empirically investigates the difference of innovation spending between public and private sector enterprises. Using data on public sector enterprises and private sector enterprises listed on the National Stock Exchange,the study captures innovation spending by research and development expenditure by firms for 2015. The study also attempts to contrast the effect of external borrowing on R&D spending for the two set of firms by taking interactions between public sector dummy and external debt for each firm. The study employs propensity score matching and regression methods to capture the effects. The results suggest that listed public sector enterprises spend more than the listed private sector enterprises in India. Further, external borrowing acts as a strong and strict tool to increase innovation spending for private firms.*

**Keywords:** innovation, public ownership, propensity score matching, external borrowing

**JEL Codes**: O32, L32, L33

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**Acknowledgement:** I thank Kiran Kumar Kakarlapudi for his suggestions. I also extend my gratitude to the two reviewers of Globelics 2017 for their excellent comments.

## I. Introduction

According to Schumpeter (1942), an enterprise operating in a competitive environment may lead to efficient resource allocation in the static sense, but for output to expand in the long run the most conducive driver would be a large firm operating in a concentrated environment. This challenged the existing economic thinking about the optimality of perfectly competitive markets. The Schumpeterian view also implied that policies aiming at eliminating or reducing competition may inhibit innovation in those industries. Following this, there was an outburst of literature attempting to examine the relationship between market structure and innovation spending and outcomes. There was no consensus in the literature with studies supporting and nullifying his theory. The moot issue then was how these studies captured innovation outcomes. Studies relied on patent counts and research and development spending as measures to capture innovation efforts. Innovation efforts may be captured by the total money spent on research and development (R&D) activities but it does not capture the quality of efforts. On the other hand, while patent counts focus on the success of R&D efforts it fails to capture the amount spent on each of these patents.

Against this background, this study aims to contrast the innovation efforts made by public sector enterprises and private sector enterprises. Public sector enterprises, owned by the government, expand from the narrow paradigm of profit objectives into an array of multidimensional social objective function that includes reducing regional imbalances, avoiding price rises, providing employment, increasing consumer welfare. Further, public sector enterprises, also referred to as state owned enterprises, operate in sectors that have long gestation periods, high uncertainties with low profitability and industries that are of strategic value to the economy. This leads to these enterprises operating in an environment which is free or has limited competition due to the unwillingness or inability of the private sector to operate. This makes research and development in public sector enterprises very different from that of private sector enterprises due to the difference in the structure, ownership and objectives of these firms.

As a next step, innovation in any firm is very strongly associated with the financing options and channels available to the firm. Given the uncertainties and volatile nature of R&D spending, an enterprise's ability to innovate will be limited if it does not have access to funds. There are two important aspects in the financing options in the present context. First of all, the choice between equity and debt financing are two available and contrasting options if the funds would be used for innovation activities. While equity financing involves dilution of ownership, debt financing has more stringent criteria such as sufficient collateral, timely interest payments and strict repayment. So, firms borrowing money from the debt market will invest money on R&D more prudently as compared to equity financing. Hence, R&D and innovation activities will be of high quality and high expected returns and profitability if the firm borrows money from the debt market. Secondly, this relationship will have very different implications and ramifications on the basis of the ownership of these firms. If the firm is a public sector enterprise external borrowings are not as strict as compared to their private counterparts. The presence of soft budget constraints, backing up by the government in terms of recapitalization and frequent political interference might make public sector enterprises more complacent to innovation efforts.

Against this background, the current study attempts to examine the effect of ownership on innovation expenditure. Specifically, the study tries to understand if government ownership has a positive effect on innovation activities done by a firm. As a next step, the study attempts to examine the effect of external borrowing on innovation. While doing so, the study conditions the effect of external borrowing on innovation on public ownership. The study uses Indian listed central public sector enterprises data for 2015. Central public sector enterprises, owned by the Central government of India, are approximately 240 in number. Of these, approximately seventy of these enterprises have been selected for disinvestment at least once since 1991. These enterprises are listed on the stock market and have to follow the same conditions and regulations (Securities and Exchange Board of India) as the listed private counterparts. This setting makes it interesting to contrast the innovation efforts made by the two sets of firms.

The main issue in the analysis of innovation efforts, expenditure or outcome for Indian firms is the unavailability of data. We proxy innovation activity in a firm by the amount a firm spends onresearch and development due to data limitations. The study uses propensity score matching

methods and regression analysis for contrasting the research and development spending between the listed public sector enterprises and the private sector enterprises. The results suggest that public sector enterprises spend more than the private sector enterprises. Also, external borrowing spurs up innovation expenditure in firms. And the effect is strongly conditioned by ownership. Specifically, the effect of external borrowing on research and development spending is higher in private sector enterprises as opposed to public sector enterprises. These results suggest that innovation in India is better if the industry has public sector enterprises because of better widespread network, availability of funds, lower concerns of profit variations by the public sector. External borrowing acts as a stringent tool for better research and development activities for the private sector more than the public sector.

The study makes an important contribution in examining the contrasting pattern of research and development expenditure between public and private sector enterprises. India provides a good context for the study as the public sector in India has a presence in many manufacturing sectors making it easier for comparison with private sector enterprises. The study attempts to take explicit account of the role that external financing plays in innovation and contrasts it for the two sectors. The rest of the paper is organized as follows. Review of literature, the evolution of technology and innovation policy and the Indian scenario of R&D (public versus private R&D spending) is discussed in the next three sections. The data, variables, empirical strategy and results follow in the second half of the paper. Finally, Section IX concludes.

## II. Review of Literature

There is an abundance of studies that examine performance differences in private and state owned enterprises. Caves and Christenen (1980) use Canadian railroads to contrast the relative efficiencies of public and private firms in a competitive environment. They find that if the firms operate in a competitive industry the tendency of inefficiencies in a public firm are overcome. This has been further explored by Caves and Christenen (1980), Davies (1971), Defraja (1993), Atkinson and Halvorsen (1986), Estache and Rossi (2002), Dewenter and Malatesta (2001) and so on. Most of these studies discuss about the inefficiencies associated with public sector enterprises as compared to the private ones. This study deviates from the performance of these

enterprises in terms of economic efficiency. Instead we try to examine the R&D investment differences between public and private firms.

David et al (2000) survey the strand of R&D literature for a span of thrity years and attempt to capture the relationship between public and private R&D spending. The study divides past papers under different categories and examine if public spending is adding or crowding out to private spending. The main result suggests that the overall findings are ambivalent without any consensus. In fact the results are very strongly driven by the experimental design and set up used by the past researchers. Belloc (2014) focus on innovation efficiency done by state owned enterprises and private firms where these firms compete in a competitive set up. The study asserts that instead of adopting privatization as a remedial policy to improve R&D efficiency, the government should focus on improving the quality of management and limiting political interference. Many studies have tried examining the impact of disinvestment or privatization (which involves transfer of ownership and/or control from the public to the private sector) on R&D spending. Studies like Munari et al (2002), Munari and Sobero (2003) and Munari and Oriani (2005) find that newly privatized and disinvested firms cut R&D spending in a firm. Further, Mazzucato (2011) emphasize on the fact that state owned enterprises are not driven by profit variations as much as the private ones which makes them better placed in terms of spending on R&D projects. The study reports that ".. governments in industrialized countries have funded the riskiest research, whether applied or basic, and have been the source of many radical innovations also in non-basic research areas in pharmaceuticals, biotech and other high-tech sectors. For instance, the initial algorithm used in Google was funded in the US by a public grant by the National Science Fundation. Analogously, molecular antibodies, which have been the foundation for biotechnology, were discovered in the UK in the public labs of the Medical Research Council." This has been reiterated by many other studies such as Ruttan (2006), Mazzucato and Dosi (2006), Block and Keller (2011) and Lazonick and Tulum (2011).

The above studies suggest that there is a drift in the literature on R&D spending by public and private firms. The results are driven by the context, time and location of the study. The next aspect that the current study focuses on is the role of external borrowing on innovation spending. Acharya and Xu (2016) examine the relationship between a firm's financial dependence and

innovation for listed and unlisted firms. They find that in external finance dependent industries, public firms spend more on innovation than their private counterparts. Kortum and Lerner (2000) examine the impact of venture capital on patented innovations in the United States for twenty industries for thirty years. They find that venture capital spurs innovation spending and patent rates. Winston (2011) examines the influence of financing choices and innovation spending for firms. The results suggest that bank loans play an important role in financing firms operating in technology intensive industries. However, the effect is significant only for early stages of firm operation.

The current study attempts to combine the literature on public and private R&D spending with that of external borrowing and its impact on innovation spending. As a next step, the study combines the two aspects and attempts to investigate if the effect of external borrowing on R&D spending will be uniform or non-uniform for public and private sector enterprises.

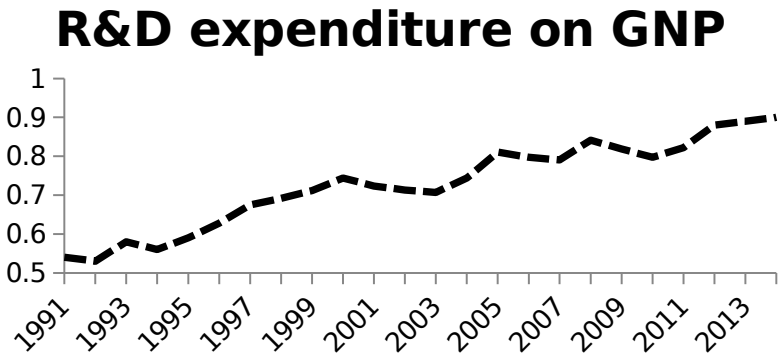
## III. Indian Scenario

According to the WIPO Global Innovations Index- 2016, which is based on a country's capacity and success in innovation, India is on the 66$^{th}$ rank (Global Innovations Index Report, 2016). In terms of average GNP expenditure on R&D, India has spent o.72% over the period of 1995-2013.This is much lower than most developed countries such as US (2.6%), Germany (2.5%), Japan (3.2%) and Switzerland (2.63%). In fact, compared to all other BRICS member countries, India ranks the lowest in average GNP on R&D (GERD).

| Member countries | Average GERD |
|---|---|
| Brazil | 1.06 |
| India | 0.72 |
| China | 1.29 |
| Russian Federation | 1.11 |
| South Africa | 0.87 |
| Source: The World Bank | |

**Table 1: R&D expenditure as a ratio of GNP by BRICS countries**

Table 1 suggests that research and development activities in India have not recorded the same attention as the other developed and BRICS nations. The trend of R&D expenditure as a fraction of GNP in India for the post liberalization period has been plotted below.




Source: World Bank

**Figure 1: Percentage of GNP spending on R&D in India**

Figure 1 depicts that there has been a slight rise in the percentage of GNP being spent on research and development activities in India in the post liberalization period. As of 2014, India had spent 0.9% of GNP on research and development activities. As a next step, the study segregates the innovation expenditure made by the public and private sectors. The total number of public R&D units stand at 117 as compared to 1333 private R&D units. Despite the private R&D units outnumbering the public ones by thirty times, the expenditure trend is quite contrasting.

| Year | Public | Private |
|---|---|---|
| 2006 | 128720.1 | 7416.97 |
| 2007 | 146540.8 | 9345.12 |
| 2008 | 187725.4 | 11564.86 |
| 2009 | 245701.8 | 12840.56 |
| 2010 | 281456 | 13587.28 |

Source: Department of Science and Technology

**Table 2: R&D expenditure in public vs. private R&D units in India**

The amount of R&D expenditure in pubic R&D units for the period 2005-10 is Rs. 1693 lakhs as compared to Rs. 8 lakhs in private R&D units (Table 2). This requires careful examination of the R&D expenditure made by the public and private sector in India.

## IV. Evolution of R&D policies in India

The department of science and technology discusses the evolution of the science and technology policy and how its changing. The first policy on science and technology, Science Policy Resolution (SPR) in 1958 aimed at dispersion of technology to various sectors. In 1983, the Technology Policy Statement (TPS) aimed for technological proficiency and self-sufficiency. Till 2003, the Indian economy mostly relied on imported technology. It was only in 2003 that investment in research and development was brought in the forefront of TPS reframing. As the department of Science and Technology states ".. it called for integrating programmes of socioeconomic sectors with the national R&D system to address national problems as well as creating a national innovating system." The policy discussed creation and management of intellectual property, development of new technology and optimal utilization of existing resources. The latest SPR policy has been revised in 2013 which emphasizes on "science, technology and innovation for the people".

**Specific R&D policies for Central Public Sector Enterprises**

The department of public sector enterprises has made it mandatory for central government owned enterprises to invest in R&D. In fact, since 2011-12, in Memorandum of Understanding (MoU) documents, that is non-negotiated document between the government and the enterprise about the roles of the two entities, 5 percent weightage out of fifty percent for non-financial parameters has been embarked for R&D activities. The R&D policy document of 2011 for CPSEs suggests that each CPSE must have a specific R&D manual and plan aligned with the enterprise's short, medium and long term objectives. Further this plan needs to be approved by the Board of directors. The policy document provides specific details on the exact items to be mentioned in the plan. The policy clearly states that the minimum expenditure on R&D as a percentage of PAT is one percent for Maharatna and Navratanas and 0.5 percent for others.[2]It also mandates Maharatnas and Navaratnas to select five R&D projects and the rest to take three as targets for R&D. The policy also highlights the various incentives introduced by the government of India to encourage R&D investment. The government will write off revenue and capital expenditure on R&D, weighted tax deduction on sponsored research programmes with certain universities and

2 Ratna statuses are awarded to CPSEs based on their financial performance and valuation in the last three years. There are four ratna statuses that may be awarded to a CPSE- Maharatna, Navratna, Miniratna I and Miniratna II in the descending order of rank.

research think tanks, custom duty exemption on goods imported for R&D projects, excise duty waiver for three years on goods produced and duty patented in any two developed countries outside India. The policy does allow exemption of certain profit making CPSEs from investing in R&D but that requires written submission to the Department and this exemption would be valid for a single year. The policy further discusses about timely reviewing of these projects and recording results to ensure better quality research.

**Private listed firms**

India has a very favorable tax structure for firms investing in R&D. The benefits provided in India can be categorized as direct tax benefits, indirect tax benefits and various state government incentives. Under direct tax benefits comprise of benefits for expenditure on R&D investments, accelerated depreciation and contributions for R&D expenditure. Under indirect tax incentives the policy provides for lower excise duty, lower custom duty on imports of goods required for R&D activities. There are several state government incentives in place too. Besides tax benefits, intellectual property rights play an important role in incentivizing firms for R&D investment. India complies by Trade Related Aspects of Intellectual Property Rights (TRIPS), monitored by the World Trade Organization.

Thus, the current regime of R&D policy has benefits for both public and private sector enterprises in India. However, the two sets of enterprises do not come under the same umbrella of R&D policies. Against this backdrop, it would be interesting to examine if public and private sector enterprises invest in R&D in a similar or dissimilar way. The next extension of external borrowings and its impact on R&D expenditure also may not be uniform for the public and private sector companies.

## V. Hypotheses to be tested

**Ownership and Innovation**

There are two opposing channels in which ownership may affect innovation. State owned enterprises may not be invest In R&D as much as private sector enterprises. This may be due to the following reasons. State owned enterprises are owned by the state which makes these

enterprises operate in an environment which is generally protected and face less competition. This may lead to these enterprises becoming complacent to product improvement and/or process innovation. Thus the incentives of innovation may not be as strong as in the case of private enterprises. Secondly, along with this protected environment these enterprises also enjoy the privileged positions of grants and aids from the government. In other words, state owned enterprises actually face a soft budget constraint. This reduces the incentives that these enterprises have for investing resources and funds in risky R&D activities. Finally, the financial incentives for employees in innovation in the public sector are not as high as that of the private counterparts. This may lead to low quality or unsuccessful innovation by the public sector as the most competent individuals choose the private sector for better financial incentives.

However, there is an alternateset of explanations that may lead to better innovation in state owned enterprises as compared to the private sector. Firstly, since state owned enterprises are not driven purely by profits, or rather profit variations, it is in a better position to invest resources in an uncertain activity such as innovation. Secondly, since the public sector has a widespread network and presence across sectors with the same ownership, the state, it can lead to a more structured and coordinated effort in R&D investment as compared to the private sector. This can avoid the problem of R&D overinvestment common in private sector enterprises. Since R&D investment is tax free, private enterprises invest resources into R&D with not a clear intent to innovate but only to save money. This may lead to poor quality research and unfruitful innovations. State owned enterprises are not as much focused on tax saving activities and hence may not get into innovation with the wrong intent.

These contrasting theories suggest that investment on innovation may/may not be higher in public sector enterprises. Thus we leave this as an empirical exercise to examine the effect of public ownership on innovation and R&D expenditure.

**External borrowing and Innovation**

The effect of external borrowing on innovation investment stems mainly from the difference between equity financing and debt financing. With diluting ownership, equity financing is an easier way of generating more funds for the firm. On the other hand, external borrowing comes

with strict conditions such as timely principal and interest payments. Thus a firm that invests in a risky activity such as innovation will be more concerned about the innovation output if the firm has external borrowing. We expect that external borrowing may act as a strict regulator in getting better innovation.

However, on the other hand creditors may find innovation activities unattractive because of the uncertainty and volatility of innovation. Rajan (2012) points out that in order to avoid risk of losing important tangible assets to creditors firms may not be willing to finance innovation with external borrowing. Thus, like ownership, the effect of external borrowing on innovation may also go in either direction.

However, the effect of external borrowing on innovation is not uniform across the public and private sector. It is natural to expect the effect of borrowings to be stronger for private sector enterprises no matter what the direction of the relationship is. For instance, if borrowings spur innovation expenditure, the effect will be stronger for the private sector because these enterprises have stricter timelines for debt repayment as compared to the public sector enterprises. To summarize, the impact of external borrowing on innovation will be stronger for private sector enterprises as compared to public sector enterprises.

## VI. Data and Variables

The study draws data on financial variables of all enterprises from the database Prowess that is maintained by Centre for Monitoring Indian Economy (CMIE). It contains information obtained from annual reports, press releases and stock market filings. The current study uses all the listed enterprises. The data obtained from Prowess is merged with research and development expenditure incurred by each firm. This data is collected from the annual reports of each of the enterprises.[3]The study uses a cross sectional data for all Indian listed firm in 2015.

**Research and Development expenditure**

3 PROWESS reports data on R&D expenses but for most companies it is a null value. To get an accurate estimate, the study has used data on R&D expenses as reported in the annual reports specifically.

We use expenditure incurred by firms on research and development activities to capture innovation. R&D expenses is important as it acts as a tax saving and entry deterrent activity for most firms. It is the best available indicator of innovation in India as it captures the investment made by firms in product innovation and/or process improvement activities. Hence, we use the natural logarithmic transformation of R&D expenses as the dependent variable. Keeping in mind that the public and private enterprises are different in structure, using profits or size for normalization may not be a suitable task. Instead we control for each of these variables in our econometric models.[4]

**Ownership**

To capture the ownership effects on innovation activities, the study uses a dummy variable that takes unit value if the enterprise is owned by the central government. One limitation of the study is that since the study focuses only on listed enterprises, the public sector enterprises are not fully government owned. In fact, these are enterprises that have been selected for disinvestment at some point and thus are listed on the stock market. The novel feature of disinvested firms is that some proportion of these enterprises is owned by the private sector while the control lies in the hands of the government.

**External Borrowing**

The study investigates if a particular enterprise borrows money from any external financial agency such as banks, financial institutions, central and state governments. Since the prime focus of the study is to capture the effect of external borrowing on innovation the study does not consider the modes/agencies of external borrowing differently. We define a dummy variable that takes the value unity if the enterprise has borrowed money from *any* of the external borrowing agencies. Additionally, the study also considers the total amount borrowed by an enterprise which is defined as the sum of money borrowed from each of these agencies.

As an extension, the study also attempts to capture if the effect of external borrowing on innovation of firms is conditioned by ownership. We use an interaction between the public firm

4 The analysis has been repeated with R&D normalized over sales, R&D normalized over assets and R&D normalized over profits. But given the heterogeneity of the two groups of enterprises, we do not report them in the paper. It may be produced on request.

dummy with the borrowing amount and test if there are any ownership effects on the borrowing impact on innovation.

**Other Firm specific variables**

The study uses firm specific data on firm size, firm age, firm profitability, employee size and capital employed. Firm size is defined as the natural logarithmic transformation of total assets of an enterprise. Firm age is the number of years since the enterprise has been in operation. Firm profitability is defined using natural logarithmic transformation of the profits after taxes earned by each enterprise. Finally employee size and capital employed are also used as logarithmic transformation of the number of employees and total capital expenditure. To control for any industry level unobserved effects, the study uses industry level dummy variables.

## VII. Econometric Methodology and Descriptive Statistics

PROWESS data on research and development expenditure has a limitation of being scarcely populated. However, the current study does not get affected due to this. Since the main aim of the study is to focus on the ownership differences between the public and private firms, the study uses a matching technique to find matches for every public firm in the private counterparts. The details of the dataset are as follows

| Variables | Number of firms |
|---|---|
| Total number of firms | 2013 |
| Number of central public sector enterprises | 68 |
| Number of private enterprises | 1945 |

Source: Author's calculation from the dataset

**Table 3: Basic description of the dataset**

Table 3 suggests that the number of listed central public sector enterprises is sixty eight. If we consider a public firm as a treatment unit and a private firm as a control unit, the above distribution of the firms adds a lot of advantage to the matching technique. With abundant number of units in control, the accuracy of finding a counterfactual control unit for every treatment unit increases. Thus, we start with a propensity score matching method for finding out the probability scores of public and private firms. The model is given by

$$p_i = \alpha + \beta\, x_i + \eta z_s + \varepsilon_i$$

In equation (1) $p_i$is a dummy variable taking a value of one if the firm is a public sector enterprise and 0 if it is a private one. $X_i$ is a set of covariates on which the firms are matched. The study uses firm age, firm size, profits, employee size and capital employed for matching firms. $z_s$are a set of industry dummy variables to capture the unobserved industry effects.This model helps us to reduce the sample size from 2013 to 136. As a next step, we use this model and compare the R&D difference on the matched sample to check for ownership effects.

***External borrowing and R&D activities***

To examine the effect of external borrowing on R&D activities we run a regression of R&D expenses on the public dummy variable, financial borrowing variables and other control variables. The model is given by

$$y_i = \alpha + \beta p_i + \gamma b_i + \lambda p_i * b_i + \theta x_i + \eta z_s + \varepsilon_i$$

In equation (2), $y_i$is the R&D expenses incurred by the enterprises. The variables $p_i$ and $b_i$ arethe public dummy and borrowing variables respectively. The variables $x_i$ and $z_s$ are the same as before. The main coefficients of interest are the $\beta$, $\gamma$ and $\lambda$. These coefficients capture the effect of ownership, external borrowing and external borrowing conditioned on ownership on innovation.

## VIII. Results

The results of the propensity score matching has been presented below.

| | **Public Firms** | **Private firms** | **Difference** |
|---|---|---|---|
| ***After Matching*** | | | |
| ROA | 0.016 | 0.014 | -0.001 |
| Capital | 7.84 | 5.2 | 2.64*** |
| Employee size | 7.57 | 5.45 | 2.12*** |
| Firm age | 50.27 | 33.34 | 16.92*** |
| Firm size | 546536.7 | 25739.2 | 520796.3*** |
| ***After Matching*** | | | |
| ROA | 0.017 | 60.33 | -60.31 |
| Capital | 7.77 | 7.78 | -0.01 |
| Employee size | 7.824 | 8.09 | -0.271 |

| | | | |
|---|---|---|---|
| Firm age | 44.82 | 49.32 | -4.5 |
| Firm size | 220325.3 | 272292.1 | 51966.8 |

Note: ROA is return on assets. It captures profitability of enterprises. *, ** and *** indicate significance at 10 percent, 5 percent and 1 percent respectively.

**Table 4 : Covariates before and after propensity score matching**

Table 4 indicates that the mean differences before matching for the public and private firms is statistically significant. However after matching this becomes insignificant indicating a suitable match between the treatment and the control groups. The matching technique used here is nearest neighbor matching. The propensity scores for the sample before and after matching is given in figure 2.

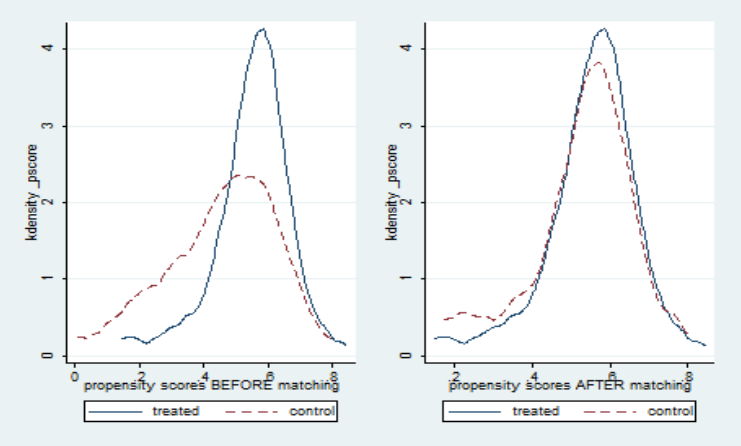



**Figure 2: Propensity score distribution of the treatment and control groups before and after matching**

The average treatment effect of the propensity score matching is given in Table 5. The average R&D expense incurred by listed public sector enterprises is significantly higher than private enterprises.

| **Treatment effects** | **Public Firms** | **Private Firms** | **T-Stat** |
|---|---|---|---|
| R&D Expenses | 4.69 | 2.53 | 2.48** * |

Note: *** indicates significance at 1%

**Table 5: Average treatment effect of R&D expenses between public and private firms**

***External borrowing and R&D activities***

To examine the effect of external borrowing by firms on research and development expenses incurred we use a regression model based on equation (2). The results have been discussed in Table 6 below:

| **Dependent variable** | **R&D expenses** |
|---|---|
| ***Ownership and external borrowings*** | |
| Public firm | 2.069*** |
| | (0.707) |
| External borrowings | 0.019*** |
| | (0.003) |
| Public * External borrowings | -0.022*** |
| | (0.006) |
| ***Firm specific variables*** | |
| Profits | -1.497 |
| | (3.637) |
| Capital | 0.095 |
| | (0.222) |
| Employee size | 0.391** |
| | (0.201) |
| Firm age | -0.004 |
| | (0.012) |
| Firm size | 0.007 |
| | (0.007) |
| ***Other*** | |
| Industry dummies | Yes |
| No. of observations | 136 |
| R squared | 0.61 |
| Note: Standard errors are reported within parentheses. *,** and *** indicate significance at 10%, 5% and 1% respectively. | |

**Table 6: Effect of ownership and external borrowing on R&D expenses**

Table 6 suggests that public firms spend significantly more than the private firms. This is in line with the results obtained from the propensity score matching. Comparing this to the first hypothesis, it suggests that since public sector enterprises are not driven by pure profit and tax saving motives, their innovation expenditure is higher than the private sector enterprises. A second reason for public sector to innovate more than private sector may be the advantage that the public sector enjoys in terms of infrastructure and wide network between different industries. Also, since most state owned enterprises are in sectors or areas which have a high gestation

period or require heavy innovation the natural demand in these sectors would drive up the innovation expenditure.

Further, higher external borrowings spur innovation and R&D activities. External borrowings act as an instrument to tackle the constraint limits of financing R&D activities across both firms. However, the effect of external borrowing on firm innovation is not homogenous for the two sets of firms. It is strongly conditioned on whether the enterprise is a private or a public sector one. Specifically, when a public sector enterprise gets access to external finance in the form of borrowings it leads to a rise in innovation but not as much as the private ones. The effect of external borrowings on innovation is stronger if the enterprise in question is a private sector one. There may be three reasons for this.

First of all, central public sector enterprises operate with a wider social objective as compared to private enterprises. With providing goods and services at a subisidized price, the amount borrowed by public sector enterprises has to spread across a lot of activities as compared to private ones. Secondly, the amount borrowed by public sector enterprises may not be exactly comparable to private sector ones. In fact, according to the current study, the average amount of external borrowings by public sector enterprises was 40% less than the private sector enterprises. This is a contrasting observation as the sixty eight public firms have been compared with the sixty eight matched private sector firms. Finally, the public sector does not have to rely just on external borrowings for R&D investment. In fact, the soft budget constraints that the public sector enjoys might act as a deterrent for these enterprises to use the borrowed money prudently.

The results have controlled for firm specific variables. It is seen that only employee size is significant in explaining R&D expenses. In fact it is seen that higher is the employee size more is the amount spent on innovation. The lack of data on workers and employees prevents us from examining this more carefully. The regression model includes industry level fixed effects to control for unobserved heterogeneity.

**Robustness tests**

As a robustness test, we tried including patents and technology imported as part of the investment in R&D activities. The results remain qualitatively similar for both propensity score matching and regression models.

## IX. Conclusion

The current study has tried to examine the effect of ownership on innovation efforts and expenditure. Specifically, focusing on listed firms on Indian National Stock Exchange, the study tries to contrast the research and development spending for state owned enterprises and private sector enterprises. As a second objective, the study also focuses on the effect of external borrowing on innovation expenditure and whether this effect is conditioned by the ownership of the firm. The study finds significant impact of firm ownership on R&D spending directly and on the impact of external borrowing on R&D spending indirectly. It is seen that the effect of external debt on R&D spending is stronger if the firm is a listed private sector enterprise.

The study has important policy implications. It is in line with the Schumpeterian view of innovation that suggests that innovation may not be hampered due to market concentration. With state owned enterprises, not getting influenced by profit variations as much as their private counterparts, the research and development spending may be better. However, this comes with a word of caution. With the absence of patent counts, R&D spending just captures the amount of effort put into innovation. The outcome of innovation cannot be captured. Also, the current study has focused only on 2015. Extending the time period and including unlisted public sector enterprises is a part of future research.

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