# Is R&D spending influenced by disinvestment and local political corruption?

## The case of Indian central public sector enterprises

**Ritika Jain**[1]

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***Abstract***

*The current study examines the effect of disinvestment (dilution of state ownership) and local political corruption on R&D spending in enterprises owned by the Central government of India. Based on certain characteristic features of innovation as a strategy available to state owned enterprises, the study builds two sets of hypotheses formalising the channels of how these variables may affect R&D possibility and amount. Drawing data from multiple sources, the study compiles a dataset that covers all manufacturing central government owned enterprises in India and spans for a period of ten years from 2007 to 2016. The study employs instrument variable technique for reducing the endogeneity between disinvestment and R&D decisions. The study finds that while disinvestment and local political corruption have strong negative effects on whether a firm invests in R&D or not, it has no effect on R&D amount. In fact, R&D amount is driven by a host of firm specific factors such as size, profit and proficiency of labor- share of skilled labor, managerial strength and non-unionisation of labor. Finally, the study finds that the effects are strongly driven by the size of firm, type of firms and ideology of the state where the enterprise operates.*

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[1] Centre for Development Studies, Trivandrum. Email- ritika@cds.edu

## 1. Introduction

The role of state owned enterprises (SOEs) is multidimensional and important in many countries (Götz and Jankowska, 2016). According to the OECD report (2012), SOEs in the OECD area are valued at near two trillion USD, employing 2.5% of national population on average.[2] In principle, these enterprises deviate from the narrow focus of profit maximization and cater to a host of social objectives that span across providing employment to the masses, reducing regional inequalities, investing in projects with long gestation periods and so on (Boycko et al., 1999). This makes performance of these enterprises to be driven by a hazy multidimensional objective function which may imply performance complacency (Boycko et al., 1999). While there is large attention being given to the effect of state ownership on standard accountancy measures of firm performance such as profits, productivity and so on (Megginson, 2005; Gupta, 2005), there is paucity of studies on examining innovation of state owned enterprises.

Innovation, defined as the activities undertaken by a firm in introducing new products, marketing strategies, organizational practices and/or reducing costs in existing processes[3], has been identified as a conducive driver for profits. While private enterprises are driven by supernormal profits as the main motivation for investing in innovation, public sector enterprises have different reasons for engaging in innovation activities. First of all, as Stiglitz (1999) describes, innovation has a public good property making state ownership better than private ownership for avoiding underprovisioning. Secondly, limited focus on profits and profit variation makes SOEs better suited for a costly and risky activity as innovation. Finally, the widespread presence and network of public sector across various industry groups allows for a better coordinated and structured approach to innovation.

Against this background, the current study aims to study specific issues related to innovation in public sector enterprises. The aim of the study is not to contrast innovation activities by ownership, but to focus on innovation patterns in public sector enterprises. This study focuses on enterprises owned by the Central government of India for this context, better known as central public sector enterprises (CPSEs). The specific questions addressed are built on the premise that performance of an enterprise is not driven by firm specific factors in isolation. In

[2] Source: http://www.oecd.org/corporate/oecd-dataset-size-composition-soe-sectors.htm (Last accessed on August 4, 2018)
[3] Source: https://www.oecd.org/sti/inno/oslo-manual-guidelines-for-collecting-and-interpreting-innovation-data.htm (Last accessed on August 4, 2018)

fact, it is a combination of internal and external factors that influence performance. These external factors that comprise of institutions, policies, political and economic environment shape the business conditions in which the enterprise operates. Indian CPSEs provide an excellent premise for the question in hand due to the federal nature of Indian government. Despite being owned by the Central government, these CPSEs come under the jurisdiction of the state governments as it is the electricity tariffs, infrastructural quality and local factors (which are controlled by the state government) that shape performance.

The study uses two particular external factors that may affect innovation activities in CPSEs in India. First, as part of major reforms initiated in 1991, the Indian government adopted disinvestment, which is defined as the transfer of ownership in CPSEs from the government to the private sector. This policy, in the Indian context implied dilution of state ownership which makes it a relevant policy to affect decisions and efforts related to provisioning of a public good such as innovation. Secondly, innovation as a strategy requires enterprises to have frequent and lengthy dealings and engagements with public officials for getting several licenses, permits and other bureaucratic complexities. This makes the local political environment particularly important for firms choosing to innovate. The current study focuses on crime related to corruption among public officials (such as bribes) in the state where the enterprise is located to capture local political corruption. Based on these, the specific objectives of the study are: (i) to examine the effect of disinvestment on innovation efforts in Indian CPSEs and (ii) to examine the effect of local political corruption on innovation efforts in Indian CPSEs.

The study develops two sets of hypotheses relating disinvestment and local political corruption to innovation efforts. The study draws data from multiple sources and covers all manufacturing CPSEs from 2007 to 2016. The study limits capturing innovation activities by focusing only on innovation efforts within a firm which is captured by R&D spending due to unavailability of data on innovation type and quality. Taking explicit account of the possible endogeneity between disinvestment and R&D spending due to unobservables and reverse causality, the study employs an instrument variable estimation methodology. The study uses two sets of dependent variables to capture different dimensions of innovation – the decision of investing in R&D activities as measured by a dummy variable and a transformed variable on the amount of R&D investment. Given the slow implementation of disinvestment policy in India (with only five firms being privatized), most of the transactions involve miniscule ownership transfer. To capture this feature of Indian disinvestment experience the study uses

two variables- share of private ownership in a CPSE and the time since the enterprise was selected for disinvestment for the first time. For capturing local political corruption, the study uses the number of people arrested for corruption related cases involving public officials in a state (where the enterprise is located) per thousand population. The study also uses an interaction of this measure with incumbency of the state government in the most recent elections. Besides this, the study employs a host of firm specific financial and profiling variables that may influence innovation investment decisions. Finally the study uses dummy variables for year, industry and state level unobserved effects.

The main findings of the study are as follows. Private share of ownership has a non-uniform impact on R&D possibility and amount. While it hampers the possibility of a firm to invest in R&D, it has no effect on the amount of R&D investment. Time since first time disinvestment has a positive and significant impact on both R&D decision. The reverse sign of private share and time since disinvestment, given the minuscule dilution of ownership in Indian CPSEs, reflects that disinvestment does not have a permanent hampering effect on R&D decisions within CPSEs. The effect of local political corruption on R&D investment decisions is similar to the effect of disinvestment. High local political corruption in states leads to lower R&D possibilities for CPSEs operating in that state but it has no effect on R&D amount. Further, the negative effect of local political corruption is stronger in states that have the same party coming into power in the most recent state level elections as compared to enterprises located in states that had a different party elected. This suggests that the effect of local corruption is strengthened when the party has longer years in office. Broadly, the results reflect an interesting pattern between decision to invest in R&D or not and the amount spent on R&D activities. While policy shocks such as disinvestment and external political environment has a strong bearing on the decision of the CPSE to engage in R&D or not, it has no effect on the amount spent. On the contrary, amount of R&D is driven by firm specific internal factors that capture the quality of labor- managerial influence, ratio of skilled workforce and non-unionisation of labor. Finally, the study also finds that the effect of both disinvestment and local political corruption on R&D investment is strongly conditioned by factors such as firm size, ratna status and ideologies of the state government where the enterprise is located.

The study makes an important contribution to the literature on R&D spending in public sector enterprises. The effect of partial privatization on R&D decisions has been explored in the context of developed countries but studies on firms in developing countries remain scanty. Further, while there are abundant studies on the effect of corruption on profitability,

productivity and export performance of firms, there is a very sparse literature on how corruption affects innovation activities. The current study is one of the first efforts to examine the effect of corruption on R&D spending in public sector companies.

## 2. Review of Literature

With the widespread prevalence of privatization and disinvestment policies being adopted by various countries, there has been an outburst in the literature with a heavy focus on the impact of these policies on the performance of state owned enterprises. Theoretical studies such as Defraja and Delbono (1989), Matsumura (1998) and Fujiwara (2007) argue about welfare generation due to partial privatization of public sector enterprises. However, empirical evidence on the effect of privatization on output based outcomes has been mixed (Megginson, 2005; Cull et al, 2005 and Aghion and Blanchard, 1998). Some studies such as Gupta (2005), Ghosh (2008), Majumdar (2008) and Jain (2017) have specifically focused on the effect of disinvestment on firm performance in India as captured by profits, efficiency, productivity and employment.

Despite a lot of attention has been given to the effect of disinvestment on standard accountancy measures of firm performance, the effect of disinvestment on innovation expenditure has been a sparsely researched area. Munari and Sobero (2002) use data on 35 firms that were fully or partially privatized across nine countries in Europe and examine the R&D effort and outcome. The study reports that while privatization affects R&D expenditure negatively, it has a positive and significant effect on patent quality and quantity. Sanyal (2007) reported reduction in expenditure on environment related research after deregulation of electricity utilities in 1996. Similar results were reported by Sanyal and Cohen (2009). Schmitt and Kucsera (2014) find a similar strong negative association between R&D investment and privatization for European data.

There is limited attention given to the effect of corruption on innovation. Veracierto (2008) use a game theory model and show how strategic interaction between producers and corrupt officials leads to the main result of corruption hampering product innovation. Mahageonkar (2008) use firm level African data and show how corruption has a negative effect on product as well as organisation innovation. Huang and Yuan (2016) use firm level data from the US and find that firms located in more corrupt districts are less innovative as compared to firms located in less corrupt districts. The study also finds that the effect is stronger in areas with lower local religiosity and firms that have weaker bargaining power. In contrast, Xia et al

(2018) use data on small and medium firms operating and China and study the relationship between corruption and firm innovation. The study finds that corruption has a positive effect on the possibility of innovation. Further, high share of females in the firms' management dampens the effect.

The current study aims to contribute to the existing literature in the following way. First of all, while the effect of partial privatization on firm innovation has received some attention in the developed countries context, literature on developing context remains sparse. Secondly, the effect of corruption on firm innovation has been studied by selected studies but only in the context of private sector enterprises. Against this backdrop, the current study aims to examine how disinvestment (partial privatization) and local political corruption affects innovation expenditure in India. The issue is interesting to investigate as both disinvestment and local political corruption are external factors that CPSEs have to combat for smooth operation.

## 3. Indian Scenario

### *3.1 Public sector and the disinvestment policy*

After gaining independence in 1947, India thrived in building an industrial and manufacturing base that fostered a dominant state presence in most sectors. However, with burgeoning losses in public sector enterprises, the government made a systematic shift from the late eighties towards greater reliance on market forces. This finally led to the introduction of disinvestment policy as part of the wider reforms adopted by the country in 1991. Since inception, the policy has never been a well accepted option making it political costly and hence the implementation has been sluggish. However, the policy has undergone shifts in its vision and objectives which can be best categorised as broad phases. The first phase beginning from 1991, marked miniscule shares being transferred from the government to the private sector in selected CPSEs. With political instability at the Centre, the policy came to a stand still for brief period in between. Since 1999, disinvestment policy shifted towards performance improvements emphasizing on control right transfer as a remedial tool. Thus till 2004, the Indian disinvestment experience had a strong focus on privatization. But since 2004, the government has been targeting all ratna companies to get listed on the stock market bringing back the attention to disinvesting small proportions of ownership. To summarize, selected CPSEs have been selected for disinvestment in India. The particular feature of the

Indian disinvestment experience is the mere transfer of ownership with control rights still lying with the government.

*3.2 R&D policies in CPSEs*

In general, the Indian economy has relied on imported technology till the early 2000s. The policies after 2000, specifically the Technology Policy Statement of 2003 and the Science Policy of Resolution, 2013 brought investment in innovation and R&D for the first time to the forefront of policy formulation in India. It emphasized on development driven innovation to enhance welfare. However, in terms of specific R&D policies for CPSEs, the major breakthrough was marked in 2011 when the Government of India mandated all profit making CPSEs to spend a certain amount on R&D. Specifically, Maharatnas and Navaratnas are supposed to spend 1% and Miniratnas a 0.5% of their profit after tax on R&D respectively. The government has also provided 5% weightage of R&D on MoU score calculations. But R&D in the public manufacturing sector is limited to specific areas such as chemicals, agriculture or medicine. There are as many as 30% Ratna status CPSEs that do not invest in R&D activities. Despite being mandated by the government, the lack of implementation of mandatory R&D policy leads to the relevance of the question addressed. The decision of whether or not to invest in R&D and by how much is a decision made at the firm level. The current study takes the following premise and addresses if a politically sensitive policy such as disinvestment has an effect on R&D decisions at the firm level. Further, since R&D is a risky and lengthy activity that involves numerous permits and bureaucratic responsibilities, the local corruption level may also influence R&D investment related decisions. In this respect, the study lays out the theoretical channels through which disinvestment and local corruption may affect R&D investment decisions.

## 4. Hypotheses to be tested

*4.1 R&D spending and disinvestment*

Disinvestment as a tool initiates convergence in the conflicting objectives of state and private ownership. Boycko et al (1999) discuss that state ownership reflects a hazy multidimensional objective function that is built on welfare generating activities such as reducing regional inequalities, investing in projects with high gestation periods, avoiding frequent price rise in certain industries and so on. Disinvestment may or may not involve transfer of control, but the entry of private ownership drives SOEs towards a more narrowed and focused objective

function. Further, Gebka (2014) finds that with disinvestment, SOEs are listed on the stock market that acts as a monitoring mechanism and constant analyst scrutiny on financial operations. This disciplining action of the stock market reduces the lack of transparency in management of SOEs. These theories suggest that disinvestment may lead to better performances in SOEs.

While the above theories of disinvestment are well suited for output oriented measures such as efficiency and profit, the effect of disinvestment on innovation demands focus on innovation as an activity. Innovation, as Stiglitz (1999) mentions, is a public good that cannot be constrained by geographical boundaries. Thus, state ownership seems to be an effective tool for the government to avoid underprovisioning. Besides public goods property, the risky nature of innovation is also a contributing factor for why state ownership may be more beneficial for R&D spending. Jain (2018) discusses that since SOEs are not driven by profit variations as much as their private counterparts, they are more forthcoming to the idea of investing in risky activities such as R&D. Secondly, the government is better suited to have a more structured and coordinated effort avoiding overinvestment in innovation due to its presence in several industries, projects and locations. These factors suggest that dilution of state ownership due to disinvestment may be detrimental to R&D investment in SOEs.

There is another theory that focuses on reduced innovation efforts due to disinvestment but the underlying rationale is different. According to Munari and Sobrero (2002), under state ownership, less attention is paid to control mechanisms against leakage, know-how spillover and overspending in terms of resources and money in innovation since the main aim of the government is the wider ambit of social welfare generation. Disinvestment, thus, dilutes the focus on social welfare by bringing in share holders with narrow private ownership objectives. Further, Vickers and Yarrow (1988) discuss that the efficiency gains of disinvestment leads to an increased alignment of managerial incentives, firm performance and efficient utilisation of resources. This may also lead to reduced innovation efforts after disinvestment.

Further, the study also focuses on the long term effects of disinvestment on firm innovation efforts by considering the years passed since disinvestment. In disinvestment transactions, where even a miniscule percentage of ownership transfer from the government classifies as a regulatory action it would be interesting to examine if disinvestment has a permanent effect or not. It can be expected that the effect of disinvestment will be permanent only in those

disinvestment transactions that involve transfer of control rights to the private player. In remaining SOEs, with control rights residing with the government, as time since disinvestment increases, innovation spending will not reduce.

Based on the above theories, the current study hypothesises the following:

*H1A: Disinvestment dampens the decision to invest or not in R&D*

*H1B: Disinvestment has a detrimental effect on R&D spending*

*H1C: Time since disinvestment reduces R&D spending only if control is transferred from the government to the private sector.*

*4.2 Corruption and innovation spending*

There is a huge strand of literature that has focused on the effect of corruption on firm performance. There are contrasting strands in this context- Lein (1986) and Huntington (1968), proponents of "grease the wheel" theory suggest corruption may act as a bridge of commerce between operations and bureaucratic complexities thus leading to pareto improving outcomes. In contrast, Shleifer and Vishny (1993) and Kauffmann and Wei (2001) regard corruption to "sand the wheel" of commerce by creating incentives for inefficient rent seeking, delays in completion of projects, misallocation of resources and thus distorting economic outcomes. While, there is an ambiguity in how corruption influences output based firm performance, there is a general consensus on the direction of its impact on R&D spending.

Huang and Yuan (2016) suggest that political corruption impedes innovation spending through two channels –disincentive effect and the cultural effect. Murphy et al (1993) discuss several reasons as to why political corruption impedes innovation. Due to uncertainty, lengthy and cumbersome procedures (in the form of permits, licenses and so on) involved in innovation investment, innovating firms face the brunt of corruption more than the non-innovating ones. In such cases, a corrupt environment characterised by rent seeking public officials lead to delays in permits, bribes in every stage of progress and hence results in hampering innovation spending. However, the hampering effect of political corruption is also channelized through cultural effect. A politically corrupt environment hinders social trust and leads to a local culture that distorts individual behaviour (Liu, 2016; Dass et al., 2017). For a risky and collaborative activity such as R&D investments which involves multiple stake

holders with diverse objectives and huge amounts of money, political corruption leads to less and poor innovation spending. The study focuses only on wholly or partially owned SOEs and not on private firms. Despite being owned by the central government, the CPSEs operate in a similar business environment shaped by the local policies, institutions and actions. Thus, there is no reason to believe that these channels would not affect performance and innovation capabilities of SOEs. However, it is difficult to compare if the negative effect of corruption on innovation spending will be weaker or same for SOEs as compared to their private counterparts. Based on these theories, the study hypothesises that:

*H2A: Political corruption impedes innovation decision*

*H2B: Political corruption impedes R&D spending*

## 5. Data and Variables

The study draws data from multiple sources. Data on central government owned manufacturing enterprises has been collected from the Public Enterprise Survey. Public Enterprise Survey is an annual survey that reports financial accounting and profit and loss statements of all enterprises owned by the central government. Data on disinvestment has been collected from www.bsepsu.com, which is a website maintained by Bombay Stock Exchange and reports data on all disinvestment transactions in India since the inception of the policy in 1991. The financial CPSE data spans from 2007 to 2016. This data is combined with corruption data which is available at the state level by identifying the state where the enterprise has an operational headquarter (obtained in the Public Enterprise Survey). This corruption data is web scraped from National Crime Records Bureau website (www.ncrb.gov.in). The Bureau, maintained by the Ministry of Home Affairs, publishes an annual report called "Crime in India", that reports data on crime statistics under various categories of crime at the state and union territory level.

Further, there are certain political factors that may affect innovation spending of firms. For instance, under the Member of Parliament Local Area Development Scheme (MPLADS) in India, each Lok Sabha Member gets a specific sum of money during his term that can be spent on infrastructure and development needs of the residents. Under this scheme, the government has also set specific financial incentives for innovation by individuals/firms or institutions. The implementation of this scheme is hugely dependent on the motivation and vision of the Member of Parliament in question. However, there are evidences of non-

utilisation of funds under the scheme.[4] In fact, the Central Information Commission (CIC) has reported that underutilisation or non-utilisation of MPLADS scheme is driven by the will of the MP. If the Member of Parliament is not corrupt and is highly educated it may lead to a more conducive local environment for industry in general and innovation activities in particular. On the other hand, a Member of Parliament, who is corrupt, may not shape an environment that leads to favourable environment. Hence, the study uses a host of political factors such as the educational attainment, no. of registered crimes and wealth of the Member of Parliament in the constituency where the enterprise is located. The study relies on collating this data using the pin code of the enterprise location and mapping it with the electoral districts in India. This data has been collected from www.myneta.info, a website maintained by Association for Democratic Reforms. This Association was formed by a group of professors in Indian Institute of Management, Ahmedabad. It was based on the 2002 Supreme Court judgment that made it mandatory for all election contestants to disclose educational, criminal and financial information before contesting any election in India. Finally, the study also uses ideology of the government running the state where the enterprise is located which is borrowed from Dash and Raja (2012).

*5.1 Variable construction*

i. Innovation spending

The study focuses on in-house research and development expenses to capture innovation spending. While there may be imported technology contributing to innovation activity, the lack of availability of data limits the focus to R&D spending. R&D spending is the best available indicator for capturing efforts made by CPSE in investing on product development and process improvement based innovation activities. The study captures R&D spending using two variables. *Innovation decision* is a dummy variable that segregates firms that invest in R&D activities and firms that do not. *Innovation expenses* is a natural logarithm of the amount invested by firms in R&D activities.[5]

ii. Disinvestment

[4] Source: https://www.thehindubusinessline.com/news/ensure-100-utilisation-of-mplad-funds-cic-to-legislature-parties/article9920867.ece (Last accessed on July 28, 2018)

[5] Innovation expenses is taken as the natural log of (1+R&D expenses) since selected firms do not invest in R&D at all.

The study uses two variables to capture two aspects of disinvestment. *Private share* captures the proportion of ownership with the private players for that CPSE in that year. It captures the bargaining power of the private owners in the CPSE. Indian disinvestment experience suggests that on an average only twelve percent shares have been transferred from the government to the private players across all disinvestment transactions. This highlights the Indian disinvestment experience- transfer of ownership with control rights still lying in the hands of the government of India. The mere dilution of ownership without control demands examining the effect of a firm being selected for disinvestment for the first time. To investigate if disinvestment leads to a permanent change in R&D spending or not, the study employs *time since disinvestment* which is the natural logarithmic transformation of the number of years since a firm was selected for disinvestment for the first time.

iii. Local corruption

In line with Butler (2009) and Huang and Yuan (2016), the study uses people arrested in corruption related crimes. In India, it is captured by arrests in Offences under Prevention of Corruption Act and Related Sections of Indian Penal Code. The ambit of this Act covers corruption in government agencies and public sector businesses in India. It covers public servants accepting bribes (money or gifts) in official duty for favouring a person and any person helping in this act. The study uses *crime rate* which is captured as the number of arrests per 1000 population in the state where the enterprise is located. A higher arrest rate in that state indicates a higher corruption rate. The variable does suffer from the limitation of focusing only on reported crime in the light of unavailability of data on actual crime rates.

iv. Member of Parliament characteristics

To capture the goodwill and motivation of the MP ruling the constituency where the enterprise is located, the study uses observable characteristics of the MP. The study uses data on the MP's criminal, financial and educational attainment. To account for inter-constituency heterogeneity, the study uses relative position of the winner in that constituency as compared to the average for every characteristic. Specifically, the study uses *winner crime* which is the proportional difference in number of crime cases between the winner and the average crime case number for that constituency. A similar approach has been used for *winner education*, *winner net assets* and *winner age.*

v. Ideology

Dash and Raja (2014) have coded national and state level parties' ideologies in India on a scale of 1 to 5 where a higher score denotes moving towards the left end of the ideological spectrum. These scores are based on election manifestoes, policies undertaken, past actions and reactions to other policies. The study uses these ideology scores by identifying the party running that state.

vi. Other controls

The study uses firm specific data on firm age, firm size, firm profitability, share of skilled labor force, unionised labor, mangers and loans taken by government. Firm age is the number of years since the enterprise has been in operation. Firm size is the natural logarithmic transformation of total employees. Firm profitability is defined using natural logarithmic transformation of the profits after taxes earned. Finally, the study take the share of skilled employees to total work force, share of unionised supervisors to all supervisors and share of managers to total employees to capture skill, unionisation and managerial capabilities of the CPSE. These variables have an important contribution to the performance (in general) and innovation (in particular) activities of firms. The study also uses the share of loans given by governments to capture the soft budget constraints of CPSEs. The study controls for policies that may affect the performance of the firms such as Ratna statuses and Memorandum of Understanding undertakings. Ratna statuses are awarded to CPSEs to award autonomy in financial decisions and operations of the firms. CPSEs recording continuous good financial performance for three consecutive years are awarded Miniratna I, Miniratna II, Navratna and Maharatna statuses in ascending order. Memorandum of understanding is a negotiable document signed by the CPSE and the government outlining the specific roles and responsibilities of the two parties, thus enabling autonomous in day-to-day operations of the enterprise. Signing of an MoU leads to firms getting an MoU score at the end which captures the performance of the firm in financial and non-financial parameters. Finally, to control for any industry level, state level and yearly unobserved effects, the study uses group dummy variables.

*5.2 Description of the data*

Of the 247 enterprises owned by the central government, the current study focuses on manufacturing enterprises. The study also drops firms which have null sales values for a continuation of ten years. The data is winsorized for profits and R&D amount at 5% and 95% to reduce the effect of outliers on the effects. This leaves us with approximately 220 firms

spanning a period of ten years- 2185 firm year observations. Of the 220 firms, only fifty percent of the firms are involved in R&D investment. In terms of policies, 27% of firms have been selected for disinvestment atleast once since the inception of the policy in 1991. Approximately, 35% of the firms have Ratna status. Similarly, approximately 65% firms have signed an MoU with the government.

## 6. Econometric Methodology

R&D spending decision in the *i*th firm operating in *j*th industry situated in *c*th constituency of state *s*, in the *t*th year is regressed on a function of disinvestment, local corruption and political factors, after controlling for other factors in the following probit model

$$P_{ijcst} = \alpha + \beta_j + \chi_s + \delta_t + \phi_{ijcst} x_{ijcst} + \theta_{ijcst} D_{ijcst} + \varphi_{jt} y_{jt} + \gamma_{ct} z_{ct} + \eta_{st} w_{st} + \varepsilon_{ijcst} \quad (1)$$

where $P_{ijcst}$ is dummy variable that takes a unit value only if the *i*th firm has invested resources in R&D activities in the *t*th year. $\alpha$ is the intercept, $\beta_j$, $\chi_s$ and $\delta_t$ are industry, state and year level fixed effects. Further, $D_{ijcst}$, $z_{ct}$ and $w_{st}$ capture disinvestment, constituency level and state level local corruption and political factors. Remaining controlling firm and industry specific factors are included in $x_{ijcst}$ and $y_{jt}$. $\varepsilon_{ijcst}$ is the error term in equation (1). Similarly, for capturing R&D spending amount, the study uses a fixed effects regression given by the following model

$$RD_{ijcst} = \alpha + \beta_j + \chi_s + \delta_t + \phi_{ijcst} x_{ijcst} + \theta_{ijcst} D_{ijcst} + \varphi_{jt} y_{jt} + \gamma_{ct} z_{ct} + \eta_{st} w_{st} + \varepsilon_{ijcst} \quad (2)$$

where $RD_{ijcst}$ captures the amount spent by firms on R&D activities. The rest of the variables have their usual notations. Fixed effects estimation between R&D activities and disinvestment is appropriate only if it can be established that disinvestment is uncorrelated with unobservable variables that affects innovation as well. However, variables such as motivation of the managers may boost firm performance and innovation activities and also augment its chance of being selected for disinvestment. This has been discussed by Jain (2017) and Gupta (2005). Another type of endogeneity issue that the model may face is reverse causality where firms are being selected for disinvestment based on their innovation activities. To reduce these endogeneity concerns, the study employs a two stage least square (2SLS) estimation using valid instrument variables.

Two stage least square estimation requires capturing the disinvestment decision in the first stage and then using the fitted values of disinvestment in the second stage model that captures

innovation activities. To obtain unbiased efficient estimates, 2SLS requires a set of variables in the first stage, known as instruments that influence disinvestment but not innovation spending in enterprises. The choice of instruments stems from the nature of disinvestment policy. Disinvestment related decisions are made by the owners of these enterprises, the Central government of India and the Ministry under which the jurisdiction of each of these enterprises fall. Based on this, the study employs certain centre specific political factors and ministry level variables that shape the decision making environment for disinvestment. While these factors affect disinvestment, it does not influence internal firm specific decisions such as the amount of resources and funds to be invested in R&D. Output as well as research oriented decisions are taken by managers and higher authorities at the firm level and are influenced more by the local economic conditions. Similar instruments have been employed by Gupta (2005) and Jain (2017). The first stage of 2SLS is captured by the following model

$$D_{ijcst} = \mu + \kappa_j + \lambda_s + \pi_t + \sigma_{ijcst} x_{ijcst} + \varsigma_{mt} m_{mt} + \ell_t f_t + \omega_{ct} i_{ct} + \upsilon_{st} w_{st} + e_{ijcst} \quad (3)$$

where all notations have their usual meanings. Here $m_{mt}$ and $f_t$ are the ministry level and centre level instruments. $D_{ijst}$ is the private share of ownership in the *i*th firm in *j*th industry located in *c*th constituency in *s*th state in the *t*th year.

For capturing ministry level effects the study uses dummy variables. Further, the study uses two central government level factors- *political ideology* and *seat share of the main party.* There are two Lok Sabha elections that took place during the period of analysis- 2009 and 2014. Based on this, there are three election terms that needs to be accounted for. Both the variables contribute to the decision making of disinvestment and take explicit account of the coalition driven political era in India. Political ideology of the centre is captured as the seat shared weighted average of ideologies of all parties forming the coalition. Seat share of the main party in the most recent Lok Sabha election signals the stability of the government and its bargaining power in the coalition. The data on ideology of parties is taken from Dash and Raja (2014). Data on seat shares in the most recent Lok Sabha elections is collected from the Election Commission of India website, www.eci.in.

The fitted values of private share are used in the second stage which is captured by equation (1) and (2) after correcting the standard errors.

## 7. Results

The results of the regression analysis have been summarized in Table 1. It presents four models. Model 1 is a pooled probit model where the choice of whether or not to invest in R&D activities is captured. Model 2 is a fixed effects regression with extent of R&D as the dependent variables. Both models 1 and 2 are based on disinvestment being treated as one of the exogenous variables on the right hand side. However, to reduce the endogeneity issue, the table also compiles the second stage results of the 2SLS estimation in Models 3 and 4. The endogeneity tests of the first stage of these models have been reported in Appendix A. All models have used industry, state, ratna status and year dummy variables to control for the unobserved effects. The models have controlled for heteroskedasticity by using robust standard errors.

| | **Linear regression** | | **2SLS regression** | |
|---|---|---|---|---|
| | **Indicator** | **Amount** | **Indicator** | **Amount** |
| **Dependent Variable** | **(1)** | **(2)** | **(3)** | **(4)** |
| *Disinvestment* | | | | |
| Private share | -0.201*** | -0.016*** | -0.033*** | -0.034 |
| | (0.042) | (0.008) | (0.009) | (0.022) |
| Time since disinvestment | 0.147*** | 0.058* | 0.040*** | 0.063*** |
| | (0.040) | (0.033) | (0.009) | (0.022) |
| *Corruption* | | | | |
| Local corruption | -1.307* | -1.399*** | -1.824*** | -0.569 |
| | (0.801) | (0.584) | (0.611) | (1.425) |
| Local corruption* incumbency | 0.191*** | 0.028 | 0.041*** | 0.031 |
| | (0.061) | (0.026) | (0.013) | (0.031) |
| *Political factors* | | | | |
| Ideology of the state | 0.094 | 0.009 | 0.003 | 0.001 |
| | (0.066) | (0.042) | (0.009) | (0.002) |
| Education qualification of the minister | 0.121* | 0.050 | 0.029* | 0.043 |
| | (0.075) | (0.040) | (0.017) | (0.041) |
| *Firm specific factors* | | | | |
| Firm age | 0.055 | 0.045* | 0.007 | 0.037 |
| | (0.063) | (0.027) | (0.013) | (0.031) |
| Firm size | 0.234*** | 0.115*** | 0.035*** | 0.119*** |

| | | | | |
|---|---|---|---|---|
| | (0.039) | (0.013) | (0.005) | (0.012) |
| Firm profits | 0.113*** | 0.077*** | 0.028*** | 0.076*** |
| | (0.044) | (0.017) | (0.009) | (0.021) |
| Govt share in long term borrowings | -0.004*** | -0.001 | -0.001*** | -0.001 |
| | (0.000) | (0.001) | (0.000) | (0.02) |
| Skilled workforce ratio | 0.222 | 0.189* | 0.032 | 0.195* |
| | (0.208) | (0.112) | (0.047) | (0.110) |
| Manager ratio | 0.054 | 1.050*** | 0.043 | 0.064* |
| | (0.071) | (0.248) | (0.084) | (0.036) |
| Unionised labor | -0.787* | -0.309* | -0.272*** | -0.360* |
| | (0.424) | (0.178) | (0.096) | (0.220) |
| MoU signed | 0.407*** | 0.055 | 0.116*** | 0.068 |
| | (0.090) | (0.043) | (0.020) | (0.048) |
| *Other control factors* | | | | |
| Ratna status | Yes | Yes | Yes | Yes |
| ABCD Status | Yes | Yes | Yes | Yes |
| State | Yes | Yes | Yes | Yes |
| Industry | Yes | Yes | Yes | Yes |
| Year | Yes | Yes | Yes | Yes |
| No. of observation | 1920 | 2124 | 2124 | 2124 |
| R- squared | 0.40 | 0.53 | 0.45 | 0.52 |

Note: The table presents regression results of determinants of R&D decisions in CPSEs. Models (1) and (2) present results from a probit and fixed effects model respectively. Models (3) and (4) present results from the second stage of instrument variable regressions using ivprobit and ivreg2 with relevant dummy variables. Values indicate the coefficients. Values within parentheses indicate standard errors. *, ** and *** indicate significance at 10%, 5% and 1% respectively.

**Table 1: Effect of disinvestment and local corruption on R&D variables**

According to Table 1, disinvestment as a policy option has a strong influence on R&D decisions within a firm. It is observed that private share, which is measured as the total share of private ownership in a CPSE, has a negative effect in Models 1 and 2. However, after controlling for endogeneity in Models 3 and 4, it is observed that disinvestment affects the decision of a firm to invest in R&D but not in the amount of resources that the firm would want to invest in it. This implies that disinvested firms have a lower chance of investing in R&D activities. This may be due to any of the following factor(s). First, dilution of state ownership has a detrimental effect on provisioning of the public good (R&D) as discussed by Stiglitz (1999). Secondly, as Jain (2018) puts it, a rise in private ownership reduces R&D investment due to its uncertainty and slow process. While state ownership, which is not heavily affected by profit variations, is well suited for adequate R&D investment, private ownership has a more narrow focus. Thirdly, the lack of mechanisms to control leakages and managerial slack under state ownership may lead to overspending on R&D (Munari and Sobrero, 2002).

Without data on the quality of R&D investment, the choice of which channel is driving the negative effect of disinvestment on R&D spending cannot be explored. Further, an interesting observation of Table 1 is that while greater private ownership leads to lesser firms investing in R&D activities, it has no impact on the amount of R&D spending. This suggests that only the decision of spending on R&D is influenced by the extent of private ownership. However, since most of the disinvestment transactions in India involve only dilution of ownership, the amount invested in R&D activities is not being affected. This is because the amount to be invested in R&D is an internal decision made by the managers and owners and with majority ownership lying in the hands of the government, private share has no impact on it.

Timing since first disinvestment has a positive and significant effect on R&D decision and investment amount across all model specifications. This again reflects a typical feature of the Indian disinvestment experience where most of the firms have been selected for disinvestment once and only a small percentage of share ownership is transferred from the government to the private sector. In cases where the firms have been selected for disinvestment multiple times, the private ownership is still low. In fact, the number of firms which have been privatised in the current sample is merely five. With Indian disinvestment experience described best as dilution of ownership in fits and starts, it is imperative to examine the effect of first time selection of these firms for disinvestment. This is to test if the effect of the policy is permanent or not. In fact, it is observed that probability of R&D

investment and the amount spent on R&D activities increase as time since disinvestment increases.

Further, it is observed that, local corruption has a negative effect on R&D investment decision but not on R&D amount (Models 3 and 4). This suggests that a corrupt local environment in which the firm operates has an impact on the firms decision to invest in R&D or not. The study deals with a particular level of corruption – bribery given to government officials for getting permits, licenses and managing other bureaucratic complexities. As expected, while the state level political corruption has a strong negative effect on the choice of the CPSE to engage in a risky and lengthy R&D activity (filing of patents, permits and so on) it has no influence on the amount to be spent on R&D. This reflects that the decision of investing in R&D involves firms interacting with government officials which make local political corruption a relevant variable. However, R&D amount as a decision is more internal to the firm limiting the influence of political interference and hence corruption. Further, the interaction of political corruption with *Incumbency* is positive and significant suggesting that the effect of political corruption on R&D investment decision becomes stronger if there is an incumbent party ruling the state.

Coming to firm level variables, it is observed that larger and more profitable firms choose to invest in R&D activities and spend higher amounts on the same. Further, unionisation of labor has a negative effect on both the decision to invest in R&D and the amount to be spent on R&D. Further, signing an MoU and lower loans from the government increases the chance of a firm to invest in R&D it does not have an impact on the amount. Since, R&D amount is an internal decision it can be seen that labor related variables such as ratio of skilled labor and managerial influence affects amount. To summarize, while external variables such as policy or local corruption environment may influence the decision of CPSE to invest in R&D or not, the amount of R&D is driven by more internal factor such as firm size, profits and labor skill and competency. All regression models have controlled for state, industry, year and ratna fixed effects. Further, the models use robust standard errors. To investigate the effect of disinvestment and local corruption further, the study examines the effects by bifurcating the data using different dimensions.

*7.1 Some extensions*

i. Ideology of the state

Despite being owned by the Central government, these enterprises come under the jurisdiction of the states since state policies shape the business environment which includes electricity tariffs, infrastructure facilities, labor laws and governance quality. This business environment provides the external factors that shape firm performance. Hence, innovation in firms that are located in states with policies that make the economic business environment more conducive will be higher as compared to states that do not focus on business environment as much. One effective way to capture whether the state has a business environment favourable to industry or not is to focus on the ideology of the party ruling that state. Traditionally, right wing states have policies that are more aligned with a complimentary local business environment as compared to left wing sates. Thus, ideology influences innovation decisions and also the effect of disinvestment and local corruption on innovation. Results of the instrument variable regression models have been presented in Table 2. It is observed that ideology of the state has an opposite effect on R&D decisions based on whether the enterprise is operating in a left or right leaning state. In fact, the results suggest that extreme ideology of states hamper R&D outcomes in firms. Further, it is observed that disinvestment has a stronger impact on left leaning states. Private share in CPSEs reduce probability and extent of R&D activities if the firm is located in a left wing state. Similarly, incumbency has no effect on the impact of local political corruption on R&D. Over all, it can be summarized the external factors and policies have a stronger impact in states that have a left leaning government.

| **Dependent Variables** | **R&D decision** | **R&D Amount** |
|---|---|---|
| | *Left leaning states* | |
| **Disinvestment variables** | | |
| Private share | -0.021* | -0.049* |
| | (0.012) | (0.028) |
| Time since disinvestment | 0.058*** | 0.072*** |
| | (0.011) | (0.026) |
| **Corruption variables** | | |
| Local corruption | -3.561* | -0.171 |
| | (1.974) | (4.456) |
| Local corruption* incumbency | 0.053*** | 0.090** |
| | (0.016) | (0.037) |
| Ideology of the state | -0.040** | -0.738* |

| | | |
|---|---|---|
| | (0.020) | (0.045) |
| All Controls | Yes | Yes |
| No. of observations | 1241 | 1241 |
| R squared | 0.48 | 0.53 |
| *Right leaning states* | | |
| **Disinvestment variables** | | |
| Private share | -0.035*** | -0.020 |
| | (0.012) | (0.029) |
| Time since disinvestment | 0.001 | -0.020 |
| | (0.017) | (0.041) |
| **Corruption variables** | | |
| Local corruption | -1.449** | -0.468 |
| | (0.683) | (1.659) |
| Local corruption* incumbency | 0.013 | 0.083 |
| | (0.032) | (0.077) |
| Ideology of the state | 0.123** | -0.063 |
| | (0.058) | (0.142) |
| All Controls | Yes | Yes |
| No. of observations | 883 | 883 |
| R squared | 0.46 | 0.57 |

Note: The table presents coefficients from the second stage of IV estimation of the two models. *, ** and *** denote significance at 10, 5 and 1 percent respectively. Standard errors are reported in parentheses.

**Table 2: Regression results for the sample divided by ideology of the state**

ii. Ratna status

Based 2011 policy introduction of firms with Ratna status to involve in R&D with a prescribed amount, the next bifurcation in the data is done according to Ratna and Non-ratna firms. The results have been reported in Table 3. It shows that while private share and local corruption has a negative effect on R&D decision in Ratna CPSEs, the effects are much more acute in Non-ratna firms. In fact, it is observed that if Non-ratna firms are being disinvested,

even ownership transfer by small percentage leads to a more favourable disinvestment outcome both in terms of chances of investing in R&D and amounts. This indicates the skewed nature of innovation patterns within the public sector enterprises. Further, the positive effect of private ownership on non-Ratna firms does not die down as indicated by the insignificant effect of years since disinvestment variable. Local corruption reduces the probability of R&D investment both in Ratna and non-ratna firms. However, it also reduces the amount spent on R&D for non-ratna firms. Thus, the detrimental effects of both disinvestment and local political corruption are stronger for non-ratna firms.

| **Dependent Variables** | **R&D decision** | **R&D Amount** |
|---|---|---|
| | *Ratna firms* | |
| **Disinvestment variables** | | |
| Private share | -0.029*** | -0.003 |
| | (0.007) | (0.020) |
| Time since disinvestment | 0.013 | -0.019 |
| | (0.013) | (0.034) |
| **Corruption variables** | | |
| Local corruption | -5.919** | -9.137 |
| | (3.022) | (7.923) |
| Local corruption* incumbency | 0.042 | 0.012 |
| | (0.023) | (0.060) |
| All Controls | Yes | Yes |
| No. of observations | 952 | 952 |
| R squared | 0.42 | 0.65 |
| | *Non ratna firms* | |
| **Disinvestment variables** | | |
| Private share | 1.706*** | 1.957*** |
| | (0.483) | (0.803) |
| Time since disinvestment | -0.050 | -0.075 |
| | (0.047) | (0.079) |
| **Corruption variables** | | |
| Local corruption | -1.815*** | -0.045* |
| | (0.631) | (0.027) |
| Local corruption* incumbency | 0.034 | 0.025 |
| | (0.016) | (0.027) |

| | | |
|---|---|---|
| All Controls | Yes | Yes |
| No. of observations | 1172 | 1172 |
| R squared | 0.43 | 0.29 |

Note: The table presents coefficients from the second stage of IV estimation of the two models. *, ** and *** denote significance at 10, 5 and 1 percent respectively. Standard errors are reported in parentheses.

**Table 3: Regression results for the sample divided by ratna status**

iii. Firm size

The study also considers dividing firms according to firm size. This is because size of the firm has an important bearing on how disinvestment and corruption may affect R&D decision within a firm. Bigger firms operate at scale economies which makes them better equipped as compared to the smaller firms implying that external policy shocks and unfavourable business environment will have a larger impact on smaller firms. The current study divides firms according to larger and smaller CPSEs based on the deviation from average size. The results, according to this classification, have been presented in Table 4. It can be observed that while disinvestment has a negative effect only on the decision of investing in R&D or not for larger firms, political corruption has no effect. In contrast, smaller firms invest a larger amount on R&D activities if they are disinvested. However, this effect is temporary. Further, local corruption has a negative and significant effect on R&D decision for smaller firms which intensifies if the previous party comes into power again in the recent state level elections.

| **Dependent Variables** | **R&D decision** | **R&D Amount** |
|---|---|---|
| | *Larger firms* | |
| **Disinvestment variables** | | |
| Private share | -0.030*** | -0.001 |
| | (0.007) | (0.020) |
| Time since disinvestment | 0.024** | 0.001 |
| | (0.010) | (0.022) |
| **Corruption variables** | | |
| Local corruption | 1.002 | -1.435 |
| | (0.569) | (1.739) |

| | | |
|---|---|---|
| Local corruption* incumbency | 0.012 | 0.001 |
| | (0.018) | (0.042) |
| All Controls | Yes | Yes |
| No. of observations | 1234 | 1234 |
| R squared | 0.37 | 0.59 |
| *Smaller firms* | | |
| **Disinvestment variables** | | |
| Private share | -0.211 | 14.972** |
| | (5.762) | (6.588) |
| Time since disinvestment | 0.083 | -0.904** |
| | (0.373) | (0.426) |
| **Corruption variables** | | |
| Local corruption | -4.977** | -2.157 |
| | (2.110) | (2.413) |
| Local corruption* incumbency | 0.051*** | 0.029 |
| | (0.017) | (0.019) |
| All Controls | Yes | Yes |
| No. of observations | 890 | 890 |
| R squared | 0.37 | 0.45 |

Note: The table presents coefficients from the second stage of IV estimation of the two models. *, ** and *** denote significance at 10, 5 and 1 percent respectively. Standard errors are reported in parentheses.

**Table 4: Regression results for the sample divided by firm size**

## 8. Conclusion

The current study examines the effect of disinvestment and local political corruption on R&D spending for CPSEs in India for a period of ten years spanning from 2007-2016. Based on certain characteristics of innovation as a strategy for a public sector enterprise and the channels that would drive the effect of disinvestment and local political corruption, the study builds two sets of testable hypotheses. The study employs a two stage least square technique using appropriate instruments to reduce the endogeneity between disinvestment and R&D decisions. The study finds strong empirical support that while both disinvestment and local

political corruption reduce the chance of a firm investing in R&D activities, it has no effect on the amount that a firm decides on spending.

This highlights the fact that external factors which are beyond the firms' control have an important bearing on the decision of a firm to choose to invest in R&D or not. It is intuitive since investing in a new risky and costly strategy such as R&D might be driven by owners' objectives and it may also demand frequent interactions with the government officials. Thus both disinvestment and high political corruption reduce disinvestment possibilities for a CPSE. In contrast, the amount of funds to be invested in R&D is a decision that may be taken internally by the top management and might not require either ownership interference or frequent government engagements. Thus, the results suggest that amount of investment on R&D is driven by large size, higher profits and labor proficiency. The effect of disinvestment and political corruption is strongly conditioned by firm size, ratna status and ideology of the states.

The study has some caveats. First of all, the study collapses innovation within a firm to R&D activities. Secondly, the firm focuses only on the amount of R&D activities which captures the effort of the CPSE in R&D. The study does not discuss about quality of R&D or the choice of R&D. Most of these limitations surface due to unavailability of data.

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**Appendix A**

The robustness tests for the instruments used in Models 3 and 4 of Table 1 have been presented below. The Sanderson-Windmeijer test indicates that the regressor is identified. The LM test for under-identification also suggests that regressor is not under- identified (P-value=0) for all the three models. The Cragg-Donald weak identification test suggests the instruments are strong since Cragg-Donald Wald F statistic for all the models is higher than the Stock-Yogo weak ID test critical values. The Anderson-Rubin Wald test and Stock Wright LM S statistic is also satisfied to ensure that the instruments are not weak. These tests indicate that the instruments chosen are identified, strong and valid for all the models.

| | **R&D Indicator** | **R&D Amount** |
|---|---|---|
| Sanderson Windmeijer test | 80.69 | 35.42 |
| | (0.000) | 0 |
| Anderson Canon. Corr. LM statistic | 1305.90 | 104.9 |
| | (0.000) | 0 |
| Cragg Donald F statistic for predicted probability | 80.69 | 35.42 |
| *Critical values* | | |
| 5% maximal IV relative bias | 21.37 | 13.91 |
| 10% maximal IV relative bias | 11.21 | 9.08 |
| 20% maximal IV relative bias | 5.97 | 6.46 |
| 30% maximal IV relative bias | 4.17 | 5.39 |
| Anderson Rubin Wald test | 372.75 | 13.17 |
| | (0.000) | 0 |
| Stock- Wright LM L statistic | 317.10 | 39.38 |
| | (0.000) | (0.000) |

Note: The values indicate the test statistic and the values within the parentheses indicates the P-value associated with the test statistic above.