Corruption: A catalyst for economic growth?

The case of India

Selver Berbic & Hugo Molander

Abstract:

This thesis aims to investigate and evaluate the role of institutional quality in fostering innovation in developing countries, specifically focusing on corruption's impact on product and process innovation at the firm level in India. The study utilizes a probit model with and without fixed effects applied to data from the World Bank Enterprise Survey (WBES) for both 2014 and 2022, individually. The separate tests serve as the foundation for analyzing what has transpired during the research period.

The findings reveal contrasting effects of bribery on innovation between the two time periods. In 2014, bribery exhibits a negative impact, hindering innovation. However, in 2022, bribery displays a positive impact, facilitating innovation. Notably, the relationship between corruption and innovation has been significantly and adversely influenced by the Covid-19 pandemic. The pre-Covid data aligns with the 'sand the wheels' theory, suggesting that corruption impedes innovation. Conversely, the survey data collected from the period showed opposing results, indicating an outcome consistent with the 'grease the wheels' theory, where corruption aids innovation. When running a simplified fixed effects model, the results were consistent with previous regressions, but showed insignificance.

The study contributes to existing research regarding the dynamic relationship between corruption and firm-level innovation in India. Further research could employ recent data and investigate the causal link between the effects of the covid-19 pandemic and relationship between corruption and innovation in India.

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Supervisor: Heather Congdon Fors
Department of Economics
School of Business, Economics and Law
University of Gothenburg

1. Introduction

Emerging markets constitute an increasing fraction of the world economy. Consultancies and organizations have predicted the economic world of the future, and in an overwhelming majority of these predictions, emerging economies are projected to have an increasing importance, both in absolute terms and on a per capita basis. Due to its demographic advantages and vast market size, India is often identified as the future powerhouse of the emerging economies. This was symbolically emphasized earlier this year, as India overtook China as the world's most populous nation, prompting headlines that speculated in a coming "Indian century"(Travelli A., & Cai W., 2023).

But economic growth is difficult to predict and depends on many more factors than size and demography alone. Two such factors are institutional quality, in terms of public sector corruption, and a nation's ability to innovate. It is widely recognized that these factors have an impact on growth, but the degree and directionality of this impact is still up for debate, especially with regard to emerging markets.

India recognized the importance of innovation as it opened up its economy and undertook major market liberalization reforms in 1991. The reforms achieved an accelerating rate of economic growth, and reform policies along with foreign competition and investment stimulated innovation (Rajagopalan., 2021). Despite this, the economy has continued to suffer from structural issues and has been described as underachieving, especially compared to its neighbor of similar size and economic potential, China (Subrahmanya., 2014). Many issues are connected to the political economy (Rajagopalan., 2021), with corruption being an ongoing and important issue, as India has consistently ranked on the lower end of global corruption indexes over the last few decades (Dixit., 2016). Considering these developments, the reforms of the 90's have spawned a litany of research on the achievements and shortcomings of the liberalizing Indian economy.

According to Tyfield (2017), within the emerging field of research examining the interaction between innovation and political economy, India is grouped in with the developing economies, and there are two main competing theories regarding the influence of corruption on innovation: 'Grease the wheels' and 'Sand the wheels', which will be presented in the theory section further on.

An increasingly useful dataset when researching these theories has been the World Bank's enterprise surveys (WBES). Described as "the world's most comprehensive company-level data on emerging economies", researchers have used the dataset to investigate the relationship between corruption and innovation in several developing markets, finding support for both theories mentioned above. Considering the novel nature of the research field, many research gaps remain, and this thesis aims to close some of that gap by using WBES data from 2014 and 2022 to examine recent developments in India.

With this in mind, this bachelor thesis aims to investigate two research questions regarding the impact of bribery on firm-level innovation in India and if the relationship has changed during the COVID-19 pandemic. The first question focuses on understanding the influence of bribery on innovation within Indian firms, exploring whether bribery acts as a facilitator or barrier to innovation. The second question examines any potential changes in the bribery-innovation relationship between the researched periods.

1.1 Purpose

The general aim is to investigate and evaluate the role of institutional quality in fostering innovation in developing countries. To be precise, the study will investigate corruption's impact on product and process innovation on a firm level in India. The Indian federal government has made efforts to combat corruption through various legislative measures. Some of those are the Whistle Blowers Protection Act (2014) and The Prevention of Corruption (Amendment) Act (2018). Also, the pandemic has affected the Indian economy in general, with disruptions that could have impacted the patterns of corruption and innovation in the country. Therefore, the article aims to analyze data from 2014 and 2022 to explore how corruption impacts innovation.

In this thesis, institutional quality is measured in terms of corruption, which in turn is measured through bribery. Analyzing data on corruption can be subdivided into measuring crime data related to corruption or by surveys indicating the perceived amount of corruption happening. There are concerns with both measurements, regarding problems with absence of honesty in self-reported data and differences between perceptions, among others. This thesis is based on the WBES dataset consisting of self-reported survey answers of perceived bribery

on a firm level. To specify even more, bribery is defined as the state-sector average of a dichotomy whether the respondent perceives engagement in bribery within similar firms.

Innovation can be seen as an alternative measure of productivity and economic growth; hence it is an interesting measuring tool. Innovation, defined as the development of new ideas and improvement of existing production techniques, is regarded as one of the most important determinants of economic growth. The thesis evaluates innovation in terms of firm engagement in at least one of either product and process innovation during the last three years.

Conducting a comprehensive study encompassing all developing countries poses considerable challenges, including the scarcity of appropriate data and the difficulty of accounting for omitted variables. This study focuses specifically on India, serving as a representative for developing nations. A recent literature review of innovation in India supports the notion that an increased emphasis on innovation since economic reforms in 1991 have had a positive impact on the nation's economy, which suggests that institutional reforms to promote innovation is a key tool to encourage growth and an important field of research (Nair et al., 2015).

2. Background

2.1 The current situation in India

India, with its 28 states and 8 union territories, is a country of diversity, exhibiting differences in various aspects among its states. General differences among Indian states could be seen from multiple perspectives, including geography, language, culture, religion, economic development, education, governance, and demographics.

The differing geographical features give rise to different types of economies, where some have a vast agricultural sector while others specialize in industry. Also, India is known for its linguistic plurality, with each state having its own official language and numerous regional languages. Many different languages reflect cultural richness but could also hinder economic activity and trade between the regions.

Some states are considered economically advanced and have thriving industries, IT hubs, and bustling cities. On the other hand, states like Bihar and Jharkhand face economic challenges and have agrarian-based economies. These differences in economic development levels result in variations in the standard of living, employment opportunities, and overall economic well-being.

Each state in India has its own government and political landscape, with varying political dynamics, party affiliations, and power equations. To provide an example, the states imposed local lockdowns during the second wave of the pandemic, with various economic and social effects on the affected states (Bhandari et al., 2021). Consequently, regulations as well as attitude and culture among the inhabitants will differ between the states.

In the context of global market positioning, India holds a significant position due to its large population and vast geographical expanse. However, it is not typically classified as an advanced economy; rather, according to Anand et al (2021), it is often considered to be in the opposite spectrum. The authors explain that by most measures India can be considered an emerging market, having exhibited sustainable growth, yet it is still considerably lagging behind developed economies.

Corruption is prevalent in various sectors and states in India, including the police, judiciary, politics, and business, with varying degrees of severity. As mentioned, approaches to reduce corruption have been made through different legislative measures such as the Right to Information Act (2005), Whistle Blowers Protection Act (2014) and The Prevention of Corruption (Amendment) Act (2018). However, in 2022, India ranked 77th out of 139 countries in the World Justice Project's rule of law index and 85th out of 180 countries in Transparency International's index on perceived corruption (World Justice Project., 2022; Transparency International., 2022). This suggests that corruption is still a major issue in present-day India. A review of the corruption indexes for the last decade shows that India exhibits stagnation in terms of corruption perception. This indicates that political measures must be implemented to combat the relatively high levels of corruption, as corruption is seen as an inhibitor of economic growth in most, if not all, economic circumstances (Acaravci et al., 2023).

While the relationship between corruption and growth has seen plenty of research, the impact of institutional quality on innovation has been less widely examined. It is a growing field of research however, as it is increasingly acknowledged that innovation is a determinant of sustainable long-run economic growth. Traditionally, research examining these relationships has been conducted on advanced economies, especially since it is easier to collect data in these states. But with more resources spent on data collection in developing countries, the opportunity to examine less developed economies has been growing. While differing economic circumstances between advanced and developing economies produce somewhat deviating theories of their development, there is considerable overlap. For instance, in both circumstances there are competing theories as to whether, and under what conditions, corruption can have a positive effect on innovation (Elahi., 2008).

An event with far-reaching consequences for Indian society, and thus a possible impact on the relationship above, is the outbreak of covid-19 in 2020. Following the outbreak, India introduced measures to stem the spread of the disease, which had major impacts on the social fabric and economy of India; some measures wouldn't be fully lifted until 2022. The most significant measure introduced was nation-wide lockdowns, beginning in March 2020. The scope and length of these lockdowns, which were rigorously enforced by police, meant that India had one of the most stringent containment policies in the world (Ray & Subramanian., 2022). The federal government decided on a centralized response to the crisis, an approach which was criticized considering the heterogeneity and relative autonomy of the Indian states. Subsequent research suggested a more decentralized approach involving local and regional actors (Bose., 2023).

During the pandemic years, India fell in several democracy indexes, among them Freedom House, which emphasized authoritarian restrictions on mobility and free speech related to covid as a reason for the declining freedom scores. The ease-of-doing business score declined in 2023, following government shutdowns of Muslim establishments after sectarian tensions that were exacerbated by the disruptions in the wake of covid-19 (Freedom House., 2023).

Regarding firm-specific impacts of covid-19, research has focused on micro- to small- and medium-sized enterprises (MSMEs), with some studies conducting industry-wide research. The studies showed that exporting firms were more resilient to the effects of the lockdowns, since foreign markets generally implemented less restrictions on people, goods and services

(Chen et al., 2023). Furthermore, pre-existing firm characteristics were a determinant of how well firms fared through the pandemic. Specifically, the higher the share of pre-pandemic Research and Development (R&D) spending within a firm, the better it handled the economic shocks of covid-19 (Biswas., 2022). In general, the micro- and small-sized firms suffered worst in terms of profitability during the crisis (Jain & Kumar 2023). The Indian government provided several rounds of economic stimulus packages directed at firms, with some measures aimed at MSMEs specifically, to aid companies through the crisis (Prusty et al., 2021).

As for the institutional quality of India, the World Bank Governance Indicators, a widely used dataset in research, shows Indian government effectiveness and rule of law declined in the year following the outbreak, though India was still ranked higher than in 2014 (World Bank., 2023).

The Covid-19 pandemic had significant effects on India's domestic market. Research shows that India experienced several different types of shocks to the economy; businesses suffered negative supply shocks across all sectors as the country shut down. The global lockdown also resulted in negative financial shocks. In the recovery period after the shutdowns, industries experienced positive demand shocks that couldn't be met due to continuing supply issues (Patnaik., 2022). Macroeconomic figures showed a contraction of the economy due to disruptions in sectors like manufacturing and services (Dhingra & Ghatak., 2022) Corruption has posed challenges, with concerns about mismanagement of resources and irregularities in Covid-19 relief efforts. However, the crisis has also sparked some sorts of innovation, with the adoption of digital technologies and the emergence of innovative solutions in healthcare and other sectors.

2.3 Corruption

Corruption is defined as the misuse of power for personal gain or advantage, and can take many forms (Transparency International., 2021). According to Transparency International corruption can occur in many areas where the public sector is included. Areas such as public procurement, tax collection, allocation of licenses and permits, education and healthcare, the judiciary, police and military, customs and border controls, and many other areas. Corruption can have negative effects on both economic and political systems (UN., 2021). According to

the United Nations, corruption can lead to increased inequality and poverty, weaken trust in democratic institutions and reduced economic growth.

In recent years, there have been several high-profile corruption cases in India, including the 2012 coal allocation scam, the 2013 AgustaWestland VVIP helicopter scam, and the 2018 Punjab National Bank fraud case. These cases have highlighted the pervasive nature of corruption in India and the need for continued efforts to address the problem. Overall, while India has made progress in addressing corruption, it remains a significant challenge for the country. The government and civil society organizations continue to work towards reducing corruption and improving transparency and accountability in government and business practices.

The demonetization in India in November 2016 was a policy measure implemented to address various domestic issues, including combating black money and promoting digital transactions. While the move aimed to bring about positive changes in the economy, it also resulted in short-term disruptions. The long-term impact and efficacy of the demonetization cannot yet be evaluated.

2.4 Innovation

Innovation is the process of developing and implementing new or improved products, services, processes, or organizational structures that lead to economic progress and growth (European Central Bank, 2021). It involves introducing novel ideas, technologies, or methodologies that enhance productivity, create value, or improve the quality of life. Innovation can take various forms and occur in different domains, such as STEM, social sciences, humanities, and arts (European Commission, 2021). It can be incremental or radical and result from factors such as research and development, entrepreneurship, or collaboration among various economic actors (Mazzucato, 2018).

Since the mid-20th century, innovation has been recognized as a crucial determinant of long-term economic growth and societal wealth, as emphasized by Schumpeter's foundational work on the theory of innovation for profit. Schumpeter posited that innovation, rather than pure price competition, is the primary driver of growth, firmly establishing the pivotal role of innovation in shaping the wealth of societies (Schumpeter, J. A., 1934, 1980).

A dynamic business environment characterized by constant technological advancements, shorter product life cycles, and intensified competition has posed formidable challenges for companies seeking to sustain their competitive advantage. In the globalized world, competition has become increasingly dynamic, and innovation has emerged as a pivotal driver of maintaining a competitive edge. To outperform competitors and maintain a competitive advantage, companies must proactively harness the latest technological innovations and consistently develop and improve their products and processes (Ireland et al., 2001).

Innovation is complex, uncertain, and influenced by multiple factors, making linear models flawed. The innovation process should be viewed as a series of interconnected changes across a holistic system that includes not only hardware, but also market dynamics, production capabilities, knowledge, and the social context of the organization that innovates (Kline & Rosenberg., 2009).

Policymakers often promote innovation through policies that support research and development, education, and entrepreneurship, recognizing innovation as a crucial driver of economic growth and job creation (Organisation for Economic Co-operation and Development., 2015). Moreover, innovation can have social and environmental impacts, such as reducing greenhouse gas emissions or improving public health (European Commission., 2021).

Overall, innovation is a critical element of economic growth and development. It leads to the creation of new markets, the improvement of living standards, and the resolution of societal challenges. Therefore, it is essential to encourage and support innovation through policies and initiatives that foster creativity and entrepreneurship.

3. Theory

The relationship between corruption and innovation is not clear-cut. While intuitively, corruption should conceivably hamper the ease of doing business, and therefore also dampen innovation activity, the research is somewhat split regarding the actual relationship.

3.1 Grease the wheels

The ‘grease the wheels’ theory has its roots in the study of corruption and its effects on economic development. The concept of "grease payments" dates to the early 20th century when U.S. companies doing business in foreign countries would offer small payments to officials to facilitate their operations. Leff (1964) was the first to present the theory of grease the wheels in an academic paper in the article “Economic Development Through Bureaucratic Corruption”. The theory of grease the wheels is an economic concept that suggests that bribery or small payments to government officials can help reduce bureaucratic inefficiencies and facilitate economic growth and innovation. The theory states that corruption in the form of small informal payments can serve as a lubricant to help move the wheels of bureaucracy more smoothly. To provide an illustration, corruption can assist in lowering transaction costs and eliminating specific entrepreneurial constraints.

Leff (1964) suggests that in developing countries with weak institutions and bureaucratic inefficiencies, the cost of complying with regulations and obtaining necessary permits can be prohibitively high for businesses. By offering small bribes or gifts to officials, businesses can expedite these processes and reduce the time and cost associated with navigating bureaucratic red tape, e.g innovation processes as applying for patents. This form of corruption, in turn, can instead encourage more innovation, business activity and economic growth. Hence, corruption can grease the innovation processes and therefore generate higher levels of innovation and economic growth in the long run.

Peter G. Klein (1998) is providing further support of the grease the wheels theory in his theory, called the New Institutional Economics (NIE) theory. It examines the impact of economic and social institutions on business development. Institutions, including corruption, play a crucial role in shaping economic behavior and outcomes according to the theory. NIE emphasizes the role of transaction costs in economic behavior, arguing that institutions can

affect transaction costs. Higher corruption yields reduced transaction costs which, according to NIE, can lead to more efficient economic outcomes, in accordance with the 'grease the wheels' theory.

3.2 Sand the wheels

The 'sand the wheels' theory is a concept that emerged in response to the 'grease the wheels' theory. While the 'grease the wheels' theory suggests that small bribes or payments to officials can help reduce bureaucratic inefficiencies, the 'sand the wheels' theory argues that intentionally slowing down bureaucratic processes can be an effective way to prevent corruption and ensure that regulations are followed properly.

The academic study of the 'sand the wheels' theory emerged in the 1990s and 2000s as a response to concerns about the negative effects of corruption on economic development. Some scholars argue that intentionally slowing down bureaucratic processes can create transparency and accountability, as officials are forced to follow regulations and procedures. This, in turn, can help build trust in government institutions and reduce opportunities for corruption.

De Soto (2000) was among the first to introduce the theory of 'sand the wheels'. The concept is referred to as the bureaucratic and legal obstacles that hinder economic activity. De Soto states that these obstacles arise from the lack of formal property rights, which in practice makes it difficult for entrepreneurs in the informal sector to access credit, expand their businesses, and participate in the formal economy. The theory suggests that by providing entrepreneurs with legal recognition and protection of property rights, these obstacles can be removed. In summary, De Soto highlights the importance of formal property rights to avoid corruption and to promote innovation and economic development in developing countries.

However, critics of the 'sand the wheels' theory argue that intentionally slowing down bureaucratic processes can be counterproductive, as it can increase transaction costs and deter economic activity. They argue that the key to addressing corruption is to strengthen institutions and improve the rule of law, rather than relying on strategies that may undermine economic growth.

Trinh (2019) presents another aspect of ‘sand the wheels’. She states that corruption leads to mismanagement of human resources, as efforts are diverted towards unproductive and corrupt activities rather than innovative and productive endeavors. This misallocation of resources can have negative consequences on overall economic growth and innovation in the long run.

3.3 The relation between corruption and innovation

As previously mentioned, it is commonly believed that corruption can hinder the ease of doing business and, consequently, impede innovation. This aligns with the concept of ‘sand the wheels’. However, research on the actual relationship between corruption and innovation is somewhat divided, with differing perspectives and findings presented beneath.

Leff (1964) argues in favor of the grease the wheels theory in his famous article “Economic Development Through Bureaucratic Corruption”. The author was the first to state that corruption will grease the innovation process and therefore generate higher levels of innovation and economic growth in the longer run. Huntington (1968) is another supporter of the ‘grease the wheels’ theory. He argues that political stability relies on effective institutions. This implies that in the longer run, political instability and ineffective institutions force innovative firms to engage in corruption. Like Leff (1964), Huntington (1968) views corruption as a pragmatic alternative to a deficient rule of law.

Tebaldi & Elmslie (2008) suggests that some political actions affect the rate of innovation in an economy. The authors present political innovation-boosting actions in line with the theory of ‘sand the wheels’, for instance control of corruption, market-friendly policies, protection of property rights and a more effective judiciary system. Özen & Küskü (2009) explains that legal and regulatory factors play a significant role in shaping corporate environmental behavior, in their study regarding why some companies go beyond environmental regulations when implementing their corporate social responsibilities.

Méon and Sekkat (2005) suggests that corruption acts as a barrier or friction that slows down economic progress and hinders growth, in accordance with sand the wheels. Their study states that corruption creates inefficiencies in the economy by distorting market mechanisms, undermining the rule of law, and reducing the quality of public services. This leads to increased transaction costs, reduced competitiveness, and decreased investment, as

individuals and firms may face obstacles, uncertainties, and additional costs when engaging in economic activities. As a result, corruption can hinder innovation by impeding the smooth functioning of markets and reducing overall productivity.

Wellalage and Thrikawala (2021) examines the impact of innovation at the firm level in Latin American countries, and their findings also provide support for the 'sand the wheels' hypothesis. They argue that this detrimental effect is slightly more pronounced in process innovation as compared to product innovation. The study employs interaction terms to examine how informal payments impact firms of varying sizes and operating within different institutional structures. The findings reveal that bribery has a detrimental effect on firm innovation for micro and small firms, while it does not significantly impact large firms. Moreover, the findings indicate that corruption's negative effect on innovation is intensified for firms operating in weak institutional environments, in contrast to those operating in strong institutional settings.

Seker & Yang (2012) conducted a similar study, but in the Latin America and Caribbean region. They also found evidence of the 'sand the wheels' theory. Another similar study was conducted by Huang and Yuan (2021) in the United States. Their measurement of interest was patent applications and they discovered that firms operating in highly corrupt areas tend to engage in less innovation.

In the context of India, previous research suggests that the level of corruption does indeed exhibit a negative relationship with measures of productivity. S.N & Sen (2017) use the level of bureaucratic corruption as a measure of institutional quality and use the World Bank Enterprise Survey to obtain data on corruption and firm performance. They conclude that institutional corruption "negatively influences firm productivity", although they use innovation as a control variable in their research. Poddar & Singh (2022), also relying on data from the World Bank, narrows the research by investigating the causal relationship between corruption (using bribery as an indicator) and innovation, proxied by the amount of patent applications nationally. They too find that corruption has a negative impact on innovation at the firm-level. In the study most like ours, Waldemar (2012) uses the WBES data set from 2005 to examine the relationship between corruption and innovation and averages the firm level replies on a state-sector level. Controlling for state level factors, Waldemar finds considerable heterogeneity in corruption and innovation among states but concludes that corruption indeed has a negative effect on innovation. Our study builds on this research by

using more recent datasets and including data from two different time periods and with many more firms compared to the 2005 dataset used in Waldemar.

To our knowledge, broad research on business corruption during the pandemic in India hasn't been conducted, especially not with regard to innovation. The OECD, in collaboration with many international organizations, has however highlighted the heightened risk of bribery because of covid-19; particularly in countries such as India that already suffer from relatively high rates of corruption. A report on the issue finds that anti-corruption measures are deprioritized by businesses in times of crisis while transparency and scrutiny is loosened in governments in favor of quick action in emergencies. Moreover, increased government involvement through emergency acquisitions in the health care sector and stimulus packages to aid business increase the opportunities for bribery as private-public sector interactions are multiplied. The uncertain economic environment also raises the overall corruption risk for companies that try to find new paths to conduct business (OECD, 2022).

By summarizing all these findings, we can conclude that the context in which a company operates has a significant effect on its ability to innovate and on the impact of corruption. In uncertain conditions, such as weak institutional settings, corruption might not always lower innovation in the short-term.

4. Data

The availability and selection of data determines what type of questions can be answered and limits the set of models that can be applied to investigate a hypothesis. This chapter therefore presents and explains the data used, along with limits and concerns with using it. Finally, the chapter presents and provides rationale for the dependent, independent and control variables chosen from the data.

4.1 Data description

To investigate the relationship between innovation and corruption in India, the primary data source is the World Bank Enterprise Surveys (WBES). These surveys regularly investigate the business climate worldwide. For India, the two latest rounds of surveys available, from

2014 and 2022, will be used. The surveys collect data from thousands of firms across India, and the firms can be sorted at a state level.

WBES gathers information from private companies with five or more employees in non-agricultural industries. It uses a specific method to pick companies based on their size, type of business, and location. The survey targets small, medium, and large-sized businesses in manufacturing, services, transportation, and construction industries. They exclude public utilities, government services, health care, and financial services. The geographic regions are based on where most businesses operate, and they receive information of eligible companies from government agencies. The data collection is made by asking business owners and managers to fill out a survey form, with standardized questionnaires. Although the WBES covers 135 countries, this study only looks at data from India. To be more specific this study investigates corruption and innovation in India from the last two surveys. The surveys were made in 2014 and 2022 and included 9,281 and 9,376 firms, respectively. A similar survey was conducted in 2005, but the set included significantly fewer responding firms and their questions regarding innovation and corruption differ to the point where incorporating 2005 would not provide value to the data. The 2005 survey will however be used as a reference point when discussing and interpreting the results.

Population data is gathered from the Ministry of Health and Family Welfare in India, whose national commission on population provided state-wise population projections for 2014 and 2022 (Ministry of Health and Family Welfare.,2019). It used the widely applied Component Method that projects population based on fertility, mortality and migration rates. The basis of the projection was the 2011 national census of India and the Sample Registration System under the Ministry of Home Affairs, which provides continuous statistics on fertility and mortality in India.

Data on GDP per capita was gathered from the Reserve Bank of India, which annually provides state-wise statistics on its webpage (Reserve Bank of India, 2022).

4.2 Dependent, independent and control variables

An overview of the variables in the regression is found in table 1 below.

Table 1. Variable Names and Definitions

Variable Name	Definition	Variable
Innovation	*=1* if firm engaged in at least one of product and process innovation during the last three years	Dependent variable
Bribery	Sector-state average of the self-generated variable dbribe (dbribe:*=1* if firm perceives that similar firms engage in bribery)	Independent variable
Locality Size	Size of firm locality (Less than 50,000 (*1*), 50,000-250,000 (*2*), 250,000-1 million (*3*) and more than 1 million (*4*)	Control variable
Firm Size	Size of the firm (Small(1), Medium(2) or Large(3))	Control variable
Internet	*=1* if firms interact with client and suppliers via website and email	Control variable
Trust in institutions	*=1* if firm views institutions as Unfair, Partial and Corrupted	Control variable
Overdraft	*=1* if the firm has an overdraft credit	Control variable
Corruption obstacle	*=1* if firm views corruption as an obstacle	Control variable
Education	% of Full Time Workers Completed High School	Control variable
Export	*=1* if firm engages in export, either directly or indirectly	Control variable
*Population (log)**	Population in the state where the firm operates (logged)	Control variable
*GDP/capita (log)**	GDP/capita in the state where the firm operates (logged)	Control variable

** Included in equation (1) only.*

Note: Dummy variable if not stated otherwise.

Dependent variable

In collecting the data, questions regarding innovation and corruption are particularly interesting. Specifically, two questions are used to build the dependent variable across the two surveys: Question (1): "During the last three years, has this establishment introduced new or improved products or services?" and Question (2): "During the last three years, has this establishment introduced any new or improved process?". The first question is originally stated as H1 in both datasets. The other question, regarding process innovation, is stated as H3 in the 2014 dataset and H5 in the 2022 dataset.

Different indicators for innovation may be used, such as the number of patent approvals or R&D spending. In line with theory on innovation in developing economies provided above, the indicators product and process innovation may better capture actual innovation activity. Given the sample size and regional spread, the questions stated above provide a good approximation of the level of process and product innovation in India. Indeed, company identities vary among businesses, and by incorporating both process and product innovation measures, we can capture all types of firms. By considering both aspects of innovation, we can account for the diverse strategies and approaches employed by different companies. This comprehensive approach allows for a more inclusive analysis, ensuring that various types of firms are adequately represented and their contributions to innovation are properly assessed.

Both variables for product and process innovation are constructed as dummies, taking the value of one if innovation has taken place during the last three years. To create our innovation variable, we generated a new binary variable taking the value one if the individual firm has engaged in either of, or both, product or process innovation the last three years and value zero otherwise. The new variable for general firm-level engagement in innovation is called Innov.

Independent variable

To build the independent variable, one question was utilized for both surveys:
Question (3):

> *" It is said that establishments are sometimes required to make gifts or informal payments to public officials to "get things done" regarding customs, taxes, licenses, regulations, services etc. On average, what percentage of total annual sales, or estimated total annual value, do establishments like this one pay in informal payments or gifts to public officials for this purpose?"*

Using self-reported data on bribery may better capture ongoing bribery activity than direct indicators, such as number of reported bribery cases, that exist only at macro level and may instead be better used for investigating control of corruption. However, in the context of firm-level analysis, it would be challenging to incorporate data that is only available at the regional, state, or national level. This limitation restricts the ability to directly include such variables in the analysis and control for their effects at the firm level, therefore the chosen dataset enables firm level analysis. The strength of the dataset lies in its extensive micro-level observations, enabling both detailed analysis and macro-level generalization.

The independent variable that we used was constructed as a state-sector average on a dummy variable with the value one (1) given to any firm providing an answer above 0% to question (3); otherwise, it was set to zero. So firstly, we remade the initial percentage data into a new dummy variable where one represents if the firm perceives bribery and zero otherwise. We created this binary variable to get rid of potential biased responses, as we found that a small number of respondents had responded unrealistically.[1] The *bysort* command in Stata was used to generate a state-sector average value for the newly generated binary variable. Using a measure at the sector-state level helps address problems related to endogeneity and errors in measurement that can occur when relying only on individual firm responses Utilizing a measure at the sector-state level helps mitigate issues associated with endogeneity and measurement errors that may arise when relying solely on individual firm responses (Dollar et al., 2005; Fisman & Svensson., 2007). By aggregating data at this higher level, potential biases from individual firm-level factors can be minimized, providing a more robust and reliable analysis. This approach helps to capture broader trends and patterns within sectors and states, allowing for a more comprehensive understanding of the underlying dynamics and factors influencing outcomes. Therefore, we treat the bribery-variable as exogenous, similar to Waldemar (2012).

Control variables

Control variables are a crucial aspect of probit regression analysis, as they allow researchers to account for other factors that may be influencing the relationship between the dependent variable and the independent variable of interest. The eleven chosen control variables are

[1] Some firms even estimated that bribes stood for 100% of annual sales.

included in the analysis to reduce the error term. They are all listed and defined in table 1 above. By including those, we can isolate the effect of bribery and improve the accuracy of the analysis. Thus, the inclusion of control variables in probit regression analysis not only improves the accuracy and reliability of the estimated coefficients but also increases the precision and interpretability of the results.

According to Majumdar's (2009) theory, R&D should correlate positively with innovation; we therefore include this as a control variable. Interestingly, firms of all sizes have shown a considerable uptick in R&D since economic liberalization in 1991.

To capture the heterogeneity of the state characteristics, the state control variables population, which expresses differences that arise from the variance in population, and GDP per capita (as a proxy for living standards) are used. They are in logged form to correct for outliers.

As one can see from the definition of the control variables, many are defined as categorical variables rather than numerical ones. This is especially important to keep in mind for the variables Firm Size, Locality Size and Corruption Obstacle, as the different values are not on a continuous scale, they simply represent different categories of ordinal data.

4.3 Concerns

Self-reported data is prone to concerns regarding reliability and validity. Response bias, subjective interpretation and limitations in willingness and ability to provide accurate information are key concerns. To address these issues, researchers can employ techniques like ensuring anonymity, using standardized questionnaires, and conducting follow-up interviews for validation. The WBES has done all of these to avoid biases creating invalid and unreliable data. The design is good, so we can't say for sure if these concerns are a problem.

The data for GDP per capita is from 2019-20, which does not overlap with the time at which the survey data was collected. The survey was conducted recently enough for full data on state-wise GDP to be missing, as it is not expected to be released until the end of 2023. Furthermore, data from 2020-21 is heavily impacted by the covid-19 lockdowns and might skew the results, as states experienced very differing fluctuations in GDP as a direct effect of the global lockdowns. Furthermore, preliminary indicators show an economic recovery in

2022 that mitigated the effects of covid. Finally, the survey questions related to innovation cover the previous three years, including 2019, along with a bribery question that is not time constrained. Considering this, GDP per capita for 2019-20 is a sufficient dataset for the purposes of this study.

5. Method

This section explains the econometric model used to analyze the data from the two sets of surveys that the World Bank provides. In addition to this, the reasoning behind the chosen robustness checks and possible limitations about the model of choice is presented.

5.1 The Probit model

As the dependent variable of choice is presented as a binary question in the data, a binary regression model is preferred. Following empirical evidence and the established method of analyzing WBES binary variables, a binary probit model is used for analyzing the probability to innovate connected to the explanatory variables. To test if corruption lowers the probability of innovation at the firm level, the study estimates innovation in equation (1) and (2) as probit models, following the model used in (Goedhuys., 2007; Lederman., 2010) among other studies on innovation and development. The contrast between equation (1) and (2) is that the first one incorporates additional state control variables, and the later one incorporates the state-fixed effect.

$$Innov_t = \beta_0 + \beta_1 Bribery_{jst} + \gamma X_t + \varepsilon_t \quad (1)$$

$$Innov_t = \beta_0 + \beta_1 Bribery_{jst} + \gamma X_t + FE_j + \varepsilon_t \quad (2)$$

Where *j* and *s* represent regions and sectors, respectively, and *t* represents time. Innov is the binary dependent variable, Bribery is the independent variable, X represents additional explanatory control variables, and the final term is the error term. The model is specified for the two surveys analyzed in equation (3), (4), (5) and (6) below:

$$Innov_{2014} = \beta_0 + \beta_1 Bribery_{2014} + \gamma X_{2014} + \varepsilon_{2014} \quad (3)$$

$$Innov_{2022} = \beta_0 + \beta_1 Bribery_{2022} + \gamma X_{2022} + \varepsilon_{2022} \quad (4)$$

$$Innov_{2014} = \beta_0 + \beta_1 Bribery_{2014} + \gamma X_{2014} + FE_j + \varepsilon_{2014} \quad (5)$$

$$Innov_{2022} = \beta_0 + \beta_1 Bribery_{2022} + \gamma X_{2022} + FE_j + \varepsilon_{2022} \quad (6)$$

The dependent variable, Innov, is binary and combines the Questions (1) and (2) that are devised to be binary, of the type yes/no, and Innov acquires the value 1 if the company has introduced a new product or process within the last three years. The results of these regression models are presented in the subsequent chapter.

The probit model is suitable for binary dependent variable analysis as it can handle non-linear relationships and is less restrictive than linear regression. The probit model does not assume that the error terms are normally distributed, unlike linear regression models. Instead, the probit model assumes that the error terms follow a standard normal distribution. This makes the probit model more robust than linear regression models when the normality assumption is not met.

The coefficients of the probit model can be interpreted as the effect of a one-unit change in the independent variable on the probability of the binary outcome, holding all other variables constant. This makes it easier to interpret the results of the model compared to other non-linear models. The data on firm size and population size have been transformed into categorical variables in the regression analysis, since the large difference in range between the categories could skew the results if these variables are treated as continuous ones.

To account for unobserved factors among states that may affect outcome, a fixed effect coefficient was used, meaning two models have been implemented in the analysis: one using state controls but no fixed effects, and another using state fixed effects and no other state controls. Fixed effects is most commonly used on time-series panel data to account for

time-invariant factors that affect outcome, but it can also be used on cross-sectional data such as the World Bank Enterprise Survey provided that the results can be grouped into sections (Waldemar., 2012). This study groups the results into states in order to examine the state fixed effects.

Marginal effects

In the thesis, we also incorporate the interpretation of marginal effects (found in Table 6). By including this analysis, we aim to enhance the understanding and significance of our findings, providing deeper insights into the relationships between variables and their impact on the outcome of interest. The interpretation of marginal effects allows us to quantify the effect of the independent variables on the predicted outcome. It goes beyond the ordinary probit regression coefficient estimates by providing a more tangible understanding of how changes in the independent variables influence the dependent variable. Using this method, in addition to the probit model, enables us to provide a more comprehensive understanding of the relationships between variables, quantify their effects, and communicate the practical implications to a wider audience.

5.2 Robustness check

We've performed a limited check for robustness by running the robust probit regression. Endogeneity occurs when a variable, observed or unobserved, that is not included in the model, is related to a variable that has been incorporated into the model. The WBES has tried to control for endogeneity through the modeling of the survey. Any additional endogeneity is tested for by plotting the residuals and fitting them over the regression. This gives an estimate of the predicted values versus the actual values shown.

5.3 Limitations

The appropriate method for this cause is the quantitative method, with regression analysis in general and the probit model particularly. Quantitative methods rely on data and statistical analysis, which aims to provide an objective view of corruption's impact on innovation in India. According to Neuman (2014), quantitative research focuses on objectivity through statistical analysis. He also states that large sample sizes reduce biased findings. Hence, the

chosen method will reduce bias, increase reliability, and provide a more representative view of the population which ensures generalizable findings.

Neuman (2014) also states that a narrow approach on numerical data can be a limitation when studying a wide phenomenon. In this case, studying corruption and innovation with the quantitative method may not fully capture the contextual complexity of innovation's impact. The understanding of various multifaceted institutional factors that shape innovation can be hindered. For instance, social and cultural influences on innovation may not be adequately captured by quantitative approaches, potentially leading to incomplete findings.

As described in the background, the states of India exhibit considerable heterogeneity, whether related to social, cultural, language or economic issues. These potential omitted variables might bias the results, and the bribery variable might act as a proxy for the omitted variables; yet these can be difficult to accurately measure. By applying a number of control variables and controlling for size and wealth of the different states, many of these effects should be captured. Additionally, the method of averaging bribery across states and sectors mitigates concerns when handling micro-level data, as the effect of idiosyncratic errors will trend towards zero with the large sample size.

The issue of potential reverse causality is another limitation when analyzing the impact of corruption on innovation. To illustrate, there is a possibility that high levels of innovation lead to reduced corruption, rather than corruption negatively affecting innovation. A reverse probit regression was conducted to test for the potential issue, showing no tendencies of existing reverse causality.

Alternative parameter methods can be used as a robustness check of the method, which has not been applied to this study, considering the complexity of doing alternative regressions and time limitations. Specifically, using an instrumental variable approach has been commonly applied in previous studies of the same phenomenon. The study relies on previous empirical research and control variables in ensuring that the main analysis is correct. Additionally, since the study does not purport to show strong causal inference, the need for robustness checks diminishes.

A final set of limitations concern the use of fixed effects on a cross-sectional probit model;

non-linear models may for instance suffer from the incidental parameter problem when using fixed effects, leading to biased results. This occurs when the number of parameters in relation to the number of observations in the grouped data (in this case, firms grouped into states) are large. With 10 000 firms in approximately 30 states, this issue is mitigated to an extent. (Beck., 2018). But recent research (Hole et al., 2011) suggests that even with a large number of observations, the fixed effect estimator may yield biased results in non-linear models.

Another suggested limitation is that a fixed effect estimator will not be accurately interpreted unless taking within-group variation into account (Fletcher., 2010). Measures to address the bias include using two-step approaches, clustering models and finding alternate appropriate groupings of the data (Hole et al., 2011), but this falls outside the scope of this study. To provide accurate fixed effects estimation and prove causation, previous studies on WBES data and other studies using similar models and surveys have included an instrumental variable approach to correct for endogeneity. This however, falls outside the scope of this study which does not try to prove causation but rather searches for correlation.

6. Results

The regression results are presented in three sections. The initial section describes the statistics used in the analysis. The subsequent section analyzes the effect of corruption on innovation in the year 2014 and 2022 via the probit model. The final section provides the marginal effects of the variables on the dependent innovation variable.

6.1 Descriptive statistics

Table 2: Summary statistics for 2014

Variable	**Mean**	**Std. dev**	**Min**	**Max**	**N**
Innovation (2014)	0.600	0.490	0	1	9281
Bribery (avgdbribe14)	0.063	0.110	0	1	9255
Locality size	3.042	0.919	1	4	9281
Firmsize	1.890	0.742	1	3	9281
Internet	0.531	0.499	0	1	9269
Trust in institutions	0.291	0.454	0	1	9011
Overdraft	0.586	0.493	0	1	9152
Corruption obstacle	2.145	1.329	0	4	9264
Education	50.819	31.720	0	100	9036
Export	0.156	0.363	0	1	9281
Population (log)	4.657	0.381	3.173	5.321	9281
GDP/capita (log)	3.002	0.224	2.459	3.394	9281

Table 3: Summary statistics for 2022

Variable	Mean	Std. dev	Min	Max	N
Innovation (2022)	0.054	0.226	0	1	8718
Bribery (avgdbribe22)	0.396	0.327	0	1	8548
Locality size	3.366	0.832	1	4	8718
Firm size	1.995	0.815	1	3	8718
Internet	0.613	0.487	0	1	8717
Trust in institutions	0.226	0.410	0	1	8630
Overdraft	0.610	0.488	0	1	8686
Corruption obstacle	1.099	1.224	0	4	8592
Education	73.958	26.123	0	100	7514
Export	0.143	0.350	0	1	8718
Population (log)	4.596	0.478	3.195	5.368	8718
GDP/capita (log)	3.212	0.227	2.690	3.684	8718

Table 1 and 2 shows the summary statistics for 2014 and 2022, respectively, including the dependent variable, the explanatory variable, and the different control variables. Average innovation declined drastically, and average bribery increased drastically between the time periods.

6.2 Main results

Table 4 and 6 presents the outcome of the Probit regression model conducted from the WBES dataset from 2014 and 2022. Table 4 with state controls and Table 6 with state-fixed effect. Within parentheses are the robust absolute z-values presented. Table 5 presents the marginal effects of each variable on the dependent variable, according to the output from Table 4.

Table 4 Regression output (Equation 1)

Variables	2014	2022
Dependent variable: *If firm introduced a new product or service during the last three years=1*		
Bribery	-0.640 (4.81)**	0.330 (3.46)**
Locality size	(1): Base level (2): 0.153 (2.29)* (3): 0.294 (4.42)** (4): -0.021 (0.31)	(1): Base level (2): 0.521 (2.37)* (3): 0.437 (2.01)* (4): 0.373 (1.75)
Firmsize	(1): Base level (2): 0.090 (2.68)** (3): 0.113 (2.57)**	(1): Base level (2): -0.088 (1.38) (3): -0.188 (2.84)**
Internet	0.279 (8.56)**	0.239 (3.66)**
Trust in institutions	-0.039 (1.24)	0.533 (9.27)**
Overdraft	0.280 (9.11)**	-0.150 (2.49)*
Corruption obstacle	0.024 (2.17)*	-0.025 (0.98)
Education	0.005 (4.19)**	0.001 (0.55)
Export	0.147 (3.43)**	0.677 (11.26)**
Population	0.013 (0.26)	0.089 (1.23)
GDP/capita	0.309 (4.12)**	0.394 (2.73)**

** Significant at 5%; ** Significant at 1%*

Note: Absolute value of robust z statistics are in parentheses.

The values displayed in the table represent the changes in the dependent variable as the independent variables change from 0 to 1. The coefficients related to the binary explanatory variables display the effect of moving from one category to another. In contrast, values associated with the marginal effects are presented in Table 6 further beneath.

Table 5 Marginal effects from the probit estimator without Fixed Effects

Variables	2014	2022
Bribery	-22.7%**	3.3%**
Internet	9.9%**	2.4%**
Trust in institutions	-13.8%	5.4%**
Overdraft	10.0%**	-1.5%**
Corruption obstacle	0.9%*	-0.2%
Education	0.2%**	0.00%
Export	5.2%**	6.9%**
Population	0.4%	0.9%
GDP/capita	11.0%**	4.0%**

** Significant at 5%; ** Significant at 1%*

As can be seen, the coefficient for Bribery is negative and statistically significant at a 1% significance level for 2014. This indicates a negative impact of corruption on innovation in the year 2014. With other words, the data from 2014 supports the ‘sand the wheels’ theory described earlier. Interestingly, the table simultaneously shows that the coefficient for Bribery takes on a positive value, with statistical significance at 1% for 2022, indicating proof in support of the ‘grease the wheels’ theory. These results hold for postestimation tests of the data, including residual plot testing. Further examination of the factors contributing to this discovery will be presented in the discussion section.

Regarding the control variables, the regression output in Table 4 states statistical significance at a 1%-level for the majority of the control variables in both 2014 and 2022. Although, they do differ a bit between the years. The firm size coefficient changes sign over the years. It is negative and statistically significant in 2022, but instead positive and statistically significant for 2014. The significance level also differs between the two datasets for the locality size variable.

The education coefficient also varies in significance level between the years. In line with predictions, the level of complement of high school among employees was positively correlated with the probability of innovation. For 2014, the education variable takes a positive value close to zero, although the value is statistically significant at a 1%-level. The education term is almost equal to zero and insignificant for 2022. The reverse relationship appears in the export variable, which represents a binary variable equaling one if the responding firm engages in direct or indirect export of products and services, and zero if they do not export at all. The coefficients for export is positive and statistically significant for both 2014 and 2022, taking values of 0.147 and 0.677 respectively.. One interpretation is that the differential handling of the Covid-19 pandemic may be contingent on whether firms engage in exporting or not.

Regarding finances, the overdraft variable represents a dummy if the responding firm has an overdraft credit or not. The outcome of this variable is statistically significant at a 1%-level for 2014, and at a 5%-level for 2022. Notably, the results vary between the years. For 2014 the results showed an increasing probability of innovation with 10% if an overdraft credit exists. For 2022 the existence of an overdraft credit showed a negative coefficient, representing a decreasing probability of innovation of 1.5%.

The two variables representing the firm's belief on the institutional system are those called Trust in institutions and Corruption obstacle. Trust is measured whether the respondents view institutions as unfair, corrupted and partial (1) or as fair, uncorrupted and impartial (0). This variable finds insignificance in 2014. For 2022, the finding is significant at 1% and shows that firms lacking institutional trust were associated with a 5.4% increase in the probability of innovation. The corruption obstacle variable is constructed as a dummy on whether the firm finds corruption as an obstacle or not and shows small negative effects, with statistical significance only for 2014.

Lastly, two variables are used as state controls. Population acts as a proxy for the rate of urbanization within the state. The coefficients for 2014 as well as 2022 are positive, although they are statistically insignificant and the effect is close to zero. A positive value would indicate that a higher state population increases the probability of engagement in innovation. The other state control, GDP/capita, works as a proxy for living standard and economic activity. It also takes positive coefficient values for both periods but unlike the population variable it finds statistical significance at a 1% level. This provides indications that firms operating in states with higher levels of wealth and prosperity obtains increased probability of engagement in innovation.

Table 6 Regression output with Fixed Effects (Equation 2)

Variables	2014	2022
Dependent variable: *If firm introduced a new product or service during the last three years=1*		
Bribery	-0.283 (1.62)	0.148 (0.83)
Locality size	(1): Base level (2): 0.042 (0.58) (3): 0.165 (2.26)* (4): 0.132 (1.77)	(1): Base level (2): 0.326 (1.37) (3): 0.184 (0.78) (4): 0.011 (0.05)
Firmsize	(1): Base level (2): 0.133 (3.73)** (3): 0.138 (2.91)**	(1): Base level (2): -0.019 (0.28) (3): -0.138 (2.00)*
Internet	0.408 (11.63)**	0.268 (3.73)**
Trust in institutions	0.061 (1.68)	0.445 (6.57)**
Overdraft	0.220 (6.54)**	-0.149 (2.29)*
Corruption obstacle	0.014 (1.06)	0.035 (1.23)
Education	0.004 (6.67)**	0.000 (0.43)
Export	0.138 (2.98)**	0.480 (6.60)**

** Significant at 5%; ** Significant at 1%*

Note: Absolute value of robust z statistics are in parentheses.

Table 6 presents the Regression output from equation (5) and (6), where Fixed Effects are incorporated. The result pattern remains the same, but in contrast to the previous table, no significance is found. Importantly, all 481 observations from the states Himachal Pradesh and Uttarakhand where omitted from the 2022 results in the table above, due to collinearity when running the fixed effects model. The results do not therefore completely match with those obtained in Table 4.

The findings of the 2022 regression output overlaps with the period of covid lockdowns and restrictions that disrupted the Indian economy, where firms were heavily impacted from 2020 onwards. To summarize, the difference between the 2014 and 2022 outputs suggests that the pandemic also affected the relationship between corruption and innovation, pushing the country towards sand-the-wheel conditions, although the causality of this correlation cannot be interpreted from the results.

This results in answers to our research questions:

1. *How does bribery impact innovation on a firm level in India?*

For 2014, bribery sand the wheels of innovation. Bribery has a negative impact on innovation. For 2022, bribery greases the wheels of innovation. Bribery has a positive impact on innovation. Including state effects yields no significant results.

2. *Has the relationship changed during the researched periods (2014-2022)?*

After investigating the effect of corruption on innovation in India, we can state that innovative actions decreased while bribery-activities increased. The data from pre-covid showed proof in line with the ‘sand the wheels’ theory. The data from during/after-covid showed opposite results, indicating outcome in line with the ‘grease the wheels’ theory. The implications are further discussed in the following section. Again, a state fixed effects-adjusted approach finds insignificance.

7. Discussion

As presented in the results the outcome from the two datasets differs. The bribery variable for 2014 indicates a relatively strong decreasing probability of innovation engagement within the last three years. This result is in line with our predictions and can help us bring clarity in the first research question. The 2014 data also supports the findings of Waldemar (2012) for the 2005 data. The intriguing aspect emerges upon recognizing that the corruption indicator for 2022 displays a rise in the likelihood of involvement in innovative activities. In 2014, the theory of "sanding the wheels" appears to be applicable, whereas in 2022, the theory of "greasing the wheels" seems to be the relevant theory. What is the underlying reason for these divergent outcomes, and what factors might contribute to the significant disparity in results?

During the survey period for the 2022 WBES data, the global economy was heavily affected by the covid-19 pandemic and as mentioned, India had one of the harshest responses in the world to the outbreak, especially in terms of lockdowns. This threw a wrench into Indian society and its economy. Our findings support this in that the descriptive statistics show an increase in bribery incidence and a decrease in innovation. An explanation for our findings in 2022 may be found in that several of the covid impacts in India led it in a direction which, according to theory, economies who experience grease-the-wheels condition exhibit. Since the level of government effectiveness and rule of law declined, this should have pushed India towards the 'grease the wheels' direction. The fact that India provided an economic stimulus package to firms amid continued turbulence and in a bribery culture might have contributed to the uptick in bribery.

A scenario that could explain the results from 2022 is that firms with connections in regulatory institutions and with sufficient means might have taken advantage of the turbulence of the pandemic years to forego restrictions, or exploited laxer financial regulations, and gained a competitive advantage, providing opportunities to introduce innovation in the markets. A deeper analysis would require gathering of new data on both business and the regulatory environment of the time to conclude whether this is the case.

The findings point to the vulnerability of emerging markets to disruptions in the economy. Unlike previous research, it suggests that a changing context can cause a country to shift from one regime within the corruption-firm innovation nexus to another. Without suggesting direct

causal impacts, the major disruptive event of this period was clearly the covid-19 pandemic. As explained in this study, plenty of research on its impacts in India have been conducted, and several possible reasons for our findings connected to this pandemic have been given above.

It is important to note that the limited investigation into the data with state-fixed effects yielded no significant results. This is in contrast to earlier research on the subject, where significance was found by Waldemar in 2005.

R&D and Firm size

Traditionally, innovation correlates positively with firm size. In fact, ”innovation increases more than proportionately with firm size”, because larger firms benefit from economies of scale, have a larger capacity for R&D projects and easier access to finance (Symeonidis, 1996). The statistically significant inverse relationship found in 2022, while still small, could be explained by two specific issues with the data: the definition of innovation and the period during which the data was collected. In the first half of 2022, during which the survey was performed, firms were still in the midst of the covid-19 pandemic. Additionally, process and product innovation as measured in the survey does not necessarily include introduction of brand-new inventions and products that require a lot of R&D and access to finance. Thus, while large firms may cut costs and ride out the impact of the pandemic, SME:s may be forced to change their processes, and the smaller firms operating in 2021 could be those that have either changed their operations significantly or taken advantage of the economic disruption by introducing new products or services.

Firm size, Internet and Export

Generally, large companies tend to export on a higher frequency than small companies. Also, large companies tend to have a higher access rate to the internet in developing countries. As we can tell by the results for 2014. All these variables show positive coefficients, which means that as they increase, the likelihood of firm engagement in innovation increases. For 2022, the firm size effect has gone in the opposite direction while the two others remain positive. This could be because large firms on the domestic market suffered harder than those exporting firms with a wider sales circle. Intuitively, exporting firms are generally more likely to have a website, and vice versa. The correlation matrix shows a correlation of 0.281 and 0.156 for 2014 and 2022, respectively, to ensure that multicollinearity does not exist.

Education and trust in institutions

The negligible impact of education on innovation finds support in research that shows a higher level of correlation with innovation only once a higher level of education is attained. This is especially true for skilled sectors, such as the IT-sector, where India excels (Kong et al, 2022). Institutional trust is a complex phenomenon, connected to and affected by many other factors. These include socio-economic factors as well as education. It is most strongly linked to, and measured by, the strength of the rule of law in a region, although in this study, the survey question acts as a proxy for the rule of law in Indian states. The results from the study of Audretsch et al (2018) support the theory, although the exact mechanisms cannot be established.

Overdraft

For businesses that lack easy access to borrowing, overdraft is a method of financing whereby the current account is used to the point where the payment balance is negative. For firms in developing economies, this is heavily connected to new investments, and therefore innovation, according to evidence presented by Fombang & Adjasi (2018). For 2014, the data supports this theory. The data for 2022 may be explained by the fact that overdraft becomes a heavy financial burden in times of recession, and in 2021, when the data was collected, India was still in recovery from the covid-induced recession.

Population and GDP/capita

To control for the states, we used state population and state GDP/capita as control variables. Those were logged to mitigate potential biases related to outliers in the data. Generally, innovation, in terms of research output, tends to grow at a faster rate than proportionally. This growth is attributed to factors such as market size, increased intellectual interactions, and greater specialization within places with higher population numbers (Coccia., 2013). Our result presents evidence that supports Coccia's thesis, but only with statistical significance for 2014. Regarding the controller for living standard, state GDP/capita, we found positive effects in both time periods, which means that firms within areas with higher living standards are more likely to innovate. While the marginal effect exhibited a positive trend in both time periods, it was notably larger prior to the onset of the COVID-19 pandemic. Similarly to the population-trend, this result shows that firms in areas with higher population numbers and living standards are more likely to engage in innovative activities.

Further research

In line with previous research and the consistently low placement for India in corruption rankings, the anti-corruption legislation has not brought about a decrease in firm-level corruption, although the impact of the legislation has not been examined. The increase in bribery incidence is in line with the literature review provided above, as businesses are expected to deprioritize anti-corruption measures and the Indian public sector loosens transparency and scrutiny during a time of crisis.

This study provides interesting insights into the development of the corruption-firm innovation nexus in India over time but leaves room for plenty of further research. To further explore the topic, a causal model for examining the effects of the pandemic on the corruption-firm innovation nexus could be performed, especially as relevant data from these most recent years is still to be presented. To validate the models' findings an IV-approach and additional robustness checks are recommended. Further research could focus on what kind of red tape (bureaucratic obstacles) or lack of control might have led to 'grease the wheels' conditions. Another crucial factor to consider within further research is the firm's affiliation with governing bodies. As previously stated, it is plausible that a company may derive benefits from their institutional ties by engaging in bribery to avoid regulatory constraints. A final consideration is to investigate short-term variances in the relationship between corruption and innovation, as this study indicates that short-term shifts might arise from crises; we have yet to see such context-varying research being presented.

While the fixed effect model yielded insignificant results, it should be noted that the simplicity of the model did not correct for potential biases of the fixed effect estimator in non-linear models. Additionally, correcting for within state-variation and using an instrumental variable approach fell outside the scope of this study. Nonetheless, the pattern of correlation stands compared to the non-fixed effects model, suggesting that further research may still prove that the reversal of the relationship between corruption and innovation holds up. As more data from the recent covid-impacted years arrive, a deeper study using alternate fixed effect-estimators and an instrumental variable-approach should provide more conclusive answers to the questions in this study.

To conclude, the research in this study has built upon and contributed to the scarce amount of research on corruption and innovation in developing nations such as India. The new findings suggest that a correlation between corruption and innovation indeed exists in India, but the relationship might be dynamic across time and varying economic circumstances. The complexity of the subject requires advanced econometrics models to suggest any actual causation or correlation, as shown by the simplified fixed effects implemented in this study, and we welcome future research with updated models and data to discern what the relationship is, as it may have a great impact on what policies should be created to foster economic growth in the developing world.

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