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Mini Symposium on Foreign Direct Investment in India

Foreign direct investment to and from emerging economies has experienced significant growth over the past 2 and a half decades. In 2014, these economies absorbed 59% of cumulative global FDI inflows and accounted for 39% of the world's total FDI outflows. The changing pattern of FDI inflows and outflows is expected to have significant impacts on the economies of developing countries in the years to come. FDI inflows have enormous potential to influence economic performance in host countries not only directly by providing access to modern technologies, but also indirectly through spillovers. In the current era of globalization, multinational enterprises (MNEs) have become powerful economic players as the primary vehicle of FDI. Out of 37 million listed companies and investors worldwide, 147 MNEs controlled 40% of the world's economic value. By virtue of their size; technological prowess; and internalized markets for skills, capital, technology, and brands; MNEs can enable developing countries to acquire updated technologies and access international networks to expedite industrialization and economic growth, create decent jobs, and reduce poverty. The United Nations has identified the revitalization of global partnerships for development as one of its Sustainable Development Goals. FDI flows figure prominently in this goal as a source of much-needed capital, technology, and market access for host countries.

There is a contrasting view claiming that as economic wealth becomes increasingly concentrated in MNEs, it may not be possible for the global economy to develop in a sustainable way. MNEs have the potential to destroy sustainable consumption and production patterns, leading to damaging economic, social, and environmental impacts. For instance, MNEs can support the creation of monopolies and oligopolies that crowd out domestic investment. Another concern is that MNEs will introduce technologies in host countries that destroy jobs, perpetuate inequalities, and generate pollution.

Thus, a pertinent question to ask is whether FDI is a vehicle for promoting sustainable development or a threat to such development. The existing literature appears to be ambiguous and inadequate to answer this question. While the literature on FDI is substantial, not enough is known about the impacts of FDI across different dimensions. Most studies, particularly in the context of developing countries, remain beset by a lack of quality data and weak methodology. In addition, the existing literature focuses primarily on FDI inflows, while issues surrounding outward investment are relatively less known.

To encourage FDI-related studies in developing countries, an international conference on Leveraging FDI for Sustainable Economic Development in South Asia: Evidence, Challenges, and Prospects was organized by the Asia Research Centre of the Copenhagen Business School in October 2015. Five studies, all pertaining to India, have been selected for the mini symposium presented here. Each of these studies falls into one of three broad categories covering the economic, social, or environmental aspects of development.

On the economic front, improving industrial competitiveness is central to raising the underlying growth rate of an economy. Competitiveness means deepening the technological and organizational skills of local firms, including research and development (R&D) efforts, enhanced efficiency in the use of resources, and performance in national and international markets. Two studies published in this symposium analyze the impacts of foreign ownership on technological spending and international competitiveness. Aggarwal links foreign ownership with the mode of technology sourcing used by firms. She argues that the spillover effects of foreign ownership remain limited if domestic firms depend on their parent organization for acquiring technology. She analyzes the intensities of local R&D efforts and the technology imports of local and foreign firms in a comparative analytic framework. Propensity score matching analysis reveals that foreign companies, particularly those with majority stakes, spend less on R&D and more on acquiring technology from their parent organization than their local counterparts. While focusing on the export behavior of domestic and foreign firms, Ghosh and Sinha Roy find that foreign ownership does not significantly enhance the export intensity of Indian manufacturing firms. Rather, firms enhance their international competitiveness from a mix of imported raw materials, foreign technical know-how, and local R&D.

The study by Sharma focuses on the social dimensions of FDI. She investigates whether FDI inflows in an industry increase plant-level employment, average wages, and skilled labor. Theoretically, foreign ownership provides host countries with access to knowledge, which, if absorbed by domestic workers, enhances the human capital stock. The effects spill over to domestic firms through the training of suppliers, imitation, labor mobility, and formal and informal transfers of know-how to domestic workers. This should lead to an increase in average wages for workers in both domestic and foreign firms. Further, if there are complementarities between foreign inputs accompanied with foreign investment and the skills of workers, an increase in FDI should also lead to an increase in demand for skilled workers. The results suggest that there are strong market reallocation effects as the share of foreign ownership increases in an industry, while a critical mass of FDI is likely required to influence the demand for and pool of skilled workers in an industry.

Concerning the environmental dimension, Kathuria finds that MNEs are not investing in polluting industries in India. His study tests the pollution haven hypothesis—the possibility that investors seek out jurisdictions with fewer regulatory requirements and therefore cheaper operating costs—by focusing on the impacts of environmental governance using data for 21 Indian states. The results do not find any evidence in support of the pollution haven hypothesis. Other market and infrastructure-related variables are more important in influencing foreign firms' location decisions in India than a state's environmental stringency.

The literature on outward FDI from emerging economies has also proliferated of late. India's outward FDI stock registered a quantum jump over the last decade from only about $25 million annually during the early 1990s to $241 billion in 2013. Sasidharan and Padmaja investigate how firms in a resource-poor country invest internationally by analyzing the role of both internal and external financing constraints of Indian manufacturing firms in determining their outward FDI decisions and number of foreign affiliates. Their empirical findings confirm the importance of internal funds in firm investment decisions and the magnitude of such investments. Firms that are large, highly productive, and export oriented are more likely to invest abroad.

The studies presented here are methodologically rigorous. We believe that both academics and policy makers will find them useful. Taken together, they have demonstrated that the benefits of globalization and FDI are not automatic. Improved infrastructure, stronger institutions, and expanded capabilities among domestic firms are needed to promote both inward and outward FDI flows and exploit the opportunities created by globalization. Inward FDI flows must be matched with host country policies to facilitate the spillovers and linkages needed to ensure that FDI contributes to structural transformation and growth.

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The Impact of Foreign Ownership on Research and Development Intensity and Technology Acquisition in Indian Industries: Pre and Post Global Financial Crisis

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This study examines how interfirm heterogeneities in modes of technology acquisition and technology intensities are linked to firm ownership in India using a panel data set of about 2,000 firms listed on the Bombay Stock Exchange for the period 2003–2014 drawn from the Prowess database of the Center for Monitoring Indian Economy. Foreign ownership is categorized according to the level of control exercised by foreign firms as defined under the Companies Act of India. A comparative analysis of domestic and different categories of foreign firms was conducted for two time periods: (i) the global boom period of 2004–2008, and (ii) the post global financial crisis period of 2008–2014. A horizontal cluster analysis of 3-digit, industry-level data shows that foreign firms cluster in high-technology industries. The propensity score matching analysis, however, reveals that in a matched sample of foreign and domestic firms, majority-owned foreign firms spend less on research and development and more on technology transfers than their local counterparts, demonstrating that the level of equity holdings by a foreign firm matters. There is little evidence of the global financial crisis affecting the relocation of research and development activities to India. An alternative assessment based on panel data regression analysis confirms these findings and validates the propensity score matching results.

Keywords: domestic firms, foreign firms, global financial crisis, local R&D, majority-owned foreign subsidiaries, minority-owned subsidiaries, technology acquisition
JEL codes: G21, G32, K22, L25

I. Introduction

Rapid advances in technology, which have been reinforced by the process of globalization, have exposed firms in developing economies to intense technological competition both in domestic and export markets. Efforts toward building

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technological capabilities are increasingly becoming vital for them to compete. However, building these capabilities is costly, cumulative, and evolutionary; it takes time and progress is uncertain (Lall 1992). Realizing this, the governments of developing economies have encouraged multinational enterprises (MNEs) to set up local production facilities in the hope of importing new technologies and building the technological capabilities of domestic firms. It is expected that the presence of MNEs will entail technology transfers to domestic firms through spillover mechanisms such as labor turnover, imitation, competition, and demonstration. However, there is evidence that technology spillover effects are neither robust nor consistent across economies (see, for example, Mebratie and van Bergeijk 2013, Demena and van Bergeijk 2017). There is growing recognition that foreign direct investment (FDI) can ensure more profound knowledge spillovers to domestic firms if MNEs perform a larger share of their research and development (R&D) activities in host economies (UNCTAD 2005). Therefore, attracting R&D-intensive FDI is a critical concern for national policy makers in developing economies.

The present study analyzes the technological behavior of MNEs in India and investigates whether MNE subsidiaries are significantly different from their domestic counterparts in terms of technology intensity and modes of technology sourcing. Specifically, it examines whether MNEs spend more on R&D than their domestic counterparts or whether they are more likely to acquire new technologies from their global networks through licensing and imported capital goods.

It is assumed that R&D-intensive MNE subsidiaries (with significantly more R&D spending than domestic firms) are likely to have more robust effects on the technological capabilities of host economies than those subsidiaries that depend on technology imports from their parent firms (i.e., spending more on technology imports than their domestic counterparts). The former are better embedded into the local innovation systems and have greater potential for technological spillovers. The possibility that MNEs are not significantly different from domestic firms in either R&D spending or technology imports cannot be ruled out. Such MNEs would be considered technological laggards. The opposite is true if MNEs spend significantly more on both R&D and technology imports than their local counterparts. These MNEs may have the greatest potential for knowledge transfers to host economies.

In general, the distribution of corporate R&D spending is highly skewed across industries. A few high-technology sectors account for the overwhelming share of R&D activity (Hirschey, Skiba, and Wintoki 2012). Given that MNEs undertake the bulk of global R&D expenditures and tend to have a strong presence in high-technology industries, differential technological behavior of foreign affiliates may reflect the fact that MNEs are attracted to such industries (Globerman, Ries, and Vertinsky 1994; Girma, Greenaway, and Wakelin 2001; Bellak 2004). However, the possibility that they predominate in resource- or labor-intensive industries cannot be ruled out either. Selection bias can thus be a major problem in such studies (Damijan et al. 2003, Javorcik and Spatareanu 2008, Hake 2009).

Therefore, this analysis begins by identifying the sectoral distribution of MNEs in India by technological intensity using cluster analysis. This is followed by the use of propensity score matching methods to match each foreign firm with a domestic counterpart within broad industry groups to estimate the impact of foreign ownership on different forms of technological spending. To check the validity of my results, I also conduct panel data regression analysis on matched samples. The data are partitioned into two periods: (i) the global boom period of fiscal year (FY)2003–2004 to FY2007–2008, and (ii) the global financial crisis and postcrisis period of FY2008–2009 to FY2013–2014.[1] I conduct a separate analysis for each period to investigate the impact of global conditions on the technological behavior of foreign and domestic firms. There is evidence that the global relocation of R&D activities suffered following the global financial crisis (Kinkel and Som 2012; Dachs, Stehrer, and Zahradnik 2014). This paper explores how the crisis impacted on the technology sourcing and technology spending of MNEs and domestic firms in India in a comparative analytic framework.

The study contributes to the existing literature in the following ways. First, it offers a systematic analysis of the differential technological behavior of MNEs and domestic firms. Indeed, there are studies that indicate the impact of foreign ownership on the R&D intensity of firms (Becker 2013; Tomiura 2003; Kumar and Saqib 1996; Kumar and Aggarwal 2005; Sasidharan and Kathuria 2011; Balsari, Özkan, and Varan 2015). Yet, few have analyzed the technology strategies of foreign firms by considering alternative modes of technology sourcing. Second, most existing studies are concerned with foreign ownership; the strategic importance of the share of foreign ownership holding is largely ignored. This study identifies three levels of foreign ownership holding (10%–25%, 25%–50%, and 50% and above) and analyzes how impacts vary with the level of foreign ownership. Finally, the firm ownership data available from secondary sources, which form the basis of most studies (particularly for India), are subject to several limitations including a lack of transparency in the identification of foreign firms. Ownership data for the latest year are used for identifying foreign firms for all previous years. Given that a firm's ownership structure (particularly of publicly traded firms) is subject to continuous change, this practice is likely to yield spurious results. The present study addresses this gap through scrutiny of changes in ownership patterns for each firm over the relevant time periods.

Since the economic liberalization of the early 1990s, India has increasingly lowered barriers to entry for FDI. It is expected that FDI strengthens the competitiveness of Indian industries through technology transfers and by upgrading the technological capabilities of domestic firms through spillover effects, thereby contributing to restructuring and growth in the Indian economy. This study is

[1] In India, a fiscal year is the period between 1 April and 31 March.

expected to have important implications for policy makers in India and other developing economies that have adopted a similar growth path.

The rest of the study is organized as follows. Section II discusses the changing role of FDI in the Indian economy and establishes the relevance of India as the reference economy. Section III describes the theoretical underpinnings of the analysis. Sections IV and V provide methodological and data-related detail, respectively. Section VI presents the empirical results and section VII concludes.

II. Foreign Direct Investment in India

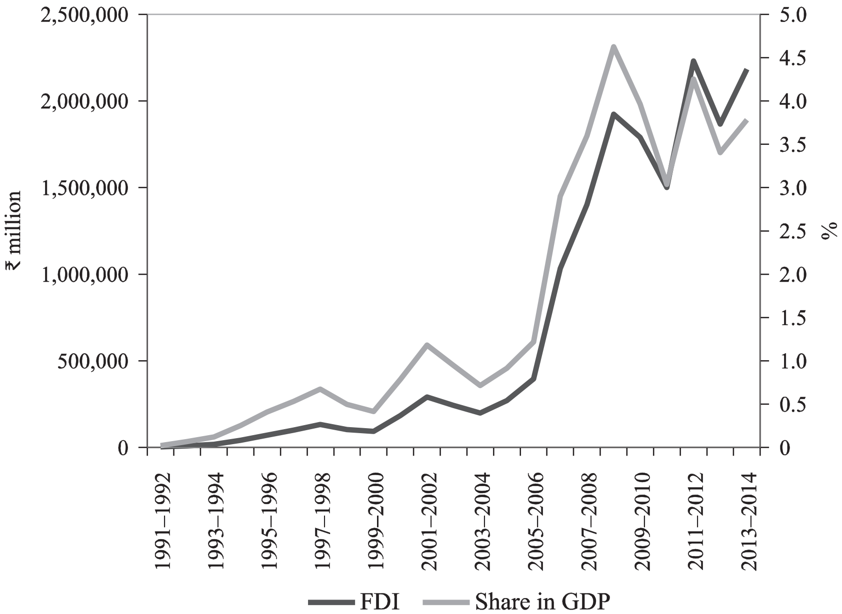
There has been a tremendous increase in inward FDI in India since economic reforms were adopted in 1991, particularly since 2005. Prior to 1991, FDI was only allowed in core technology-intensive industries in which little technological progress had been made domestically. The Foreign Exchange Regulation Act imposed numerous restrictions on MNEs' ownership control, entry into markets, and growth, including the setting up of joint ventures with domestic partners, local content clauses, export obligations, and promotion of local R&D. In the post-1991 period, FDI has provided access to international networks and become a critical source of scarce capital, technology, and managerial skills. There has been a complete shift in government policy in favor of FDI since 1991, including the amendment of investment laws and guidelines to facilitate and promote inflows of FDI. In 2005, the Government of India began to accelerate its FDI reforms, lowering caps on foreign ownership across all sectors, particularly in construction, development of townships, defense, insurance and pensions, and single brand and e-commerce retail sectors. Currently, 100% foreign ownership is allowed in most sectors with a few exceptions.[2] In addition, attempts have been made to ease the norms, streamline rules and regulations, and improve the business climate.

These reforms have led to annual FDI inflows in India growing from about $129 million (₹3.2 billion) in FY1991–1992 to over $46 billion (₹2.2 trillion) in FY2011–2012 (Figure 1). FDI inflows as a percent of gross domestic product also grew steadily during this period, with the ratio of FDI to gross domestic product improving from less than 2% in FY1991–1992 to over 4.5% in FY2008–2009, before declining to 3.8% in FY2013–2014.

The stock of FDI has increased astronomically since FY1991–1992. According to the RBI (2015), total foreign liabilities were only $1.23 billion in 1992. This figure rose sharply to $265 billion as of 31 March 2015 (RBI 2015). Nearly half of the total FDI stock at market prices was in the manufacturing sector in

[2]These exceptions include defense (49%), broadcasting content services (49%), print media (26%), insurance (49%), infrastructure in securities markets (49%), and private security agencies (49%). In addition, a small negative list includes lottery, gambling, chit funds, manufacturing of cigars and cigarettes, real estate business, and sectors not open for the private sector (e.g., atomic energy and railway operations).

Figure 1. **Inward Foreign Direct Investment Flows and Gross Domestic Product in India, FY1991–1992 to FY2013–2014**



FDI = foreign direct investment, FY = fiscal year, GDP = gross domestic product.
Source: Reserve Bank of India. *Monthly Bulletins* (various issues). Mumbai.

2015. Information and communication services (15.5%) and financial and insurance (13.6%) were the other major activities attracting FDI. Globally, India has become one of the most attractive destinations for FDI by improving its position vis-à-vis other economies. During FY2005–2006, India was the fourth-largest recipient of FDI in the world. After the global financial crisis, it temporarily fell from among the top 10 recipients of FDI before rejoining this grouping in 2014. On a regional basis, India accounts for more than 90% of all FDI in South Asia.

There has also been a proliferation of wholly and majority-owned foreign companies in India in the postreform period. The foreign share of total equity in foreign companies was about 72% at the end of 2014, while in the manufacturing sector it was about 85% (RBI 2015). This is significant because prior to FY1991–1992 the foreign equity share was restricted to 40% in most sectors.

Finally, there is anecdotal evidence that India is receiving R&D-intensive FDI. According to the National Science Foundation, firms from the United States spent $73 billion on R&D in host economies in 2013; of this total, around $6 billion (8%) was spent in India.[3] Many prominent United States firms have set up their R&D centers in India, including GE, Intel, Microsoft, and IBM, which has two labs

[3]National Science Foundation. Statistics. http://www.nsf.gov/statistics/.

in India employing over 500 scientists (Patra and Krishna 2015). In this context, the present study is important because it provides systematic evidence on whether foreign ownership is important for stimulating domestic R&D activities in India.

III. Theoretical Discussion

A. Technological Activities: Multinational Enterprises versus Domestic Firms

The theoretical literature on the technological behavior of MNEs comprises four major strands and is largely ambiguous with regard to predictions. The traditional international business literature, comprising the industrial organization (Caves 1996, Hymer 1976) and transaction cost theories (Dunning 1993, Williamson 1975), argues that the existence of MNEs hinges on the relative monopolistic advantages that they enjoy against rival domestic firms. They derive their competitive advantages from the assets they have generated in their home economies. Proprietary technology is the key firm-specific asset and it is guarded closely through internalization. Therefore, R&D activities are mostly being carried out at firms' headquarters and the subsidiaries depend upon imported technologies. Their own R&D activities are at best limited and mainly to adapt products and services in line with local tastes and requirements. Therefore, R&D expenditures among MNE subsidiaries are likely to be smaller than those of their local counterparts, while the opposite might be true for imports of embodied and disembodied technologies.

The resource-based view turns the focus from the firm (MNE) to the subsidiary (Peng 2001; Rugman, Verbeke, and Nguyen 2011). It conceptualizes an MNE subsidiary as a semiautonomous entity with its growth driven by its own distinctive capabilities developed through entrepreneurial efforts, including the creation and development of local technological competencies complementary to the rest of the MNE.

The newly emerged literature on R&D relocation (Cantwell and Janne 1999, Kuemmerle 1999, Dunning and Lundan 2009) focuses on the internationalization of R&D by MNEs and views it as part of their strategic business decisions, which are driven by the motivations of accessing talent at lower costs, tapping into local centers of excellence, commercializing products in foreign markets with the speed required to remain competitive, and contributing to their headquarters' stock of knowledge. But the decision to internationalize R&D is contingent upon specific MNE, home country, and host country advantages (e.g., market size, scientific and engineering capabilities, lower costs, university research, and level of industrialization) that shape the decisions of MNEs (see, for example, OECD 2008a; Dachs, Stehrer, and Zahradnik 2014).

The social network theory focuses on parent–subsidiary relationships, subsidiary roles and strategies, and subsidiary resources and capabilities. Its proponents (Ghoshal and Bartlett 1990; Gupta and Govindarajan 1991; Birkinshaw, Hood, and Jonsson 1998; Birkinshaw, Hood, and Young 2005; Cantwell and Mudambi 2005) argue that an MNE is not a compact, rationally conceived organization with a uniform goal, but a differentiated network of a variety of subsidiaries that face heterogeneous national contexts. There are three levels of networks:

(i) intraorganizational networks that encompass headquarters and subsidiaries, and their interrelationships;

(ii) interorganizational networks that are formed between the MNE and other organizations in joint ventures, strategic alliances, and licensing agreements; and

(iii) MNE local networks with customers, suppliers, and authorities.

The extent to which an MNE subsidiary is embedded in these networks determines its technological behavior. The greater it is embedded within intraorganizational networks the greater will be its dependence on the headquarters for technological knowledge and information. On the other hand, a greater embeddedness of MNEs in local networks is associated with greater technology creation in host economies. But the network embeddedness of subsidiaries is essentially a matter of the strategic choices of the parent firm, which in turn are influenced by subsidiaries' own initiatives, resources, and capabilities, as well as the locational advantages of host economies.

The arguments related to technology spending by MNEs in host economies are ambiguous. Thus, we set up competing hypotheses for quantitative testing:

(i) Hypothesis 1: MNE subsidiaries have an R&D intensity significantly higher than that of domestic firms.

(ii) Hypothesis 2: MNE subsidiaries exhibit a higher intensity of spending on royalty payments for technology imports from international networks than their local counterparts.

B. Ownership and Technological Activity

The classical international business theories postulate that a strategic (controlling) ownership stake ensures greater embeddedness of subsidiaries within internal networks to minimize leakages of their proprietary technology. In contrast, the network approach argues that the subsidiaries that are subject to a controlling or majority ownership stake are more likely to compete for excellence within the organization and commit larger resources to R&D spending because such subsidiaries are vital to the success of the parent firms and are therefore more likely to be assessed with regard to their long-term objectives. This argument also underpins the institutional approach, which posits that a firm's strategic behavior is influenced by the surrounding institutional environment (Dunning and Lundan 2008). When the regulatory environment is weak in the host economy and/or the social and cultural distance between the home and host economies is large, the company lowers its ownership stake and commits lower resources. The lower the ownership stake, the lower the level of support that subsidiaries receive from their parents for local initiatives. This also implies that their dependence on internal networks is higher. There are thus conflicting arguments regarding the impact of ownership stakes also. We therefore test two competing hypotheses:

(i) Hypothesis 3: Majority-owned subsidiaries exhibit a greater tendency to embed in local networks and incur larger R&D expenditures than their local counterparts.

(ii) Hypothesis 4: Majority-owned subsidiaries are more likely to depend on imported technologies from their parent firms and other internal network actors.

C. Global Crisis, Ownership, and Technological Activity

In contrast to the above, there is no clear theoretical prediction regarding the effects of global economic and financial crises on the globalization of R&D activities by MNEs. One argument is that negative market growth expectations during a crisis can drive MNEs to lower the coordination costs of dispersed R&D. The opposing argument is that amid economically challenging conditions, firms tend to minimize costs by relocating more of their activities to cheaper locations (Kinkel and Som 2012). Empirically, Dachs, Stehrer, and Zahradnik (2014) find that in most economies, the R&D spending of MNEs is more severely affected by global crisis than that of domestic firms. They observed a reversal in the trend of R&D internationalization in the period following the recent global financial crisis. Kinkel and Som (2012), on the other hand, find that small firms were hurt by the crisis even as large firms continued to relocate their R&D amid the crisis. Thus, once again I set up opposing hypotheses:

(i) Hypothesis 5: Foreign firms exhibit higher R&D intensity than their local counterparts during periods of economic crisis.

(ii) Hypothesis 6: Foreign firms exhibit lower R&D intensity than their local counterparts during periods of economic crisis.

IV. Methodology

For empirical analysis, I used a multilevel methodology, which is discussed below.

A. Identifying Foreign Firms

Following International Monetary Fund guidelines, a direct investment enterprise in India is defined as an incorporated or unincorporated enterprise in which a foreign direct investor owns 10% or more of the ordinary shares or voting power (for an incorporated enterprise) or the equivalent (for an unincorporated enterprise). There is, however, recognition that a numerical guideline of 10% does not capture the essence of FDI for economic analysis. This definition is adopted for the sake of consistency and cross-country comparability of FDI statistics and is based on the premise that a share as low as 10% of voting rights or equity capital allows the investor to "influence the management," providing the basis for an FDI relationship. The System of National Accounts Framework of the United Nations uses "controlling stakes" as the basis for economic analysis of FDI for which more than 50% ownership is necessary. OECD (2008b, 21–23) defines "companies with a 50% or more stake as FDI subsidiaries (controlled enterprises), while those with a 10%–50% stake are FDI associates (influenced enterprises)." Under the Companies Act of India, there are three threshold levels of shareholding from the perspective of defining "influence" and "control" (10%, 25%, and 50%). Based on this classification and the available data, I have identified three types of foreign firms:

(i) minority holding (10%–25%) with minor influence,

(ii) dominant minority holding (25%–50%) with dominant influence, and

(iii) majority holding (above 50%) with controlling stake.

In addition, I have created a category for experiential foreign firms. These firms are not predominantly foreign firms; rather, they have foreign ownership for only a short time during the review period.

B. Investigating the Sectoral Distribution of Multinational Enterprises by Technology Intensity Using Cluster Analysis

To identify the sectors targeted by MNEs, I clustered industries at the 3-digit level by technological orientation and brand value using the "wards linkage" method of hierarchical clustering (Everitt, Landau, and Leese 2001). Based on the dendograms and appropriate stopping rules, I determined the number of clusters in the sample and then examined the presence of foreign firms by ownership stake in each group. The analysis was conducted at the 3-digit level of aggregation using the STATA statistical package and the following variables:

(i) R&D spending-to-sales ratio = 1 if it is > 0 for the industry and 0 otherwise,

(ii) ratio of royalty payments abroad to sales = 1 if it is > 0 for the industry and 0 otherwise,

(iii) ratio of capital goods imports to sales = 1 if it is > 0 for the industry and 0 otherwise,

(iv) ratio of advertisement expenditures to sales = 1 if it is > 0 for the industry and 0 otherwise, and a

(v) dummy variable = 1 if the firm is in the manufacturing sector and 0 if it is in the service sector.

C. Assessing the Difference in Technology Intensity between Local and Foreign-Owned Firms

1. Propensity Score Matching

Propensity score matching is a nonparametric estimation method that creates a comparison group (domestic firms) with identical distributions of observable characteristics to those in the treatment group (foreign firms) to address the issue of endogeneity. The basic idea is to find for every foreign firm a matching domestic firm in terms of all relevant observable characteristics X. The mean effect of foreign ownership (or the average treatment effect) is then calculated as the average difference in outcomes between the foreign and matched domestic firms.

For matching, I constructed four propensity score models corresponding to four categories of the foreign firms using firm- and industry-specific attributes.[4] In each case, it was ensured that the balancing property was satisfied. A kernel method was used to identify the domestic firms that match the foreign firms. The condition of common support resulted in discarding some firms. The level of rejection of unmatched domestic firms varied between 14% and 23%. Considering that there are a large number of domestic firms, this does not amount to a significant loss of

[4]Further details are available upon request.

data and is therefore unlikely to compromise the representativeness of the results. To assess the quality of matching, appropriate tests were conducted. However, while matching removes any bias caused by selection on observable variables, it leaves the possibility of bias due to selection on unobservable variables. Thus, perfect matching is not possible, which affects the quality of estimates. The propensity score matching analysis is therefore complemented by a generalized least squares (GLS) regression analysis based on the panel database to check the consistency and robustness of the results.

2. Generalized Least Squares Regression on the Matched Sample

The variables representing technological activity are regressed on foreign ownership variables after controlling for firm- and industry-specific characteristics using the matched sample. The firms that are off the common support are dropped to include only those in the common support region. The following model is used for the analysis:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \upsilon_{it}$$

where Y_{it} is the dependent variable representing two alternative modes of technology sourcing: (i) R&D, and (ii) international transfer of disembodied technologies. These estimations are performed only for local R&D (RD_INT) and disembodied technology imports (ROY_INT). The control variables are drawn on the existing literature (see, for example, Becker 2013, Cohen 1995) and are described in Table 5.

The two modes of technology activity, R&D and acquisition, are not independent of each other. Technology imports by firms are likely to influence their R&D efforts, while the intensity of technology imports may itself depend on R&D efforts. Thus, there is possible simultaneity between the two. Further, with respect to most explanatory variables in the model, there could be a problem of endogeneity. To address these issues, I assume that both technology choice and intensity are strategic decisions with a long-term orientation. Firms do not spontaneously determine them based on current performance. Rather, they take account of past, current, and planned behavior and performances in making such decisions. Therefore, I converted the behavioral explanatory variables into a moving average of 3 years comprising the lagged year, current year, and lead year. However, tax rate (TAX) and profit margin (PCM) are lagged by 1 year only. The inclusion of lagged and lead variables addresses the issues of causality and simultaneity, and allows us to estimate the two models separately to explore the impact of foreign ownership on technology intensities.

A panel data approach is employed to control for unobserved firm- and time-specific characteristics. A fixed-effect specification of the model is normally considered ideal but has been ruled out here because it does not return estimates of the time-invariant variables, which are the main variables. Thus, I have used the random-effect specification. In general, fixed-effect estimates are preferred over random effects because the latter produce biased estimates if the regressors and the residuals (firm effects) are correlated. Recent studies have found this justification insufficient to prefer fixed over random effects based on the argument that if the units are relatively similar on average, then the appropriate model should be guided by the researcher's goals (Clarke et al. 2010, Clark and Linzer 2015). Since I am using matched samples, the firms are rather similar. Therefore, the use of random-effect GLS estimates is not expected to be inferior. For ensuring the robustness of the GLS estimates, I have also controlled for the time effects by incorporating year dummies to capture fixed effects of intertemporal shifts and corrected the estimates for heteroscedasticity. For yet another validity check, I have obtained Mundlak estimates (see, for example, Bell and Jones 2015). These estimates relax the assumption in the random-effects estimator that the observed variables are uncorrelated with the unobserved variables. But these estimates cannot control for time-specific variations and heteroscedasticity. For a comparative analysis of the main variables, I have presented Mundlak's estimates only for the key variables in the text.

V. Data

Empirical analysis is based on firm-level data from Prowess, a database of the financial performance of over 27,000 listed and unlisted Indian firms from a wide section of the manufacturing, utilities, mining, and service sectors. The data are collected by the Centre for Monitoring Indian Economy from the balance sheets of firms and are updated continuously. Along with financials, the database also provides detailed information on the shareholding patterns of these companies. Most studies use the ownership data of the latest year, assuming that the shareholding patterns of firms remain the same over the years prior to the latest year. However, this assumption is not reasonable for two reasons. First, the shares of most of these companies are actively traded in the market and the acquisition of shares of the existing firms through the market has become an important mode of entry for foreign firms in India. Second, the data on shareholding patterns for a given period is available only for those firms that are actively traded in the market during that period. Clearly, the studies that use the ownership data from the latest year are subject to selectivity bias. For different periods, the results may vary depending upon the availability of ownership data and firms' ownership stakes in the latest year. There is evidence that the distributional properties of samples drawn from Prowess are not consistent for different periods (Choudhury 2002). To address this limitation, we procured the ownership data of 5,109 listed firms as of 31 March of each year from FY2000–2001 to FY2013–2014. The data were matched with the Stock Exchange Board of India and Bloomberg ownership databases available online for validation purposes. For each firm, the data for the available years were cross-checked and gaps were filled wherever possible. Since the data pertain only to actively traded firms, it was cleaned for the purpose of making consistent comparisons. First, only those firms for which the information was available for each of the 11 years were included, leaving 2,004 firms. Second, those firms reporting zero or negative net sales were dropped. After the cleaning process, the final data set consisted of a balanced panel of 1,781 firms spanning 11 years (FY2003–2004 to FY2013–2014).

VI. Empirical Results

A. Cluster Analysis of the Sectoral Distribution of Multinational Enterprises by Technology Intensity

Based on the standard rules mentioned above, I identified five clusters of industries. Each of the clusters is well populated, confirming that each cluster is substantive. Table 1 gives the mean values of the variables in the five principal clusters. The main dividing line runs between the manufacturing and service industries on one hand, and between industries that score high and low on the technology and product differentiation variables on the other hand.

Table 2 reports the clustering results by ownership mode, which is of primary interest here. Between FY2003–2004 and FY2007–2008, the distribution of foreign companies was highly skewed in favor of high-technology manufacturing industries. As stated above, the technological or brand superiority of MNEs is the primary reason they venture into investing abroad in the first place. In India, this pattern can also be attributed to the legal framework prior to 1991, which sought to channel FDI into high-technology production by setting higher FDI caps in these sectors. By the period from FY2008–2009 to FY2013–2014, services had become more promising and the sectoral distribution of FDI became somewhat diffused (as shown by the reduced levels of standard deviations). There was a substantial restructuring in the distribution of experiential firms from services to manufacturing during this decade, reflecting a shift of FDI from manufacturing to services. But within each broad sector, changes have been marginal rather than substantive. Within manufacturing, there is a visible shift of foreign firms in favor of medium-technology consumer goods. However, over 62% of majority-owned companies still belonged to the high-technology manufacturing cluster and almost one-fourth of these were concentrated in the high-technology services cluster. Only about 15% could be classified as low technology, either in manufacturing or services.

A critical question is whether foreign firms are also more active in R&D than their local counterparts or if they continue to embed in internal knowledge networks. In the propensity score matching and regression analyses, I shall address

Table 1. **Mean Values by Clusters**

	Manufacturing			Services	
Variable	**High Technology and High Product Differentiation**	**Medium Technology and High Product Differentiation**	**Low Technology and Low Product Differentiation**	**High Technology and High Product Differentiation**	**Medium Technology and High Product Differentiation**
Number of industries	83	67	53	25	52
R&D expenditure-to-sales ratio (%)	0.65	0.30	0.00	0.39	0.00
Royalty payments abroad-to-sales ratio (%)	0.35	0.04	0.00	0.10	0.05
Capital goods imports-to-sales ratio (%)	1.79	2.54	1.19	2.32	3.50
Advertisement expenditure-to-sales ratio (%)	1.50	2.17	0.91	0.98	3.02

R&D = research and development.
Source: Author's calculations.

Table 2. **Classification of Firms by Technological Orientation of Industries (%)**

	FY2003–2004 to FY2007–2008				
	Majority Owned	**Dominant_ Minority**	**Minority Owned**	**Experiential_ Foreign Firms**	**Domestic Firms**
High technology and high product differentiation manufacturing	64.6	62.3	62.2	36.7	37.7
Medium technology and high product differentiation manufacturing	6.3	7.5	2.7	10.0	13.2
Low technology and low product differentiation manufacturing	1.3	9.4	13.5	0.0	5.5
High technology and high product differentiation services	19.0	18.9	13.5	46.7	32.2
Medium technology and high product differentiation services	8.9	1.9	8.1	6.7	11.4
Total	100.0	100.0	100.0	100.0	100.0
Standard deviation	25.7	24.4	24.0	20.4	14.1
	FY2008–2009 to FY2013–2014				
	Majority Owned	**Dominant_ Minority**	**Minority Owned**	**Experiential_ Foreign Firms**	**Domestic Firms**
High technology and high product differentiation manufacturing	62.4	56.0	50.0	46.2	37.7
Medium technology and high product differentiation manufacturing	7.3	12.0	9.3	19.2	12.9
Low technology and low product differentiation manufacturing	0.9	4.0	11.1	7.7	5.4
High technology and high product differentiation services	22.9	22.0	18.5	26.9	32.0
Medium technology and high product differentiation services	6.4	6.0	11.1	0.0	11.9
Total	100.0	100.0	100.0	100.0	100.0
Standard deviation	25.1	21.3	17.1	17.9	14.0

Source: Author's calculations.

this question after matching each foreign firm with a domestic counterpart within the broad industrial classifications adopted above.

B. Propensity Score Matching and Generalized Least Squares Results

Descriptions of the variables are provided in Table 3. Table 4 reports the summary results of matching quality assessment tests.

The results of matching for individual covariates show large differences in the covariates between the foreign and domestic firms in the original sample. These

Table 3. **List of Variables**

Category	Variable	Description
Foreign ownership	DFOR50	Firms that had been majority holders (above 50%)
	DFOR25	Firms that had been dominant minority holders (25%–50%)
	DFOR10	Firms that had predominantly been minority holders (10%–25%) (Predominantly is defined as more than two-thirds of the period.)
	DFOR_EXP:	The remaining firms that have been under a 25% or more foreign ownership stake in at least one of the years but less than two-thirds of the period.
Modes and intensities of technological activities	RD_INT	Total research and development expenditure of *i*th firm as a proportion of its sales (%)
	ROY_INT	Royalties and technical fees paid abroad by *i*th firm as a proportion of its sales to measure acquisition of disembodied technologies (%)
	CAPIMP_INT	Imports of capital goods by *i*th firm as a proportion of its sales to measure acquisition of embodied technologies (%)
Firm specific	SIZE	Net sales (transformed into logarithms)
	SIZE2	Square of SIZE
	AGE	The current year net of the year of incorporation
	EX_INT	Exports of goods and services as % of net sales
	CAPINT	Net fixed assets as % of net sales
	IMPR_INT	Imports of raw materials and components as % of net sales
	PCM	Profits before tax as % of net sales
	Tax	Profits before tax as % of profits after tax
Industry specific (Based on the cluster analysis)	HTECH_MFG	High technology and high product differentiation manufacturing industry = 1
	MTECH_MFG	Medium technology and high product differentiation manufacturing industry = 1
	LTECH_MFG	Low technology and low product differentiation manufacturing industry = 1
	HTECH_SER	High technology and high product differentiation services
	MTECH_SER	Medium technology and high product differentiation services

Source: Author's description.

differences are considerably reduced after the kernel matching. In all the cases, the absolute mean bias turns out to be insignificant.

The pseudo R-squared, which is obtained by regressing treatment propensity scores on all covariates used in matching on the matched and unmatched samples, substantially decreased after matching in all cases. Rosenbaum and Rubin (1983) suggest that a standardized difference of more than 20 should be considered to be large. Our results show that, post matching, none of the standardized differences have an absolute value larger than 3. Finally, the likelihood ratio is insignificant in

Table 4. **Kernel Matching Performance: Results of the Mean and Median Absolute Bias, Pseudo R-Squared, and LR Tests**

	Pseudo R^2	LR chi^2	p>chi^2	Mean Bias	Medium Bias
Unmatched	0.102	64.78	0	33.5	24.2
Matched	0.002	0.49	1.000	2.6	2.2
Unmatched	0.049	23.36	0.005	20.9	15.3
Matched	0	0.06	1.000	1.3	1.1
Unmatched	0.063	22.71	0.007	23.2	20.2
Matched	0.006	0.65	1.000	3.3	1.1
Unmatched	0.057	17.05	0.03	19.1	14.1
Matched	0.002	0.14	1.000	3.2	2.6
Unmatched	0.071	58.26	0.000	28.0	24.9
Matched	0.001	0.27	1.000	2.0	1.1
Unmatched	0.026	11.94	0.217	17.0	10.3
Matched	0	0.03	1.000	0.8	0.6
Unmatched	0.024	11.80	0.225	13.4	11.0
Matched	0.002	0.35	1.000	0.9	0.4
Unmatched	0.015	3.88	0.867	19.0	9.6
Matched	0	0.01	1.000	0.7	0.6

LR = likelihood ratio.
Source: Author's calculations.

all models in the matched samples, confirming the results of the previous two tests. Matching clearly removes a large part of mean and median biases across the board.

The average treatment effects presented in Table 5 show the average difference in the technology intensities between foreign and domestic firms. The GLS estimates are presented in Table 6.

The results reveal that the majority-owned and dominant-minority MNEs were technologically more active than their minority-holding and experiential counterparts during the precrisis period, even though they largely depended on their internal networks to acquire technologies. The modes of technology acquisition adopted by them and technology intensities were also found to be different from those of matched domestic firms. The firms with minority ownership were not significantly different from their local counterparts, while experiential firms appear to be the technological laggards, possibly because they were clustered in the service sector where R&D expenditures were relatively small. The gap between technology expenditures by local and foreign enterprises across all categories narrowed considerably in the postcrisis period. The GLS estimates indicate that this was due to MNEs accelerating their technological expenditures. I discuss the results by mode of technology sourcing below.

1. Research and Development Activity

It may be seen that the average treatment effect on R&D intensity is negative across almost all groups in the pre global financial crisis period. The average R&D

Table 5. **Propensity Score Matching Estimates of the Average Effect of Foreign Ownership and Ownership Stakes**

	Foreign Firms	Domestic Firms	Technology Spending Indicator	Average Treatment Effect	Bootstrapped Standard Deviation	t-statistics
			FY2004–2005 to FY2007–2008			
DFOR50	77	1,549	RD_INT	−.131	.079	−1.658*
	77	1,549	ROY_INT	.520	.118	4.410***
	77	1,549	CAPIMP_INT	−.496	2.342	−.212
DFOR25	53	1,336	RD_INT	0.147	0.237	0.619
	53	1,336	ROY_INT	0.403	0.181	2.219**
	53	1,336	CAPIMP_INT	−0.305	0.424	−0.721
DFOR10	37	1,305	RD_INT	−0.168	0.165	−1.1018
	37	1,305	ROY_INT	−0.018	0.061	−0.299
	37	1,305	CAPIMP_INT	0.615	1.173	0.524
DFOR_EXP	30	1,206	RD_INT	−0.276	0.129	−2.132**
	30	1,206	ROY_INT	−0.087	.050	−1.1734
	30	1,206	CAPIMP_INT	0.520	1.054	0.493
			FY2009–2010 to FY2013–2014			
DFOR50	109	1,499	RD_INT	0.091	0.133	0.685
	109	1,499	ROY_INT	0.526	0.111	4.760***
	109	1,499	CAPIMP_INT	0.136	0.320	0.426
DFOR25	50	1,340	RD_INT	0.604	0.560	1.079
	50	1,340	ROY_INT	0.220	0.120	1.830*
	50	1,340	CAPIMP_INT	0.291	0.464	0.627
DFOR10	50	1,340	RD_INT	−.005	0.184	−0.027
	50	1,340	ROY_INT	0.031	0.046	0.672
	50	1,340	CAPIMP_INT	−0.135	0.351	−0.384
DFOR_EXP	26	1,209	RD_INT	2.703	2.836	0.953
	26	1,209	ROY_INT	0.112	0.115	0.974
	26	1,209	CAPIMP_INT	0.034	0.569	0.059

Note: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Author's calculations.

intensity of majority-owned subsidiaries is 0.13 percentage points less than that of matched domestic firms and was significant at 10%. The GLS estimates presented in Table 6 confirm this result. This gap in R&D intensity increased as foreign equity holdings declined, with dominant-minority MNEs being an exception. The gap is as large as –0.276% for experiential MNEs. In general, the R&D intensities of foreign firms (leaving aside dominant-minority firms) across all categories turned out to be less than that of matched domestic firms during the global boom period. These findings are in line with earlier studies on the post-1991 period, which suggest that MNEs are not significantly more R&D intensive than their local counterparts in India. In an earlier study on the R&D behavior of manufacturing firms in India, Kumar and Aggarwal (2005) used firm-level data from FY1992–1993 to FY1998–1999. Their findings reveal that MNEs have increased their R&D expenditures

Table 6. **GLS Estimates of R&D and Technology Transfers on Matched Samples**

	FY2004–2005 to FY2007–2008		FY2009–2010 to FY2013–2014	
Variable	**RD_INT**	**ROY_INT**	**RD_INT**	**ROY_INT**
	Model 1	Model 5	Model 9	Model 13
SIZE	−0.0149	0.0272*	0.0489	0.0314**
	(−0.741)	(1.716)	(1.430)	(2.113)
SIZE^2	0.00480	−0.000495	−0.00402	–0.00198
	(1.512)	(−0.307)	(−0.925)	(−1.508)
AGE	−0.00381**	7.14e-05	−0.00428**	0.000673
	(−2.082)	(0.0387)	(−2.057)	(0.489)
3 years average of ROY_INT	−0.00330		−0.0911	
	(−0.770)		(−1.112)	
3 years average of RD_INT		−0.000169		–0.00667
		(−0.452)		(−1.177)
3 years average of CAP_INT	−4.93e-06	4.01e-06*	−5.58e-07	1.15e-07
	(−0.672)	(1.722)	(−0.759)	(0.340)
3 years average of CAP_IMP	0.00831	−0.000104	0.000207	2.30e-05
	(0.845)	(−0.234)	(0.935)	(0.210)
3 years average of EXINT	0.0198***	0.000595	0.0169***	–0.000569
	(2.638)	(0.617)	(3.018)	(−0.886)
3 years average of IMPR_INT	−0.00911***	−0.000325	0.00111	0.00123*
	(−2.648)	(−0.636)	(0.422)	(1.700)
PCM with 1-year lag	−2.89e-06	5.48e-07	1.42e-05	1.84e-07
	(−1.276)	(0.419)	(1.261)	(0.298)
MTECH_SER	−0.0332	−0.0791	−0.109*	0.0292*
	(−0.655)	(−0.726)	(−1.769)	(1.688)
HTECH_SER	0.179	0.110	0.133	0.208***
	(1.290)	(0.679)	(0.947)	(2.823)
HTECH_MFG	0.448***	−0.0469	0.454***	0.0961***
	(5.014)	(−0.342)	(4.708)	(4.815)
MTECH_MFG	−0.0311	−0.125	−0.159***	0.0130
	(−0.754)	(−1.047)	(−2.805)	(0.874)
DFOR50	−0.296***	0.450***	0.0565	0.520***
	(−3.517)	(3.948)	(0.401)	(4.883)
DFOR25	−0.109	0.482**	–0.0490	0.242*
	(−0.908)	(2.228)	(−0.420)	(1.771)
DFOR10	−0.268***	0.00817	−0.0835	0.0377
	(−3.321)	(0.180)	(−0.720)	(0.894)
DFOR_EXP	−0.189*	−0.0735	0.583	0.186
	(−1.761)	(−1.192)	(0.721)	(1.067)
TAX with 1-year lag	−8.71e-07	−9.07e-07	−1.16e-06	2.11e-06
	(−0.265)	(−1.006)	(−0.518)	(1.168)
Constant	0.122	−0.0659	0.204**	–0.175***
	(1.037)	(−0.716)	(2.113)	(−3.033)
Year dummies	Yes	Yes	Yes	Yes
Observations	4,800	4,800	5,229	5,229
Number of code	1,690	1,690	1,615	1,615

GLS = generalized least squares, R&D = research and development.

Notes: Parentheses represent t-statistics. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Source: Author's calculations.

faster than their local counterparts in response to the process of liberalization. However, after controlling for the effects of other firm-specific characteristics, their average R&D intensity still turned out to be less than that of domestic firms. The study was revisited by Sasidharan and Kathuria (2011). They showed that the average R&D intensity of foreign firms was significantly lower than that of domestic firms between FY1993–1994 and FY2004–2005. For other economies, the results are mixed. Rasiah (2007) reviewed the cases of the People's Republic of China; Indonesia; Malaysia; the Philippines; and Taipei,China; and García, Jin, and Salomon (2013) reviewed the case of Spain (a developed economy with a lower level of dynamism). These studies found that firms with foreign ownership preferred technological transfer instead of R&D investment as a technological achievement policy (see, for example, Fors and Svensson 2002). However, in probit estimates based on 28,000 firm observations, Falk (2008) shows that foreign-owned firms are more innovative than domestic firms, particularly in new European Union member states. Balsari, Özkan, and Varan (2015) and Pamukçu and Utku-İsmihan (2009) found similar results for Turkey. Evidence from the People's Republic of China is mixed. While Fu (2008) and Yang and Lin (2012) show positive effects, Chen et al. (2008) are not so optimistic.

In contrast to the precrisis period, foreign firms in the post global financial crisis period in India outperformed local firms in R&D intensity, albeit weakly. Table 6 shows that it was due to acceleration in the R&D intensity of MNEs, which may have been partly due to accelerated reforms in the FDI regime in India that were initiated in the post-2005 period (Figure 1). It could also be that the crisis in advanced economies shifted the focus to emerging markets where competition for market share intensified, forcing MNEs to increase their technological efforts. But the possibility of the global financial crisis affecting companies' offshoring strategies for R&D as a result of the credit crunch in the developed world cannot be ignored. This could have forced firms to search for highly qualified personnel at lower cost. Apparently, India offered an ideal location with its pool of engineers and technologists growing at breakneck speed. The share of students enrolled in engineering and technology institutions as a percentage of total enrollments increased from 13% in FY2006–2007 to 26% in FY2011–2012 on average annual growth of around 25%; growth in enrollment at education and medical institutions followed closely at around 16% per year (Government of India 2013). Thus, contrary to global patterns of contraction in R&D relocation (Kinkel and Som 2012; Dachs, Stehrer, and Zahradnik 2014), India exhibited growing R&D spending by MNEs in almost all categories except for minority-held companies. India's experience mirrored that of France, Poland, and the United Kingdom, which also showed rising trends in R&D relocation activities during the review period (Dachs, Stehrer, and Zahradnik 2014). However, in no case was the R&D intensity of foreign firms significantly greater than that of matched local firms.

2. Royalty Payment Intensity

During the precrisis period of FY2003–2004 to FY2008–2009, majority-owned and dominant-minority firms spent significantly more on royalty payments than matched local counterparts. Their average royalty-to-sales ratios were 0.53 and 0.40 percentage points higher than that of local firms, respectively. In the postcrisis period, the gap did not show any perceptible change. However, the other two categories, minority-holding and experiential firms, which appeared to be technologically laggards in the precrisis period, enhanced technology acquisition from internal networks and managed to outperform domestic firms, albeit insignificantly, in the postcrisis period. These results support the traditional view of the greater embeddedness of MNEs in internal networks to protect against the spillover of proprietary technologies. This translates into a slow process of R&D relocation and is in line with the results related to R&D spending. The GLS estimates in Table 6 confirm these results. DFOR50 and DFOR25 are significant in all specifications for ROY_INT during both periods. The results for other categories of foreign firms also indicate that foreign firms are not technologically embedded in India. They are more likely to depend on their parent labs.

3. Capital Goods Imports

Imports of capital goods have been a significant mode of technology transfer for both local and foreign-owned firms in India. In the precrisis period, minority-holding and experiential foreign firms were associated with larger spending on capital goods imports than matched local firms; while in the postcrisis period, MNEs with higher ownership stakes enhanced their spending on capital goods imports, along with R&D, over their local counterparts. The minority-holding companies focused more on disembodied technology acquisition. However, the difference in average spending on this mode of technology acquisition is not significantly different between foreign and domestic firms in either period for any category of foreign firms.

Mundlak's estimates presented in Table 7 validate the results for the main variables. A comparison of these results with the GLS estimates shows that the results are robust.

Finally, it is observed that R&D and royalty intensities are affected differently by other strategic explanatory variables (Table 6). High-technology industries in both the manufacturing and service sectors attract significant technology transfers, but only those in manufacturing induce significantly higher R&D intensities. Thus, promoting high-technology manufacturing is more likely to accelerate R&D efforts in Indian industries. Further, exporting is significantly associated with local R&D efforts, while its relationship with technology imports is insignificant. Age turns out to be negative, indicating that younger firms are more likely to undertake R&D. The

Table 7. **Mundlak Estimates of the Main Variables**

	ROY_INT			RD_INT	
Variable	**Coefficient**	**t-statistics**	**Variable**	**Coefficient**	**t-statistics**
		FY2004–2005 to FY2007–2008			
DFOR50	0.451	3.91***	DFOR50	−0.336	−1.34
DFOR25	0.467	2.15**	DFOR25	−0.054	−0.18
DFOR10	−0.023	−0.40	DFOR10	−0.172	−0.49
DFOR_EXP	−0.042	−0.89	DFOR_EXP	−0.164	−0.42
		FY2008–2009 to FY2013–2014			
DFOR50	0.525	6.61***	DFOR50	0.073	0.36
DFOR25	0.240	2.07**	DFOR25	0.004	0.02
DFOR10	0.029	0.26	DFOR10	−0.081	−0.29
DFOR_EXP	0.170	1.05	DFOR_EXP	0.595	1.47

Note: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Author's calculations.

size variable indicates that relatively larger firms are more likely to engage in R&D, while relatively smaller firms exhibit a greater tendency to import technologies. Finally, the relationship between R&D intensity and technology transfers is found to be negative; the gap appears to have widened over time. Thus, technology transfers may not positively influence local R&D efforts. It is important to identify the triggers for such efforts to augment the technological capabilities of firms.

VII. Conclusion

Majority-owned and dominant-minority-owned firms are considered to be conduits of technology transfers. This study finds that their local R&D intensities are less than those of their local counterparts in India. The activities of technology generation are found to be concentrated in the home economies of MNEs located in India. It is also found that minority-owned firms are not significantly different from their local counterparts. Finally, the technological dynamism of MNEs was found to have increased across all categories in the postcrisis period. But, it did not result in significant changes in the modes of technology acquisition or significantly larger technology intensities than that of local firms. I find no evidence of a significant increase in relocation of R&D activity to India by production firms after the global financial crisis despite India being much less affected by the crisis than many other economies and having an expanding pool of skilled labor.

The global distribution of R&D is essentially the result of strategic decisions among firms to gain global efficiency through local responsiveness and worldwide learning. A firm's strategic objective is to leverage its innovative advantages to exploit a host economy's knowledge base by tapping into local clusters (e.g., well-educated workforce and high-quality research institutions) and by creating network relations with external partners (e.g., customers and suppliers) and building a strong knowledge base and competitiveness advantages (Andersson, Forsgren, and Holm 2002). Their ability to create, manage, and take advantage of internal and external network-based knowledge flows is a strong source of their competitiveness. Therefore, the host-specific advantages in creating assets are the key attractions for them; markets and resources alone are not sufficient. There are numerous studies that have analyzed the factors affecting the internationalization of R&D by MNEs. According to Hall (2010, 12), "[t]he variables that most strongly affect location choice are invariably the size of the market, the R&D intensity of the host country, the availability of technical and educated workers, and the presence of lead customers." Their decision to relocate R&D depends in part on the quality of host economy R&D networks, the sophistication of its markets, and the intellectual property rights regime. India is benefiting from a growing pool of engineers and technologists, as well as from the presence of a World Trade Organization-compliant intellectual property rights regime. At the same time, India needs to focus on improving the quality of its skilled labor and local networks, and pursue more effective implementation of the intellectual property rights regime to establish itself as a hub of R&D-intensive FDI. The results in this paper have important policy implications for governments in developing economies such as India. They must strengthen their capabilities to attract knowledge-intensive FDI and exploit the benefits generated through knowledge spillovers (see, for example, Fu, Pietrobelli, and Soete 2011). Building strong local technological capabilities through a well-designed innovation strategy should be at the core of an FDI-induced development strategy.

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Foreign Direct Investment, Firm Heterogeneity, and Exports: An Analysis of Indian Manufacturing

MAITRI GHOSH AND SAIKAT SINHA ROY*

Using firm-level data, this paper investigates whether foreign direct investment and the presence of multinational enterprises explains India's improved export performance during the postreform period. The recent literature stresses that firm heterogeneity gives some firms an edge over others to self-select into export markets. Apart from ownership, this paper considers firm heterogeneity and other firm-specific factors of export performance. Estimation results show that the impact of foreign ownership on export performance does not significantly differ from that of domestic firms across sectors in Indian manufacturing. Rather, firms build their international competitiveness by importing raw materials and foreign technical know-how, and by investing in research and development. Further, firm heterogeneity, measured in terms of sunk costs, significantly impacts firm-level export intensity. The study also reveals that there are ownership-specific factors that determine firm-level exports.

Keywords: dynamic panel data estimation, export competitiveness, firm heterogeneity, Hausman–Taylor estimation, multinational enterprises
JEL codes: C23, F16, F23, L25

I. Introduction

Foreign direct investment (FDI) through multinational enterprises (MNEs) delivers to recipient economies tangible and intangible assets such as technology

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and know-how, skills, efficient marketing and distribution networks, and managerial capabilities;[1] and induces international competitiveness (Markusen and Venables 1998) in emerging economies such as India (Feenstra 2006).[2] MNEs access foreign markets with greater ease than their domestic counterparts and often use the host economy as an export platform. Given their scale of operations and a wide array of intangible assets, MNEs have the capability to overcome the large sunk costs required for entering export markets.[3] These advantages give foreign firms an edge over domestic firms in export markets. Apart from ownership, the recent literature shows that firm heterogeneity is a key to export performance (Melitz 2003). Reforms in foreign investment policies initiated in India since 1991 have allowed Indian firms to access global technology and build strategic alliances to penetrate world markets (Ahluwalia 2008), and have improved India's export competitiveness (Kumar and Joseph 2007). Exports across sectors responding differently to wide-ranging reforms (Sinha Roy 2009) is indicative of various firm-specific factors—such as ownership, productivity, and sunk costs—determining export performance. This paper investigates whether firm ownership (foreign versus domestic) explains postreform export performances across manufacturing industries in India.

There is a rich body of literature analyzing various dimensions of MNE operations on export performance. MNE affiliates with better knowledge of foreign markets have the advantage of established marketing channels (Dunning 1977) and greater experience and expertise in international marketing, thereby gaining a competitive advantage. For a better understanding of such effects on a host economy's export performance, it is useful to distinguish between horizontally and vertically integrated multinational firms. In cases of horizontally integrated MNEs, the same product is produced in multiple plants located in different economies. The literature indicates that, in the presence of oligopoly competition, FDI boosts exports of the host country, even if the latter faces high transport costs and imposes export tariffs (Markusen and Venables 1998, Markusen 2002). In cases of vertically integrated MNEs, different segments of the production process are carried out in different economies and intermediate products are necessarily traded (Zhang and Markusen 1999, Markusen 2002). In such cases, FDI has positive effects on the host economy's exports.[4]

Despite evidence in the literature of the export-enhancing role of FDI, there is no conclusive empirical evidence of better export performance among MNEs than domestic enterprises. Varying FDI–export relationships can be traced across

[1]As the main channel through which FDI flows into host economies, MNEs either acquire a substantial controlling interest in a host-economy firm or set up a subsidiary in a host economy (Markusen 2002).

[2]Feenstra (2006) provides an in-depth analysis of the effects of FDI, particularly the activities of MNEs, in developing economies.

[3]See Greenaway and Kneller (2007) and Roberts and Tybout (1997) for details.

[4]However, FDI can be export limiting if the MNE affiliates trade in high-technology goods (Lall and Streeten 1977).

economies and sectors (Pain and Wakelin 1998). While Jenkins (1979) identified no significant difference between the export performance of foreign-controlled enterprises and their domestic counterparts, Cohen (1975) found domestic firms outperforming foreign firms. For India, Aggarwal (2002) and Siddharthan and Nollen (2004) found better export performances among MNE affiliates than their domestic counterparts.[5] Aggarwal (2002) showed that low-technology industries with high levels of foreign ownership have a greater competitive advantage than high-technology industries. Subramanian and Pillai (1979) and Kumar (1989) earlier arrived at similar results in reviewing the case of Indian manufacturing. The domestic affiliates and subsidiaries of MNEs are also found to have a greater propensity to export in some sectors of Indian manufacturing (Ghosh 2016).

Apart from the mode of ownership, a recent strand of research focuses on the effects of firm heterogeneity, measured in terms of productivity, on industry performance. Bernard and Jensen (2004); Aw, Chung, and Roberts (2000); and others show self-selection among productive firms in the export market.[6] These empirical observations were formalized by Melitz (2003) in a theoretical model with heterogeneous firms. Exporting entails large sunk costs and the firms that are capable of bearing such costs can participate in the export market (Roberts and Tybout 1997; Das, Roberts, and Tybout 2007). In Indian manufacturing, Srinivasan and Archana (2011) show that firm heterogeneity is an important factor in a firm's decision to export. Firm heterogeneity thus needs to be accounted for while understanding the differences in export performances between MNEs and their domestic counterparts in a host economy.

The above review of studies shows that the nature of the FDI–export relationship across economies is far from conclusive. Further, most of these studies have not considered firm heterogeneity. This paper investigates whether MNEs demonstrate better export performances than their domestic counterparts across manufacturing industries in India during the postreform period. Our study contributes to the existing literature by controlling for the heterogeneity of firms along with various supply-side factors.

The paper is organized as follows. Section II provides some stylized facts on the overall export performance of Indian manufacturing industries during the postreform period. Section III discusses the analytical framework, empirical model and method, and database used for analyzing the determinants of firm-level export performances. Section IV presents the empirical results and discusses the determinants of firm-level export performance. Section V summarizes the major findings of the paper and presents policy implications.

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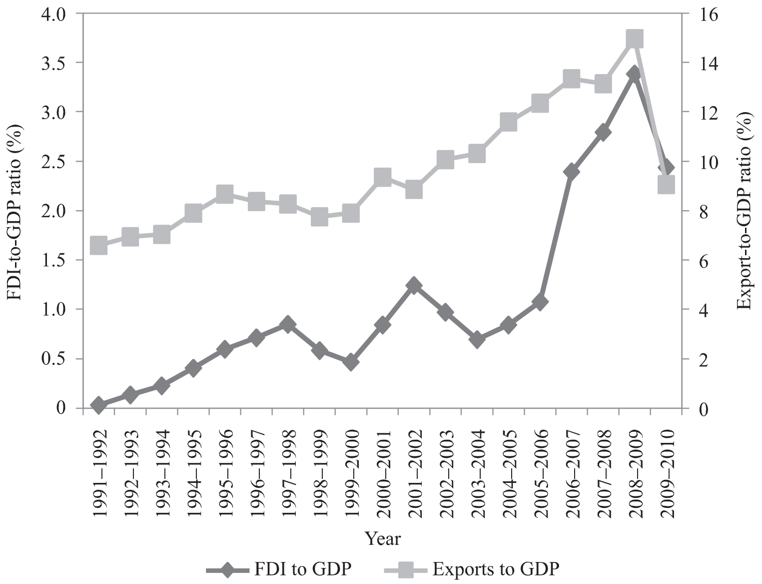
[5] Siddharthan and Nollen (2004) analyze export performances among information technology firms.

[6] Ranjan and Raychaudhuri (2011) and Srinivasan and Archana (2011) suggest that exporters tend to outperform nonexporters in terms of productivity and size, among other indicators.

Figure 1. **India's Foreign Direct Investment Inflows and Exports, 1991–2010**



FDI = foreign direct investment, GDP = gross domestic product.
Sources: Reserve Bank of India and UNCTAD databases.

II. Export Intensity during the Postreform Period

The existing literature often shows a theoretical possibility and an empirical connection between FDI and export performance. The figure above shows that, despite a downturn after 2008, both FDI intensity and export intensity have increased in India since 1991.

Along with increased FDI inflows, firm-level average export intensity, measured as the ratio of export of goods to sales (expressed as percentage), in Indian manufacturing improved during the postreform period, especially since 2000. Average export intensity for manufacturing increased from 0.07 in the 1990s to 0.12 in the 2000s, with individual ratios for the chemicals, transport equipment, machinery, food and beverages, textiles, and basic metals industries each increasing after 2000 (Table 1).[7]

The average export intensity of the chemicals industry, of which drugs and pharmaceuticals account for the largest share, more than doubled between the 1990s and 2000s.[8] Despite improvements in the export intensity of the machinery industry, the firm-level average export intensity for electronics and

[7]Detailed tables on export intensity across industries will be made available upon request.

[8]Foreign ownership up to a level of 100% has been legally permitted in the drugs and pharmaceuticals industry since December 2001.

Table 1. **Firm-Level Average Export Intensity in India during the Postreform Period, 1991–2010**

Industries	Food and Beverages	Textiles	Chemicals	Basic Metals	Machinery	Transport Equipment	All
All firms							
1990s	0.0635	0.1661	0.0655	0.0268	0.0422	0.0186	0.0711
2000s	0.0714	0.2512	0.1312	0.0557	0.0650	0.0684	0.1216
Domestic firms							
1990s	0.0646	0.1678	0.0663	0.0282	0.0406	0.0194	0.0730
2000s	0.0736	0.2528	0.1298	0.0586	0.0638	0.0709	0.1240
Foreign firms							
1990s	0.0441	0.0274	0.0484	neg.	0.0508	neg.	0.0440
2000s	0.0311	0.0307	0.1613	neg.	0.0717	0.0132	0.0859

neg. = negligible.
Source: Calculations based on the Centre for Monitoring Indian Economy. Prowess database. https://prowess.cmie.com/.

electrical machinery remained low in the 2000s. The export intensity of computers, peripherals, and storage devices was the only exception in this industry. The corresponding improvements for transport equipment were larger.[9] Improvements in the export intensity of textiles can be observed after the complete phaseout of the Multifibre Arrangement in 2004. Such improvements occurred despite low productivity, technological obsolescence, small-scale operations, and rigid labor laws in the textiles industry.

The export intensity of nonferrous items (aluminum products, copper products, and other nonferrous items) and iron and steel products registered a significant increase post-2000.[10] In the case of food and beverages, value-added items like marine food and processed and packaged food exhibited increased export intensity after 2000. A quantum increase in export intensity was also observed for value-added items including drugs and pharmaceuticals, miscellaneous electrical products, computers, peripherals and storage devices, steel, tubes and pipes, marine food, and processed and packaged food. These findings conform with the findings of Aggarwal (2002) and Kumar and Pradhan (2003).

There are further nuances to improvements in performance. Table 1 shows similar increases in average export intensity across industries between the 1990s and 2000s for domestic firms and foreign firms. The only exception to this pattern is the basic metals industry. The export intensity of foreign firms in the food and

[9] Transport equipment shows an increase in export intensity during the review period, particularly after 2003. This is important as many joint ventures in this industry have been set up in India with foreign technical and financial collaboration.

[10] Except for pig iron, the export intensity of most iron and steel products increased after 2000. The People's Republic of China is a major iron and steel market for India, accounting for about 32% of India's exports of these products in 2006.

Table 2. **Differences in Firm-Level Average Export Intensity—Domestic versus Foreign**

Industry	Mean Export Intensity of Domestic Firms	Mean Export Intensity of Foreign Firms	t-value	Inference
Chemicals	0.1012	0.1105	−0.6091	No significant difference
Food and beverages	0.0695	0 .0369	3.1890	Significant difference
Machinery	0.0533	0.0623	−1.5487	No significant difference
Transport equipment	0.0477	0.0072	7.6201	Significant difference
Textiles	0.2145	0.0292	9.6074	Significant difference

Note: The t-values are calculated using two-sample (export intensity of the domestic and the foreign firms) mean comparison test with unequal variances. For large samples, the critical t-value at the 5% level of significance is 1.96 and at the 1% level is 2.57.
Source: Authors' calculations based on Prowess database. https://prowess.cmie.com/.

beverages industry also showed a marginal decline in the 2000s, while the export intensity of domestic firms in the food and beverages and transport equipment industries outperformed that of foreign firms. Table 2 shows that foreign firms in the relatively high-technology chemicals and machinery industries do not have significantly higher export intensity than domestic firms in the same industries.[11]

In sum, firm-level export intensity generally increased across all manufacturing industries in India in the postreform period, particularly after 2000. A further exploration is needed of the factors underlying the observed similarities and differences in export performances across different ownership categories in Indian manufacturing.

III. Determinants of Firm-Level Export Performances

A. Analytical Framework

FDI flows to emerging market economies can have a range of impacts on the host economy. Apart from supplementing resource mobilization, facilitating access to world-class technology, and providing better marketing and distribution networks and managerial skills, MNE affiliates and subsidiaries are often able to penetrate external markets with greater ease. The higher productivity of MNEs is expected to lead to improved export performance compared with their domestic counterparts. Furthermore, the export intensity of MNEs is expected to be higher given their greater capacity to bear the sunk costs of exporting. Again, firm-specific supply factors—such as size and age, imported raw materials, imported capital goods and foreign technical know-how, expenditure on advertising and marketing, local research and development (R&D), and credit availability—are crucial in determining firm-level exports. Assessing these factors, which are described in

[11]The basic metals industry is excluded in the analysis as the number of foreign firms compared with domestic firms is too small to produce statistically valid results.

greater detail below, can help develop a framework for analyzing firm-level export performance in an emerging market economy like India.

1. Ownership

As compared to their domestic counterparts, MNEs can more easily overcome possible barriers to entry in foreign markets due to firm-specific advantages. These advantages can be in the form of the acquisition of knowledge-based assets, better managerial know-how, strong marketing and distribution channels, branding, and the capacity to bear sunk costs. On account of their relatively larger scale of operations, MNEs also generally have lower per unit costs. Thus, ownership and, hence, MNE presence is likely to play an important role in explaining export performance. As has been observed in recent studies, MNE affiliates in India are found to have better export performances than their domestic counterparts.

2. Productivity

Empirical literature shows that trade forces the least productive firms to exit the market (e.g., Aw, Chung, and Roberts 2000), implying that a few productive firms, which expect a profit stream sufficiently high to cover the sunk costs of entry into a foreign market, find it profitable to export. Models that follow Melitz (2003) postulate that firms are heterogeneous and only productive firms self-select into export markets. In this study, firm heterogeneity, measured in terms of productivity, is postulated to have a positive impact on exports. However, such studies linking productivity and exports in the Indian context are rare.

3. Specific Costs

Exploiting a foreign market requires strong marketing and distribution networks. A firm's expenditure on advertisement, marketing and distribution, and the creation of service networks often leads the firm to attain cost competitiveness. These costs are sunk in nature. Roberts and Tybout (1997); Bernard and Jensen (2004); and Das, Roberts, and Tybout (2007) suggest that there exist large sunk costs for exporting in developed and developing economies alike. Heterogeneity also exists in terms of the capacity to bear these specific costs, which possibly explains the export performance of firms. Following studies such as Srinivasan and Archana (2011), a positive relationship is expected between such costs borne by Indian manufacturing firms and exports.

4. Availability of Credit

There are empirical studies explaining the impact of credit constraints on a firm's export performance (e.g., Manova 2013, Minetti and Chun 2011). The main results of such studies show that in addition to heterogeneity of firms, credit constraints also affect exports. In the Indian context, Ranjan and Raychaudhuri (2011) have established a causal link between the availability of subsidized credit and real outcomes for exporting firms. In this study, increased credit availability is expected to improve firm-level export performance.

5. Research and Development

In an increasingly knowledge-based world, technological capacity is an important factor underlying an economy's international competitiveness. In-house R&D makes a firm cost competitive and therefore improves its export performance (Fagerberg 1988). With MNE operations, the transfer of embodied and disembodied technology to MNE affiliates takes place through both internalized and externalized modes. Such technology transfers are often complemented by a firm's R&D through product improvement and/or adaptation, process improvement, and original equipment manufacturing, which is of particular importance for export expansion in emerging economies. Roper and Love (2002) provide evidence that R&D expenditure has a significant positive impact on a firm's export intensity. In this study, a positive relationship between in-house R&D and firm-level export performance is postulated.

6. Imported Technology

Introducing foreign technology to domestic production processes can increase total factor productivity. Firms in most developing economies, including India, rely extensively on imported technology and acquired knowledge. Imported technology can be in both embodied and disembodied form. It is believed that, like in-house R&D, imported technology makes a firm more cost competitive and thereby induces greater exports. In the postreform period in India, imported technology is likely to have a positive impact on firm-level exports. The relationship can be nonlinear as well.

7. Firm Size

Larger firms are perceived to have a bigger resource base and a better risk perception of international markets. Size is a proxy for several effects (Bernard and Jensen 2004), including economies of scale, that determine the export attitude and performance of a firm (Kumar and Pradhan 2003). Given their resource constraints, smaller firms are mostly scale inefficient, while larger firms can exploit economies of scale. Thus, larger firms have lower average and/or marginal costs, which aids exports (Srinivasan and Archana 2011). Furthermore, larger firms have more capacity to bear the sunk costs associated with entry into foreign markets. Hence, a positive relationship between firm size and export performance is hypothesized, though the empirical literature often shows mixed findings and nonlinearity in the relationship (e.g., Kumar and Aggarwal 2005).

8. Age

The age of a firm is a proxy for the extent of a firm's learning experience, including experimental and tacit knowledge (Bhaduri and Ray 2004). The age of a firm is found to be positively associated with exporting. Older firms with experience in exporting have better knowledge of export markets and are also more capable of bearing the sunk costs of exporting given their established marketing and distribution channels. A similar relationship is expected to be found in this study.

B. Estimation Models

In the estimable form, the export intensity of a firm depends on production and various supply-side factors including age, size, technology imports, and credit availability. Firm heterogeneity in terms of firm productivity and sunk costs are controlled for when estimating the impact of ownership on exports.

The model as estimated is as follows:

$$\begin{aligned} Expi_{it} &= \alpha_0 + \alpha_1(size_{it}) + \alpha_2(impr_{it}) + \alpha_3(ki_{it}) + \alpha_4(fptr_{it}) + \alpha_5(mktcost_{it}) \\ &\quad + \alpha_6(age_{it}) + \alpha_7(pdtivity_{it}) + \alpha_8(crdt_{it}) + \alpha_9(rdi_{it}) + \alpha_{10}(own_i) + \mu_{it} \end{aligned} \tag{1}$$

where α_k, $k = 1$ to $10 > 0$.

The independent variables are defined as follows:

Expi: export intensity measured as the ratio of exports to sales at the firm level;

size: size indicated by the ratio of firm sales to industry sales;

impr: raw material import intensity measured as the ratio of expenditure on imports of raw materials to sales;

ki: capital goods import intensity measured as the ratio of expenditure on imports of capital goods to sales;

fptr: foreign technical know-how intensity measured as the ratio of technical fees and royalties paid abroad to sales;

mktcost: specific costs measured as the ratio of the sum of advertising, marketing, and distribution expenditure to sales;

age: absolute age of the firm in number of years since incorporation;

pdtivity: labor productivity measured as the ratio of output to salaries and wages;[12]

crdt: availability of credit measured as the ratio of total borrowing to output;

rdi: R&D intensity measured as the ratio of R&D expenditure to sales; and

own: ownership is a dummy variable taking the value of 1 if the firm is foreign and 0 otherwise.

As specified in equation (1), ownership is the time-invariant variable. As the industries analyzed in this study vary widely, equation (1) has been modified for some industries as well as for Indian manufacturing as a whole. Two variables are used for the purpose:

fortech: foreign technology intensity measured as the ratio of the sum of expenditure on imported capital goods, raw materials, and foreign technical know-how to sales; and

sci: sunk costs intensity measured as the share of the sum of expenditure on advertising, marketing, distribution, and R&D to sales of the firm.

The model specified in equation (1) is irrespective of ownership categories. However, domestic firms and foreign firms should theoretically have different motives. The affiliates and subsidiaries of firms that are headquartered in foreign countries often depend on the resources of the parent firm. This is surely not the case with domestic firms. Often, ownership-specific models are estimated in the literature (Siddharthan and Nollen 2004) to identify the behavioral differences of foreign and domestic firms. Such ownership-specific models can be as follows:

$$
\begin{aligned}
Expi_{ijt} = {} & \alpha_0 + \alpha_1(Expi_{ijt-1}) + \alpha_2(size_{ijt}) + \alpha_3(age_{ijt}) + \alpha_4(impr_{ijt}) \\
& + \alpha_5(mktcost_{ijt}) + \alpha_6(rdi_{ijt}) + \alpha_7(pditivity_{ijt}) + \alpha_8(crdt_{ijt}) \\
& + \alpha_9(fortech_{ijt}) + \mu_{it}
\end{aligned} \tag{2}
$$

where α_k, $k = 1$ to $10 > 0$, j denotes either domestic or foreign ownership, t denotes time, and x_{ijt} is the export intensity of the ith firm with the jth category of ownership at time t. The study estimates the above models for the pre-2000 and post-2000 periods based on an earlier observation that the export intensity of both categories of firms improved in the 2000s compared with the 1990s.[13]

[12]Srinivasan and Archana (2011) also used labor productivity in their estimation instead of total factor productivity, which is more commonly used in the heterogeneity literature.

[13]In this study, the pre-2000 period considers the years 1991–1999 while the post-2000 period refers to 2000–2010.

C. Method and Data

The Hausman–Taylor and dynamic panel data estimation techniques are used in this analysis. The Hausman–Taylor estimation technique has been used in analyzing manufacturing as a whole as well as sector-specific analysis. This is primarily because of the inclusion of the time-invariant ownership variable in the models.[14] The ordinary fixed- and random-effects estimation methods were initially used to identify the control variables. Hausman and Taylor (1981) first proposed an estimation procedure where some of the regressors are correlated with the individual effects. The Hausman–Taylor estimator is based upon an instrumental variable estimator that uses both between and within variations of the strictly exogenous variables as instruments. Specifically, the individual means of the strictly exogenous regressors are used as instruments for the time-invariant regressors that are correlated with the individual effects. As fixed-effect models do not generate coefficients of time-invariant regressors, the Hausman–Taylor estimation is the more appropriate method of estimation.

As time-invariant regressors are absent in the ownership-specific model (equation 2), the dynamic panel data estimation technique is used. This method helps to simultaneously accommodate large data sets across time and distinguishes between time series movements and cross-sectional differences in the data. Dynamic effects can be examined in panel data analysis by introducing lagged dependent variables in the set of explanatory variables, where the lagged dependent variable, $Y_{it\text{-}1}$, captures the entire historical impact of the explanatory variables. Dynamic panel data estimation is usually carried out using the generalized method of moments instead of the least square dummy variable or feasible generalized least square methods. This is done by estimating the model in first difference to avoid the problem of endogeneity arising from the presence of a lagged endogenous variable in the set of explanatory variables. The Arellano and Bond (1991) generalized method of moments instrumental variables estimation method is applied to obtain unbiased consistent estimators. A two-stage iteration method is used to obtain Arellano and Bond two-step estimators. To obtain original Arellano and Bond estimates, no correction for the degree of freedom is carried out. In this type of estimation, a Sargan test of overidentifying restrictions is conducted.

Firm-level data across manufacturing sectors for the period 1991–2010 were obtained from the Prowess database published by the Centre for Monitoring Indian Economy. Prowess provides information from audited financial statements

[14]This study controls for important measurable factors that might give MNEs an edge over their domestic counterparts. Yet, ownership is considered a separate variable in this study as there can be a host of other factors, measurable and qualitative, relating to foreign ownership that can play a crucial role in explaining export performance. Such factors include better managerial capacities, reputation and brand name, proprietary knowledge, scale economies at the plant level, and an internationalization advantage.

and thereby uses company balance sheets and income statements as sources. The database covers both listed and unlisted firms from a wide cross section of the manufacturing, services, utilities, and financial sectors, covering 60%–70% of the organized sector in India, 75% of corporate taxes paid, and 95% of excise duties collected by the Government of India (Goldberg et al. 2010). However, the database has some limitations, especially with regard to this analysis.[15] First, an important step involves identifying firms according to their ownership; that is, finding the "FDI firms" as opposed to the "non-FDI firms."[16] Prowess provides data for a foreign promoter's equity holdings. If, for a company, the equity holdings of the foreign promoter exceed 25%, it is classified as a foreign-owned or FDI firm. However, a foreign promoter's equity holdings are reported in the database only from the year 2001. As this study covers a 20-year period (1991–2010), the information on equity holdings to identify firm ownership cannot be used. Numerous missing values for firms' equity participation also reduces the sample size significantly. The database instead provides separate information on the ownership of firms, including the following categories: private Indian, private foreign, and state-run enterprise. Such ownership classifications, however, do not differentiate between MNE affiliates and the licensees of foreign firms, between wholly owned foreign enterprises and joint ventures, or between foreign investment firms and investment from Mauritian firms. (India attracts a significant amount of FDI from Mauritius.) Second, the information on firms is based on their balance sheets and is not product specific. Therefore, comparisons between MNEs and domestic firms are not product specific even though most firms are multiproduct by nature. Given the nonavailability of detailed product-wise data for individual firms, broad product groups are considered. Third, Prowess does not provide data on output. However, firm-level data on sales over time is available. Data on changes in stock can be calculated from the available data on opening stock and closing stock for each firm in each year. Output is calculated using such information. Again, the database does not provide information on the number of employees. However, it provides data on salaries and wages. Labor productivity is calculated as the ratio of output to salaries and wages.

The problems with data notwithstanding, the industries used in this study include chemicals, machinery, transport equipment, food and beverages, textiles, and basic metals industries. Taken together, all six of these industries comprise the manufacturing sector. Statistical information was collected only for exporting

[15]The Annual Survey of Industries database of the Government of India's Central Statistical Organisation is an alternate source of unit-level data. However, this database could not be used in this study as the units are not identifiable over time. Further, the unit-level data do not provide information on exports.

[16]Statistical information on India's overseas FDI can be availed. However, the database does not provide any information on source- and destination-wise FDI. As a result, there is no scope to arrive at an estimation of redirected investment or estimates of actual foreign investments in India.

firms.[17] A total of 1,473 observations for the chemicals industry, 777 observations for the machinery industry, 326 observations for the transport equipment industry, 154 observations for the food and beverages industry, 596 observations for the textiles industry, and 143 observations for the basic metals industry were obtained. These observations across sectors include both domestically owned and foreign-owned firms. Panel structures for each of these six industries and the manufacturing sector as a whole were constructed for the period 1991–2010. For the ownership-specific model (equation [2]), domestic and foreign firms engaged in manufacturing in India are treated separately for dynamic panel data analysis.[18]

IV. Empirical Results

The Hausman–Taylor estimation results of equation (1) showing the determinants of firm-level export performance are presented in Table 3.

The empirical exercise in our study was carried out in three stages. First, the determinants of firm-level exports for all manufacturing and across sectors were estimated using the Hausman–Taylor estimation method for the entire postreform period. Second, export determination for all manufacturing during both the pre-2000 and post-2000 phases was conducted. The third and final stage included separate analysis of export determination for all manufacturing by ownership category (domestic versus foreign) during both the pre-2000 and post-2000 phases using the dynamic panel data method of estimation.

As Table 3 demonstrates, the Wald statistic justifies the overall significance of the model. The Hausman–Taylor estimation results suggest that the mode of ownership has no impact on firm-level exports in Indian manufacturing. This finding is in sharp contrast to the common contention in the literature that foreign ownership promotes exports. However, this finding is in conformity with Athukorala, Jayasuriya, and Oczkowski (1995), who find no significant relationship between MNE affiliation and the export orientation of firms. This counterintuitive result will be explained after the impacts of other supply-side factors are analyzed.

The existing literature shows that firm heterogeneity, measured in terms of firm productivity, impacts a firm's export performance. The estimation results in Table 3 show that productivity does not explain the export performance of firms during the postreform period for the manufacturing sector as a whole and across individual industries, with the exception of the machinery industry. This is in sharp contrast to the theoretical conjecture of Melitz (2003). At the same time, labor

[17] In this study, the firms which have consistently exported for at least 3 years have been considered. However, Table 1 reflects that foreign firms in some sectors have negligible export intensities during the postreform period. The study did not restrict to a minimum average export intensity of firms in order to get a meaningful understanding of the factors explaining the differences in export performance between domestic and foreign firms.

[18] Sector-wise, ownership-specific analysis could not be attempted as the number of foreign firms in sectors like textiles and basic metals is too small to have meaningful econometric results.

Table 3. **Factors Determining Firm-Level Export Performance Using a Hausman–Taylor Estimation**

Determinant	**Chemicals**	**Machinery**	**Transport Equipment**	**Food and Beverages**	**Textiles**	**Basic Metals**	**All Manufacturing**
Own	−0.07	0.006	2.16	−0.11	−18.25	0.01	−0.064
(Time-invariant exogenous variable)	(−0.76)	(0.14)	(0.21)	(−1.47)	(−0.38)	(0.07)	(−0.82)
Age	0.003***	0.0003	0.71***	0.0004	−0.01	0.0005***	0.0004**
	(5.93)	(0.71)	(8.79)	(0.64)	(−0.43)	(5.09)	(2.17)
Size	1.32***	−1.36	−21.01	0.45**	65.33	0.34***	0.258**
	(3.18)	(−0.07)	(−1.06)	(2.41)	(1.34)	(2.78)	(2.06)
$Size^2$							−0.00007**
							(−2.06)
Mktcost	1.17***	0.49***	-	-	63.79***	-	0.00006
	(7.56)	(2.63)			(3.75)		(0.04)
$Mktcost^2$	−3.34***	−1.49**	-	-	−20.75***	-	-
	(−8.40)	(−2.45)			(−3.48)		
Rdi	0.54***	−0.46	-	-	322.35	-	.743***
	(2.94)	(−0.98)			(0.45)		(3.86)
Rdi^2	−0.17***	-	-	-	-	-	−2.62***
	(−2.98)						(−4.35)
Sci	-	-	59.55***	0.94***	-	−0.0002	-
			(2.99)	(3.97)		(−0.34)	
Ki	0.36***	0.06	-	-	15.39**	-	-
	(4.34)	(0.97)			(1.89)		
Fptr	0.002	−0.91*	-	-	−100.15	-	-
	(0.76)	(−1.69)			(−0.53)		
$Fptr^2$	-	-	-	-	-	-	-
Impr	0.08***	0.0005***	-	-	0.18***	-	-
	(5.45)	(3.06)			(5.22)		
$Impr^2$	-	−1.18***	-	-	−0.00003***	-	-
		(−3.05)			(−5.27)		

Continued.

Table 3. *Continued.*

Determinant	Chemicals	Machinery	Transport Equipment	Food and Beverages	Textiles	Basic Metals	All Manufacturing
Fortech	-	-	−13.75**	2.34***	-	1.01***	0.0004***
			(−2.35)	(4.91)		(2.52)	(4.50)
$Fortech^2$	-	-	2.74**	-	-	-	−9.50***
			(1.90)				(−4.57)
Crdt	−5.26	−2.33	−5.91***	−0.0001	−0.008	0.00005	−0.0004***
	(−0.10)	(−0.17)	(−3.31)	(−0.51)	(−0.30)	(0.48)	(−3.05)
$Crdt^2$	-	-	1.91***	-	-	-	1.53
			(4.07)				(0.45)
Pdtivity	−0.00002	0.00001*	−0.002	−0.00006	0.009	−0.00001	−.00008
(Endogenous)	(−0.44)	(1.71)	(−0.06)	(−0.10)	(1.31)	(−0.29)	(−0.26)
Wald Chi^2	183.37***	24.44**	108.27***	58.17***	47.86***	53.37***	61.42***
Observations	1,473	777	326	154	596	143	4,119

Notes: The z-values are provided in parentheses.***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Authors' calculations.

productivity across sectors in organized manufacturing is not necessarily rising, which possibly explains the disconnect between firm-level productivity and export performance.[19] Rising exports in organized sectors during the postreform period can be attributed to other supply-side factors.

The heterogeneity of firms, measured in terms of sunk costs, is also an important factor explaining export performance (Das, Roberts, and Tybout 2007). In this study, the sum of expenditure for advertisement, marketing, and distribution comprise the sunk costs incurred to penetrate foreign markets. Expenditure on R&D is also considered a sunk cost. As hypothesized, the intensity of such sunk costs is found in our study to be a significant factor across sectors.[20] This result holds for both high-technology and low-technology industries. Nonlinearity in the relationship is found to exist with specific sunk costs for marketing in the chemicals, machinery, and textiles industries. This relationship further suggests that there exists a threshold beyond which specific costs do not impact export intensity in these industries at the firm level. This finding is particularly important as it shows that investment by firms beyond a threshold often raises per unit costs, which can lead to a decline in cost competitiveness. On the other hand, the relationship is found to be linear for transport equipment and food and beverages, which conforms to theoretical conjecture as well as the empirical finding of Srinivasan and Archana (2011) on firm heterogeneity in terms of sunk costs and the capability of overcoming such costs in entering a foreign market is an important factor explaining export intensity. Therefore, sunk costs incurred by firms turn out to be a significant determinant of export intensity for all manufacturing industries. Given the operations of MNEs and the import of frontier technology, one of the choices available to firms to gain international competitiveness is to invest in R&D. Such investment can be complementary to importing foreign technology. A nonlinear relationship is observed in this case as well.

Credit availability was not found to impact the exporting behavior of Indian manufacturing as a whole. A finance–trade linkage is empirically evident only for the transport equipment industry (with nonlinearity in the relationship), possibly because transport equipment exports consist of automobile parts and components, which are largely dependent on short-term trade finance. Nonlinearity in the relationship also exists for all manufacturing, although a significant relationship is not evident.

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[19]On the other hand, labor productivity in unorganized manufacturing, as Goldar and Sengupta (2016) suggest, has been relatively higher than that of organized manufacturing in the 2000s, particularly for textiles, leather, paper, printing and publishing, chemicals and chemical products. Further, there has been a significant increase in informal labor through contractual labor in Indian industries (Goldar and Ghosh 2015) in recent years, which often explains productivity growth and exports across sectors. However, this is outside the scope of this analysis.

[20]In this econometric exercise, the measure of sunk costs as used in the estimation for chemicals, machinery, and textiles includes marketing, distribution, and advertisement costs, while that for transport equipment and food and beverages includes R&D expenses as well. R&D expenditure is treated as a separate factor for chemicals, machinery, and textiles.

Other firm-specific factors, including the size and age of firms, are also important in explaining firm-level export performance. Firm size, measured as a share of firm sales to industry sales, is significant in positively impacting firm-level export performance in the chemicals, food and beverages, and basic metals industries. The relationship across these industries is linear, which is not in conformity with the findings of Bernard and Wagner (2001). On the other hand, firm size remains an insignificant factor for exports in the machinery, transport equipment, and textiles industries.[21] For all manufacturing, firm size is found to be significant in explaining firm-level export intensity and the relationship is nonlinear as suggested in the literature. The estimation results further show that the age of a firm, measured as the number of years in operation since inception, plays a significant role in determining firm-level export performance in low- to medium-technology industries like metals and metal products, and high-technology industries like chemicals and transport equipment. Firm age is also a significant factor in export intensity for all manufacturing. These findings suggest that older firms have acquired the capability to penetrate the world market, particularly in high-technology industries.

In industries like machinery, textiles, and food and beverages, the relationship between age and firm-level export intensity is insignificant. Older firms in the machinery industry that may have started operations during the period of import substitution, continue to cater to the domestic market despite subsequent reforms. This finding is in conformity with that of Kumar and Pradhan (2003), suggesting that older firms in these industries have continued to concentrate on the domestic market during the postreform period.

Technological factors are also important in attaining international competitiveness. Dependence on imported technology for export competitiveness is evident in Indian manufacturing. Importing raw materials, capital goods, and foreign technical know-how is one of the major ways for firms to acquire knowledge from the rest of the world in pursuit of cost competitiveness. Disembodied foreign technology aids the process. Table 3 shows that these factors impact export intensity positively for all manufacturing as well as across industries. For chemicals, machinery, and textiles, importing raw materials has a significant positive impact on firm-level export intensity. A significant nonlinear relationship exists between importing raw materials and export intensity in the cases of machinery and textiles. Most knowledge-based industries as well as textiles gain international competitiveness from imported raw materials. Taking a cue from Sen (2008), it can be argued that imported raw materials have led to technical changes that improved efficiency in Indian manufacturing.

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[21] Small-scale industries, which account for 40% of Indian exports (Government of India 2010), and industries like textiles, general purpose machinery, and transport equipment, where small firms constitute a majority share (Bhavani 2016), are not taken into account. Further, labor legislation has prevented large firms from operating in the textiles industry. Also, there is no small-scale unit included in the database. Therefore, the results have limitations.

Importing capital goods is another important way to access global frontier technology in embodied form. It is evident from the above results that the import of capital goods has a positive impact on firm-level export performance in the chemicals and textiles industries. The relationship, however, does not hold true for other industries. Further, the import of technology in disembodied form does not play any role in explaining export performance across industries. It is striking to note that the import of foreign technology has a significant negative impact on exports of machinery, although this is significant only at the 10% level. Careful scrutiny might reveal that this result holds true for only certain subsectors where imported foreign technology has perhaps aided in capturing the domestic market rather than in increasing export intensity.

Again, imported embodied and disembodied technology together plays an important role in explaining the export performance of the transport equipment, food and beverages, and basic metals industries. While the relationship is nonlinear for transport equipment, it is linear for the other two sectors. For all manufacturing, imported (embodied and disembodied) technology significantly explains exports, although the relationship is nonlinear. In conformity with the findings of Hughes (1986), the results show the significant impact of R&D intensity on firm-level export performance. The relationship is nonlinear. Similar results are found in the case of chemicals, of which pharmaceuticals is an important component. As the chemicals industry is knowledge based, R&D turns out to be significant along with technology imports. This result shows that developing technological capabilities is essential for gaining international competitiveness.

The above analysis shows that while ownership does not have a bearing on firm-level export performance, various other supply factors explain improvements in postreform export performance for all manufacturing as well as across industries. The import of raw materials turns out to be an important factor along with the capacity to bear sunk costs. The observation of improvements in export intensity, particularly in the post-2000 period, leads us to investigate the factors underlying such improvements. However, the small number of observations for certain sectors restricts the analysis to all manufacturing. As mentioned earlier, the variables as specified in equation (1) have been modified for the purpose of this analysis.

The results presented in Table 4 show that the mode of ownership does not have a significant impact on firm-level export intensity in the post-2000 period, while it is found to be negative and significant in the earlier period.

The results indicate that foreign firms in India were essentially catering to the domestic market in the pre-2000 period rather than using their Indian operations as an export platform. The nature of the ownership–export performance relationship, however, underwent a change in the post-2000 period, with MNE affiliates and subsidiaries becoming more export oriented. Both MNEs and their domestic counterparts were found to be more export intensive during the post-2000 period. Meanwhile, MNEs were not necessarily better performers than the latter

Table 4. **Factors Determining Firm-Level Export Performance in Indian Manufacturing—Pre-2000 and Post-2000**

Determinant	Pre-2000	Post-2000
Own	−1.16*	−0.11
(Time-invariant exogenous variable)	(−1.78)	(−1.14)
Age	−.001	.0001
	(−1.12)	(0.52)
Size	−0.00002	0.21
	(−0.59)	(1.24)
Sci	2.18***	0.68***
	(2.96)	(9.11)
Sci^2	−10.9***	−0.00005***
	(−3.06)	(−2.65)
	Endogenous variables	
Pdtivity	0.00002	0.0001***
	(2.96)	(3.57)
Crdt	0.02**	−0.004***
	(2.05)	(−5.95)
$Crdt^2$	−0.001**	0.00001***
	(−1.91)	(5.05)
Fortech	0.001**	.0002***
	(1.86)	(2.62)
Wald Chi^2	23.04***	122.70***
Observations	514	2,300

Notes: z-values are provided in parentheses.***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. The number of observations varies in the two periods due to missing values for the dependent variable (omitted for estimation) in the two periods.
Source: Authors' calculations.

(Tables 1 and 2). The results further suggest that for the pre-2000 period, while firm heterogeneity, measured in terms of labor productivity, does not explain the export intensity of Indian manufacturing, it does impact export intensity in the post-2000 period. In both periods, however, firm heterogeneity, measured in terms of sunk costs, explains the export intensity of Indian manufacturing. Credit availability also significantly affects the export performance of firms during both the pre-2000 and post-2000 periods. The estimation results suggest nonlinearity in the relationship. However, the relationship between credit availability and export intensity is inverted and U-shaped for the pre-2000 period and U-shaped for the post-2000 period. Imported foreign technology—comprising imported raw materials, capital goods, and payments for foreign technical know-how—is positive and significant during both phases, while age and size remain insignificant.

The period-wise results are indicative of the fact that while MNEs and their domestic counterparts improved their export performance during the post-2000 period, the export performance of Indian manufacturing depends on imported foreign technology and the capacity to bear the sunk costs of exporting. The export intensity of firms also depends on imported technology. Explanations for there being no difference in performance across ownership categories can also be offered. For example, with easy access to standardized technology, foreign firms are unlikely to outperform domestic firms in terms of export performance. Further, MNEs plan their operations worldwide, with the parent firm often discouraging the export activities of subsidiaries or affiliates if such activities are perceived to be in competition with operations in other locations. For MNE subsidiaries, the strategy of the parent firm is important, particularly for high-technology goods (Lall and Streeten 1977) and when the MNE and its affiliates are horizontally integrated. The basic strategy in such cases might not just be efficiency seeking, but also domestic market seeking. In the presence of tariffs, foreign firms often produce in the host economy to capture the domestic market and do not have an incentive to use the host economy as an export platform. On the other hand, if domestic firms are being edged out of the domestic market, they might explore foreign markets. This might explain why, despite higher productivity, better technological know-how, and increased capacity to bear sunk costs, the foreign ownership of firms does not explain firm-level export intensity. With no significant difference in ownership-wise export performance, the factors that underlie export performance across the two categories of Indian firms can vary.

Dynamic panel data estimation results of equation (2) for domestic and foreign firms for the pre-2000 and post-2000 periods are presented in Table 5 and Table 6, respectively.

Significant path dependence is noted for both domestic and foreign firms in Indian manufacturing with regard to exporting for both time periods. This implies that firms with export experience are likely to export irrespective of their ownership. The estimation results suggest that the size of firms does not impact the export intensity of domestic firms in either period, while firm size is found to have a significant positive impact for foreign firms in the pre-2000 period. This result, however, does not hold for foreign firms in the post-2000 period, where firm size is negative and significant. Similar is the case with the age of firms, which turns out to be negatively significant for domestic firms in the pre-2000 period and insignificant in the post-2000 period. This result can be best understood by keeping in mind the inward-looking policies in Indian manufacturing for more than 3 decades following independence (Kumar and Pradhan 2003). Older Indian firms have accumulated experience in catering to highly protected domestic markets through well-developed networks. Such experience is unlikely to give firms a competitive edge in export markets. Age also turns out to have a negative and significant impact on foreign firms for both periods.

Productivity turns out to be positively significant for domestic firms in both periods, while it remains insignificant for foreign firms in both periods. Thus, firm heterogeneity when measured in terms of productivity holds only

Table 5. **Factors Determining the Export Performance of Domestic Firms—Pre-2000 and Post-2000**

Determinant	Pre-2000	Post-2000
$Expi_{t-1}$	0.678***	0.630***
	(14.58)	(13.60)
Age	−0.001*	−0.0001
	(−1.77)	(−0.20)
Size	−0.00001	0.033
	(−0.76)	(−0.37)
Pdtivity	0.0003**	0.001***
	(1.90)	(2.76)
Fortech	0.001***	−0.0001
	(2.66)	(−0.29)
Sci	2.96***	0.77***
	(3.71)	(4.13)
Sci^2	−14.18***	-
	(−4.14)	
Crdt	0.003	0.023***
	(0.96)	(3.52)
Wald Chi^2	440.63***	348***
Observations	390	392

Notes: z-values are provided in parentheses.***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Authors' calculations.

Table 6. **Factors Determining the Export Performance of Foreign Firms—Pre-2000 and Post-2000**

Determinant	Pre-2000	Post-2000
$Expi_{t-1}$	15.49***	0.628***
	(15.73)	(13.55)
Age	−0.044*	−0.001**
	(−2.48)	(1.97)
Size	8.34***	−0.46**
	(4.16)	(−2.13)
Pdtivity	−0.007	−0.0002
	(−1.29)	(−0.46)
Fortech	−107.35***	0.66
	(−4.19)	(0.34)
$Fortech^2$	1,095.57***	-
	(4.00)	
Sci	35.19*	2.74***
	(3.71)	(3.35)
Sci^2	−578***	−8.09**
	(−6.61)	(−1.90)
Crdt	.578***	−0.001
	(6.83)	(0.93)
Wald Chi^2	1,222.49***	431.12***
Observations	56	175

Notes: z-values are provided in parentheses.***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Authors' calculations.

for domestic firms in Indian manufacturing. However, firm heterogeneity when measured in terms of the sunk costs of exporting plays a significant role in explaining export intensity. This finding holds for both periods across ownership categories. Interestingly, a nonlinear relationship holds for foreign firms in this case. Further, imported foreign technology is an important factor for both domestic and foreign firms in explaining exports during the pre-2000 period. A significant nonlinear relationship holds for foreign firms in this case. This is indicative of a complementary relationship between imported technology and local R&D efforts for exports in Indian manufacturing irrespective of ownership. Similar is the case of credit availability, which has a significantly positive impact on export intensity for both foreign and domestic firms. However, this significant relationship holds only for domestic firms in the post-2000 period and for foreign firms during the pre-2000 period. These results can vary across industries within the manufacturing sector.

In sum, foreign ownership does not play a significant role in explaining firm-level export performance across industries in Indian manufacturing. Rather, there are ownership-specific factors that explain exports at the firm level. Productivity, though not an important factor in explaining export performance across manufacturing industries, significantly explains the exports of domestic firms. Heterogeneity, measured in terms of capacity to bear sunk costs, has induced Indian manufacturing firms to export during the postreform period irrespective of their mode of ownership. Imports of technology and raw materials and capital goods are important factors in explaining firm-level exports. The above analysis, however, does not capture whether domestic and foreign firms are exporting in different segments within the same industry groups.

V. Conclusions and Policy Implications

This paper attempts to explore the role of FDI and MNE operations in determining firm-level export intensity in Indian manufacturing since 1991. MNE operations in emerging market economies like India are expected to expand output and accelerate exports. It has been increasingly recognized that the presence of foreign firms contributes, directly or indirectly, to the export performance of the host economy. The literature suggests that apart from ownership, factors like firm heterogeneity, measured in terms of productivity and the capacity to bear the sunk costs of exporting, also significantly explain export performance at the firm level. This paper estimates whether firm ownership has impacted the firm-level export performance of Indian manufacturing during the postreform period (1991–2010).

Export performance of both MNEs and their domestic counterparts are found to have improved since 2000. The export intensity of industries like food and beverages, textiles, chemicals, metal and metal products, machinery, and transport equipment has been rising since 1991, particularly after 2000. Such stylized facts led us to inquire whether exports have responded to the presence of foreign firms in the manufacturing sector. Again, as domestic and foreign firms are likely to be guided by different motives, the factors underlying the export performances of two sets of firms are estimated separately in this study for the pre-2000 and post-2000 periods. Hausman–Taylor and dynamic panel data estimation techniques are used for export determination.

Estimation results show that foreign ownership does not have any effect on firm-level export performance across industries in Indian manufacturing. As the focus of foreign firms operating in India is primarily on the domestic market, even in industries like chemicals and machinery, export intensity cannot be explained by foreign ownership. This result contradicts the common contention based on cross-economy evidence that MNE operations promote export performance, possibly among other explanations, due to the domestic-market-seeking behavior of most manufacturing MNEs investing in India. Firm heterogeneity, measured in terms of bearing the sunk costs of exporting, is an important determining factor of export intensity; productivity is not. Importing raw materials and capital goods has turned out to be an important factor explaining firm-level exports, perhaps through improvements in productivity and efficiency. Separate panel data estimation results reveal that factors like imported technology explain firm-level exports across modes of ownership.

India is attracting FDI that is domestic market seeking rather than efficiency seeking. This calls for important policy prescriptions with regard to FDI and exports to enhance production efficiency and international competitiveness through the sourcing of raw materials and capital goods, R&D, importing technology and skills, and developing infrastructure.

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Does Plant Size Matter? Differential Effects of Foreign Direct Investment on Wages and Employment in Indian Manufacturing

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This paper examines the differential effects, based on the size of the plant, of industry-level foreign direct investment (FDI) on plant-level employment and the wages of skilled and unskilled workers in India's manufacturing sector. On average, there are strong positive differential effects of increased inward-level FDI for large plants relative to small and average-sized plants in terms of employment and the average wages of both skilled and unskilled workers. Small plants experience negative effects from inward FDI, which can be explained by intra-industry reallocation of output from smaller to larger plants. After conducting a regional analysis, I find positive spillovers to small plants in Indian states that receive large and persistent flows of FDI. This suggests that a critical mass of FDI is necessary for small plants to experience positive spillover effects.

Keywords: foreign direct investment, skill, spillovers, wages, workers
JEL codes: D22, F62, J24, J31

I. Introduction

Economic theory and policy has often stressed the important role of foreign direct investment (FDI) in transforming the productive capacities of an economy and contributing to the development of human capital. It is posited that increased globalization, as measured by increased FDI, has greater beneficial effects than tariff liberalization because of the accompanying transfer of technology and skills to the domestic economy in the case of the former. Of particular concern are the effects of spillovers to other domestic players in industries that receive FDI. While most studies have focused heavily on what factors attract FDI and under what conditions one observes the spillover effects, the literature on the impacts of such FDI on employment and wages is less extensive, especially in the developing economy context and specifically in the South Asian context.

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Most developing economies' policies are aimed at encouraging more inward FDI in keeping with growth and development objectives. India has moved to a more liberalized FDI regime over the past few years, which includes allowing FDI to enter through the automatic route in most cases while also raising FDI caps for many sectors. In 2014, India launched its Make in India campaign, which aims to attract more FDI with a special thrust toward improving domestic production capabilities.

Indian policies have been successful in attracting foreign investors. According to UNCTAD (2015), FDI in India reached $34 billion in 2014, making it one of the top 10 global destinations for FDI inflows. However, little is known about how this influx has affected wages and employment. An important goal of the Make in India campaign, which is aligned with India's National Manufacturing Policy, is to increase employment in the manufacturing sector in absolute terms. The National Skill Development Corporation was set up to provide skills to India's labor force, an acknowledgment that the development of an economy is contingent on the growth and development of its human capital. Most studies on FDI in India are focused on the determinants of inward FDI and are either industry-level studies or case studies. While the former studies do not take into account important within-industry plant heterogeneity when estimating the effects of FDI, the latter may be informative but not statistically robust or generalizable.

This paper focuses on the effects of industry-level FDI on plant-level employment and the wages of both skilled and unskilled workers in India's manufacturing sector. It investigates whether FDI increases plant-level employment and average wages, and more importantly, whether the change in demand for workers due to increased FDI inflows is skill biased or not. According to traditional theory, foreign ownership provides host economies with access to knowledge, which, if absorbed by domestic workers, enhances the domestic human capital stock, making it permanently more productive. This impact spills over to domestic firms through the training of suppliers, imitation, and labor mobility, while workers migrate from multinational firms to domestic firms and transfer their know-how to domestic workers through various channels of formal and informal interaction (Aitken and Harrison 1999, Poole 2013). An improvement in the quality of workers should lead to an increase in average wages for workers in both domestic and foreign firms. Further, if there are complementarities between foreign inputs accompanied with foreign investment and workers' skills, an increase in FDI should also lead to an increase in demand for skilled workers and increase the skill composition at foreign plants while putting upward pressure on the wage–skill premium. However, spillovers to domestic plants might not occur if inflows of FDI are neither large nor persistent enough to transform the workforce at recipient firms or create a large enough supply of skilled workers who can then migrate to smaller domestic firms. In such cases, we would see greater poaching of skilled workers from domestic firms by foreign firms as opposed to an increase in the supply of skilled workers.

This paper estimates the aforementioned relationship in India by using plant-level data available from the Annual Survey of Industries (ASI) conducted by the Ministry of Statistics and Programme Implementation, and industry-level FDI data from the Department of Industrial Policy and Promotion under the Ministry of Commerce and Industry, for the years 2000–2006. The main finding is that with increased inflows of industry-level FDI, large plants experience a greater increase in the employment of and average wages paid out to both skilled and unskilled workers relative to small and average-sized plants. The effects are negative for small plants as far as the employment of production workers is concerned, which suggests that there are greater market reallocation effects away from small plants with increased industry-level FDI, causing them to reduce production and employment. Moreover, there are negative effects for average-sized and small plants even in terms of average wages paid out to skilled and unskilled workers, suggesting that there is poaching of higher-quality production and skilled workers by large plants as industry-level FDI increases. I also find that the differential increase in the employment of production workers at large plants is biased toward male workers as industry-level FDI increases. When considering the differential impact on regions, however, I find that states that are the biggest winners in terms of FDI inflows, both in terms of the quantity and persistence of flows, experience strong spillover effects in the wage–skill premium and skill composition; that is, big and small plants alike experience an increase in relative wages as industry-level FDI increases, as well as a higher composition of skilled workers. This could be because for an industry to experience positive horizontal spillovers in wages, a critical mass of FDI should be realized and the inflows should persist over a period of time. Only then do we observe the greater training, mobility, and imitation that contributes to an expanded pool of skilled workers in an industry such that plants can benefit from increased supply and the enhanced skill composition of the workforce. For instance, Poole (2013) highlights that higher-skilled former multinational enterprise workers are better able to transfer technology, while higher-skilled incumbent workers are better able to absorb the transferred technology. Based on this mode, workers at multinational enterprises are expected to experience an increase in their skills only after a certain period of working and training. Furthermore, incumbents are expected to increase their level of skills only when there is a substantial share of multinational enterprise workers at their firms. Moreover, regions with high levels of FDI might even have better backward and forward linkages, allowing FDI to flow over a sustained period of time.

This paper is divided into nine sections. Section II reviews the literature on the impact of FDI on employment and wages, and the evidence of spillovers. Section III presents evidence on regional inequalities in inward FDI in India. The empirical model is discussed in section IV. A description of the data and measurement of the variables used in the empirical model can be found in section V. Section VI discusses the estimation results while robustness checks are presented in section

VII. A regional analysis of the differential impact of FDI is presented in section VIII. Section IX concludes.

II. Related Literature and Motivation

In the literature investigating the impacts of FDI, there has been a recent shift toward plant-level analysis as opposed to industry- or sector-level analysis. Following Melitz (2003), studies take into account firm and plant heterogeneity within industries, which is crucial to understanding the effects of FDI. Earlier studies investigating the role of FDI on labor focused mainly on the impact of FDI on labor productivity and whether there were any spillover effects to domestic plants. Blomstrom and Persson (1983) find that an increase in the foreign share in an industry is correlated with an increase in labor productivity, even at domestically owned plants within the same industry. This study, however, does not control for fixed differences in productivity across industries, which may be a source of endogeneity bias. Aitken and Harrison (1999) control for industry-level fixed effects in their study on Venezuela and distinguish between own plant effects and spillover effects of FDI by considering both plant- and industry-level FDI. They find that while own plant FDI has a positive effect on plant-level productivity, the spillover effects of FDI are negative, owing mainly to the market reallocation effect. This paper follows a similar approach in methodology but mainly considers employment, skill composition, and wages as outcomes of interest.

There are various other studies that estimate the effects of FDI on productivity and wages for developed and developing economies. Feenstra and Hanson (1995) find that during the relaxation of the FDI regime in Mexico, the offshoring of jobs that were relatively unskilled and labor intensive in the United States but relatively skill intensive in Mexico explained nearly 50% of the increase in relative wages in Mexico during the early 1980s. This effect was largely driven by FDI in maquiladoras, which are foreign-owned assembly plants in export processing zones. The other strand of literature pertains to identifying spillovers. While positive spillovers of FDI are found for the United States in terms of gains in both total factor productivity (Keller and Yeaple 2009) and wages (Aitken, Harrison, and Lipsey 1995), these spillover effects are absent for developing economies such as Mexico and Venezuela (Aitken, Harrison, and Lipsey 1995). While my study also finds negative spillovers for small plants in India, I find that regions receiving large and persistent FDI inflows actually experience positive spillovers. It is possible that high FDI regions in India mimic a developed economy environment where FDI, presumably in the presence of strong backward and forward linkages, has been able to transform domestic capability over time, resulting in increased spillovers.

More recently, Poole (2013) provides evidence of positive spillovers of FDI in Brazil by using matched employer–employee data to show that as workers migrate from multinational to domestic firms there is an increase in the wages of even domestic workers at incumbent firms. Further, the transfer of technology is greater the higher the skill level of the worker migrating from the multinational and the higher the skill level of the worker at the incumbent firm. Average wages for incumbent workers at the domestic firm increase as the share of workers from multinationals increase at the domestic firm. In my regional analysis for India, I show similar effects for small firms in regions receiving high levels of FDI. As highlighted by the mechanism described in Poole (2013), it is likely that there is a bigger pool of skilled workers in regions that have experienced a large sustained inflow of FDI, allowing for greater instances of knowledge transfers spillover even to small firms. Another study of note is by Hijzen et al. (2013), which compares the effect of FDI on wages across developed and emerging (Brazil and Indonesia) economies. The authors find that there is a positive effect of foreign ownership on wages, which is mainly driven by the creation of new high-wage jobs.

This paper derives motivation from Das (2002), who theoretically models the effect of FDI on relative wages in developing economies. Under certain conditions in his model, FDI might actually decrease relative wages. One possible channel is a decline in demand for skilled workers as there is intra-industry substitution of output from less efficient domestic firms to more efficient (by assumption) foreign firms. The second is through influencing the occupational choices of skilled workers and crowding them out from entrepreneurial jobs to equally skilled wage-based positions at multinationals. This paper empirically finds that there is an intra-industry substitution of labor from smaller to larger plants as industry-level FDI increases. Based on the assumption that size may be a proxy for efficiency and the likelihood of receiving FDI, I believe that this result corroborates with what Das (2002) predicts will happen in the case of a technological gap. If there is an intra-industry substitution of output from small plants to large plants, we must also expect intra-industry substitution of labor, with employment declining at small plants and increasing at large plants. While Das (2002) makes a prediction about what would happen to relative wages on average, this paper considers the differential effects on average wages for both skilled and unskilled workers. The main finding is that while average wages of both skilled and unskilled workers increase differentially for large plants, small plants actually experience a decline. Assuming that the technology gap between foreign plants and domestic plants still exists, this result is in line with the expectation of the model. In fact, in Indian states that are (historically) the largest recipients of FDI, this differential is likely to be smaller. I find that there are positive spillovers to both small and large plants alike.

III. Inward Foreign Direct Investment in India

Most of the literature on FDI for India has focused on the determinants of FDI inflows. There are also a few studies that focus on the impact of FDI on various industry- or firm-level outcomes. FDI has increased in India since the liberalization of previous restrictions on FDI in the 1990s and it is now one of the major recipients of FDI among emerging economies (UNCTAD 2015). In addition to liberalization at the national level, state-level policy reforms have also increased the ease of doing business to make it more attractive for foreign investors to operate in India.

In a study that investigates the role of state-level policies that affect inward FDI, Banga (2003) finds that there is a differential effect of state-level policies on sources of FDI. While the removal of restrictions shifts FDI from developed economies to developing economies, fiscal incentives are more effective for attracting FDI to developing economies. In addition, bilateral investment treaties play an important role in attracting FDI from developed to developing economies. Aggarwal (2005) investigates the role of labor market institutions in attracting FDI, distinguishing between domestic-market-seeking and export-oriented FDI to find that while rigid labor market institutions discourage both kinds of FDI, the effect is more pronounced in domestic-market-seeking FDI. Mukherjee (2011) shows that FDI in India is highly concentrated regionally and examines the state-level factors that play an important role. Market size, agglomeration effects, and the size of the manufacturing and services base in a state have a positive and significant effect on FDI inflows. On the other hand, she finds that taxation policies and labor costs have a significant negative impact on FDI inflows. Morris (2004) echoes the findings that FDI is strongly concentrated regionally and further examines the determinants of FDI inflows, specifically for Gujarat.

These studies highlight the regional concentration of FDI and the importance of state-level policies that affect taxes, infrastructure, and labor market institutions, all of which are instrumental in determining the level of FDI inflows. In keeping with these findings, I will control for these effects while empirically estimating the relationship between industry-level FDI and plant-level outcomes. Further, this study will investigate how the estimated relationship varies for each region. I will divide the states into three groups according to the amount of FDI received: (i) the top third, (ii) the middle third, and (iii) the bottom third.

IV. Empirical Estimation

In the estimation exercise, I want to distinguish between the effects of industry-level inward FDI on employment and wages for large, average-sized, and small plants. For the baseline specification, I will use the log of total sales by the plant as a measure of size. Data on whether a plant is the recipient of FDI is not available from the ASI. However, there are certain benefits of not using plant-level FDI for the estimations. Plant-level FDI will generate various endogeneity bias concerns when studying its impact on plant-level variables. We can assume that FDI mainly goes to the large plants. I provide empirical evidence using Prowess data to show this in section V. Prowess data is not suitable for the main analysis because it does not have information on the outcome variables of interest, such as employment and the wages of skilled and unskilled employees. Additionally, large firms that do not receive FDI are most likely the competitors of firms that do receive FDI and must adjust their technology and management systems to remain competitive. These firms are also more capable of making such adjustments than smaller firms in the same industry. Using Prowess data, I will further alleviate concerns regarding endogeneity by showing in section V that there are not a few focal firms in an industry receiving all of the FDI. I use the following specification for my estimation:

$$\ln y_{it} = \alpha_i + \alpha_{rt} + \alpha_j + \beta 1 \ln FDI_{jt} + \beta 2 \ln FDI_{jt} \times \ln size_{it} + \beta 3 \ln size_{it} + \beta 4 \ln X_{it} + \varepsilon_{it} \quad (1)$$

where y_{it} is the dependent variable at the plant level varying across time t, a_i controls for the plant fixed effects, a_{rt} *is* the region-time fixed effects, and a_j represents the industry fixed effects. The variable $\ln FDI_{jt}$ is total FDI in industry j, $\ln size_{it}$ is the log of measures of plant-level size captured by fixed assets, and $\ln X_{it}$ is a vector other plant-level controls.

The various outcomes of interest are at the plant level and include total employment, employment of skilled workers (comprising managerial and supervisory staff and other skilled employees), employment of production (unskilled) workers, skill composition, total wages, total average wages, and relative wages. Consider the impact of an increase in industry-level FDI. The interaction term in the specification considers the level of FDI in the industry and the plant size. As highlighted above, it is assumed that larger firms are either direct beneficiaries of FDI or are competing firms that imitate technologies and adjust to increase their competitiveness. Therefore, we can expect an increase in production with an increase in industry-level FDI at larger plants, which also has a positive impact on total employment. Further, given technology transfers and complementarities between superior technology and quality (proxied by the skills of workers), we can assume that bigger firms will also experience an increase in relative demand for skilled workers. Therefore, for all the outcome variables, we should expect $\beta_2 > 0$. Even in cases where size does not act as a proxy for the presence of foreign equity and technology in a plant, we can expect the biggest plants to respond most aggressively to an increase in FDI in the industry by upgrading their own technology and worker skills (e.g., increasing wages to retain workers) such that $\beta_2 > 0$. β_1 in equation (1) captures the spillover effects and the impact of FDI on small plants in the industry. If the spread of technological know-how due to the presence of foreign investors leads to an industrywide increase in economic activity, and if this know-how is transferred to workers on a persistent basis, leading to an increase in skill of the workforce in general, we should expect $\beta_1 > 0$ for all outcome variables as well. However, if there is a greater market contraction effect on smaller domestic firms and there is no transfer of technology, but rather a poaching of skilled workers from domestic plants to large plants that receive FDI, we should expect $\beta_1 < 0$ for the outcome variables.

There is a concern that in regions receiving high levels of FDI, even small plants are recipients of inward FDI and so a positive β_1 does not capture spillovers but rather the effects of plant-level FDI. In section V, I show that, even in high FDI regions, it is plants that are much larger than the average or median size that receive FDI rather than FDI being more evenly distributed across firms of different size. Therefore, even in these regions, β_1 continues to capture spillover effects.

To control for within-industry plant heterogeneity and unobservable time-invariant characteristics that may influence the relationship that I am trying to estimate, the specification includes plant fixed effects. As stressed by Aitken and Harrison (1999) and Keller and Yeaple (2009), various time-invariant unobservable industry characteristics can cause FDI to flow into certain industries rather than others. To make sure these do not affect my estimation, I control for industry fixed effects. Finally, while year fixed effects would control for any economywide policy that affects all plants equally, from Banga (2003), Morris (2004), Aggarwal (2005), and Mukherjee (2011), we know that there are important regional variations in the distribution of FDI and that state policy plays a crucial role in attracting FDI. The estimation therefore controls for state-year fixed effects, which control for any unobservable changes that were made at the state level that would affect inward FDI and the outcome variable. The standard errors in the estimation are robust and have been clustered at the industry-year level.

V. Data and Measurement

The main data used to measure the variables in the above specification are the plant-level data from the ASI released by the Ministry of Commerce and Industry. The survey is the most comprehensive data set of India's manufacturing sector and has recently been made available as a panel. This data set is better suited to my analysis than the other commonly used Prowess data set because it contains detailed information on employment and wages of skilled and unskilled workers that the latter is unable to provide. The data include information on various plant characteristics such as fixed assets, working capital, total sales, employment, location, and wages for all categories of workers and employees at the five-digit National Industrial Classification (NIC) industry level.

For this study, I have used a strongly balanced panel of 5,425 plants. A strongly balanced panel is considered because the ASI is a combination of a survey and census; thus, if some plants are missing for a few years, we cannot infer the exit or entry of those plants. Instead, it is more likely that these firms were not surveyed in those years. Outcome variables of interest have been used or calculated from the

Table 1. **Summary Statistics**

	Mean	**Standard Deviation**
Log(Fixed capital)	18.96	(1.86)
Log(Working capital)	16.32	(2.80)
Log(Production workers)	4.87	(1.68)
Log(Total employment)	5.13	(1.67)
Log(Skilled workers)	3.51	(1.65)
Log(Male workers)	4.40	(1.75)
Log(Female workers)	3.27	(1.74)
Log(Managerial workers)	2.68	(1.61)
Log(Other workers)	3.00	(1.58)
Log(Total sales)	18.53	(2.50)
Skill composition	0.24	(0.16)
Observations	36,875	

Source: Author's compilation.

data set. For instance, skill composition has been calculated as a ratio of skilled employees (supervisory and managerial staff as well as other professionals such as engineers, accountants, and designers) to total workers. Relative average wages have been calculated by taking a ratio of the average wages paid out to a skilled employee to the average wages paid out to a production worker. The estimations use the natural logs of all variables except skill composition, which is a ratio. Summary statistics for these variables are reported in Table 1. A list of all the variables used as well as their definitions and units of measurement are provided in the Appendix (Table A1).

In section IV, it was assumed that larger firms were more likely to receive FDI. Using Prowess, which includes data on foreign ownership, it was demonstrated that firms receiving FDI are, on average, much bigger in terms of total sales, fixed assets, and total wages. (As mentioned earlier, Prowess data do not contain information on employment.) Table 2 shows the size distribution of firms receiving FDI from the Prowess data set in the first column, followed by all firms in the Prowess data set and all plants in the ASI data set in the second and third columns, respectively. This is presented for all plants followed by regions receiving low, medium, and high levels of FDI. Firms that receive FDI have a much higher mean and median than the grouping of all firms in the Prowess data set. These findings hold for the entire sample when considered separately for low-FDI, medium-FDI, and high-FDI regions. This analysis adds credibility to using size as a proxy for receiving FDI.

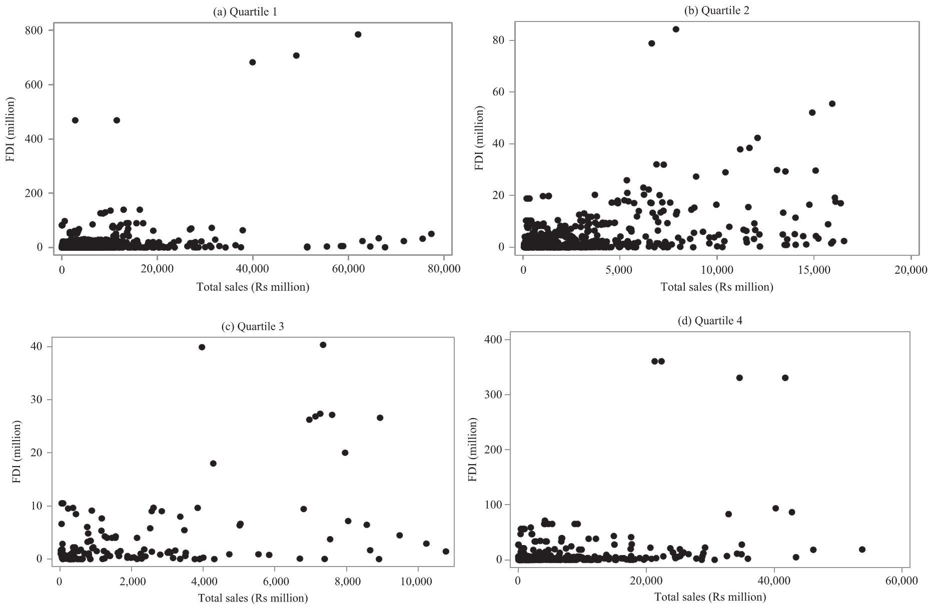
Using Prowess data, I also show the distribution of FDI across firms of different size, which is measured as total sales. This shows that there are not just a handful of focal firms receiving FDI in order to allay endogeneity concerns with the use of industry-level FDI. Figure 1 shows the distribution for the four industry quartiles, with quartile 1 receiving the smallest amount of FDI and quartile 4 receiving the largest.

Table 2. **Regional Heterogeneity in Inward Foreign Direct Investment Flows**

	All Plants			Low-FDI Region			Medium-FDI Region			High-FDI Region		
	Prowess FDI	**Prowess All**	**ASI All**	**Prowess FDI**	**Prowess All**	**ASI All**	**Prowess FDI**	**Prowess All**	**ASI All**	**Prowess FDI**	**Prowess All**	**ASI All**
Total sales (Rs million)												
Observations	4,114	36,160	29,267	151	1,887	5,590	706	7,079	6,571	2,949	24,981	15,808
Mean	1,212.77	518.63	446.10	948.59	385.10	219.53	1,370.24	578.11	450.35	1,222.63	515.22	559.68
Median	841.20	192.00	179.13	891.60	133.60	64.17	1,036.30	231.00	148.85	847.70	191.10	314.10
Standard Deviation	1,151.42	784.97	638.99	899.87	615.58	438.38	1,199.86	817.71	671.64	1,143.83	786.35	673.89
Total wages (Rs million)												
Observations	4,246	36,789	32,922	144	1,853	6,118	766	7,304	7,196	3,012	25,372	18,039
Mean	63.27	25.46	25.74	47.52	23.29	12.97	64.00	24.31	23.33	65.69	26.47	33.17
Median	42.45	8.20	12.79	24.30	7.90	3.62	42.20	7.40	10.12	45.65	8.80	21.46
Standard Deviation	60.49	40.85	33.04	56.60	37.51	23.19	60.38	39.97	32.23	60.85	41.81	35.05
Fixed assets (Rs million)												
Observations	4,172	40,345	20,387	142	2,084	3,196	695	8,049	4,524	3,017	27,658	12,500
Mean	761.10	278.84	359.82	847.57	242.11	191.82	768.80	266.70	369.38	772.97	284.63	403.67
Median	535.90	98.80	159.79	500.05	79.20	62.30	587.80	92.90	127.39	548.50	101.40	219.48
Standard Deviation	702.10	450.10	493.92	818.65	419.53	361.75	684.84	442.82	533.47	703.20	452.49	500.83

ASI = Annual Survey of Industries, FDI = foreign direct investment, Rs = Indian rupee.
Source: Author's calculations.

Figure 1. **Distribution of Foreign Direct Investment by Firm Size for Industry Quartiles**



FDI = foreign direct investment, Rs = Indian rupee.
Source: Centre for Monitoring Indian Economy. Prowess database. https://www.cmie.com/kommon/bin/sr.php?kall=wcontact&page=prowess.

The industry-level FDI data used in this study are from the Department of Industrial Policy and Promotion of the Ministry of Commerce and Industry (National Council of Applied Economic Research 2009). The report compiles statistics released by the Reserve Bank of India for 2000–2006. Using the concordance between the Department of Industrial Policy and Promotion's sector-level codes and the three-digit level NIC 2004 provided in the 2009 report, as well as concordance tables for three-digit NIC codes for 1998–2004 from the Ministry of Commerce and Industry website, inward FDI flows are reported at the NIC 1998 three-digit level. There are a total of 75 industries considered in the data for the manufacturing sector, with significant variation across industries.

Section VIII of this paper studies the relationship between industry-level FDI and various plant-level employment and wage outcomes for India's regions. Based on the combined FDI and plant-level data, Indian states have been divided into three groups according to the amount of FDI received: (i) the top third, (ii) the middle third, and (iii) the bottom third. The states in group (i) are Andhra Pradesh, Gujarat, Haryana, Karnataka, Maharashtra, Tamil Nadu, Uttar Pradesh, and West Bengal. The states in group (ii) are Dadar and Nagar Haveli, Delhi, Goa, Jharkhand, Madhya Pradesh, Odisha, Punjab, Rajasthan, and Uttaranchal. The states in group (iii) are Assam, Bihar, Chandigarh, Chhattisgarh, Daman and

Diu, Himachal Pradesh, Kerala, Pondicherry, and others.[1] The states that did not receive FDI are not included in the analysis for this section. As mentioned above, Banga (2003), Aggarwal (2005), and Mukherjee (2011) provide evidence on how FDI inflows are spatially distributed. Section VIII of this study delves into the consequences that these regional disparities in FDI inflows have on employment and the wages of skilled and unskilled workers.

VI. Results and Discussion

The specification in section IV has been estimated for various outcome variables. Table 3 shows how alternate specifications, especially in terms of various fixed effects, affect the coefficient of interest. The dependent variable in Table 3 is total employment at the plant level. Model 1 only considers the level of FDI (firm size is proxied by total sales) and it also includes various plant-level controls such as total fixed capital and working capital. Model 1 only controls for plant fixed effects and year fixed effects. The effect of aggregate industry-level FDI on plant-level total employment is negative, but it is not statistically significant.

Model 2 introduces the interaction term between FDI and plant-level total sales, which is the measure of size being used in this estimation. If we only consider in the interaction term the levels of FDI and total sales, which are two continuous variables, the coefficient is not very informative. It will give the differential effect of FDI on plants that have nonzero total sales relative to plants that have zero total sales. To make this more informative, total sales has been centered around the mean, so we can compare the effect of FDI on plants that are of average size relative to plants that are of below-average size. We find that the coefficient on the interaction term is positive and significant. This implies that for plants that are larger than the average plant in the sample, an increase in industry-level FDI leads to a bigger increase in total employment relative to plants that are smaller than average. These plants are either receiving FDI or are large enough to compete with plants benefiting from FDI, and they are expanding production activity and total employment more than small plants in the same industry. β_1 in this model is negative but insignificant, which can be interpreted as either a lack of industry-level spillovers in terms of employment or simply as small plants not gaining from the increased levels of FDI in their industry. The coefficient β_2 varies from 0.002 to about 0.003. While this may not seem economically significant, many industries have seen large percentage increases in FDI. Also, this effect will be bigger the larger the plant is relative to an average-sized plant. In addition, it will vary from industry to industry and region to region. The variations across industries and regions are explored in section VII.

Model 3 includes industry fixed effects, which control for any fixed differences across industries that may lead to a higher inflow of FDI and affect

[1]Pondicherry was renamed Puducherry in 2006.

Table 3. **Foreign Direct Investment and Total Employment**

	(1) Log(Total employment)	(2) Log(Total employment)	(3) Log(Total employment)	(4) Log(Total employment)	(5) Log(Total employment)	(6) Log(Total employment)	(7) Log(Total employment)
Log(FDI)	−0.00150	−0.00275	−0.00398	−0.00398	0.104	-0.00391^{*}	0.0739
	(0.00208)	(0.00235)	(0.00256)	(0.00256)	(-)	(0.00227)	(-)
Log(FDI) × Log(Total sales)		0.00210^{*}	0.00240^{**}	0.00240^{**}	0.00298^{**}	0.00255^{**}	0.00337^{**}
		(0.00114)	(0.00117)	(0.00117)	(0.00141)	(0.00117)	(0.00141)
Log(Total sales)	0.203^{***}	0.169^{***}	0.163^{***}	0.163^{***}	0.155^{***}	0.161^{***}	0.148^{***}
	(0.0113)	(0.0205)	(0.0208)	(0.0208)	(0.0241)	(0.0206)	(0.0240)
Constant	2.862^{***}	2.896^{***}	3.045^{***}	3.045^{***}	2.232	2.887^{***}	2.370
	(0.222)	(0.222)	(0.263)	(0.263)	(-)	(0.213)	(-)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year FE	No	No	No	No	Yes	No	Yes
State-year FE	No	No	No	No	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	No	No	No
Industry FE	No	No	Yes	Yes	No	No	No
State FE	No	No	No	Yes	No	No	No
Observations	23,559	23,559	23,559	23,559	23,559	23,559	23,559
Adjusted R^2	0.200	0.201	0.203	0.203	0.215	0.209	0.223

FDI = foreign direct investment, FE = fixed effects.

Notes: All models include plant fixed effects. Standard errors are in parentheses and are clustered at the three-digit NIC industry-year level. Log(Total sales) has been centered around its mean. (-) indicates that the standard error could not be calculated because of the fixed effects. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Source: Author's calculations.

plant-level employment. Model 4 includes state fixed effects in addition to industry fixed effects, which further controls for any fixed differences across states that may be affecting the relationship between inward FDI and plant-level employment. It may be possible, however, that the differences across industries vary over time and β_1 may pick up these changes that are affecting the dependent variable. To control for this, Model 5 includes industry-year fixed effects, which allows us to estimate only the differential effects across big and small plants of industry-level FDI changes. Similarly, differences across states vary across time, especially with respect to state-level policies. As has been highlighted by Banga (2003), Morris (2004), Aggarwal (2005), and Mukherjee (2011), these policies play a very important role in affecting FDI inflows. Therefore, Model 6 controls for state-year fixed effects. Model 7 controls for both industry-year fixed effects and state-year fixed effects. The main coefficient of interest β_2 continues to be positive and statistically significant across all models. The magnitude also roughly remains the same, though it is largest in Model 7, where we include the most controls. Ideally, we would like to use the specification in Model 7 as the baseline because it includes both state-year fixed effects and industry-year fixed effects, but because β_1 is of interest to us in order to estimate the spillover effects to small plants, we use state-year fixed effects and industry fixed effects in all the following estimations. While not presented in Table 3, I also estimated models that include industry-region-year fixed effects to better account for the endogeneity of FDI. Again, the coefficient of the interaction term is what will be better identified rather than the spillover effects (β_1). The estimation results reveal that the coefficient on the interaction term is robust to this specification.[2]

The specification used in all models in Table 4 includes firm fixed effects, industry fixed effects, and state-year fixed effects. The outcome variables all pertain to employment, starting with total employment at the plant level in Model 1. The effects are not different from those discussed in Table 3, wherein we find evidence of a relative increase in total employment at large plants, possibly those that benefit from increased industry-level FDI, and no evidence of spillovers to small plants. Similar effects are found for employment of skilled workers and production workers in Models 3 and 4. Both models show that big plants differentially employ more skilled workers and production workers relative to small plants as industry-level FDI increases. However, Model 3 shows evidence of negative spillovers of production workers to small plants. This can be interpreted as the market contraction effect for small firms in favor of large firms due to FDI. As industry-level FDI increases, small plants, which are likely not receiving this FDI nor are productive enough to compete with plants with a foreign presence, experience a decline in market share. Therefore, as their market share and production declines, they experience lower derived demand and less employment

[2] The results are available from the author upon request.

Table 4. **Foreign Direct Investment and Skilled Workers**

	(1) Log(Total Employment)	(2) Log(Skilled Workers)	(3) Log(Production Workers)	(4) Skill Composition	(5) Log(Managerial Employees)	(6) Log(Other Employees)	(7) Composition of Other Employees
Log(FDI)	−0.00561**	−0.00268	−0.00712***	0.000765	−0.000351	−0.00461	−0.000232
	(0.00244)	(0.00250)	(0.00260)	(0.000535)	(0.00299)	(0.00326)	(0.00246)
Log(FDI) × Log(Total sales)	0.00295**	0.00272***	0.00259***	0.0000785	0.00222*	0.00559***	0.00193**
	(0.00119)	(0.00103)	(0.000942)	(0.000197)	(0.00126)	(0.00120)	(0.000785)
Log(Total sales)	0.154***	0.0872***	0.147***	−0.0132***	0.0993***	0.0339	−0.0363***
	(0.0207)	(0.0179)	(0.0201)	(0.00361)	(0.0220)	(0.0207)	(0.0139)
Constant	3.141***	0.546	2.556***	0.337***	−0.231	1.005*	−0.511
	(0.259)	(0.489)	(0.284)	(0.0763)	(0.390)	(0.593)	(0.310)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,559	23,486	23,503	23,506	23,378	22,837	22,706
Adjusted R^2	0.211	0.119	0.152	0.018	0.069	0.060	0.005

FDI = foreign direct investment, FE = fixed effects.

Notes: All models include plant fixed effects. Standard errors are in parentheses and are clustered at the three-digit NIC industry-year level. Log(Total sales) has been centered around its mean. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Source: Author's calculations.

of production workers. In terms of the composition, however, Model 4 shows that there are no differential effects in terms of bias toward skilled workers. At least compositionally, there is no evidence of complementarities between skilled workers and sophisticated technology that is embodied in FDI, either in terms of differential effects or in terms of spillovers. Models 5 and 6 analyze how the two subcategories of skilled workers (managerial and supervisory staff and other technically skilled employees) are affected by industry-level FDI. The estimations reveal that the differential effects are much larger in the case of other technically skilled employees compared with supervisory and managerial staff. This indicates that there are bigger complementarities between technical skills and FDI than managerial skills and FDI. Alternatively, it could mean that although plants would like to adjust their organizational structures and hire more and better managers as FDI increases, they are unable to do so because of systemic lags in adjustment or rigidities in organizational structures. This could be further exacerbated by the fact that there are supply-side constraints as far as hiring managers is concerned.

Table 5 studies the relationship between wages of various worker categories and industry-level inward FDI. Model 1 examines how the total wage bill at the plant level changes with industry-level FDI. Not only do big plants pay out higher total wages than small plants, there are negative spillovers to small plants as industry-level FDI increases. Total wages, however, capture both changes in employment and average wages, and may be a reflection of the employment effects observed in Table 4. Model 2, therefore, considers the average wages paid out to workers and whether the positive differential effect for big plants as well as the negative spillover effects to small plants still persist. The dependent variables in Models 3 and 4 are the average wages paid out to skilled workers and production workers, respectively. Again, big plants differentially pay higher average wages to both skilled workers and production workers relative to small plants, while small plants experience negative spillovers as industry-level FDI increases. This implies there is no evidence of the transfer of technology or skills to workers or an upskilling of the labor pool. Bigger plants that are either recipients of FDI or are more aggressively able to compete with plants with FDI poach these workers to stay competitive in the market. There is, however, no differential increase in relative wages or the wage–skill premium. This could be because foreign firms pay efficiency wages to both production and nonproduction workers to elicit more effort. The increase in wages to both categories is perhaps proportional, which is why it does not reflect in the measure of the wage–skill premium. Additionally, the measure of skill here does not include education; therefore, it is possible that more educated workers in each of these categories are experiencing a bigger increase in wages than those with less education and training. Unfortunately, I am unable to capture this because of a lack of data. Skilled employees are further classified into two subcategories—(i) managerial and supervisory staff, and (ii) other skilled employees such as engineers and accountants—in Models 6 and 7, respectively.

Table 5. **Foreign Direct Investment and Wages**

	(1) Log(Wages)	(2) Log(Average wage)	(3) Log(Skilled average wage)	(4) Log(Production average wage)	(5) Log(Relative wages)	(6) Log(Managerial average wage)	(7) Log(Other skilled average wage)
Log(FDI)	−0.0103***	−0.00470**	−0.00493**	−0.00393**	−0.00110	−0.00836***	−0.00628**
	(0.00306)	(0.00188)	(0.00215)	(0.00179)	(0.00195)	(0.00249)	(0.00255)
Log(FDI) × Log(Total sales)	0.00533***	0.00232***	0.00287***	0.00182***	0.00103	0.00378***	0.00254**
	(0.00125)	(0.000677)	(0.000866)	(0.000668)	(0.000820)	(0.00109)	(0.00101)
Log(Total sales)	0.167***	0.0139	0.0283*	0.0377***	−0.00948	0.00819	0.0342*
	(0.0241)	(0.0111)	(0.0153)	(0.0116)	(0.0149)	(0.0185)	(0.0177)
Constant	13.77***	10.64***	11.31***	10.35***	0.921**	11.35***	10.50***
	(0.358)	(0.253)	(0.394)	(0.176)	(0.359)	(0.427)	(0.469)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,557	23,557	23,462	23,501	23,457	23,370	22,834
Adjusted R^2	0.337	0.261	0.237	0.193	0.032	0.176	0.147

FDI = foreign direct investment, FE = fixed effects.

Notes: All models include plant fixed effects. Standard errors are in parentheses and are clustered at the three-digit NIC industry-year level. Log(Total sales) has been centered around its mean. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Source: Author's calculations.

The differential effects are also strong for these categories and there are negative spillovers for the average-sized plant.

Putting the results from the employment and wage effects together, we find that large plants experience an expansion in employment of both skilled and unskilled workers relative to small plants as industry-level FDI increases, along with a relative increase in the total wage bill and average wages paid out to skilled and unskilled workers. There is no evidence of positive spillovers in terms of wages or employment to average-sized and small plants. Based on the coefficient of log(FDI), which measures the effect of industry-level FDI on averaged-sized to small plants, one can infer that there is no evidence of positive spillovers in terms of wages or employment. In fact, there seem to be negative spillovers to small plants as far as wages of skilled and unskilled workers are concerned, pointing toward the fact that there is probably more poaching than training with increased industry-level FDI. Further, there are negative spillovers to small plants as far as employment of production workers is concerned, likely due to decreased market share from the market reallocation effect of greater industry-level FDI. There also seem to be no relative adjustments in terms of skill composition at large plants as FDI increases; neither is there a relative increase in the demand for skilled workers as reflected by the insignificant effects on the wage–skill premium. It is possible, however, that to find stronger effects on spillovers in terms of wage–skill premium or skill composition, we should consider the lagged effects of FDI. I consider this in section VII, which also serves as a robustness check for the results. It could be the case that a critical mass of FDI needs to be achieved before spillover effects are observed. This question will be revisited in section VIII, where I compare regions receiving low, average, and large inflows of FDI.

In the concluding part of this section, I investigate how the employment and wages of male and female production workers are affected by industry-level inward FDI. There is a different perception about the skills and commitment of male and female production workers, as theorized by Yahmed (2012), such that employers discriminate against female workers. This discrimination is exacerbated as plants globalize and become quality conscious. I find that this holds in the context of FDI in India's manufacturing sector. Table 6 shows that, with an increase in industry-level FDI, large plants differentially increase the employment and average wages paid out to male workers, while the employment of female workers remains unaffected. This leads to a slightly statistically significant lower wage for women at large plants relative to small plants.

VII. Robustness Checks

This section addresses the various endogeneity concerns that can arise when estimating the specification in section IV. It is an extension of Table 3, which shows that the estimation is robust to various other specifications. First, I show that the

Table 6. **Foreign Direct Investment and Wages of Male and Female Workers**

	(1) Log(Male workers)	(2) Log(Male average wage)	(3) Log(Female worker)	(4) Log(Female average wage)	(5) Log(Gender relative wages)	(6) Female composition
Log(FDI)	-0.0112^{***}	-0.00439^{**}	−0.00298	−0.00323	0.00600	0.00212^{*}
	(0.00306)	(0.00200)	(0.00640)	(0.00419)	(0.00378)	(0.00128)
Log(FDI) × Log(Total sales)	0.00245^{***}	0.00215^{***}	0.000709	0.00153	-0.00258^{*}	0.000195
	(0.000907)	(0.000660)	(0.00189)	(0.00193)	(0.00148)	(0.000376)
Log(Total sales)	0.117^{***}	0.0422^{***}	0.0718^{*}	0.0373	0.0305	−0.00584
	(0.0182)	(0.0119)	(0.0394)	(0.0315)	(0.0256)	(0.00690)
Constant	2.809^{***}	10.20^{**}	1.575^{***}	10.54^{***}	0.281	0.285^{**}
	(0.326)	(0.191)	(0.540)	(0.292)	(0.330)	(0.110)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
State-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,155	23,152	7,954	7,940	7,888	7,966
Adjusted R^2	0.129	0.224	0.057	0.142	0.011	0.036

FDI = foreign direct investment, FE = fixed effects.

Notes: All models include plant fixed effects. Standard errors are in parentheses and are clustered at the three-digit NIC industry-year level. Log(Total sales) has been centered around its mean. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Source: Author's calculations.

Table 7. **Robustness Checks**

	(1) Log(Total employment)	(2) Log(Total employment)	(3) Log(Total employment)	(4) Log(Total employment)
Lagged Log(FDI)	−0.00348	−0.00685***		−0.00582**
	(0.00216)	(0.00218)		(0.00267)
Log(FDI) × Log(Total fixed capital)	0.00210***			
	(0.000767)			
Log(Total sales)	0.203***	0.141***		
	(0.0114)	(0.0224)		
Lag(Log(FDI)) × Log(Total sales)		0.00360***		
		(0.00128)		
Log(Total fixed capital)	0.0985***	0.151***	0.200***	0.197***
	(0.0168)	(0.0142)	(0.0186)	(0.0190)
Log(FDI)			−0.00676**	
			(0.00317)	
Log(FDI) × Lag(Log(Total sales))			0.00369***	
			(0.00126)	
Lag(Log(Total sales))			0.0876***	0.0901***
			(0.0232)	(0.0257)
Lag(Log(FDI)) × Lag(Log(Total sales))				0.00345**
				(0.00151)
Constant	1.834***	3.165***	0.0234	2.246***
	(0.275)	(0.310)	(0.350)	(0.398)
Controls	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
State-year FE	Yes	Yes	Yes	Yes
Observations	23,559	20,024	20,262	19,960
Adjusted R^2	0.211	0.198	0.118	0.113

FDI = foreign direct investment, FE = fixed effects.
Notes: All models include plant fixed effects. Standard errors are in parentheses and are clustered at the three-digit NIC industry-year level. Log(Total sales) has been centered around its mean. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Author's calculations.

estimation is robust to different measures of size. Model 1 in Table 7 considers fixed assets as a measure of size instead of total sales. The estimation results are not affected by this change. Another important concern is the endogeneity of FDI inflows. As mentioned in section IV, one can expect FDI to flow into productive industries, which may lead to an endogeneity bias in the estimates. A few ways in which we control for that in Table 3 is by including industry fixed effects and by showing that the estimation is robust when industry-year fixed effects are included.

I further show that the estimation is robust by considering lagged FDI in Model 2. The differential effect is positive, significant, and of a greater magnitude, showing that the effects of FDI only increase over time. Another important endogeneity bias that the specification possibly suffers from is the reverse causality that may exist between size and the various outcome variables. Bigger plants may employ more workers, pay higher wages, and have a higher skill composition. In

Model 3 of Table 7, I use lagged total sales and find that the main result still holds. Model 4 of Table 6 considers the lagged effects of both FDI and total sales, and finds that the results are robust to this specification as well.

VIII. Regional Heterogeneity

While the estimation exercise so far has estimated the effect of FDI on plant-level employment and wages, it is important to understand how these effects differ across regions. Banga (2003), Aggarwal (2005), and Mukherjee (2011) highlight the regional FDI disparities in India that are driven by differences in state policies, infrastructure, and labor market institutions. Based on a ranking of the states in these studies and data from the Department of Industrial Policy and Promotion, I have divided the states into three groups according to the amount of FDI received: (i) the top third, (ii) the middle third, and (iii) the bottom third.

I estimate the relationship for each of these regions and the models now contain only plant fixed effects, industry fixed effects, and year fixed effects. The outcome variables considered are total employment, skill composition, and relative wages (wage–skill premium). The results are shown in Table 8.

The estimates reveal that in states that receive the largest FDI, group (i), there are no differential effects of FDI between big plants and average-sized plants. There are only negative spillovers in terms of total employment to small plants owing to market reallocation effects. This is also the case in group (ii). In group (iii), however, while there are no differential effects of FDI between big and small plants, there are strong spillover effects for both kinds of plants. Models 8 and 9 show higher skill composition and higher relative wages at average-sized plants as industry-level FDI increases. Since these are regions where FDI inflows are large and persistent, there is stronger evidence of spillovers. It is possible that a certain critical mass of FDI inflows has to be achieved before skilled workers gain from the transfer of technology and knowledge induced by foreign investment. Further, the transfer takes place over time, which is why there is evidence of spillovers only in regions that have historically been and continue to be the biggest recipients of FDI inflows. There may be a concern that it is likely that average-sized plants in high-FDI regions might be recipients of FDI, in which case one cannot interpret the coefficient on log(FDI) as spillovers. Therefore, I estimated all specifications with size centered around the 25th percentile in order to measure the effects of FDI on this group of plants. While not included in this paper, I find that the results continue to be robust for this specification.[3]

This finding is further highlighted in Table 9 in which three states are considered: (i) Maharashtra, a state with a very high level of FDI; (ii) Madhya Pradesh, a state that receives an average amount of FDI; and (iii) Assam, a state

[3]The results are available from the author upon request.

Table 8. **Regional Effects of FDI**

	Low-FDI Region			Medium-FDI Region			High-FDI Region		
	(1) Log(Total employment)	**(2) Skill composition**	**(3) Log(Relative average wages)**	**(4) Log(Total employment)**	**(5) Skill composition**	**(6) Log(Relative average wages)**	**(7) Log(Total employment)**	**(8) Skill composition**	**(9) Log(Relative average wages)**
Log(FDI)	−0.0155***	0.000220	0.000325	−0.0208***	−0.00114	0.00285	−0.0265***	0.00132**	0.0210***
	(0.00488)	(0.00122)	(0.00548)	(0.00497)	(0.000895)	(0.00401)	(0.00493)	0.000564)	(0.00385)
Log(FDI) ×	0.000999	0.00000979	0.00148	0.00115	0.000340	0.00206	0.00487**	−0.000286	−0.000461
Log(Total sales)	(0.00179)	(0.000392)	(0.00154)	(0.00164)	(0.000388)	(0.00165)	(0.00229)	(0.000273)	(0.00154)
Log(Total sales)	0.195***	−0.0170**	−0.0123	0.199***	−0.0213***	−0.0384	0.101***	−0.00442	0.0248
	(0.0325)	(0.00732)	(0.0266)	(0.0328)	(0.00657)	(0.0296)	(0.0355)	(0.00493)	(0.0284)
Constant	4.055***	0.170*	0.181	4.296***	0.107	0.544	4.874***	0.447***	−1.398***
	(0.388)	(0.0935)	(0.441)	(0.384)	(0.108)	(0.489)	(0.303)	(0.0815)	(0.376)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,914	3,902	3,886	5,177	5,166	5,150	14,217	14,189	14181
Adjusted R^2	0.220	0.026	0.008	0.205	0.023	0.011	0.152	0.011	0.018

FDI = foreign direct investment, FE = fixed effects.

Notes: All models include plant fixed effects. Standard errors are in parentheses and are clustered at the three-digit NIC industry-year level. Log(Total sales) has been centered around its mean. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Source: Author's calculations.

Table 9. **Foreign Direct Investment in Various Indian States**

	Maharashtra			**Madhya Pradesh**			**Assam**		
	(1) Log(Total) employment)	**(2) Skill composition**	**(3) Log(Relative average wages)**	**(4) Log(Total employment)**	**(5) Skill composition**	**(6) Log(Relative average wages)**	**(7) Log(Total employment)**	**(8) Skill composition**	**(9) Log(Relative average wages)**
Log(FDI)	-0.0291^{***}	0.00282^{**}	0.0164^{***}	-0.0305^{***}	−0.000244	0.0228^{**}	−0.0187	0.00174	0.00179
	(0.00736)	(0.00116)	(0.00628)	(0.00710)	(0.00163)	(0.0102)	(0.0127)	(0.00446)	(0.0131)
Log(FDI) × Log(Total sales)	0.0116^{**}	−0.000455	−0.00385	0.00132	−0.000415	0.00372	0.0162^{**}	−0.00149	−0.00211
	(0.00473)	(0.000547)	(0.00281)	(0.00339)	(0.000700)	(0.00318)	(0.00742)	(0.00224)	(0.00650)
Log(Total sales)	0.00791	−0.00435	0.0921^{*}	0.195^{***}	−0.00144	−0.0624	0.0203	−0.0149	0.0643
	(0.0751)	(0.0102)	(0.0522)	(0.0568)	(0.0132)	(0.0532)	(0.133)	(0.0377)	(0.104)
Constant	5.951^{***}	−0.247	-1.216^{*}	3.935^{***}	0.413^{**}	1.922	3.485^{***}	0.498^{*}	3.309^{***}
	(0.866)	(0.154)	(0.621)	(0.960)	(0.182)	(1.351)	(1.050)	(0.283)	(1.233)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,498	3,488	3,487	981	981	981	436	435	433
Adjusted R^2	0.193	0.030	0.021	0.247	0.039	0.019	0.309	0.057	0.034

FDI = foreign direct investment, FE = fixed effects.

Notes: All models include plant fixed effects. Standard errors are in parentheses and are clustered at the three-digit NIC industry-year level. Log(Total sales) has been centered around its mean. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Source: Author's calculations.

with a very low level of FDI. Maharashtra experiences an increase in both skill composition and relative wages through spillovers to even average-sized plants as industry-level FDI increases. In fact, there is no differential effect of FDI based on size. In Madhya Pradesh, these spillovers are present for relative wages but not for skill composition or total employment. In Assam, on the other hand, these spillovers are absent.

While these tables help give an aggregate sense of the relationship between FDI and various labor outcomes, I further test for whether one observes these when considering a specific industry. I chose an industry that belongs to the highest quartile in terms of inward FDI and is spread across various regions, Basic Chemicals (NIC 241). Table 10 includes four panels. The first panel shows the result for the entire industry and the next three show the results for regions receiving low, average, and high levels of FDI, respectively. All panels echo the results obtained throughout the paper, which is that while there is an intra-industry reallocation of labor from large to small plants in regions with high levels of FDI, there are also positive spillovers to small plants in terms of higher average wages for both production workers and skilled employees, as well as an increase in relative wages for skilled workers.

IX. Conclusion

In this paper, I investigate the impact of industry-level FDI on plant-level employment and wages for both skilled and unskilled workers. The expectation is that given the nature of FDI, which typically embodies superior technology, increased inflows should be accompanied by a transfer of technology to plants and workers, further enhancing the skills and wages of workers. Such a transfer is expected to have positive (spillover) effects, even to those plants that do not receive FDI through the training of workers and labor mobility, and to lead to imitation among plants within an industry.

My hypothesis is that the effects of industry-level FDI in terms of spillovers will be differential based on the size of the plant. My empirical analysis, which covers 5,425 plants in India's manufacturing sector, confirms this hypothesis. Larger plants experience a differential increase in total employment as well as average wages paid out to both skilled and unskilled workers relative to average-sized and small plants. However, small plants experience negative spillovers in terms of employment of production workers and average wages paid out to both skilled and unskilled workers. This suggests that there are strong market reallocation effects as foreign ownership of plants increases in an industry. Further, increased industry-level FDI is associated with a relative increase in demand for male blue-collar workers at large plants relative to average-sized and small plants, while the demand for female blue-collar workers remains unaffected. While there is evidence of an increase in skilled workers, there are no differential compositional changes at big

Table 10. **Region-Wise Effects of Foreign Direct Investment**

	(1) Log(Total employment)	(2) Log(Production workers)	(3) Log(Skilled workers)	(4) Skill composition	(5) Log(Average wages)	(6) Log(Average production wages)	(7) Log(Average skilled wages)	(8) Log(Relative average wages)
All Plants								
Log(FDI)	-0.250^{***}	-0.192^{***}	-0.242^{***}	-0.00726	0.295^{***}	0.258^{***}	0.346^{***}	0.0881
	(0.0493)	(0.0323)	(0.0493)	(0.00613)	(0.0397)	(0.0162)	(0.0505)	(0.0523)
Log(FDI) × Log(Total sales)	0.0241^{***}	0.0322^{***}	0.00568	-0.00529^{***}	-0.0103^{*}	0.00137	-0.0102^{**}	-0.0115^{**}
	(0.00585)	(0.00632)	(0.00544)	(0.00104)	(0.00516)	(0.00613)	(0.00349)	(0.00409)
Log(Total sales)	−0.0508	-0.300^{*}	0.122	0.0852^{***}	0.268^{**}	0.105	0.346^{***}	0.241^{**}
	(0.151)	(0.124)	(0.0806)	(0.0164)	(0.101)	(0.0861)	(0.0446)	(0.0822)
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	759	757	756	757	759	757	756	756
Adjusted R^2	0.233	0.097	0.129	0.032	0.254	0.155	0.244	0.035
Low-FDI Region								
Log(FDI)	-0.332^{**}	-0.363^{**}	-0.256^{***}	0.0230	0.296^{**}	0.423^{***}	0.187^{**}	-0.236^{***}
	(0.0952)	(0.112)	(0.0428)	(0.0162)	(0.0959)	(0.0384)	(0.0646)	(0.0533)
Log(FDI) × Log(Total sales)	0.00216	0.0129	-0.0251^{**}	−0.00732	−0.00937	0.0124	−0.00862	−0.0210
	(0.0137)	(0.0193)	(0.00995)	(0.00397)	(0.00482)	(0.0132)	(0.00957)	(0.0172)
Log(Total sales)	0.348	0.221	0.689^{**}	0.0888	0.239^{**}	−0.135	0.227	0.362
	(0.192)	(0.302)	(0.200)	(0.0777)	(0.0660)	(0.212)	(0.154)	(0.284)
Observations	90	90	89	90	90	90	89	89
Adjusted R^2	0.516	0.457	0.480	0.137	0.631	0.397	0.702	0.643

Continued.

Table 10. *Continued.*

	(1) Log(Total employment)	(2) Log(Production workers)	(3) Log(Skilled workers)	(4) Skill composition	(5) Log(Average wages)	(6) Log(Average production wages)	(7) Log(Average skilled wages)	(8) Log(Relative average wages)
Medium-FDI Region								
Log(FDI)	−0.279**	−0.193**	−0.117	0.0112	0.198***	0.188***	0.302***	0.115
	(0.0758)	(0.0775)	(0.0799)	(0.0151)	(0.0528)	(0.0305)	(0.0627)	(0.0601)
Log(FDI) × Log(Total sales)	0.0148	0.0223	−0.0505***	−0.0137**	0.0180	0.0164	0.0301	0.0137
	(0.0130)	(0.0182)	(0.0131)	(0.00395)	(0.0200)	(0.0141)	(0.0204)	(0.0158)
Log(Total sales)	0.351	0.0766	1.262***	0.234**	−0.118	−0.254	−0.298	−0.0437
	(0.239)	(0.320)	(0.258)	(0.0713)	(0.353)	(0.246)	(0.365)	(0.256)
Observations	115	114	114	114	115	114	114	114
Adjusted R^2	0.476	0.279	0.210	0.031	0.350	0.142	0.311	0.023
High-FDI Region								
Log(FDI)	−0.260***	−0.170***	−0.266***	−0.0159*	0.348***	0.237***	0.406***	0.169***
	(0.0352)	(0.0369)	(0.0141)	(0.00747)	(0.0337)	(0.0331)	(0.0299)	(0.0161)
Log(FDI) × Log(Total sales)	0.0277**	0.0474***	0.0356**	−0.00266	0.000198	−0.0108	−0.00730	0.00352
	(0.0100)	(0.00825)	(0.00983)	(0.00252)	(0.00845)	(0.00602)	(0.00826)	(0.00831)
Log(Total sales)	−0.218	−0.780***	−0.571***	0.0460	0.0559	0.400**	0.343	−0.0567
	(0.292)	(0.166)	(0.154)	(0.0383)	(0.210)	(0.111)	(0.230)	(0.177)
Observations	552	551	551	551	552	551	551	551
Adjusted R^2	0.170	0.061	0.133	0.029	0.213	0.137	0.219	0.011

FDI = foreign direct investment, FE = fixed effects.

Notes: All models include plant fixed effects. Standard errors are in parentheses and are clustered at the three-digit NIC industry-year level. Log(Total sales) has been centered around its mean. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Source: Author's calculations.

plants; neither is there evidence of an increase in the relative wage–skill premium at large plants. While this may suggest that an increase in industry-level FDI in India is not skill biased in its demand for workers nor does it contribute to an increasing pool of skilled workers, analysis at the regional level provides a better picture of the actual effects. Analyzing the effects of industry-level FDI on different regions reveals that even average and small-sized plants in regions that receive the largest inflows of FDI experience an increase in both the wage–skill premium and the skill composition of workers. This indicates that perhaps a critical mass of FDI is required to influence the demand for skilled workers at plants and to contribute to the pool of skilled workers in an industry.

The above findings are important for understanding the effects of a liberalized FDI policy. If the inflows of FDI into an industry are low and not sustained over time, we should expect to observe greater intra-industry reallocation of output from domestic firms to multinational firms. This is associated with the poaching of high-quality workers from small and averaged-sized plants as opposed to the transformation of the workforce through the provision of better skills. The current Make in India campaign should ensure that conditions in the domestic economy not only attract FDI, but also that these inflows persist over a period of time to benefit the workforce at the industry level.

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Appendix

Table A1. **Glossary**

Variable	**Description**	**Unit**
Fixed capital	Total value of fixed assets	Rs
Working capital	Current assets minus current liabilities	Rs
Production workers	Unskilled workers	-
Skilled workers	Technical, supervisory, and managerial employees	-
Total employment	Total number of people employed	-
Male workers	Male workers	-
Female workers	Female workers	-
Managerial workers	Workers in managerial and supervisory roles	-
Other workers	Nonmanagerial, nonsupervisory, or nontechnically skilled employees	-
Total sales	Gross sale value	Rs
Skill composition	Ratio of skilled workers to production workers	-
Other skilled composition	Ratio of technically skilled workers to managerial and supervisory workers	-
Foreign direct investment	Total foreign direct investment received	Rs
Wages	Total amount paid out in wages by the plant	Rs
Average wage	Total wages / Total employment	Rs

Continued.

Table A1. *Continued.*

Variable	**Description**	**Unit**
Skilled average wage	Total amount paid out in wages to skilled employees / Number of skilled employees	Rs
Production average wage	Total amount paid out in wages to production workers / Number of production workers	Rs
Relative wages	Ratio of total wages paid to skilled workers to those paid to production workers	Rs
Relative average wages	Ratio of skilled average wages to production average wages	Rs
Managerial average wage	Total amount paid in wages to managerial workers / Number of managerial and supervisory workers	Rs
Other skilled average wage	Total amount paid in wages to technically skilled employees / Number of technically skilled employees	Rs
Male average wage	Total amount paid out in wages to males / Number of male workers	Rs
Female average wage	Total amount paid out in wages to females / Number of female workers	Rs
Gender relative wages	Ratio of female average wage to male average wage	-
Female composition	Ratio of female workers to male workers	-
Lagged Log(FDI)	Log of foreign direct investment of the previous year	-
Lag(Log(Total sales))	Log of total sales of the previous year	-

FDI = foreign direct investment, Rs = Indian rupee.
Source: Author's compilation.

Does Environmental Governance Matter for Foreign Direct Investment? Testing the Pollution Haven Hypothesis for Indian States

VINISH KATHURIA*

This paper attempts to examine the role of environmental governance on foreign direct investment by testing the pollution haven hypothesis for 21 Indian states for the period 2002–2010. To test for the hypothesis, this study computes an abatement expenditure index adjusted for industrial composition at the state level using Annual Survey of Industries plant-level data. The methodology used is based on that proposed by Levinson (2001). The index compares actual pollution abatement expenditures in a particular state, unadjusted for industrial composition, to predicted abatement expenditures in the same state. (The predictions are based on nationwide abatement expenditures by industry and each state's industrial composition.) If the adjusted index is low for a state, it implies that the state has poor environmental governance, which would be expected to induce foreign firms to invest. However, the results do not find any evidence of the pollution haven hypothesis in the Indian context. Other infrastructure and market-access-related variables are more important in influencing a foreign firm's investment decisions than environmental stringency.

Keywords: abatement expenditure, environmental governance, India, pollution haven hypothesis
JEL codes: F18, F23

I. Introduction

Over the past 3 decades, developing economies have witnessed a significant inflow of foreign direct investment (FDI). Total FDI flows to developing economies as a share of the world total increased from 17% in the early 1990s to 52% in 2013 (UNCTAD 2013). FDI inflows to developing economies were buttressed by the liberalization process embarked on by many economies in the early 1990s and

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the high growth rates that resulted from such reforms. Many host economies also devised suitable incentives to attract FDI. Another reason often cited in the literature is that relatively lenient environmental regulations in an economy can attract FDI. This is a process that has been described as a "race to the bottom" (Grossman and Krueger 1991, Xing and Kolstad 1998). Keller and Levinson (2002) posited that a key factor influencing a foreign firm's choice of location could be the compliance costs of local environmental regulations.

One of the ways in which compliance costs can be measured is to look at how much firms are spending on pollution abatement. If these costs are aggregated across firms in a particular location, they reflect the environmental governance aspects in that location. All other things being equal, a firm in one Indian state having higher pollution abatement expenditures in comparison with another firm in the same sector in a different state indicates more stringent environmental governance in the first state. This paper seeks to identify the impact of actual abatement expenditures on the location choices of foreign firms in India by computing an index of abatement expenditure for firms in each state using plant-level data from the Annual Survey of Industries for the period FY2002–2003 to FY2009–2010.[1]

Earlier studies attempting to measure environmental regulations have used either pollution intensity (see, for example, Mani, Pargal, and Huq 1997; Jha and Gamper-Rabindran 2004; Dietzenbacher and Mukhopadhyay 2007) or pollution abatement costs divided by one of the following: total employment, gross state domestic product (GSDP), or a state's manufacturing output without controlling for industry characteristics (see, for example, Friedman, Gerlowski, and Silberman 1992; Duffy-Deno 1992; Crandall 1993). A key problem with such measures is that they fail to adjust for industrial composition. States that are home to pollution-intensive industries such as steel, fertilizers, and chemicals will incur relatively high pollution abatement costs whether or not they have stringent regulations. Thus, pollution abatement costs that account for industrial composition are needed to assess a state's regulatory stringency.

In this paper, I compute industrial-composition-adjusted abatement costs using unit-level data from the Annual Survey of Industries for the period FY2001–2002 to FY2009–2010. The data are aggregated at the National Industrial Classification (NIC) 3-digit and 2-digit levels, and then computed as an index. Subsequently, I use panel data techniques to test for the pollution haven hypothesis for 21 major states in India. The results do not validate the pollution haven hypothesis in the Indian context.

The remaining paper is organized as follows. Section II explores how FDI and the environment are linked. Section III discusses measurements of

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[1]In India, a fiscal year (FY) is the period between 1 April and 31 March. FY2002–2003 implies the fiscal year running from 1 April 2002 to 31 March 2003.

environmental governance in the literature. This is followed by an explanation of the methodology used to assess the role of environmental governance on FDI in different Indian states in section IV, which also explains the methodology used to construct the industrial-composition-adjusted environmental governance index. Descriptive statistics and other control variables are given in section V. Section VI reports the estimation results. The paper concludes with a discussion of the policy implications in section VII.

II. The Relationship between Foreign Direct Investment and the Environment

The relationship between FDI and the environment in the literature can be grouped into three main strands: (i) environmental effects of FDI flows, (ii) competition for FDI and its effects on environmental standards, and (iii) cross-border environmental performance (Pazienza 2015). Despite extensive empirical work and case study evidence, there is still not a clear understanding of the associated phenomena (Erdogan 2014, Pazienza 2015).

With respect to the environmental effects of FDI flows, Pazienza (2015) argues that greater integration of the world economy through increased investment flows (and trade) and mobility of factors will impact the environment through the (i) scale effect (moving from a small to global scale), (ii) technique effect (adoption of cleaner technology), and (iii) composition effect (a shift in preferences to cleaner products and greater environmental protections with increases in income) (Kathuria 2008, Pazienza 2015). The net of these three effects is reflected in the ultimate impact on the environment.

The literature exploring the relationship between FDI and environmental regulations discusses two distinct phenomena: (i) the pollution haven hypothesis, and (ii) the "race to the bottom" or "regulatory chill hypothesis." In the context of FDI, the pollution haven hypothesis emphasizes the possibility that investors seek economies in which to locate with fewer regulatory requirements and therefore cheaper costs of operation for industries. Interestingly, most authors who focus on the pollution haven hypothesis have adopted an empirical approach (see Dean 1992 for a survey taken before 1990 and Erdogan 2014 for a recent survey).

This strand in the literature has often been used to oppose globalization given the impacts of foreign investment on local environmental standards. Generally known as the "race to the bottom" or "regulatory chill effect," the argument states that foreign firms may induce governments to reduce local environmental standards or freeze them at suboptimal levels (Erdogan 2014). Evidence shows that in the People's Republic of China, provinces compete intensely for foreign capital by offering promises of preferential treatment to potential foreign investors, which can include a tacit (or explicit) commitment to lax enforcement of environmental standards (Esty and Gentry 1997). In resource-seeking industries, where products are homogeneous, minor cost differences can translate into large gains in market share. Consequently, foreign investors occasionally exert considerable pressure on recipient economies (Erdogan 2014). These competitive pressures can also operate in the opposite direction as investors insist on higher environmental standards. For example, foreign investors in Costa Rican banana production have insisted upon the application of high environmental standards as their European customers demand an environmentally sound product (Gentry 1999, Erdogan 2014).

The focus of the present study is on testing for the pollution haven hypothesis in Indian states rather than on the responsiveness of environmental standards to FDI.

III. Pollution Abatement Costs as a Measure of Environmental Governance

Three broad methods have been used in the literature to characterize environmental stringency (Keller and Levinson 2002): (i) qualitative indexes of regulatory stringency, (ii) quantitative measures of enforcement on the part of states and economies, and (iii) compliance costs incurred by plants. Crandall (1993) and Friedman, Gerlowski, and Silberman (1992) were among the first to use industrial-composition-unadjusted pollution abatement costs (as a share of either GSDP or employment) as a measure of environmental regulation. Later studies by Levinson (2001) and Keller and Levinson (2002) used industrial-composition-adjusted pollution abatement costs to measure the level of environmental regulation.

Though variation in state-level environmental stringency is less than variation across economies, state-level variation provides three benefits. First, there are much better data on a state's environmental costs than on costs at the international level. Second, states are more comparable with one another than different economies on nonenvironmental parameters (Keller and Levinson 2002). In cross-economy studies, costs are different due to prevailing market conditions in different economies rather than purely the result of abatement-related costs. This bias is less if an analysis is conducted across states within the same economy. Third, most studies on decision-making processes with regard to location show that environmental regulations have a very small role in these decisions (OECD 1997). Factors like political stability, size and growth potential of markets, access to other markets, labor costs, ease of repatriation of profits, transparency and predictability of administrative and legal frameworks, cultural affinity, infrastructure, and quality of life are more important (Erdogan 2014). Many of these factors are the same across states within an economy; thus, the major key variable influencing the locational choices of foreign firms would be environmental costs.

The use of pollution abatement (operating) expenses as a measure of abatement costs is preferred for two reasons (Keller and Levinson 2002). First, operating expenses for pollution abatement equipment are easier to identify separately. Abatement capital expenses may be difficult to disentangle from other investments in the production process that have little to do with pollution abatement. Second, abatement capital expenditures are highest when new investment takes place. This implies that Indian states with thriving economies such as Gujarat and Tamil Nadu that have sufficient manufacturing investment also tend to have high abatement capital expenses regardless of the stringency of their environmental laws. Moreover, operating costs show a more consistent year-to-year pattern (Levinson 2001), while capital expenses can vary in line with industry business cycles. This implies that pollution abatement expenditure can be used as a proxy variable for environmental regulation. Incidentally, the Annual Survey of Industries includes the following three variables: (i) expenses incurred in the repair and maintenance of pollution equipment (which was discontinued in 2008), (ii) gross addition of pollution control equipment expenses during the year, and (iii) gross closing expenses of pollution control equipment at the end of the year.[2] In this paper, I use the latter two measures (gross addition expenses and gross closing expenses on pollution control equipment) to compute an index of environmental governance.

IV. Methodology

A. Measuring Environmental Governance

Friedman, Gerlowski, and Silberman (1992); Crandall (1993); and List and Co (2000) used measures like pollution abatement costs divided by either total employment or GSDP. A key problem with such measures is that they fail to adjust for industrial composition. Based on Levinson (2001), I compute an industry-adjusted abatement expenditure index for 25 Indian states for different time periods to see if FDI inflows are affected by any variation in abatement expenditure (reflecting the degree of environmental governance). The index compares actual pollution abatement expenditure in a particular state, unadjusted for industrial composition, to the predicted abatement expenditure in the same state. These predictions are based solely on economywide abatement expenditures by industry and each state's industrial composition. This paper improves on Levinson (2001) and Keller and Levinson (2002) by computing industry-adjusted abatement expenditure at the NIC 3-digit level instead of the NIC 2-digit level.

Let the actual abatement expenditure per unit of output be denoted as follows:[3]

$$S_{st} = \frac{P_{st}}{Y_{st}} \tag{1}$$

[2]Neelakanta (2015) is the only study in the Indian context that used repair and maintenance expenses to compute an abatement cost index for 2 years, 2002 and 2005. There seems to be a problem with the computations as the industry-adjusted abatement cost index is well below 1 for all Indian states. Since it is a relative measure, the states with higher abatement costs should have an index value greater than 1.

[3]This paper uses the same notations as used by Levinson (2001) and Keller and Levinson (2002).

where P_{st} is pollution abatement expenditure in state s in year t, and Y_{st} is the manufacturing sector's contribution to the GSDP of state s in year t. S_{st} is the unadjusted measure of compliance costs. By failing to adjust for the industrial composition of each state, it probably overstates the compliance costs of states with more pollution-intensive industries and understates the costs in states with relatively clean industries. To adjust for industrial composition, compare equation (1) to the predicted pollution abatement expenditure per unit of GSDP in state s:

$$\hat{S}_{st} = \frac{1}{Y_{st}} \sum_{i=1}^{N} \frac{Y_{ist} P_{it}}{Y_{it}} \tag{2}$$

where N is the total number of industries. In India's case, industries are indexed from 15 through 36 (covering 22 industries) following the 2-digit manufacturing NIC codes. Y_{ist} is the contribution of industry i to the GSDP of state s at time t, Y_{it} is the economywide contribution of industry i to national GDP, and P_{it} is the economywide pollution abatement expenditure of industry i. In other words, S_{st} is the weighted average pollution abatement expenditure (per unit of GSDP), where the weights are the relative shares of each industry in state s at time t. To construct the industry-adjusted index of a state's stringency, S^*_{st}, I compute the ratio of actual expenditures in equation (1) to the predicted expenditures in equation (2):

$$S^*_{st} = \frac{S_{st}}{\hat{S}_{st}} \tag{3}$$

when S^*_{st} exceeds 1, industries in state s at time t spend more on pollution abatement than similar industries in other states. When S^*_{st} is less than 1, industries in state s at time t spend less on pollution abatement. By implication, states with large values of S^*_{st} have relatively more stringent regulations than states with small values of S^*_{st} (Levinson 2001).

B. Hypothesis

A low adjusted index score for a state implies that the state has poor environmental governance, which would induce foreign firms to invest. In other words, this study tests for the pollution haven hypothesis; that is, a negative relationship between FDI and environmental governance. To test for this hypothesis, I have used the following equation that relates FDI to environmental governance after controlling for several state-specific effects such as net state domestic product (NSDP) per capita, share of manufacturing in NSDP, quality of infrastructure, and geographic dummy (proximity to coast):

$$FDI_{s,t} = \alpha + \beta S^*{}_{s,t-1} + X'_{s,t}\gamma + \varepsilon_{s,t} \tag{4}$$

β is the estimated parameter of a state's abatement expenditure index and is predicted to have a negative influence on FDI inflows; that is, the more stringent a state's environmental governance, the smaller its FDI inflows. The index also uses a lag given that a firm's decision to invest, especially with regard to FDI, is not instantaneous. Rather, an established pattern of governance may induce a firm to invest in the subsequent period. γ's are the coefficients of control variables. The control variables included are per capita net income of the state (NSDPc); share of manufacturing in NSDP; quality of infrastructure, especially the availability of electricity as measured by installed capacity (Instlcap) and transmission and distribution (T&D) losses; investment received by the state that has been implemented through an industrial entrepreneurs memorandum (IEM); availability of human capital (Literacy); and proximity to the coast. The likely effects of these control variables are summarized below.

C. Control Variables

Market size and demand

A bigger market attracts FDI (Kathuria, Ray, and Bhangaonkar 2015), due to significant potential demand and economies of scale (Walsh and Yu 2010). Market size is measured by NSDPc. A larger market size is hypothesized to have a positive sign (List and Co 2000; Keller and Levinson 2002; Fredriksson, List, and Millimet 2003; Drukker and Millimet 2007). The variable is used in log form.

Manufacturing share

NSDP accrues from the primary (agriculture), secondary (manufacturing), and tertiary (services) sectors. The manufacturing sector is relatively more capital and energy intensive in comparison with the agriculture and service sectors. A large manufacturing share in a state's NSDP reflects its status as an industrial state, which is likely to attract more FDI. Therefore, the current study uses the share of manufacturing in NSDP (Manushr) as a control variable.

Availability of power

Due to the significant capital investment required, a potential foreign investor often assesses whether a state has sufficiently available power before making an initial investment. Relatively high installed capacity implies the likelihood of available power, which is also likely to attract more FDI (Mukherjee 2011). Although installed capacity is often a good measure of power availability, this may not be the case in the Indian context where many states have T&D losses as high as 50% (Srivastava and Kathuria 2014). Actual power availability is more important for an investor than installed capacity. The level of T&D losses also indicates the effectiveness of industrial regulations in the state. Thus, I take both installed capacity (Instlcap) and T&D losses as control variables impacting the likelihood of foreign firms investing in a state. A state with low installed capacity and high T&D losses is expected to have low levels of FDI.

Proximity to a coast

Many foreign firms invest in developing economies due to cheap labor and to establish a manufacturing hub for exporting and participation in worldwide supply chains (Zhang and Song 2000). From a foreign investor's point of view, a manufacturing hub requires international connectivity in the form of a seaport so that components and final goods can be imported and exported easily. Proximity to a port reduces the transaction costs of the producer. Therefore, a state that is home to a seaport will attract more FDI (Neelakanta, Gundimeda, and Kathuria 2013). A dummy variable that is equal to 1 if a state has a seaport and 0 otherwise is used.

Clustering effect

An existing stock of investment in a state can generate positive spillovers through linkages (Kathuria 2016). It is also indicative of conducive conditions for investment. The IEM implemented in each state may capture this clustering effect as it reflects the readiness of a state to attract investment.[4] The IEM is also a reflection of better institutional characteristics like good governance, political stability, low levels of corruption, and ease of doing business. We hypothesize that the more the IEM is implemented in a state, the more FDI it will attract unless the congestion costs exceed the cost of relocating (Adsera and Ray 1998).

Human capital effect

Dunning (1998) has argued that though FDI in developing economies is often prodded by traditional factors—such as market size, lower input (labor) costs, and the cheap availability of natural resources—physical and human infrastructure, along with the host economy's macroeconomic environment and institutional framework, play a crucial role. At the state level, physical infrastructure is reflected by the availability of power and *pucca* (permanent) roads, while the literacy rate indicates the availability of human capital. The present study controls for the human capital effect through the state-specific literacy rate (Literacy).

[4]IEM is an application for acknowledgment of a unit not requiring any kind of license. The more IEMs implemented in a state, the more units in the state.

Time dummy

As my data are for 9 years, a time dummy (TIME) is employed that accounts for any macroeconomic changes occurring during the period that would affect all Indian states.

D. Data

One key problem to undertake the empirical analysis is the nonavailability of appropriate FDI data. I need state-wise FDI in the manufacturing sector. However, data on FDI inflows available from the Reserve Bank of India (RBI) and the Department of Industrial Policy & Promotion under the Ministry of Commerce and Industry are either by sector or by RBI region. RBI regions correspond to regional offices, and cover several states.[5] To solve this problem, I use responses to questions raised by members of Parliament on state-wise FDI. Data are summarized in Table A1. The data for all other variables were collected from different government agencies. The data for NSDP per capita and manufacturing share were obtained from the Central Statistical Organisation, power availability and T&D losses from the Ministry of Power and various reports of the Planning Commission, and IEM data from the Ministry of Industry and the Handbook of Statistics on Indian Economy. State-wise literacy rates were taken from 2001 and 2011 census data.

E. Econometric Specification

For the given objective, several estimation models exist. However, a simple pooled ordinary least squares (OLS) model would yield biased and inconsistent parameters if time-invariant covariates are omitted. If omitted time-invariant variables are correlated with the environmental governance variable, a fixed effects (FE) model will provide a consistent and unbiased estimate of the parameters while simultaneously controlling for unobserved unit heterogeneity. On the other hand, if these omitted time-invariant variables are uncorrelated with the environmental governance variable, a random effects (RE) model would provide a more efficient estimate than an FE model. The validity of these assumptions is examined by a Hausman test. In case of the presence of autocorrelation and heteroskedasticity, I will be using the generalized least squares method that corrects for these two problems. For the estimation purpose, I limit the sample to only 21 states and union territories for which data are available for all the variables for the period FY2002–2003 to FY2009–2010.[6] This is because many northeastern states and

[5] For example, the region Bhopal covers the states of Madhya Pradesh and Chhattisgarh.

[6] A union territory is an area under the direct administration of the Government of India. A union territory in India is similar in legal status to the District of Columbia in the United States. Though analysis in this paper includes both states and union territories, they are generally addressed collectively as "states."

union territories have neither received FDI nor are any consistent data available for their T&D losses or power consumption, thereby restricting the number of states and union territories for analysis to 21.[7]

The final econometric model estimated is

$$\begin{aligned}\ln FDI_{st} = \alpha + \beta S^{*}_{s,t-1} + \gamma_1 \ln NSDPc_{s,t} + \gamma_2 InstlCap_{s,t} + \gamma_3 T\&DLoss_{s,t} \\ + \gamma_4 Manushr_{s,t} + \gamma_5 \ln IEM_{s,t} + \gamma_6 Coastal_s + \gamma_7 Literacy_s \\ + \gamma_{8-15} Time_t + \varepsilon_{s,t} \qquad (5)\end{aligned}$$

The estimations were carried out in STATA 12.

V. Descriptive Statistics

Table 1 presents state-wise summary statistics for abatement costs after controlling for industrial composition (S^*) at the 3-digit and 2-digit NIC levels (equation 3) and without controlling for industrial composition (S) (equation 1). The correlation between adjusted (3-digit NIC data) and unadjusted abatement expenditure index is 0.9.

From Table 1, it can be inferred that several states which appear to have higher abatement expenditures as per the unadjusted index have a much lower ranking once industrial composition is accounted for. States like West Bengal and Meghalaya, which are among the top five in terms of unadjusted pollution abatement expenditure, get a much lower ranking once industrial composition is accounted for. Similarly, states like Uttarakhand and Jharkhand have a higher ranking after controlling for industrial composition. This implies that using the unadjusted measure of compliance would give a misleading picture of some states' relative stringency. Column 2 of the table gives adjusted abatement expenditure using a 2-digit NIC code. The rankings and values hardly change. The correlation between the two is 0.99. Table 1 also indicates that there are nine states for which industry-adjusted abatement expenditure is greater than 1, implying that they are spending much more than their industrial composition suggests.

Table 2 gives the trend of environmental stringency measures over three periods: period 1 (2002–2004), period 2 (2005–2007), and period 3 (2008–2010). From Table 2, it can be seen that there are six states—Andhra Pradesh, Punjab, Rajasthan, Odisha, Goa, and Haryana—which show an increasing environmental stringency trend during the entire 9-year period under review. On the other hand, there are eight states—Assam, Chhattisgarh, Gujarat, Delhi, Uttar Pradesh,

[7]To reflect popular sentiments, the official names of some states have recently been changed. For example, Pondicherry was renamed Puducherry in 2006, Uttaranchal was renamed Uttarakhand in 2007, and Orissa was renamed Odisha in 2011. This study refers to all states using their current names only.

Table 1. **Adjusted versus Unadjusted Abatement Cost Index Averages, 2001–2009**

State Code	State Name	Abatement Cost Index S^* (3 digit)	Abatement Cost Index S^* (2 digit)	Unadjusted Index, S
2	Himachal Pradesh (HP)	0.309	0.284	0.00127
3	Punjab (Pb)	0.640	0.605	0.001934
5	Uttrakhand (Uk)	1.568 **(4)**	1.469	0.005045
6	Haryana (Hr)	0.570	0.528	0.001081
8	Rajasthan (Rj)	1.077	1.099	0.005496
9	Uttar Pradesh (UP)	1.267	1.282	0.004616
10	Bihar (Bi)	0.098	0.104	0.000483
20	Jharkhand (Jh)	1.642 **(3)**	1.401	0.004923
21	Odisha (Or)	2.165 **(1)**	2.263	0.01251 **(1)**
19	West Bengal (WB)	1.447	1.476	0.00646 **(4)**
11	Sikkim (Si)	0.269	0.252	0.001755
13	Nagaland (Na)	0.002	0.001	0.000004
14	Manipur (Ma)	0.002	0.002	0.000013
16	Tripura (Tr)	0.000	0.000	0.000000
17	Meghalaya (Mg)	0.829	0.789	0.00647 **(3)**
18	Assam (As)	0.062	0.069	0.000424
22	Chhattisgarh (Ch)	1.287	1.242	0.005559
23	Madhya Pradesh (MP)	0.966	0.914	0.003674
24	Gujarat (Gj)	0.994	0.993	0.004878
27	Maharashtra (Mh)	0.875	0.851	0.00291
30	Goa (Go)	0.388	0.390	0.001821
28	Andhra Pradesh (AP)	1.467 **(5)**	1.474	0.00643 **(5)**
29	Karnataka (Ka)	2.150 **(2)**	2.176	0.00715 **(2)**
32	Kerala (Kl)	0.911	1.023	0.003778
33	Tamil Nadu (TN)	0.663	0.691	0.002045
35	Andaman and N. Island (ANN)	0.000	0.000	0.000000
4	Chandigarh (Cg)	3.223	2.910	0.007468
26	Dadra and Nagar Haveli (DNH)	0.091	0.086	0.000349
25	Daman and Diu (DD)	0.168	0.144	0.000431
7	Delhi (Dl)	0.128	0.118	0.000206
34	Puducherry (Po)	0.097	0.082	0.000317
	Average for lowest 5 states	0.035	0.033	
	Average for highest 5 states	1.772	1.760	

Notes: State codes 2, 3, 5, 6, and 8 are in the North; 9, 10, and 19–21 are in the East; 11, 13, 14, and 16–18 are in the Northeast; 22 and 23 are in the Central part; 24, 27, and 28 are in the West; 28, 29, 32, and 33 are in the South; and 4, 7, 25, 26, 34, and 35 are union territories of India.
Source: Author's calculations.

Uttarakhand, and Dadra and Nagar Haveli—which started with a high level of environmental stringency but became more lenient during the review period. Of the remaining states, eight experienced a decline in the value of the index with an increase in the middle period (2005–2007), while five showed increased stringency over the entire 9-year period with a decline in the value of the index in the middle period. The last row of Table 2 gives the average value of the abatement index for all three periods, which indicates that there is hardly any change in environmental stringency across all states over the entire review period.

Table 2. **Adjusted Abatement Cost Index, Period-Wise Analysis**

State	Period 1 (2002–2004)	Period 2 (2005–2007)	Period 3 (2007–2010)	% Change from Period 1 to Period 3	Environmental Stringency Pattern
Andhra Pradesh	1.315	1.320	1.767	34.4	Increasing
Assam	0.071	0.067	0.049	−30.9	Decreasing
Bihar	0.149	0.070	0.077	−48.5	Declined
Chandigarh	3.932	3.959	1.779	−54.8	Declined
Chhattisgarh	1.379	1.298	1.184	−14.1	Decreasing
Dadra and Nagar Haveli	0.152	0.062	0.058	−62.0	Decreasing
Daman and Diu	0.228	0.133	0.142	−37.6	Declined
Delhi	0.179	0.135	0.069	−61.3	Decreasing
Goa	0.236	0.315	0.612	159.1	Increasing
Gujarat	1.115	1.016	0.850	−23.7	Decreasing
Haryana	0.479	0.571	0.659	37.6	Increasing
Himachal Pradesh	0.218	0.193	0.516	136.2	Increased
Jharkhand	1.982	1.188	1.757	−11.3	Declined
Karnataka	2.286	2.410	1.754	−23.3	Declined
Kerala	0.886	0.932	0.916	3.4	Increased
Madhya Pradesh	0.925	0.927	1.047	13.2	Increased
Maharashtra	1.049	0.883	0.693	−33.9	Decreasing
Manipur	0.000	0.000	0.006		Increased
Meghalaya	0.201	1.452	0.834	315.4	Increased
Odisha	1.555	2.273	2.669	71.7	Increasing
Puducherry	0.118	0.086	0.087	−26.4	Declined
Punjab	0.615	0.649	0.658	7.0	Increasing
Rajasthan	0.688	1.227	1.317	91.4	Increasing
Tamil Nadu	0.727	0.597	0.664	−8.7	Declined
Tripura	0.000	0.000	0.000		No change
Uttar Pradesh	1.500	1.153	1.149	−23.4	Decreasing
Uttarakhand	2.342	1.651	0.712	−69.6	Decreasing
West Bengal	1.520	1.390	1.431	−5.9	Declined
Average	0.923	0.838	0.927	0.4	

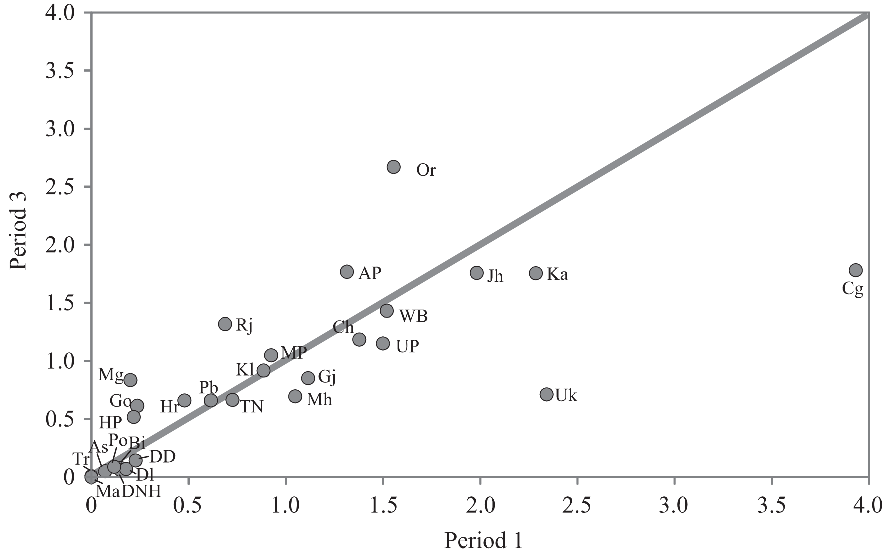
Source: Author's calculations.

Figure 1 gives the plot for environmental stringency measure between period 1 and period 3. States lying above the 45-degree line showed increased stringency between the two periods, while states falling below the line experienced a decline in environmental stringency. With the exception of Andhra Pradesh and Odisha, the stringency of environmental governance declined in all states between period 1 and period 3.

Figure 2, which gives a scatter plot between ln(FDI) and the lagged value of the industry-composition-adjusted abatement cost index, does not indicate any perceptible relation between the two.

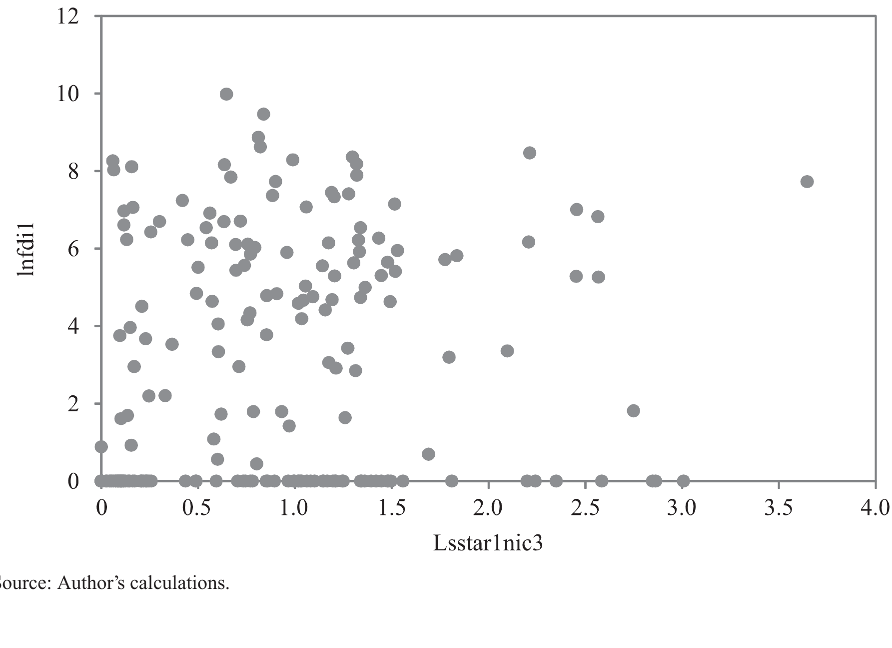
Table 3 reports the mean values of different variables used in the analysis. It shows huge variation in the values for all variables. There are states like Assam, Bihar, and Jharkhand, which hardly received any FDI. On the other hand,

Figure 1. **Change in Industry-Adjusted Abatement Expenditure Index (S^*), 2002–2004 versus 2007–2010**



Note: For actual names of states, please refer to Table 1.
Source: Author's calculations.

Figure 2. **Relation between S^*_{t-1} and ln(FDI)**



Source: Author's calculations.

Table 3. **State-Wise Descriptive Statistics**

State	FDI (INR crore)	NSDP per Capita (INR)	Manufacturing Share (%)	T&D Loss (%)	Installed Capacity (MW)	IEM Implemented (INR crore)	Literacy Rate (%)
Andhra Pradesh	1,235.72 **(5)**	22,343.95	9.52	22.12 **(5)**	6,898.51 **(2)**	988.33	63.88
Bihar	0.02	7,538.11	4.40	41.08	598.98	11.44	54.94
Chhattisgarh	207.36	15,631.20	15.07	31.75	1,650.47	214.89	67.79
Delhi	1,716.93 **(3)**	53,459.52 **(2)**	7.61	37.26	883.87	1.33	83.98 **(3)**
Goa	66.18	55,533.31 **(1)**	29.17 **(2)**	18.03 **(2)**	0.02	32.00	84.67 **(2)**
Gujarat	811.23	26,142.58	25.56 **(3)**	28.10	5,486.40 **(4)**	6,202.11 **(1)**	74.10
Haryana	174.95	33,853.01 **(4)**	16.89 **(5)**	32.76	2,603.76	144.33	72.18
Himachal Pradesh	97.13	28,461.27	9.70	19.47 **(4)**	443.81	1,114.33 **(4)**	80.07 **(5)**
Jharkhand	0.35	13,050.24	21.71 **(4)**	47.13	1,384.47	59.44	60.30
Karnataka	1,253.97 **(4)**	22,083.08	14.14	29.14	5,188.08 **(5)**	438.11	71.02
Kerala	68.99	28,824.82	6.92	27.51	2,080.99	3.11	92.37 **(1)**
Maharashtra	4,462.78 **(1)**	29,134.55	16.57	33.59	10,254.19 **(1)**	1,297.22 **(3)**	79.85
Madhya Pradesh	38.89	12,818.05	7.51	42.42	3,737.53	1,571.56 **(2)**	67.12
Odisha	22.59	14,356.21	10.76	46.91	2,385.60	43.78	68.12
Punjab	2,919.88 **(2)**	30,155.99 **(5)**	13.00	23.60	4,716.60	205.67	73.10
Puducherry	99.50	45,401.04 **(3)**	50.98 **(1)**	13.83 **(1)**	32.83	12.56	83.86 **(4)**
Rajasthan	81.68	16,298.58	8.72	40.40	3,724.64	476.33	63.67
Tamil Nadu	695.85	24,645.73	16.75	18.14 **(3)**	5,620.21 **(3)**	694.89	76.83
Uttarakhand	3.18	20,414.71	12.08	37.12	1,160.33	510.89	75.55
Uttar Pradesh	132.97	11,065.36	9.96	36.01	4,721.37	1,073.56 **(5)**	62.73
West Bengal	609.64	20,642.13	8.28	28.70	4,312.42	642.22	72.77
Average	699.99	24,830.63	15.01	31.20	3,232.62	749.43	72.81

FDI = foreign direct investment, IEM = industrial entrepreneurs memorandum, MW = megawatt, NSDP = net state domestic product, T&D = transmission and distribution.

Notes: INR crore = 10 million Indian rupees. N = 189. Figures in parentheses represent the five highest-ranked states for each of the variables.

Source: Author's calculations.

Maharashtra tops the list with an average of INR44.62 billion over this 9-year period.[8] Similarly, the share of manufacturing in NSDP is less than 5% in Bihar, compared with more than 25% in Gujarat, Goa, and Puducherry. Regarding installed capacity, Maharashtra, Andhra Pradesh, Karnataka, Gujarat, and Tamil Nadu each have more than 5,000 megawatts of power generation capacity, while states like Goa do not produce any electricity. The northern states, which do not receive much FDI and have fewer electricity installations, are also plagued with high T&D losses. Four states—Bihar, Madhya Pradesh, Rajasthan, and Uttar Pradesh—account for 40% of all T&D losses during the review period, which may discourage FDI from coming to these states. Of the five states with the highest values for human capital, as measured by the literacy rate, only Delhi has received substantial FDI, while the other four states are not even among the top 10 recipients of FDI.

VI. Results and Discussion

Before estimating the model, correlations are noted between the different control variables. Table 4 gives the Spearman correlation matrix and reports the significance of the correlation coefficient at the 5% level. A state with higher NSDP per capita is able to attract more FDI (correlation = 0.33) and have a high manufacturing share (positive correlation) with very high literacy (correlation = 0.86) and low T&D losses (negatively correlated). A state with high installed capacity is not only able to attract more FDI (correlation = 0.57), but also more domestic investment (IEM) (correlation = 0.69), and does not have any correlation with T&D losses. Similarly, a coastal state has high FDI (correlation = 0.35) and a high manufacturing share (correlation = 0.3). As expected, a literate state has a high manufacturing share and low T&D losses. Consequently, with partial correlation being statistically significant for several of the variables, I could not use all the controlled variables together.

A. Econometric Analysis

Table 5 reports the results for the econometric estimations. Equation (5) was estimated first by pooling the data for all states (column 1). As discussed, due to omitted variables, the OLS results were expected to be biased. Therefore, panel data techniques were also required and both FE and RE models were subsequently run. An F-test was carried out to see whether individual FEs exist or not. Since the F-value (6.2) is greater than the tabulated value, it implies that the null hypothesis (pooled OLS) is rejected and that FE and RE models need to be estimated separately. Columns 2 and 3 give the results of the FE and RE

[8] In July 2009, $1 = INR48.7.

Table 4. **Spearman Correlation Matrix**

	ln(FDI) (INR crore)	S^*_{t-1}	ln(NSDPc) (INR)	Manufacturing Share (%)	T&D Loss (%)	ln(Installed Capacity) (MW)	ln(IEM Implemented) (INR crore)	Coastal	Literacy Rate (%)
ln(FDI) (INR crore)	1								
S^*_{t-1}	0.048	1							
ln(NSDPc) (INR)	0.332*	−0.461*	1						
Manufacturing share (%)	0.047	−0.005	0.352*	1					
T&D loss (%)	−0.268*	0.315*	−0.660*	−0.321*	1				
ln(Installed capacity) (MW)	0.571*	0.457*	−0.121	−0.019	−0.002	1			
ln(IEM implemented) (INR crore)	0.333*	0.368*	−0.074	0.108	−0.031	0.691*	1		
Coastal	0.350*	0.158*	0.319*	0.295*	−0.439*	0.324*	0.115	1	
Literacy rate (%)	0.206*	−0.395*	0.857*	0.233*	−0.587*	−0.224*	−0.173*	0.389*	1

FDI = foreign direct investment, IEM = industrial entrepreneurs memorandum, MW = megawatt, NSDP = net state domestic product, T&D = transmission and distribution.
Notes: INR crore = 10 million Indian rupees. N = 168. *indicates significance at minimum 5% level.
Source: Author's calculations.

Table 5. **Testing for the Pollution Haven Hypothesis Dependent Variable = ln(FDI)**

Variables	**Pooled Ordinary Least Squares (1)**	**Fixed Effects (2)**	**Random Effects (3)**	**Heteroskedastic Panels Corrected Standard Errors (4)**
S^*_{t-1}	−0.329	0.203	0.0712	0.264
	(0.289)	(0.423)	(0.355)	(0.358)
ln(NSDPc)	2.964***	0.798	2.92***	3.205***
	(0.45)	(2.89)	(0.805)	(0.838)
ln(IEM)	0.213*	0.086	0.131	0.256***
	(0.085)	(0.106)	(0.093)	(0.090)
ln(Installed capacity)	0.729***	−0.215	0.662***	0.527***
	(0.116)	(0.577)	(0.183)	(0.128)
Coastal	1.395***		1.323*	1.16**
	(0.405)		(0.767)	(0.55)
Constant	−31.85***	−3.377	−31.06***	−33.73***
	(4.62)	(28.95)	(8.39)	(8.8)
Time dummies	Yes	Yes	Yes	Yes
Observations	168	168	168	168
R^2	0.51	0.112	0.50	0.40
F-test/Wald Chi^2	13.38 (0.00)	1.55 (0.12)	49.9 (0.00)	81.83 (0.00)
Number of states		21	21	21
Hausman test		4.96 (0.29)		

Notes: Figures in parentheses below the coefficients are standard errors. The numbers in parentheses in the F-test/Wald Chi^2 and Hausman test are p-values. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Author's calculations.

estimations. Whether these omitted variables (state-specific differences) are fixed or random is tested using a Hausman test (last row). This is a test for the correlation between the error and the regressors. Under the null hypothesis of no correlation between both, the RE model is applicable and its estimated generalized least squares estimator is consistent and efficient. Under the alternative, it is inconsistent. Since the test's statistic (chi-square value = 4.96) is significant only at the 29% confidence level, one cannot reject the null hypothesis. To see whether RE are needed, a Breusch–Pagan Lagrange–Multiplier (LM) test is carried out. Results lead to the rejection of the null hypothesis, in favor of the alternative, i.e., the RE model.

Row 1 shows that the industry-composition-adjusted pollution abatement expenditure index (S^*) is negative, though statistically insignificant, and thus has no impact on FDI investment. This implies that states' environmental norms do not figure in the investment decision of foreign firms. With respect to control variables, a state with high per capita income (ln[NSDPc]), which reflects a bigger internal market, can attract more FDI. A state with more domestic investment (ln[IEM]) is not able to attract more foreign investment in statistical terms. On the other hand, proximity to the coast and the availability of infrastructure, as proxied by installed capacity, has a direct bearing on foreign firms' location decisions. High installed capacity implies that power is more readily available in a state. Thus, foreign firms are expected to prefer these states. Similarly, coastal states attract more FDI due to their increased opportunities to export.

Given that panel data is used where values of different variables change over time, the possibility of autocorrelation exists. A Wooldridge test for autocorrelation (where the null is no first-order correlation) (F-value = 0.98, p = 0.33) negates this possibility. A Pesaran cross-sectional dependence test is then employed to check whether the residuals are correlated across panels, as cross-sectional dependence (contemporaneous correlation) can lead to biased results. The test value of 2.7 is significant at less than 1%, suggesting that there is cross-sectional dependence. A modified Wald test is also carried out to test for group-wise heteroskedasticity. A very high value of chi-square (≈ 175) indicates that the null of homoscedasticity (constant variance) is rejected. Given the problem of heteroskedasticity, a panel corrected standard errors model was subsequently employed and the results are reported in column 4. S^* retains the same sign and significance level even after the correction. All other control variables also retain the same sign and significance level except for domestic investment (ln[IEM]), which becomes highly significant. The results suggest that FDI flows to states that are coastal and have high installed capacity, high per capita income, and more domestic investment. Environmental stringency does not influence a foreign firm's location decision when other infrastructure and market-access-related factors are considered. In other words, the results do not validate the pollution haven hypothesis in the Indian context.

B. Robustness Test

To see whether results are robust or not, I estimated several variants of the model. Table 6 reports the results where some of the control variables are either dropped or alternate control variables are used. Column 2 (model 2) uses T&D loss instead of installed capacity. The impact of the environmental governance index (S^*) variable on FDI remains the same. The coefficient of the T&D loss variable has the expected sign, though it is not statistically significant. In model 3, the coastal variable used in model 2 is dropped. In model 4, literacy is substituted for per capita income (ln[NSDPc]), which was used in the base model. In model 5, the manufacturing share is used instead of investment in the state (ln[IEM]). In model 6, only the environmental governance index variable (S^*) and year dummies with no control variables are used. Lastly, model 7 uses state dummies and time dummies while all of the control variables continue to be excluded.

As can be seen from Table 6, the environmental management index (S^*) variable remains statistically insignificant in all variants of the model. The results are thus robust to alternate control variables and to the noninclusion of control variables. Most of the control variables retain the same sign and significance as

Table 6. **Testing for Robustness of Results–Pollution Haven Hypothesis Dependent Variable = ln(FDI)**

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
S^*_{t-1}	0.264	0.52	0.47	−0.06	0.13	0.22	0.18
	(0.358)	(0.364)	(0.34)	(0.32)	(0.30)	(0.33)	(0.313)
ln(NSDPc)	3.205***	1.655***	1.50**		3.25***		
	(0.838)	(0.756)	(0.69)		(0.52)		
ln(Installed capacity)	0.256***			0.385***	0.616***		
	(0.090)			(0.12)	(0.103)		
ln(IEM)	0.527***	0.314***	0.343***	0.286***			
	(0.128)	(0.085)	(0.081)	(0.089)			
Coastal	1.16**	0.448		1.35**	2.03***		
	(0.55)	(0.62)		(0.63)	(0.465)		
T&D loss		−0.031	−0.048#				
		(0.202)	(0.031)				
Literacy				0.089**			
				(0.038)			
Manufacturing share					−0.06***		
					(0.02)		
Constant	−33.7***	−13.84*	−11.55#	−7.26***	−33.1***	2.79***	
	(8.8)	(9.61)	(7.58)	(2.8)	(5.27)	(0.65)	
State dummies	No	No	No	No	No	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	168	168	168	168	168	168	168
R^2	0.40	0.34	0.42	0.40	0.47	0.41	0.74
F-test/Wald Chi^2	81.83	46.61	47.9	114.41	176.38	21.96	2,301.80
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Number of states	21	21	21	21	21	21	21

Notes: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. # denotes significance at the 15% level.
Source: Author's calculations.

predicted. When state dummies are included in all the variants (models 2 to 5), the main variable remains statistically insignificant. When NSDP is used instead of NSDP per capita, the main variable retains its sign and significance. Lastly, the results did not change when all models were reestimated by computing S^* at the NIC 2-digit level. The results also remain the same irrespective of how I compute S^*. The use of both gross closing expenditure and gross addition expenses on pollution abatement yield the same outcome. Based on the results, this study does not validate the pollution haven hypothesis in the Indian context.

VII. Conclusion

This paper examines the impact of environmental governance on FDI by testing the pollution haven hypothesis for 21 Indian states for the period

2002–2010. An abatement expenditure index was computed and adjusted for industrial composition at the state level using the methodology provided by Levinson (2001). The industry-adjusted abatement expenditure index was greater than 1 for nine states, which implies that these states spend more on abatement measures than their industrial composition suggests. The index also shows that over the 9-year review period, six states showed an increasing trend of abatement expenditure, while eight states showed a decreasing trend.

The paper then uses this industry-composition-adjusted pollution abatement expenditure index to test the pollution haven hypothesis in a panel data framework. The study finds that environmental stringency does not influence FDI decisions once panel-specific heteroskedasticity is accounted for. The paper concludes that a coastal state with high levels of per capita income and available power will attract more FDI. Environmental stringency does not influence foreign firms' decisions when other infrastructure and market-access-related factors are considered. The results were subsequently tested for robustness by using alternate control variables in a panel corrected heteroskedastic model. The results were found to be robust for the inclusion of control variables. To conclude, the study does not validate the pollution haven hypothesis in the case of Indian states.

There are several possible reasons why the study was not able to either validate or refute the pollution haven hypothesis in the Indian context. First, though foreign firms establish operations abroad due to low operational costs, the relevance of pollution abatement costs in comparison to total operating costs may be limited (Erdogan 2014). Second, even if these costs are high, they may still be lower than in other economies from where FDI is originating or in alternate destinations. Therefore, it may not matter where to invest within a particular economy. Finally, studies have suggested that foreign firms generally seek consistent environmental enforcement over lax enforcement (see, for example, OECD 1997), which may also hold true in the case of Indian states.

While the paper's important findings have some limitations, it can be extended to address these limitations. As mentioned, parliamentary questions were relied on to get state-wise FDI data, which showed an extremely high value of FDI for one state in a particular year. Moreover, the paper considers all FDI inflows in the 21 states under review. Instead of total FDI, only manufacturing FDI could be considered to assess the effects of environmental governance. Another extension of the present study would be testing the pollution haven hypothesis only for FDI that is associated with pollution such as investment in the chemicals and fertilizer industries. Lastly, if a race-to-the-bottom dynamic, rather than the pollution haven hypothesis, is applied in the Indian context, then FDI and environmental governance would be endogenous; the testing of which requires the use of instrumental variable estimations, which would be a further extension of the present work.

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Appendix. List of Questions and Responses by Members of the Parliament on State-Wise Foreign Direct Investment

1. UNSTARRED QUESTION NO: 182
ANSWERED ON: 01.03.2005
FOREIGN DIRECT INVESTMENTS
ADHIR RANJAN CHOWDHURY

Will the Minister COMMERCE AND INDUSTRY be pleased to state:

(a) the details of proposals for foreign direct investments submitted during 2001–2002, 2002–2003, 2003–2004 and till date statewise with particular reference to West Bengal;

(b) whether the Government has agreed to all the proposals; and

(c) if not, the status of each of the proposals as on date?

ANSWER:

THE MINISTER OF STATE IN THE MINISTRY OF COMMERCE AND INDUSTRY (SHRI E.V.K.S. ELANGOVAN)

(a) to (c) Government has put in place a liberal and transparent foreign direct investment (FDI) policy under which FDI up to 100% is allowed under the automatic route in most sectors/activities.

No prior approval of the Government is required for FDI in sectors/activities under the automatic route. Proposals requiring prior Government approval are considered under the extant FDI policy on the recommendation of the Foreign Investment Promotion Board (FIPB). State-wise details of approval/amendment granted during 2001–2002 till 2004–2005 (up to December) is shown in the enclosed statement. No FDI proposal for West Bengal is pending for consideration of the FIPB.

Source: http://164.100.47.194/Loksabha/Questions/QResult15.aspx?qref=45181 &lsno=14.

2. UNSTARRED QUESTION NO: 1032
ANSWERED ON: 01.08.2006
FOREIGN DIRECT INVESTMENTS
VIRJIBHAI THUMAR

Will the Minister COMMERCE AND INDUSTRY be pleased to state:

(a) The details of the proposals received from foreign investors for setting up of industries in the country during each of the last 3 years and the current year, statewise;

(b) The number of proposals accorded approval but have not set up industries in the country so far;

(c) If so, the reasons therefore; and

(d) The efforts made by the Government to facilitate setting up of these industries?

ANSWER:

THE MINISTER OF STATE IN THE MINISTRY OF COMMERCE AND INDUSTRY (SHRI ASHWANI KUMAR)

(a) to (d): Government has put in place a liberal and investor-friendly policy on foreign direct investment (FDI) under which FDI up to 100% is permitted on the automatic route in most sectors/ activities where no prior approval of the Government is required. For FDI proposals in sectors/activities requiring prior Government approval, the Foreign Investment Promotion Board (FIPB) acts as a single-window clearance authority. Under the liberalized economic environment, investment decisions of investors, including location, are based on techno-economic and commercial considerations.

A statement on state-wise foreign direct investment (FDI) proposals approved during the last 3 years is at Annex-I.

Statement on FDI inflows during the last 3 years as reported by the regional offices of the Reserve Bank of India is at Annex-II.

Currently, a tabular information regarding the status of establishment of industry pursuant to the approvals is not maintained.

Source: http://164.100.47.194/Loksabha/Questions/QResult15.aspx?qref=31608&lsno=14.

3. UNSTARRED QUESTION NO: 527
ANSWERED ON: 24.02.2009
FOREIGN DIRECT INVESTMENTS
MADHUSUDAN DEVRAM MISTRY

Will the Minister COMMERCE AND INDUSTRY be pleased to state:

(a) The details of investment proposed/received through industrial entrepreneurs memorandum (IEM), letter of intent (LOI), and foreign direct investment (FDI) in each of the last 3 years and the current year, statewise;

(b) The details regarding rate of utilization of such investment during the above period; and

(c) The details regarding employment generated through such investment?

ANSWER:

THE MINISTER OF STATE IN THE MINISTRY OF COMMERCE AND INDUSTRY (SHRI ASHWANI KUMAR)

(a) The details of statewise and yearwise break up of investments proposed through industrial entrepreneurs memorandum (IEM), letter of intent (LOI), and foreign direct investment (FDI) are at Annexure-I.

(b) The details of the implementation as reported by the entrepreneurs by way of filing Part B of IEMs and Letters of Intent Converted into Industrial Licence are at Annexure-II and the FDI inflow since 2005-2006 to 2008-2009 (upto September '08) is at Annexure-III.

(c) Employment for 62,06,119 persons have been proposed through the investment in terms of IEMs and LOIs during the said period. Employment generation through FDI is not maintained centrally.

Source: http://164.100.47.194/Loksabha/Questions/QResult15.aspx?qref=69930&lsno=14.

4. UNSTARRED QUESTION NO: 1074
ANSWERED ON: 28.11.2011
FOREIGN DIRECT INVESTMENTS
ASHOK KUMAR RAWAT

Will the Minister COMMERCE AND INDUSTRY be pleased to state:

(a) whether the domestic industries are lagging behind and their production has also decreased due to licenses being given to foreign companies;

(b) if so, the details thereof and the steps taken by the Government to protect/support the domestic industries; and

(c) the number of investment proposal received from foreign companies to set up industrial units in the States during the last 3 years and the current year?

ANSWER:

THE MINISTER OF STATE IN THE MINISTRY OF COMMERCE AND INDUSTRY (SHRI JYOTIRADITYA M. SCINDIA)

(a) Based on the index of industrial production (IIP) released by the Central Statistical Organisation, a table showing the growth figures in respect of industrial production (general), the three sectors of industry namely, mining, manufacturing and electricity and the 22 major industry groups of industries for the last 3 years is at Annexure 1. It does not suggest that the production is affected by foreign investments. However, under the Industrial (Development and Regulation) Act, 1951, industrial licenses are only granted to Indian companies.

(b) The steps taken/being taken by the Government for improving the industrial climate are the creation of world class infrastructure; promotion and facilitation of industrial investment including the foreign direct investment; improvement in business environment; and development of industry relevant skills. Government has also announced a national manufacturing policy with the objectives of enhancing the share of manufacturing in GDP to 25% within a decade and creating 100 million jobs. The policy seeks to empower rural youth by imparting necessary skill sets to make them employable. The policy is based on the principle of industrial growth in partnership with the States. The central government will create the enabling policy frame work, provide incentives for infrastructure development on a public–private partnership (PPP) basis through appropriate financing instruments and the State Governments will be encouraged to adopt the instumentalities provided in the policy. The proposals in the policy are generally sector neutral, location neutral and technology neutral except incentivisation of green technology. While the national investment and manufacturing zones (NIMZs) are an important instrumentality, the proposals contained in the policy apply to manufacturing industry throughout the country including wherever industry is able to organize itself into clusters and adopt a model of self regulation as enunciated.

(c) A statement showing the statewise details of foreign direct investment proposals approved during the last 3 years and current year is at Annexure 2.

Source: http://164.100.47.194/Loksabha/Questions/QResult15.aspx?qref=114624&lsno=15.

Table A1. **Trend of Approved State-Wise FDI Inflows**
(INR crore)

State	2001–2002	2002–2003	2003–2004	2004–2005	2005–2006	2006–2007	2007–2008	2008–2009	2009–2010
Andhra Pradesh	358.54	465.57	526.66	689.1	371.82	501.03	4,273.94	2,663.01	1,271.84
Assam	0	0	0	0.40	0.51	0	35.00	0	0
Bihar	0	0.18	0	0	0	0	0	0	0
Gujarat	2,042.35	414.53	148.04	1,711.81	153.05	65.79	365.15	2,274.65	125.66
Haryana	491.35	103.54	248.29	34.07	57.54	5.64	126.63	504.55	2.95
Himachal Pradesh	0.54	810.38	0.10	52.63	9.00	0	0	0	1.56
Karnataka	799.31	2,260.54	449.41	1,099.44	917.02	4,750.09	196.78	477.64	335.47
Kerala	178.06	5.99	21.22	230.43	76.77	0.09	0	107.62	0.75
Madhya Pradesh	85.64	43.55	0.44	0.05	6.00	0	0	116.34	98
Maharashtra	3,818.00	1,178.65	1527.34	1,579.60	3,961.85	12,916.78	5,551.92	7,086.16	2,544.70
Manipur	0	0	0	0	0	0	0	0	0
Meghalaya	0	0	0	0	0	0	0	0	0
Odisha	4.01	0.21	0.10	6.14	0.35	192.50	0	0	0
Punjab	16.46	0.03	465.5	690.49	19.11	1.75	3,506.00	21,579.62	0
Rajasthan	413.05	0.51	28.03	4.14	0.20	0	258.37	30.79	0
Tamil Nadu	1,123.55	446.55	815.18	348.17	261.63	805.14	1,394.82	1,003.63	64.02
Tripura	0	0	2.41	0	0	0	0	0	0
Uttar Pradesh	659.62	24.45	102.32	18.44	82.48	5.13	106.05	198.27	0
West Bengal	314.37	283.01	303.45	278.23	113.66	17.22	223.97	3,570.58	382.29
Chhattisgarh	16.05	0.03	0	200.16	0	1,650.00	0	0	0
Jharkhand	0	0.50	0.20	2.00	0	0	0	0.42	0
Uttarakhand	0	0	0	0	28.63	0	0	0	0
Chandigarh	4.22	43.13	5.75	127.99	0	0	0	0	0
Dadra and Nagar Haveli	0.04	0	0	0	0	0	0	0	0
Delhi	1,115.26	617.73	1,163.36	1,063.52	740.99	3,318.32	507.94	3,861.40	3,063.81
Goa	317.02	90.80	19.13	9.07	39.41	0	0.05	120.00	0.17
Puducherry	845.21	2.52	42.61	0.12	0	5.00	0	0	0
Daman and Diu	0	0	0.24	5.43	0	0	0	0	0
Remaining*	1,862.54	1,111.85	353.73	576.27	1,750.98	2,801.00	858.81	1,420.91	773.40
India	14,465.18	7,904.25	6,223.52	8,727.71	8,591.00	27,035.48	17,405.43	45,015.59	8,664.61

FDI = foreign direct investment.

Notes: * refers to FDI inflows in more than one state and cases when the location is not indicated; INR crore = 10,000,000 Indian rupees.

Source: Author's compilation based on the annexes to the questions raised by members of the Parliament (Lok Sabha). See the following links: http://164.100.47.193/Annexture_New/lsq14/4/au182.htm, http://164.100.47.193/Annexture_New/lsq14/8/au1032.htm, http://164.100.47.193/Annexture_New/lsq15/9/au1074.htm, and http://164.100.47.193/Annexture_New/lsq14/15/au527.htm (the latter was accessed in July 2015).

Do Financing Constraints Impact Outward Foreign Direct Investment? Evidence from India

Subash Sasidharan and M. Padmaja*

This study examines the role of financing constraints in explaining outward foreign direct investment (FDI) using unique firm-level panel data on Indian manufacturing during the period 2007–2014. We consider the role of both internal and external finance, and employ instrumental variable probit and Tobit models to examine financing constraints in outward FDI decisions and intensity. We find that internal finance impacts the likelihood of outward FDI. Further, using count data models, we examine financing constraints in determining strategies regarding a firm's number of affiliates abroad. Our findings reveal that firms with greater cash flows and liquidity are likely to have more foreign affiliates.

Keywords: financing constraints, outward FDI, total factor productivity
JEL codes: F14, F21, F23

I. Introduction

Firm-level internationalization decisions regarding foreign direct investment (FDI) have recently garnered attention in the literature on international trade. The theoretical models, which explain the process of internationalization, focus on firm heterogeneity in terms of productivity (Melitz 2003; Helpman, Melitz, and Yeaple 2004; Yeaple 2009). Productivity is highlighted as the determining factor in firm decisions to enter foreign markets, either through FDI or exports. These models posit that exporting and FDI involve sunk costs and fixed costs. Firms above a minimum threshold level of productivity engage in exporting while highly productive firms undertake FDI. Recent theoretical models extend this argument by emphasizing the role of financing constraints as a barrier to entering foreign

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markets (Chaney 2013, Manova 2013, Muuls 2015). These models incorporate financing constraints in well-known firm heterogeneity models, following Melitz (2003). The problem of financing constraints assumes greater significance in setting up affiliates abroad since firms face bigger barriers in the form of huge upfront fixed costs (Helpman, Melitz, and Yeaple 2004). During the previous 2 decades, the entry of firms from emerging economies like India into foreign markets has increasingly become a global phenomenon. Previously, firms from these economies were unable to expand beyond their own borders due to regulatory hurdles and resource constraints. Since the 1990s, reform measures adopted by policy makers in India have enabled firms to escape domestic resource constraints and integrate with global markets (Gaur, Kumar, and Singh 2014). The rapid pace at which these firms have integrated with the global economy requires thorough empirical examination given that these firms operate in an underdeveloped institutional environment that inhibits them from accessing resources (Khanna and Palepu 1997).

The much-acclaimed OLI framework (Dunning 1993) and resource-based view of FDI (Barney 1991; Peng 2001; Westhead, Wright, and Ucbasaran 2001) consider resources as the key determinant of FDI. Resources constitute both technology and capital. On the other hand, firm heterogeneity theory is based on an economic approach with a focus on efficiency considerations. Firms in emerging economies are not technologically superior but their investment decisions can also be affected by financial constraints. Surprisingly, the role of financial factors is overlooked in the above-mentioned approaches since traditionally FDI has emerged from advanced economies where capital markets are developed and financial constraints may not pose serious obstacles in making outward FDI decisions. However, the recent proliferation of multinationals in emerging economies like India poses a puzzle since capital markets are not developed in these economies. Hence, the question of how multinationals arise in resource-poor economies like India assumes greater significance. Unlike the People's Republic of China, where outward FDI is mainly driven by state-owned enterprises (Morck, Yeung, and Zhao 2008), in India outward FDI is predominantly driven by private sector firms. Therefore, it is important to understand whether financing constraints play a major role in the outward FDI decisions of firms in emerging economies like India.

Outward FDI is considered a means to escape from the "institutional voids" encountered by firms in emerging economies (Khanna and Palepu 2006). Attempts have been made to study the internationalization process of emerging market multinationals. However, the focus of these studies is mainly on entry-mode choices and determinants of outward FDI identified by using firm-level and aggregate economy-level data (Chittoor and Ray 2007; Woodcock, Beamish, and Makino 1994; Kumar 2007; Pradhan 2004). Buch et al. (2014) extended the theoretical models of internationalization strategy to the case of outward FDI in the presence of financing constraints. Since outward FDI involves high fixed costs, which are incurred upfront, firms depend on their own internal financing and/or external sources for financing FDI. However, very few empirical studies have explored the role of financing constraints in determining outward FDI decisions (Buch et al. 2014, Duanmu 2015). Financing constraints are regarded as an important factor in determining firm-specific decisions such as capital investment, research and development (R&D) investment, and exports. However, financing constraints' role in determining outward FDI decisions has not received much empirical attention.

The present study attempts to bridge this gap in the literature by examining the role of financing constraints in determining outward FDI decisions as well as the extent of outward FDI undertaken by firms. The standard empirical approach is the use of cash flow sensitivity analysis in identifying the existence of financing constraints. A recent strand of literature argues that firms lacking internal funds may be able to obtain external finance provided they have adequate collateral (Manova 2013).[1] This proposition has been verified by studies on firm-specific decisions on outward FDI (Duanmu 2015).[2] Outward FDI from emerging economies like India is increasingly becoming an important component of the world's investment flows. India's outward FDI stock registered a quantum jump over the past 2 decades, rising from a negligible $25 million during the early 1990s to $241 billion in 2013. The momentum of these investment outflows picked up during the second half of the 2000s. One can attribute this increasing trend of outward FDI by Indian firms to market-oriented reforms undertaken by the Government of India during the early 1990s. Indian policy makers have recognized the importance of these investments and take measures to ease the stringent regulatory rules on overseas investments.[3] India's share of total outward FDI from Asia recorded a significant increase from 0.4% to 4.3% between 2001 and 2011 (Export–Import Bank of India 2014). The bulk of outward FDI flows originate from the manufacturing sector, which accounted for 32% of the total outward FDI from India in 2011–2012 (Export–Import Bank of India 2014). Existing studies on outward FDI in the context of India have overlooked the role of financing constraints. Therefore, the objective of the present study is to examine financing factors in determining outward FDI based on the experience of Indian firms. We analyze the role of both internal and external financing constraints in determining outward FDI decisions and the amount of outward FDI made by Indian manufacturing firms.[4] Further, we extend our analysis to examine the role of financing constraints in determining the number

[1] In our empirical analysis, we test for the role of external finance following this line of argument.

[2] Duanmu (2015) finds a significant role for external financing constraints in determining the outward FDI decisions of manufacturing firms in the People's Republic of China.

[3] The Reserve Bank of India (RBI) relaxed the guidelines for investing overseas by raising the annual overseas investment ceiling for Indians to establish joint ventures and wholly owned subsidiaries from $75,000 to $125,000.

[4] Recent studies on sources of financing in the context of Indian manufacturing firms point to the increasing role of internal funds as a major source of financing. External sources of funding, such as banks and the corporate bond market, play a meager role in India compared with other emerging economies, reflecting the underdevelopment of Indian financial markets (Allen et al. 2012).

of a firm's foreign affiliates. This additional exercise is undertaken since establishing more foreign subsidiaries incurs higher fixed costs.

Our study contributes to the existing literature in the following ways. First, empirical studies on India's experience with outward FDI concentrate on its determinants. We add to the nascent but growing body of literature on the effects of financing constraints on FDI—controlling for firm productivity, size, ownership, and export status—based on the experience of an emerging economy like India. Unlike previous studies that considered the significance of either internal or external finance, we focus on both aspects. Second, our study uses a novel firm-level data set of outward FDI from India, which allows us to comprehensively analyze the role of financing factors in determining outward FDI. We combine data for the years 2007–2014 from the Prowess firm-level database with outward FDI data provided by the Reserve Bank of India (RBI). Further, our data set contains information pertaining to the number of affiliates and the entry mode of these firms, which enables us to understand their complex business strategies. Finally, unlike previous studies that focus on the likelihood of engaging in outward FDI, our data set permits us to account for the total amount of foreign investments, which enables us to test the relationship between financing constraints and the probability of undertaking foreign investments, as well as the amount of outward FDI.

The remainder of the paper is organized as follows. Section II explains the data and descriptive statistics. Section III provides the methodology and empirical model. The findings are discussed in section IV. The final section concludes.

II. Theoretical Underpinnings and Literature Review

The standard industrial organization approach considers FDI arising out of product and technology market imperfections (Hymer 1976, Rugman 1981). Recent theoretical models attribute the decision of a domestic firm to export or undertake FDI to productivity effects (Melitz 2003; Helpman, Melitz, and Yeaple 2004). According to this set of models, the presence of fixed costs in entering foreign markets leads more productive firms to export, with the most productive firms engaging in FDI. Following these models, numerous studies investigated the findings of Helpman, Melitz, and Yeaple (2004) and their theoretical predictions. Yeaple (2009) provides strong empirical evidence to support the findings of Helpman, Melitz, and Yeaple (2004) based on the FDI experience in the United States. Similar findings were reported by Kimura and Kiyota (2006); Girma, Kneller, and Pisu (2005); Wagner (2006); and Lee (2010) for Japan, the United Kingdom, Germany, and the Republic of Korea, respectively.

As mentioned above, productivity is not the only decisive factor driving the decision to serve foreign markets. Some of the recent models extend the Melitz (2003) model to incorporate financing factors in explaining the decision to undertake FDI and exporting (Chaney 2013, Buch et al. 2014). However, such empirical studies on firms' internationalization process and financing constraints are confined mainly to export decisions. The inclusion in the literature of the relationship between financing constraints and outward FDI is very recent. Buch et al. (2014) develop a theoretical model similar to firm heterogeneity models that show outward FDI being more vulnerable to financing constraints than exports. Firms undertaking FDI use internal funds for their international investments rather than using external finance. Firms rely more on internal funds since banks or other creditors may be unwilling to lend due to the information asymmetry surrounding the uncertainty and riskiness of investments in foreign markets. Buch et al. (2014) provide empirical support for their theoretical predictions based on the experience of German firms.

Studies on financing constraints and firm decisions in the context of India focus mainly on capital investment, R&D, and exports (Athey and Laumas 1994; Ghosh 2006; Bhaduri 2005; Bhattacharyya 2008; Sasidharan, Lukose, and Komera 2015). Some recent empirical studies have extended this framework to explain the export decisions of Indian firms. Lancheros and Demirel (2012) examined the role of credit constraints in the export behavior of Indian service firms and found that financing factors have no major impact. Instead, nonfinancing variables such as size and total factor productivity were found to be significant. In a recent study, Nagaraj (2014) analyzed the role of financing constraints in the export participation decisions of manufacturing firms in India and found that financing constraints affect the probability of firm exports. Previous research on outward FDI by Indian firms has largely been descriptive in nature (Nayyar 2008). Among these studies, some focus on the push factors of outward FDI using firm-level data (Kumar 2007, Pradhan 2004). Others concentrate on the locational choices of Indian outward FDI and motivational factors using a gravity model (Hattari and Rajan 2010). Exceptions include the firm-level studies of Goldar (2013) and Thomas and Narayanan (2013) that investigated the relationship between outward FDI and productivity. However, as mentioned above, existing studies in the context of emerging economies have overlooked the role of financing factors in determining outward FDI.

II. Data Sources

To carry out the empirical analysis, we combine two different data sources. First, financing information and firm-specific characteristics such as sales, assets, export status, and ownership information are obtained from the Prowess database provided by the Center for Monitoring Indian Economy. The Prowess database is generated from the annual reports and balance sheets of over 27,000 firms belonging to the utilities, manufacturing, and service sectors. The database contains both listed and unlisted firms, and has previously been employed in many firm-level studies analyzing financing constraints related to fixed investments and R&D (Ghosh 2006; Sasidharan, Lukose, and Komera 2015). Second, outward FDI data were obtained from the RBI to compile a database containing information about the investments of around 3,600 Indian firms in the utilities, manufacturing, and service sectors. Further, this database provides information on FDI destinations and the number and nature of affiliates (e.g., joint venture versus wholly owned subsidiary).

In our empirical analysis, we restrict the sample to firms belonging to the manufacturing sector since the fixed costs of investing abroad (e.g., setting up foreign affiliates) are more significant and higher for manufacturing firms than service firms (Helpman, Melitz, and Yeaple 2004). Further, manufacturing firms were more likely to venture abroad, with manufacturing firms accounting for about 40% of India's total outward FDI during the review period (Goldar 2013). We matched the RBI data with the Prowess data on financing characteristics and other major firm-specific characteristics to yield a subset of 329 firms engaged in outward FDI.[5] The data comprises various industry sectors.[6] We use unbalanced panel data covering the period 2007–2014.[7] The sample firms were selected based on the following criteria.[8] First, we include only those firms with positive sales and fixed assets. Second, firms reporting a negative cash flow were excluded from the sample since they were considered to be financially distressed (Sasidharan, Lukose, and Komera 2015). Flow variables such as sales are deflated with the corresponding industry Wholesale Price Index obtained from the Central Statistical Organisation. To remove the effect of outliers, variables were winsorized at the upper and lower 0.5 percentiles.

III. Methodology

We estimate the following specification using the instrumental variable probit (ivprobit) regression to analyze the role of financing constraints in determining FDI decision:[9]

$$\Pr(OFDI)_{it} = \beta_0 + \beta_1 Z_{i,t-1} + \beta_2 X_{i,t-1} + S_t + \varepsilon_{i,t} \tag{1}$$

[5] We matched the RBI data on outward FDI at the firm level with firm-level data on financial statements and other major firm-specific characteristics provided by the Prowess database. We were able to match 628 outward FDI firms belonging to the manufacturing sector. We applied filters to the matched data to clean the data. After applying the first filter of positive sales and fixed assets, the number of firms was reduced to 596. Next, we excluded those firms with a negative cash flow, reducing our sample to 568 firms. Finally, we dropped those firms with missing values for the financing constraint variables, leaving us with 329 firms.

[6] It is evident from the data that the bulk of FDI stems from the machinery and electrical equipment (39%), transport equipment (29%), chemicals and chemical products (19%), and pharmaceutical (12%) industries.

[7] The RBI provides outward FDI information at the firm level from 2007 onward. The absence of information prior to 2007 restricts our study to the period 2007–2014.

[8] We compared the characteristics of the selected sample of firms with those firms engaged in outward FDI that were excluded from the sample. The comparison shows that the selected sample for the present study is not biased. The descriptive statistics of the excluded sample are reported in column 7 of Table 1.

[9] An ivprobit model is used since the endogenous regressors included are continuous variables and the dependent variable is of a binary nature.

where i and t denote firm and year, respectively. To account for endogeneity and simultaneity among explanatory variables, we use lagged values of the time-varying explanatory variables. The dependent variable, $OFDI_{it}$, denotes whether firm i has undertaken outward direct investment or not. $OFDI_{it}$ is defined as a binary variable taking a value of 1 if a firm has reported outward FDI and 0 otherwise. Z_{it-1} and X_{it-1} represent one period lagged values of vector-of-financing constraint variables and firm-specific control variables, respectively. S_t denotes a set of time dummies to account for macroeconomic factors.

In addition to the role of financing constraints in the likelihood of engaging in outward FDI, we also examine the effect of financing constraints on the amount of outward FDI (defined as the ratio of outward FDI to total assets of the firm).[10] We employ a random-effects panel Tobit model to examine the effect of financing constraints in determining the outward FDI share (Bhaumik, Driffield, and Pal 2010).[11] Since a large number of firms in our data set report no FDI, left censoring has to be taken into account. The use of a Tobit model helps to account for the problem of left censoring. Equation (2) below shows the model specification for examining the role of financing constraints on the share of outward FDI:

$$OFDI_{it} = \max[0, \beta_0 + \beta_1 Z_{i,t-1} + \beta_2 X_{i,t-1} + S_t + \varepsilon_{i,t} \text{ } if \, OFDI_{it} > 0] \tag{2}$$

where $OFDI_{it}$ is the share of outward FDI, which is the ratio of outward FDI to total assets of the firm. The explanatory variables and other control variables are similar to the basic specification. We also control for firm-specific characteristics such as size, age, export orientation, and ownership status. Further, we undertake another empirical exercise to test the complex strategies of firms having multiple affiliates by including the number of affiliates as a count variable. This variable is used as a proxy to determine the outward investment decisions of the sample firms. In this set of analysis, we employ count data models to analyze factors that determine the number of foreign affiliates.

A. Explanatory Variables

1. Measures of Financing Constraints

Our main variable of interest is the financing constraints. We have used both internal and external financing measures to examine the role of financing constraints in determining a firm's outward FDI. However, the measurement of financing constraints is a complex issue. Previous studies have employed various

[10]The RBI data report the value of outward FDI in dollar terms. We converted to rupees and took the ratio of these converted values to the total assets of a firm.

[11]We have also estimated the model using the generalized least squares method and the results were found to be consistent. Results of this estimation are available from the authors upon request.

direct and indirect proxies of financing constraints based on firm characteristics (Farre-Mensa and Ljungqvist 2016).

2. Internal Finance Measures

Cash flow. The standard approach in measuring financing constraints in the literature is using a cash flow indicator. The cash flow sensitivity of an investment is considered to be evidence of the existence of financing constraints, following the pioneering work of Fazzari, Hubbard, and Petersen (1988). The sensitivity of a firm's investments to cash flow is interpreted as evidence of financing constraints.[12] Many subsequent empirical studies used cash flow as a measure of financing constraints (Bond and Meghir 1994; Carpenter, Fazzari, and Petersen 1998). Firms with a higher degree of internal finance find it easier to meet investment costs even if they do not have access to external finance. We define cash flow as the ratio to total assets, where cash flow is measured as profit after tax plus depreciation and amortization.

Liquidity. In addition, we use liquidity as an alternative measure of financing constraints, which is also widely used in literature. The liquidity ratio is measured as current assets minus current liabilities scaled by total assets. We expect a positive effect of liquidity on the probability of firms investing abroad. The availability of higher liquidity enables firms to meet fixed costs. In addition to the possibility of using internal funds, firms can obtain financing resources from external sources. Liquidity is a standard measure of financing constraints used by various empirical studies (Greenaway, Guariglia, and Kneller 2007; Stiebale 2011).

3. External Finance Measures

External finance is another important source of financing for firms. External finance becomes important because of the existence of upfront costs and the lag between the expenses incurred and receipts received (Manova 2015). Following Manova (2015) and Duanmu (2015), to account for the role of external finance, we include two measures: (i) capital expenditure not financed by cash flow, and (ii) access to finance (defined as a ratio of long-term bank credit to total assets). The first measure (capital expenditure not financed by cash flow) accounts for outside funding required by firms to undertake long-term investment projects and relates to fixed costs (Manova 2015). The second measure (access to finance) is an alternative

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[12] Cash flow as a measure of financing constraint has been questioned by various researchers (Kaplan and Zingales 1997). They point out that it captures the future investment opportunity and is nonmonotonic in nature. While Fazzari, Hubbard, and Petersen (2000) point out certain limitations in the approach followed by Kaplan and Zingales (1997), arguing that their theoretical model fails to capture the approach used in the literature and pointing out that their empirical classification system is flawed in identifying whether firms are constrained and the degree of financing constraints across firm groups.

measure of dependence on external finance and it accounts for a firm's access to bank credit. Both variables are expected to have a positive impact on a firm's outward FDI decisions.

4. Other Firm-Specific Characteristics

Firms that are heavily indebted have very little collateral to offer, which acts as a constraint on their expansion abroad (Buch et al. 2014). Therefore, we control for a firm's leverage (debt ratio) measured as the ratio of debt to total assets. The size of the firm is considered one of the major firm-specific factors affecting firm-level decisions. This accounts for scale effects (Krugman 1980), with larger firms always having the advantage of lower average costs, better information, and easier access to funds. Exporting is another means of serving the foreign market. Size is measured as the ratio of a firm's total assets to the industry median value. Since exporting entails ample learning opportunities about international markets, it acts as a stimulant to FDI. Therefore, we include export status as a control with a value of 1 if it exports and 0 otherwise. Total factor productivity (TFP) is an important determinant of outward FDI (Helpman, Melitz, and Yeaple 2004). We estimate TFP using the Levinsohn and Petrin (2003) procedure; we measure productivity as the ratio of a firm's TFP to mean industry TFP. Business group affiliates are a salient feature of the Indian corporate sector. Since group affiliates have access to the headquarters, they may face fewer constraints in terms of obtaining finance. Therefore, we control for group association by assigning a value of 1 for group affiliates and 0 otherwise. Regarding the effect of the age of the firm and the decision to invest abroad, previous findings in the literature are inconclusive. Some studies report that older firms are more likely to undertake FDI (Blomstrom and Lipsey 1991). However, other studies obtain mixed results (Asiedu and Esfahani 2001). We measure the age of the firm as the number of years since incorporation. Higher fixed costs involved in establishing an affiliate abroad are expected to have a negative impact on the number of affiliates owned by investing firms. In order to account for fixed costs, we include asset tangibility measured as the ratio of fixed assets to the total book value of assets (fixed costs) in the model on determinants of the number of foreign affiliates. Further, higher fixed costs are a proxy for the amount of collateral or tangibility.

B. Econometric Issues

We employ limited dependent variable models like an ivprobit model, a random-effects Tobit model, and a count data model to identify financing constraints in explaining outward FDI decisions, the amount of outward FDI, and number of foreign affiliates, respectively. The endogeneity of financing constraints is a major concern in empirical models that examine firm-level outward FDI decisions. Endogeneity arises due to the possibility that firm internationalization can enhance the financing status of firms through access to international financial markets or through export receipts (Buch et al. 2014). To control for endogeneity, we use an ivprobit model. Specifically, we control for endogeneity issues using the financing constraints of competitors of a particular firm as instruments (Buch et al. 2014). It is expected that the financing constraints of competitors are exogenous and independent of the investment decisions of a specific firm. Mean industry cash flow and mean industry liquidity, where we exclude the values of these measures specific to the firm from mean values, are employed as instruments.[13]

We use another measure, credit rating, as an alternative instrument for financing constraints.[14] Empirical evidence shows that a credit rating can be taken as a measure of financing constraints for the following reasons: (i) unrated firms are assumed to have no access to public debt markets and therefore are dependent on other intermediaries such as banks; and (ii) a credit rating reduces the information asymmetries between investors and firms, and thus implies that unrated firms are more opaque and more likely to be rationed by lenders (Farre-Mensa and Ljungqvist 2016). The reason behind employing a credit rating as an alternative instrument is that we expect firms with a credit rating to have a better financial status than unrated firms (Adam 2009, Wagner 2014, Muuls 2015). We define credit rating as a binary variable taking a value of 1 if a firm is rated by Credit Rating Information Services of India Limited (CRISIL) or 0 otherwise. However, such a measure may be inadequate since rating status may not reflect whether firms are financially constrained or not since unrated firms may not be financially constrained in a true sense (Farre-Mensa and Ljungqvist 2016). To overcome this problem, we consider firms that are rated and have been downgraded from their initial rating as financially constrained firms. Downgrading has been considered in some studies that use credit rating as a measure of financing constraints (Kisgen 2009, Tsoukas and Spaliara 2014).

To examine firm strategies for owning affiliates, we rely on the count data models. Count variables are characterized by excessive zeros, but have nonnegative values. The count models control for excess zeros in the data. The basic count model is the Poisson model, which is based on an equidispersion assumption. Since the assumption of equidispersion rarely holds, negative binomial and zero-inflated negative binomial (ZINB) regression models are often used as alternatives because they allow for overdispersion and unobserved heterogeneity (Hilbe 2014). Since in our sample there are many zero counts, in addition to the Poisson and negative

[13] We test for the potential quality of instruments using an ordinary least squares regression. The results show that all major variables are significant. The major interest variables—sector mean cash flow, sector mean liquidity, and credit rating—were found to be positively correlated to a firm's financing condition, which confirms the endogeneity problem. The results are not reported here for brevity and are available from the authors upon request.

[14] We have taken credit ratings assigned by the Credit Rating Information Services of India Limited (CRISIL) from the Prowess database.

binomial models, we employ a ZINB model to examine the role of financing constraints in determining the number of foreign affiliates. Another econometric issue with respect to count data models is the initial conditions problem associated with the data. Initial conditions account for persistence in the nature of firm-level decisions on these variables and determine the future values (Lemmon, Roberts, and Zender 2008) in the context of firm decisions like exporting and the number of foreign affiliates. Therefore, we control for the effect of initial conditions by dropping the initial year count of number of foreign affiliates in the count data model specification.

C. Descriptive Statistics

Table 1 provides the definition of the variables discussed above, their measurement, and descriptive statistics. Column 6 provides the results of the equality of mean difference between outward FDI and domestic firms using a two-tail t-test. The results of the t-test for the difference between outward FDI and domestic firms indicate that, on average, outward FDI firms are larger in terms of size and cash flow, maintain more liquidity, and are less leveraged. Column 7 reports the descriptive statistics of firms engaging in FDI that were excluded from the sample after the matching process. The average values of the firm-specific characteristics are similar to those of firms that are included in the sample. We reported this to provide evidence of our sample's unbiasedness. Figures 1(a), 1(b), and 1(c) confirm the hypothesis that the outward FDI firms are larger, have greater cash flow, and maintain more liquidity compared to their counterparts. Figure 1(d) shows that in the case of TFP, the corresponding figures are overlapping, which provides evidence that some firms with higher productivity are not engaging in outward FDI. Figure 1(e) shows no significant difference between the two groups in terms of asset tangibility (proxy for fixed costs). Based on this exercise, the heterogeneity of outward FDI and non-FDI firms with regard to their financing status is evident. However, there seems to be no clear difference in the case of asset tangibility and TFP.

IV. Results and Discussion

Table 2 presents the relationship between internal finance and the probability of firms investing abroad using an ivprobit model. Columns 1 and 2 report the estimates using cash flow and liquidity as financing indicators. Consistent with theoretical predictions, our results confirm that financing constraints (internal finance) measured by cash flow and liquidity matter for outward FDI decisions. We include size, age, productivity (TFP), export status, leverage (debt ratio), and business group association as additional control variables. The size of the firm is expected to have a positive impact on the firm's investment. On the other hand,

Table 1. **Descriptive Statistics**

Variable	Definition (1)	Observations (2)	Mean (Median) (3)	FDI Firms (4)	Non-FDI Firms (5)	p-value (6)	Mean[a] (Median) (7)
Outward FDI share	Outward FDI/Total assets	5,645	0.059 (0.059)	0.994 (0.193)	NA	NA	NA
Cash flow	Log of cash flow	5,645	2.731 (2.590)	4.276 (4.439)	2.635 (2.494)	0.000	4.776 (4.708)
Liquidity	Current assets–current liabilities/Total assets	5,645	3.692 (3.594)	5.037 (5.102)	3.609 (3.519)	0.000	5.461 (5.388)
Debt ratio/Collateral	Borrowings/Total assets	5,645	0.309 (0.301)	0.293 (0.315)	0.310 (0.300)	0.195	0.241 (0.204)
Capital expenditure	Capital expenditure not financed by cash flow/Total assets	4,137	0.015 (0.001)	0.028 (0.014)	0.014 (0.003)	0.0029	0.046 (0.019)
Access to finance	Long-term bank credit/Total assets	4,137	0.114 (0.079)	0.115 (0.074)	0.1144 (0.078)	0.951	0.114 (0.063)
Asset tangibility	Gross fixed assets/ Total assets	5,645	0.631 (0.586)	0.499 (0.491)	0.639 (0.597)	0.000	0.468 (0.451)
Size	Log of total assets/ Median industry log of total assets	5,645	1.041 (1.023)	1.317 (1.318)	1.024 (1.002)	0.000	7.258 (7.144)
Age	Number of years since incorporation	5,645	35.420 (29)	35.158 (29)	41.780 (35)	0.201	35.930 (30)
Total factor productivity	Log of TFP/Mean industry TFP	5,645	0.982 (0.725)	1.025 (0.912)	0.978 (0.711)	0.442	2.598 (2.247)
Export status	= 1 if firm exports = 0 otherwise	5,645	0.825	0.960	0.816	0.000	0.955
Business group association	= 1 if firm is associated with a group = 0 otherwise	5,645	0.386	0.465	0.381	0.0025	0.548

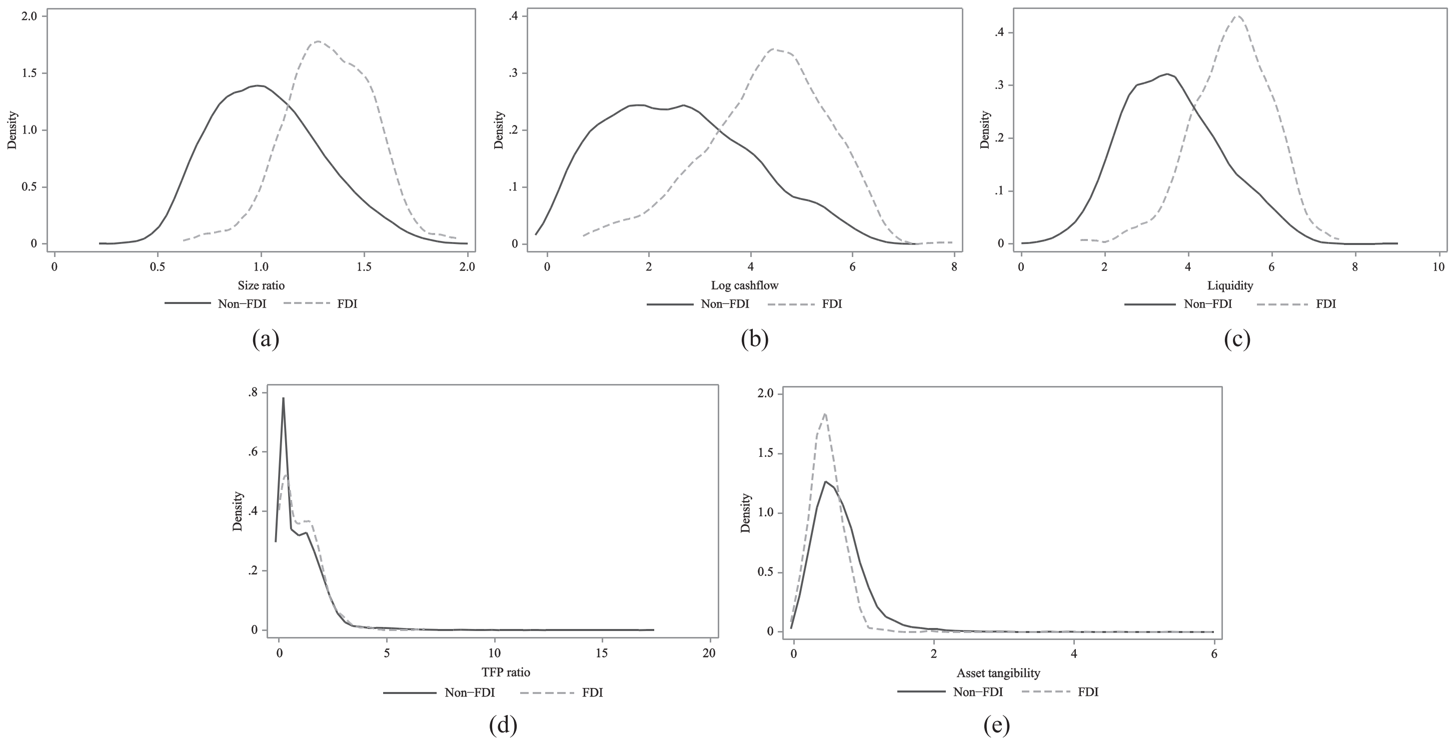
FDI = foreign direct investment, NA = not applicable, TFP = total factor productivity.

[a]Column 7 reports the mean (median) of firms excluded from the sample.

Notes: TFP is estimated using the Levinsohn and Petrin (2003) method, which involves estimating TFP using a Cobb–Douglas form of production that includes capital stock, labor, and energy as inputs, and is measured as the ratio of firm TFP to mean industry TFP. We measure capital stock via the widely used perpetual inventory method. Since the Prowess database does not include information on labor, we calculated the labor variable using Annual Survey of Industries data and the Prowess database. Labor is constructed using data on the average wage rate from the Annual Survey of Industries and salary and wage information from the Prowess database (average wage rate = total emoluments/total persons engaged; labor = salaries and wages/average wage rate). Power and fuel expenses are used as a proxy for energy expenses. We use the revenue method since value-added information is not available.

Source: Authors' calculations.

Figure 1. **Foreign Direct Investment versus Nonforeign Direct Investment Firms**



FDI = foreign direct investment, TFP = total factor productivity.
Source: Authors' calculation based on Prowess database.

Table 2. **Financing Constraints and Outward Foreign Direct Investment Decisions**

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Cash flow_{t-1}	0.758^{***}		0.896^{***}		0.789^{***}		0.864^{***}	
	(0.111)		(0.129)		(0.120)		(0.285)	
Liquidity_{t-1}		0.890^{***}		0.966^{***}		1.063^{***}		1.856^{***}
		(0.141)		(0.159)		(0.170)		(0.430)
Size_{t-1}	-1.198^{**}	-1.523^{**}	-1.354^{**}	-1.579^{**}	-1.217^{**}	-2.236^{***}	−1.940	-6.136^{***}
	(0.531)	(0.629)	(0.539)	(0.640)	(0.569)	(0.763)	(1.573)	(2.362)
Capex_{t-1}					−0.00024	-0.746^{***}		
					(0.00026)	(0.283)		
Long-term borrowings_{t-1}					0.109	0.961^{*}		
					(0.517)	(0.533)		
Age	-0.156^{**}	-0.142^{*}	-0.141^{*}	-0.136^{*}	−0.122	-0.153^{*}	−0.121	-0.158^{**}
	(0.0776)	(0.0787)	(0.0767)	(0.0785)	(0.0783)	(0.0793)	(0.0748)	(0.0641)
TFP_{t-1}	0.0613^{*}	0.0545^{*}	0.331^{***}	0.278^{***}	0.0725^{**}	0.0662^{**}	0.0556^{*}	0.00650
	(0.0322)	(0.0320)	(0.0740)	(0.107)	(0.0324)	(0.0333)	(0.0299)	(0.0364)
Exporter	0.477^{***}	0.449^{***}	0.471^{***}	0.451^{***}	0.380^{**}	0.326^{**}	0.285	0.128
	(0.143)	(0.157)	(0.140)	(0.156)	(0.149)	(0.160)	(0.178)	(0.217)
Business group	-0.319^{***}	-0.177^{*}	-0.308^{***}	−0.172	-0.461^{***}	-0.276^{**}	-0.336^{***}	−0.113
	(0.0985)	(0.105)	(0.0968)	(0.105)	(0.114)	(0.120)	(0.093)	(0.115)
Debt ratio_{t-1}	0.0180	−0.209	0.0335	−0.208	0.0586	−0.459	0.0109	0.0467
	(0.208)	(0.213)	(0.206)	(0.213)	(0.344)	(0.285)	(0.198)	(0.236)
$(\text{Cash flow} \times \text{TFP})_{t-1}$			-0.123^{***}					
			(0.0301)					
$(\text{Liquidity} \times \text{TFP})_{t-1}$				-0.068^{**}				
				(0.0305)				
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald Chi^2	343.59	303.63	373.73	306.81	285.67	260.16	405.18	703.73
Prob. > Chi^2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	5,645	5,645	5,645	5,645	4,297	4,297	5,645	5,645

TFP = total factor productivity.

Notes: This table reports the results of the ivprobit model on the probability of a firm investing abroad. Cash flow, size, age, and TFP are measured in logs. Exporter is a dummy for export status. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. The mismatch of observations is due to missing values for the external finance variable. Columns (1) and (2) report the ivprobit results using cash flow and liquidity as measures of financing constraints and mean values of cash flow and liquidity as instruments, respectively. Columns (3) and (4) report ivprobit results controlling for interaction variables between cash flow and TFP, and liquidity and TFP, respectively. Columns (5) and (6) report ivprobit results using cash flow and liquidity controlling for external finance dependence. Columns (7) and (8) report ivprobit results using credit rating as the instrument for cash flow and liquidity instead of mean values of cash flow and liquidity.

in the presence of financing constraints, the size of the firm may have a negative impact on the probability of firms investing abroad.[15] We observe that larger firms have a higher probability of undertaking outward FDI. The TFP of firms has a positive effect on outward FDI decisions. Our results are consistent with other studies that report the significant effect of TFP on outward FDI (Duanmu 2015). Similarly, firms with international market experience in exporting have a significantly higher probability of investing abroad. Firms that are exposed to international markets through exports are more likely to invest abroad. However, debt ratio fails to have a significant impact on outward FDI decisions. Firm age is found to have a negative effect, which implies that young firms tend to invest more in comparison with their counterparts. The coefficient of business group affiliation is negative and significant. Even though a bit surprising, the slightly unexpected result may be because firms affiliated with business groups prefer to focus predominantly on the domestic market. Perhaps this is because family-owned and business-group-affiliated firms find the institutional context in their home economy optimal in comparison with the overseas environment. This is mainly due to the risks involved, an unwillingness to allow dilution of ownership, and a lack of strategic relationships with foreign investors (Bhaumik, Driffield, and Pal 2010).

Columns 5 and 6 report the results of the model with two external finance measures: (i) the ratio of capital expenditure not financed by cash flow to total assets, and (ii) the ratio of long-term bank credit to total assets as a proxy for a firm's access to finance. We expect a positive effect for these two measures, which implies that firms with access to external funds will have a higher probability of investing abroad. We retain all other explanatory variables, including the internal finance measures. Contrary to the expectation, evidence of external finance ameliorating financing constraints is weak. Rather, the present findings confirm the hypothesis that a firm's foreign investment decisions rely more on the availability of internal funds. As expected, the sign and significance of other control variables such as size, TFP, and exports are found to be consistent with the previous specifications. Columns 7 and 8 report the results using credit rating as an instrument for internal financing constraints instead of the mean industry values of cash flow and liquidity.[16] The result shows that the use of alternative instruments does not change our results.

Table 2 also reports the results of the interaction term between financing constraints and productivity. The objective of including these variables is to examine whether higher productivity helps firms compensate for undertaking FDI. We control for the mitigating effect of productivity by including an interaction term

[15]Buch et al. (2014) argue that this result further depends on the instrumentation strategy.

[16]We have also carried out an ivprobit estimation using credit rating as an instrument where credit rating is defined as 1 or 0 based on credit rating status without considering changes in grading. The results were found to be consistent with the results reported in columns 7 and 8 of Table 3. We have not reported these results in Table 2 for brevity, however, they are available from the authors upon request.

Table 3. **Financing Constraints and Outward Foreign Direct Investment Share**

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Cash flow$_{t-1}$	0.028**		0.018*		0.017*	
	(0.008)		(0.009)		(0.009)	
Liquidity$_{t-1}$		0.038**		0.031*		0.037*
		(0.012)		(0.013)		(0.015)
Size$_{t-1}$	0.016	−0.027	0.019	−0.022	0.081	0.027
	(0.041)	(0.057)	(0.041)	(0.057)	(0.111)	(0.069)
Capex$_{t-1}$					−0.107	
					(0.124)	
Long-term borrowings$_{t-1}$						−0.003
						(0.038)
Age	−0.029*	−0.028	−0.029*	−0.029*	−0.040**	−0.018
	(0.012)	(0.012)	(0.012)	(0.012)	(0.0148	(0.234)
TFP$_{t-1}$	0.010*	0.009*	−0.007	−0.011	0.012*	0.104*
	(0.004)	(0.004)	(0.009)	(0.013)	(0.006)	(0.006)
Exporter	0.012	0.009	0.011	0.009	0.019	0.011
	(0.015)	(0.015)	(0.015)	(0.016)	(0.019)	(0.018)
Business group	−0.006	−0.004	−0.007	−0.0007	−0.005	−0.043**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.015)	(0.017)
Debt ratio$_{t-1}$	−0.023	−0.023	−0.024	−0.027	−0.064	−0.050
	(0.017)	(0.017)	(0.017)	(0.017)	(0.032)	(0.032)
(Cash flow × TFP)$_{t-1}$			0.008*			
			(0.004)			
(Liquidity × TFP)$_{t-1}$				0.007*		
				(0.004)		
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Wald Chi^2	63.66	61.15	69.48	64.08	51.01	57.21
Rho	0.110	0.113	0.109	0.113	0.143	0.191
Prob. > Chi^2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	5,645	5,645	5,645	5,645	4,297	4,297

TFP = total factor productivity.
Notes: This table reports the marginal effects of a random-effects Tobit model where the dependent variable is a share of outward foreign direct investment defined as the ratio of outward foreign direct investment to total assets. Cash flow, size, age, and TFP are measured in logs. Exporter is a dummy for export status. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. The mismatch of observations is due to missing values for the external finance variable.
Source: Authors' calculations.

of the financing indicators with productivity. A significant negative impact of the variable implies that higher productivity fails to compensate a firm's financing constraints and reduces the probability of a firm investing abroad. Columns 3 and 4 report the results of the empirical model controlling for the mitigating effect of productivity. The negative and significant impact of the interaction term indicates that productive firms that are financially constrained are less likely to invest abroad.

Table 3 presents the results of the role of financing constraints in determining the share of outward FDI. Columns 1 and 2 report the marginal effects of the Tobit model on the role of financing constraints in determining the share of outward FDI, while columns 3 and 4 report the estimation results of the Tobit model, including the interaction term between cash flow, liquidity, and productivity, which indicates the mitigation effect of productivity.[17] The results indicate that unlike the mitigating effect of productivity on the likelihood of investing abroad, the mitigating effect of productivity impacts the amount of outward FDI made by a firm. Our results show that internal financing constraints, measured in terms of cash flow and liquidity, are the most important determinants of outward FDI intensity. However, the results based on external finance measures—capital expenditure not financed by cash flow and access to finance—are not statistically significant (columns 5 and 6). The effects of other control variables such as TFP, age, and ownership mode are found to be similar to the specification using the likelihood of firms engaging in outward FDI.

A. Determinants of Number of Foreign Affiliates

We extend our first set of analysis to examine factors that determine the number of foreign affiliates. Decisions to invest abroad and the number of foreign affiliates vary across firms. Therefore, we try to explore the factors that drive differences across firms. For this purpose, we rely on count data models: Poisson models, negative binomial models, and zero-inflated negative binomial regression models as mentioned in the previous section. The dependent variable (number of foreign affiliates) is modeled as a function of major financing constraint indicators and other firm-specific characteristics. We introduce an additional control variable (fixed costs), which is found to have a significant impact on the number of foreign affiliates by various studies (Buch et al. 2014, Duanmu 2015).

Table 4 reports the estimates of the analysis on the role of financing constraints on the number of foreign affiliates using count data models. Columns 1–3 report the results of the Poisson models, negative binomial models, and zero-inflated beta regression models using a cash flow measure. Columns 3–6 report the results with a liquidity measure. The financing constraints are found to have a significant impact on the number of foreign affiliates. The coefficient of cash flow suggests that the greater the availability of cash flow, the higher the probability that a firm will have many foreign affiliates. Similarly, greater liquidity is associated with more foreign affiliates. The asset tangibility measure, which is the proxy for fixed costs, has the expected negative sign. This finding shows that the fixed costs involved in establishing affiliates reduce the number of foreign affiliates.

B. Robustness Checks

To check the robustness of our findings, we classify the sample firms in terms of size and drop the outward FDI firms that are concentrated in tax havens such as

[17]We carried out a panel generalized least squares estimation in addition to the Tobit model and the results were found to be consistent.

Table 4. **Financing Constraints and Determinants of Number of Foreign Affiliates**

Variable	Poisson (1)	Negative Binomial (2)	Zero-Inflated Model (3)	Poisson (4)	Negative Binomial (5)	Zero-Inflated Model (6)	Zero-Inflated Model (7)	Zero-Inflated Model (8)
Cash flow$_{t-1}$	0.674***	0.687***	0.390***				0.357**	
	(0.0678)	(0.0861)	(0.120)				(0.149)	
Liquidity $_{t-1}$				0.595***	0.770***	0.197		0.362**
				(0.0996)	(0.136)	(0.156)		(0.162)
Debt ratio $_{t-1}$	0.525***	0.506**	0.554**	−0.250	−0.462	−0.295	−0.0383	−0.303
	(0.136)	(0.224)	(0.280)	(0.279)	(0.372)	(0.364)	(0.400)	(0.400)
Capex $_{t-1}$							−1.097**	−1.414***
							(0.548)	(0.543)
Long-term borrowings $_{t-1}$							0.707	
							(0.639)	
Asset tangibility $_{t-1}$	−1.506***	−1.679***	−1.696***	−0.785***	−0.941***	−0.295	−1.872***	−1.613***
	(0.212)	(0.272)	(0.273)	(0.225)	(0.287)	(0.364)	(0.332)	(0.344)
Size $_{t-1}$	0.953***	1.116**	0.884*	1.558***	1.292**	0.830	1.037*	0.598
	(0.367)	(0.470)	(0.474)	(0.452)	(0.593)	(0.569)	(0.564)	(0.687)
Age	−0.174*	−0.189	−0.179	−0.164*	−0.248*	−0.236*	−0.124	−0.158
	(0.0906)	(0.122)	(0.122)	(0.0922)	(0.129)	(0.126)	(0.157)	(0.159)
Export dummy	0.486**	0.674***	0.521**	0.568***	0.631***	0.449*	0.246	0.159
	(0.207)	(0.245)	(0.248)	(0.205)	(0.244)	(0.247)	(0.263)	(0.260)
TFP $_{t-1}$	0.139***	0.141**	0.154**	0.128***	0.133**	0.140**	0.161**	0.149**
	(0.0444)	(0.0573)	(0.0631)	(0.0420)	(0.0579)	(0.0654)	(0.0727)	(0.0743)
Business group	−0.571***	−0.546***	−0.525***	−0.557***	−0.504***	−0.480***	−0.717***	−0.691***
	(0.105)	(0.130)	(0.127)	(0.107)	(0.133)	(0.128)	(0.158)	(0.157)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.212	0.167		0.193	0.157			
LR Chi^2	708.19	499.50	126.38	645.96	468.97	71.43	118.22	117.00
Prob. > Chi^2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	5,645	5,645	5,645	5,645	5,645	5,645	4,297	4,297

LR = likelihood ratio, TFP = total factor productivity.

Notes: This table reports the results of count models, where the number of foreign affiliates is used as the dependent variable. Cash flow, size, age, and TFP are measured in logs. Exporter is a dummy for export status. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Source: Authors' calculations.

Mauritius and Cyprus. The results of these robustness checks are reported in Tables 5 and 6. Further, to take account of differences in terms of entry mode choice, we rerun our basic specification by classifying outward FDI firms into joint ventures and wholly owned subsidiaries. Columns 5–8 report the results for joint ventures and wholly owned subsidiaries using cash flow and liquidity measures. Since the setting up of wholly owned subsidiaries involves higher fixed costs, the coefficients of the financing constraint variables show a higher value compared to the joint venture specification.

These results are found to be consistent with the basic results. The effects of financing constraints can vary by firm size. Large firms are expected to be more productive and more likely to invest abroad compared with small firms. Therefore, we expect financing constraints to matter more for the large firms. We divide the sample firms below and above mean size (total assets) and rerun our main specification. In Table 5, columns 1–4 present the coefficients for the small and large firms using cash flow and liquidity measures. The results show that in the context of small firms, financing constraints do not play a significant role in determining FDI decisions. Unlike small firms, we find a significant role for financing constraints in a large firm’s decision to invest abroad. The other firm-specific variables such as age, productivity, and business group affiliation have the expected sign, with varying levels of significance across small and large firms. Our data contain firms that channel their outward investments through tax havens with the final destination being unknown.[18] Therefore, we reestimate the main model to check the sensitivity of the results by dropping such firms from the sample since they may contaminate our findings. However, there is no significant change in the results when we reestimate the model by removing firms investing in tax havens (columns 9 and 10).

Table 6 reports the marginal effects of a random-effects Tobit model on the role of financing constriants in determining the amount of foreign investment across subsamples in terms of size, ownership mode (joint venture versus wholly owned subsidiary), and use of tax havens. The results show that financing constraints do not have any significant impact on the amount of outward FDI in the context of small firms, while both cash flow and liquidity have a positive and significant impact on the amount of outward FDI for large firms. Columns 5–8 report the marginal effects for joint ventures and wholly owned subsidiaries using two financing constriant measures (cash flow and liquidity). Financing constraints are found to be more significant in the case of wholly owned subsidiaries in determining the share of outward FDI. The results are similar even after excluding firms investing in tax havens such as Mauritius and Cyprus.

[18]Some of the sample firms report investments in Mauritius, Cyprus, and the Cayman Islands. We thank the anonymous referee for pointing this out.

Table 5. **Financing Constraints and Outward Foreign Direct Investment Decisions: Sample Splits**

Variable	Small (1)	Small (2)	Large (3)	Large (4)	Joint Venture (5)	Joint Venture (6)	Wholly Owned Subsidiary (7)	Wholly Owned Subsidiary (8)	Excluding Tax Havens (9)	(10)
Cash flow $_{t-1}$	0.374		0.723***		0.692***		0.737***		0.699***	
	(0.262)		(0.108)		(0.172)		(0.123)		(0.117)	
Liquidity $_{t-1}$		0.264		0.873***		0.662***		0.871***		0.854***
		(0.306)		(0.136)		(0.169)		(0.151)		(0.146)
Size $_{t-1}$					0.213	0.0842	−0.0747	−0.296	−1.064*	−1.527**
					(0.145)	(0.196)	(0.231)	(0.231)	(0.546)	(0.641)
Debt ratio $_{t-1}$	−0.566	−0.833*	0.616**	−0.136	−0.228**	−0.204*	−0.130	−0.111	−0.174**	−0.163**
	(0.482)	(0.500)	(0.283)	(0.247)	(0.108)	(0.114)	(0.0824)	(0.0831)	(0.0767)	(0.0764)
Age	−0.0391	−0.0500	−0.184**	−0.219**	−1.685**	−1.386*	−1.009*	−1.381**	0.0530	0.0437
	(0.141)	(0.140)	(0.0923)	(0.0925)	(0.761)	(0.740)	(0.590)	(0.675)	(0.0346)	(0.0345)
TFP $_{t-1}$	0.107**	0.0971**	0.0790**	0.0654*	−0.00731	−0.0106	0.0754**	0.0685**	0.427***	0.395**
	(0.0460)	(0.0467)	(0.0399)	(0.0390)	(0.0649)	(0.0670)	(0.0320)	(0.0314)	(0.142)	(0.154)
Exporter	0.444*	0.460	0.271	0.284	0.598**	0.598**	0.398**	0.365**	−0.271***	−0.135
	(0.248)	(0.294)	(0.184)	(0.199)	(0.235)	(0.249)	(0.157)	(0.171)	(0.0984)	(0.104)
Business group	−0.296	−0.230	−0.427***	−0.322***	−0.197	−0.0947	−0.344***	−0.196*	−0.0744	−0.289
	(0.211)	(0.186)	(0.115)	(0.111)	(0.144)	(0.155)	(0.106)	(0.115)	(0.219)	(0.222)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald Chi	28.84	26.45	134.71	133.62	82.44	74.29	301.70	278.73		
Prob. > Chi^2	0.0042	0.0093	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	2,991	2,991	2,654	2,654	5,378	5,378	5,578	5,578	5,600	5,600

TFP = total factor productivity.

Notes: This table reports the results of an ivprobit model for the probability of a firm investing abroad based on firm size, excluding firms investing in tax havens such as Mauritius and Cyprus in columns (9) and (10). Cash flow, size, age, and TFP are measured in logs. Exporter is a dummy for export status. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Source: Authors' calculations.

Table 6. **Financing Constraints and Outward Foreign Direct Investment Share: Sample Splits**

Variable	**Small (1)**	**Small (2)**	**Large (3)**	**Large (4)**	**Joint Venture (5)**	**Joint Venture (6)**	**Wholly Owned Subsidiary (7)**	**Wholly Owned Subsidiary (8)**	**Excluding Tax Havens (9)**	**(10)**
Cash flow$_{t-1}$	0.005		0.022**		0.006		0.028***		0.021*	
	(0.009)		(0.008)		(0.008)		(0.008)		(0.008)	
Liquidity $_{t-1}$		0.015		0.028**		0.034*		0.032*		
		(0.011)		(0.010)		(0.0113)		(0.012)		0.033*
										(0.013)
Size $_{t-1}$					0.066	−0.049	0.011	−0.011	0.044	−0.006
					(0.043)	(0.059)	(0.042)	(0.057)	(0.043)	(0.916)
Age	0.002	0.002	−0.044*	−0.046**	−0.027*	−0.028*	−0.022*	−0.022*	−0.028*	−0.028*
	(0.016)	(0.016)	(0.017)	(0.017)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)
TFP $_{t-1}$	0.032***	0.032***	0.014*	0.013	0.003	0.002	0.010*	0.010*	0.014**	0.013**
	(0.006)	(0.006)	(0.008)	(0.008)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Exporter	0.015	0.011	0.029	0.029	0.014	0.010	0.008	0.007	0.017	0.015
	(0.017)	(0.018)	(0.028)	(0.028)	(0.016)	(0.016)	(0.015)	(0.016)	(0.016)	(0.016)
Business group	0.014	0.013	−0.007	−0.005	0.0007	0.003	−0.008	−0.002	−0.003	0.002
	(0.017)	(0.017)	(0.018)	(0.018)	(0.014)	(0.014)	(0.013)	(0.013)	(0.014)	(0.014)
Debt ratio $_{t-1}$	−0.006	−0.006	−0.011*	−0.013**	−0.014	−0.011	−0.020	−0.025	−0.026	−0.028
	(0.018)	(0.018)	(0.045)	(0.044)	(0.018)	(0.018)	(0.017)	(0.017)	(0.150)	(0.018)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald Chi	47.93	49.53	30.76	31.25	34.92	41.16	52.68	46.45	61.22	61.14
Rho					.1186	.1197	0.102	0.105	0.190	0.193
Prob. > Chi^2	0.0042	0.0093	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	2,991	2,991	2,654	2,654	5,378	5,378	5,578	5,578	5,600	5,600

TFP = total factor productivity.

Notes: This table reports the marginal effects of a random-effects Tobit model based on firm size, excluding firms investing in tax havens such as Mauritius and Cyprus in columns (9) and (10). Cashflow, size, age, and TFP are measured in logs. The dependent variable is the share of outward foreign direct investment to total capital assets. Exporter is a dummy for export status. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Source: Authors' calculations.

V. Conclusions

The present study is an attempt to examine the role of financing constraints in determining the outward FDI decisions of Indian manufacturing firms during the period 2007–2014. For the empirical exercise, we combine a rich firm-level data set with unique data on firm-level outward FDI. Our empirical findings support the hypothesis that financing constraints matter for outward FDI decisions. The findings also suggest that large firms and firms with a bigger cash flow, greater liquidity, higher productivity, and lower fixed costs are more likely to invest abroad. Further, we do not observe a mitigating effect for productivity in the case of outward FDI, nor do we find evidence of external finance dependence. The latter finding confirms the importance of internal funds in a firm's investment decisions.

Using a random-effects Tobit model in determining the share of outward FDI, we observe that financing constraints play a significant role in determining the share of outward FDI. Financing constraint measures (cash flow and liquidity) are found to have a positive and significant impact on outward FDI. The effects of other control variables are also found to be similar to the specifications for the likelihood of firms making outward FDI decisions.

The study also finds that financing constraints impact not only the probability and amount of FDI, but also play a significant role in determining the number of foreign affiliates of firms investing abroad. Using count models, the study shows that firms with a bigger cash flow and more liquidity are more likely to have more foreign affiliates. One of the major implications of these findings is that the export orientation of firms is a major factor in determining their foreign investment decisions. This finding suggests the need for policies that strengthen firms' export orientation to further enhance their internationalization through outward FDI. The results also provide evidence that improving access to finance would help firms from emerging markets overcome barriers to entering foreign markets.

In spite of the robust findings, a shortcoming of the present study pertains to identifying sources of finance among sample firms. It is possible for firms engaging in outward FDI to finance resources from the host country. However, the data set we employ does not provide such detailed information about funding sources. Therefore, we are unable to undertake an exercise to explore the sources of finance.

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Computer and Information Technology, Firm Growth, and Industrial Restructuring: Evidence from Manufacturing in the People's Republic of China

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Computer and information technology is considered one of the most powerful engines of modern growth, but more empirical evidence is needed to quantify its impacts. This paper studies the role of computer and information technology in industrial restructuring by observing structural change in the manufacturing sector in the People's Republic of China using a large firm-level data set. Computer and information technology is found to boost changes in industrial structure substantially. This paper also identifies faster and higher-quality growth of firms as the underlying channel through which computer use can improve industrial structure. Firms using computers grow faster, spend more on research and development, and enjoy greater productivity.

Keywords: computer and information technology, firm growth, growth quality, industrial restructuring
JEL codes: L25, L60, O14

I. Introduction

In the 1950s, computers were first used by large organizations as a substitute for routine work and to augment a small fraction of nonroutine work (Bresnahan 1999). Since the advent of the personal computer in the 1980s, especially those with word processing and spreadsheet functions, the world has seen the automation of such jobs (Berger and Frey 2015). Computer technology reached a turning point during the 1980s when it became a "general purpose technology" that changed the nature of work in almost all occupations and industries (Levy and Murnane 2004, 31). Computer technology became more important as a contributor to economic growth and in reshaping economies across the world with the development of the

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World Wide Web and the growth of e-commerce throughout the 1990s. Economic development today depends more heavily than ever on computer and information technology. The United States and Germany have launched the Industrial Internet Program and Industry 4.0, respectively, to merge computer and information technology into their traditional industrial sectors. In the People's Republic of China (PRC), a report prepared by Premier Li Keqiang for the Third Session of the 12th National People's Congress in 2015, Internet +, highlighted the role of such technology in further expanding the domestic economy.

Although computer and information technology is widely considered to be one of the most powerful growth engines during the third revolution of science and technology, there is little empirical evidence on how it helps firms expand at the microlevel and contributes to economic growth at the aggregate level. For example, although Jorgenson and Vu (2005) point out that computer technology has led to an overall increase in the United States' "speed limit" for growth, empirical studies pose a challenge to this point of view. Using industry-level data, Corrado et al. (2008) and Bosworth and Triplett (2007) find that total factor productivity (TFP) grows even more slowly in industries that rely on computers. Their results, however, are in dispute; one major criticism is that TFP growth exhibits strong heterogeneity across industries and this issue has not been thoroughly addressed. It is therefore necessary to explore the effects of computer and information technology using firm-level data. Some researchers have done antecedent work in this area. Kaushik and Singh (2004) and Aker and Mbiti (2010), for example, summarize multiple ways in which the Internet can help boost firm performance in developing economies. Paunov and Rollo (2015) also identify positive impacts from Internet-enabled knowledge spillovers. Such evidence supports optimistic conclusions about the Internet's potential for improving firm performance.[1]

This paper provides complementary evidence for the effects of computer and information technology on firm performance and economic growth by using firm-level data from the PRC. I first focus on how computer and information technology affects firm growth. Growth rates and growth quality are both found to correlate positively with computer and information technology. Firms using more computers grow faster in terms of value added, sales, employees, and other aspects; they also spend more on research and development (R&D) and enjoy higher levels of productivity. The robustness of such findings is tested using several different methods. First, a subsample of newly opened firms is used to overcome potential reverse causality. Second, a propensity score matching procedure is

[1] For more details on the relationship between computer and information technology and the economy, please refer to several reviews. Berger and Frey (2015) review how computers affected labor demand and organizational practices over the course of the 20th century. Consoli, Vona, and Rentocchini (2015) review studies on how computer and information technology affects the skill structure of firms, which supplements the review of earlier studies by Autor, Katz, and Krueger (1998). Paunov and Rollo (2015) provide a brief review of multiple ways through which the Internet can help boost firm performance in developing economies, which is the study most closely related to our paper. Qiu and Bu (2013) review studies on information and communication technology in the PRC.

implemented to identify a subsample of comparable firms before regressions. Both robustness checks generate similar results to the baseline regressions. Since industrial structure adjustment plays a crucial part in economic growth, especially in developing economies, the role of computer and information technology in industrial restructuring is also studied. By aggregating the firm-level findings, it is evident that industries and regions with a high degree of computer use will grow relatively faster and industrial restructuring will occur at an accelerated pace. Computer and information technology, therefore, can boost economic growth by enhancing allocative efficiency.

This paper contributes to the literature in three ways. First, I identify the causal effects of computer and information technology on firm performance by using firm-level data and employing multiple econometric methods. This helps to rule out heterogeneity from various sources when using aggregate data, which is in line with previous studies. Second, I explore how computer and information technology improves industrial restructuring to enhance economic growth. That is, does computer and information technology boost economic growth not only through increased technological efficiency within firms and industries, but also through higher allocative efficiency across industries? Finally, I test the importance of computer and information technology in the manufacturing sector in the PRC to provide guidance for development strategies in the digital era.

The remainder of the paper is organized as follows. Section II describes the data and introduces the variables used in the empirical analysis. Section III explores the effects of computer use on firm performance, while section IV investigates how computer use at the aggregate level boosts industrial restructuring. The final section concludes.

II. Data and Measurement

A. Data

This study draws on data from the Chinese Industrial Enterprises Database (CIED), which is widely used in the literature in almost all aspects of the industrial sector in the PRC.[2] CIED is compiled from annual surveys of industrial enterprises conducted by the National Bureau of Statistics of China and comprises information on all state-owned enterprises and private firms with annual sales revenue of more than CNY5 million. The number of plants covered in the data set increased from around 165,000 in 1998 to more than 336,000 in 2007. Therefore, a large unbalanced panel is available. CIED represents approximately 90% of

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[2]The industrial sector in the PRC includes manufacturing, mining, and public utilities (the production and supply of electric power, gas, and water). In the PRC's National Industries Classification System (both GB/T 4754-94 and GB/T 4754-2002) at the 2-digit level, the industrial sector ranges from 6 to 46. See Holz (2013) for details on the PRC's industrial classification systems.

gross output and value added in the industrial sector in the PRC, guaranteeing the external validity of studies based on this data set (Brandt, Biesebroeck, and Zhang 2012). The information provided by CIED falls roughly into two categories: basic information (e.g., firm identity, industry and region, ownership, and skill composition) and operations information (e.g., balance sheet, cash flow statement, and income statement).[3]

I performed some data cleaning before engaging in the empirical analysis. First, I deleted observations for mining firms and public utilities to focus solely on manufacturing. Mining depends heavily on the distribution of natural resources, while public utilities respond to the demographic features of cities and other administrative areas. Second, I deleted observations with key variables missing. Third, since information on computer use is only reported for a single year, 2004, I lose the advantages of panel data and turn instead to cross-sectional analysis. I keep the data for 2001, 2004, and 2007, and the changes between 2004 and 2007 are employed as dependent variables to capture the impact of computer and information technology, while the changes between 2001 and 2004 are used to implement a propensity score matching procedure to address concerns about reverse causality.[4] Fourth, since CIED reports only nominal values for most indicators, it is necessary to transfer them into real values. The price index (at the 2-digit level) constructed by Brandt, Biesebroeck, and Zhang (2012) is used to conduct this exercise.[5] In addition, I winsorize all the variables by trimming 1% of observations at both the upper and lower tail of the distribution.

B. Variables

The variable of primary interest is firm growth. I examine the effect of computer and information technology on firm growth in two dimensions: the growth rate and the quality of growth. To do so, I calculate the growth rates of employment, assets, value added, sales, and profits between 2004 and 2007. These five growth rates capture different aspects of firm growth and help eliminate the bias caused by possible measurement errors. During 2004–2007, the sales of firms in the sample more than doubled on average and both value added and profits increased by about 50%. Employment grew much more slowly during this period, implying an improvement in labor productivity. As for the quality of growth, four indicators were employed: (i) R&D intensity, (ii) share of new products in sales, (iii) TFP, and (iv) average labor productivity. The differences in these indicators between 2004 and 2007 will be used as dependent variables. R&D intensity, which is the ratio of a firm's R&D expenses to its sales, measures the firm's willingness to invest in its

[3]See, for example, Brandt, Biesebroeck, and Zhang (2012) for more information on CIED.
[4]The propensity score matching procedure is discussed in detail in the next section.
[5]For more details on the data, please refer to Biesebroeck (2017).

future development.[6] The share of new products in sales is viewed as the outcome of R&D activity. From 2004 to 2007, a typical firm spent 0.17% of its income on R&D, leading to the mean share of new products in sales growing by 0.54 percentage points. TFP is calculated using the procedure first proposed by Olley and Pakes (1996), which is now widely used in estimating firm-level TFP. Labor productivity is simply the amount of value added per worker. Table 1 shows that mean labor productivity grew by CNY63,000 (in 2004 prices) per worker.

After analyzing the effects of computer and information technology at the firm level, it follows that computer use would affect industrial structure adjustments differently across industries and regions with different intensities of computer and information technology use. I construct an index both at the city level and the city–industry level to measure industrial restructuring. At the city level, I construct the Structural Change Index (SCI), following the methodology of Brender and Drazen (2010), among others:

$$SCI_{c,04\_07} = 0.5 \times \sum_{i=1}^{I} |indshare_{ic,2007} - indshare_{ic,2004}| \quad (1)$$

where $indshare_{ic,t}$ is the share of industry i for city c in year t. To eliminate bias caused by possible measurement error, I again calculate the share of each industry by using five different indicators: (i) employment, (ii) assets, (iii) value added, (iv) sales, and (v) profits. By adding up the absolute values of industry-level changes within each city, I get the SCI ($SCI_{c,04\_07}$) indicating the industrial structural change between 2004 and 2007 for city c.[7] A larger $SCI_{c,04\_07}$, by definition, means a more significant adjustment in manufacturing in city c and, therefore, a huge reallocation of production factors has taken place during the review period. The different measures of SCI are quite similar to each other, implying the robustness of the measurement I used.

The SCI may signal industrial structure adjustment at the city level, but it may also cover up different trends among various industries. To address this problem, I employ an Industry Concentration Index (ICI) to track changes in each industry at the 2-digit industrial classification level. The ICI follows the methodology of Lu et al. (2013):

$$ICI_{ic,t} = \frac{indshare_{ic,t}}{indshare_{ip,t}} \quad (2)$$

Again, $indshare_{ic,t}$ is the share of industry i for city c in year t and $indshare_{ip,t}$ is the corresponding share for the province to which city c belongs. The share is again calculated comprising five aspects. The changes in ICI_{ic} between 2004 and

[6]CIED does not report R&D expenses in 2004. Therefore, R&D expenses in 2005 are used as a proxy.

[7]Since both the growth and decline of industry share represent industrial change, it is reasonable to use the absolute value of industry-level changes when we measure industrial structural adjustment.

Table 1. **Statistics Description**

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Firm Level					
GR (Employment) (%)[a]	18,5851	27.32	90.13	−87.36	538.90
GR (Asset) (%)[a]	18,5811	93.20	166.59	−77.96	986.28
GR (Value added) (%)[a]	18,5481	56.97	277.15	−260.97	27.86
GR (Sales) (%)[a]	18,5471	126.76	169.28	−90.37	1039.25
GR (Profit) (%)[a]	18,5580	45.78	164.72	−90.15	611.64
Δ RDI[b]	18,5900	0.17	0.71	−1.31	4.58
Δ SNP[b]	18,5900	0.54	15.85	−80.01	87.07
Δ TFP[b]	16,4401	0.04	0.98	−3.12	2.97
Δ ALP[b]	18,5747	63.11	165.38	−316.61	880.00
Computer use	25,4054	8.37	12.70	0.00	77.78
Personal computer use	25,4054	7.70	12.07	0.00	74.19
Size	25,4314	9.52	1.39	6.37	13.72
Age	25,4165	8.28	9.77	0.00	50.00
Tax rate	25,0957	0.66	1.17	0.00	6.41
Leverage	25,3801	59.40	29.12	0.67	150.41
Human capital	25,4054	12.44	16.76	0.00	88.00
City–Industry Level					
Δ ICI (Employment)[b]	7,392	1.24	1.33	−2.06	6.92
Δ ICI (Asset)[b]	7,392	1.30	1.60	−3.55	7.38
Δ ICI (Value added)[b]	7,391	1.32	1.64	−2.87	7.72
Δ ICI (Sales)[b]	7,391	1.33	1.64	−5.11	7.96
Δ ICI (Profit)[b]	7,391	1.34	1.68	−4.22	8.23
City Level					
SCI (Employment)[c]	328	0.017	0.015	0.001	0.171
SCI (Asset)[c]	328	0.020	0.016	0.001	0.172
SCI (Value added)[c]	328	0.023	0.018	0.001	0.168
SCI (Sales)[c]	328	0.020	0.016	0.001	0.170
SCI (Profit)[c]	328	0.020	0.017	0.001	0.170

ALP = average labor productivity, GR = growth rate, ICI = Industry Concentration Index, RDI = research and development intensity, SCI = Structural Change Index, SNP = share of new product in sales, TFP = total factor productivity.

[a] indicates the growth rates of firms during 2004–2007.

[b] indicates the differences in corresponding variables (growth quality indicators or the ICI) during 2004–2007.

[c] indicates that the SCI is the change in industrial structure during 2004–2007.

Source: Author's calculations based on National Bureau of Statistics of China. 1998–2008. "Chinese Industrial Enterprises Database."

2007, which measure the relative growth of industry *i* in city *c*, are again used as dependent variables.

The key explanatory variable is, of course, computer and information technology. CIED reports the quantities of both computers and personal computers in each firm in 2004. Since the quantity of computers varies across firms and highly correlates with firm size, I standardize it by dividing it by employment to calculate computers per 100 workers, which is the variable primarily used in this paper. In

2004, the quantity of computers was still insufficient as there were only about eight computers per 100 workers on average. When aggregate dependent variables such as the SCI and ICI are used, I employ the mean of computers per 100 workers at the corresponding level. For example, I use the mean of computers per 100 workers within cities as the key explanatory variable for industrial structure adjustment at the city level (SCI). In other words, the mean of computers per 100 workers is applied as a proxy for the presence of computer and information technology in a particular city.

A variety of covariates are included to identify the causal effects of computer and information technology on firm growth and industrial restructuring. Firm size and age are among the first set of controls. Firm size is defined as the natural logarithm of fixed assets and age is the difference between 2004 and the year the firm opened. Tax burden is among the most important determinants of firm growth; therefore, I control for the effective tax rate, which is the ratio of income tax to sales. Financing is another crucial factor for most enterprises in the PRC (Allen, Qian, and Qian 2005) and so it is necessary to include financing constraints in our controls. I use leverage, which is the ratio of debt to assets, to measure financing constraints because greater leverage implies that a firm has easier access to finance (Rajan and Zingales 1995). Considering that human capital plays a crucial role in modern growth at both the firm and aggregate levels, especially with regard to growth rates and the quality of growth (Hatch and Dyer 2004), I control for the share of labor with at least a college degree, following Goedhuys and Sleuwaegen (2015).[8] Since firms vary across regions and industries, and by mode of ownership, I also include dummies to eliminate city fixed effects, industry fixed effects, and ownership fixed effects. Table 1 describes the statistics of key variables in this study.

III. The Effects of Computer and Information Technology on Firm Growth

A. Specification

As our primary focus is the effect of computer and information technology on firm growth, I estimate the following equations:

$$GR_{f,2004-07} = \alpha + \beta Computer_{f,2004} + X_{f,2004}\gamma + city_c + ind_i + own_o + u_f$$
$$GQ_{f,2004-07} = \alpha + \beta Computer_{f,2004} + X_{f,2004}\gamma + city_c + ind_i + own_o + u_f \quad (3)$$

where $GR_{f,2004-07}$ is the growth rate of firm f during 2004–2007 and $GQ_{f,2004-07}$ is the firm's quality of growth during the same period. The key explanatory variable,

[8]I also use share of workers holding a skill certification to measure the skill structure within firms and get similar results. These results are available upon request.

$Computer_{f,2004}$, is the quantity of computers per 100 workers in 2004 and $X_{f,2004}$ is a compilation of control variables. Finally, $city_c$, ind_i, and own_o stand for city fixed effects, industry fixed effects, and ownership fixed effects, respectively, which are used to eliminate heterogeneity across different regions, industries, and modes of ownership. The coefficient, β, is of primary interest because it implies the effects of computer and information technology on firm growth. The regressions, however, are confronted with the problem of endogeneity. Specifically, a positive β does not necessarily imply firms using computers will grow fast; on the contrary, firms with rapid, high-quality growth in the last period may have a higher probability of buying computers. To address this problem, I will provide two sets of robustness checks by using alternative specifications in subsection III.C.

B. Baseline Results

The baseline results are reported in Tables 2 and 3. Growth rates are used as the dependent variable in Table 2, in which the first five columns include computers per 100 workers as the key explanatory variable and the last five columns include personal computers per 100 workers. The coefficients on computer use are statistically significant at the 1% level in all five columns, implying that computer use exerts a positive impact on firm growth. To be specific, one more computer per 100 workers can increase the growth rates of employment and value added by over 1 percentage point each and increase the growth rates of assets, sales, and profits by around 0.6 percentage points each. The effect is, therefore, economically significant as well. Personal computer use as an explanatory variable in the last five columns generates coefficients with the same statistical significance and similar values, showing that the effects of personal computer use on firm growth are quite robust. An increase of one personal computer per 100 workers again improves the growth rates of both employment and value added by about 1 percentage point and the growth rates of the other indicators by around 0.5 percentage points each. To sum up, computer use has robust positive impacts on firm growth no matter how growth is measured.

As for the controls, firm size has a statistically significant negative effect on firm growth of all kinds, implying the existence of convergence as discussed in the literature (Cabral 1995, Beck et al. 2008). That is, large firms are more likely to grow more slowly than small firms. The same logic applies to firm age: younger firms grow faster than older firms. A higher tax rate correlates with a lower growth rate, which is consistent with the literature on the negative effect of a tax burden on firm growth (Shen and Chen 2017). Leverage positively correlates with growth because a higher debt ratio implies a greater ability to access financial support to fuel growth. Firms with a larger proportion of well-educated workers also grow faster, as documented by Lopez-Garcia and Puente (2012) and Arrighetti and Lasagni (2013).

Table 2. **The Effects of Computer Use on Firm Growth Rates**

	Employment (1)	**Asset (2)**	**Value Added (3)**	**Sales (4)**	**Profit (5)**	**Employment (6)**	**Asset (7)**	**Value Added (8)**	**Sales (9)**	**Profit (10)**
Computer use	1.308***	0.566***	1.098***	0.611***	0.603***					
	(0.023)	(0.042)	(0.123)	(0.068)	(0.067)					
Personal computer use						1.259***	0.533***	1.007***	0.534***	0.544***
						(0.024)	(0.043)	(0.126)	(0.070)	(0.069)
Size	–1.079***	–1.382***	–4.189***	–1.387***	–1.299***	–1.058***	–1.365***	–4.178***	–1.329***	–1.239***
	(0.113)	(0.207)	(0.686)	(0.371)	(0.307)	(0.135)	(0.204)	(0.686)	(0.371)	(0.307)
Age	–0.131***	–0.173***	–0.583***	–0.152***	–0.136***	–0.141***	–0.172***	–0.582***	–0.159***	–0.144***
	(0.013)	(0.027)	(0.073)	(0.035)	(0.030)	(0.019)	(0.027)	(0.073)	(0.036)	(0.030)
Leverage	0.097***	0.144***	0.083**	0.328***	0.354***	0.098***	0.144***	0.084**	0.329***	0.355***
	(0.008)	(0.014)	(0.042)	(0.023)	(0.023)	(0.008)	(0.014)	(0.042)	(0.023)	(0.023)
Tax rate	–0.041	–0.248***	–0.358**	–0.370***	–0.409***	–0.028	–0.242***	–0.343**	–0.361***	–0.400***
	(0.026)	(0.048)	(0.142)	(0.078)	(0.077)	(0.026)	(0.048)	(0.142)	(0.078)	(0.077)
Human capital	0.306***	0.546***	1.044***	0.805***	0.786***	0.365***	0.576***	1.112***	0.849***	0.826***
	(0.019)	(0.034)	(0.100)	(0.055)	(0.054)	(0.018)	(0.034)	(0.099)	(0.055)	(0.054)
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ownership fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	185,441	185,426	185,323	185,457	185,402	185,441	185,426	185,323	185,457	185,402
R^2	0.068	0.097	0.051	0.087	0.089	0.066	0.097	0.051	0.087	0.089

Notes: Robust standard errors reported in parentheses are clustered at the city level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Author's calculations based on National Bureau of Statistics of China. 1998–2008. "Chinese Industrial Enterprises Database."

Table 3. **The Effects of Computer Use on the Quality of Firm Growth**

	R&D Intensity (1)	Share of New Products (2)	TFP (3)	Labor Productivity (4)	R&D Intensity (5)	Share of New Products (6)	TFP (7)	Labor Productivity (8)
Computer use	0.020***	0.010**	0.002***	1.265***				
	(0.007)	(0.004)	(0.000)	(0.242)				
Personal computer use					0.022***	0.009**	0.001***	1.250***
					(0.008)	(0.004)	(0.000)	(0.243)
Size	0.055***	0.104***	0.011***	1.981***	0.055***	0.105***	0.011***	1.998***
	(0.001)	(0.031)	(0.002)	(0.316)	(0.001)	(0.031)	(0.002)	(0.315)
Age	0.029***	0.130***	–0.041***	–2.150***	0.029***	0.130***	–0.041***	–2.144***
	(0.001)	(0.033)	(0.002)	(0.332)	(0.001)	(0.033)	(0.002)	(0.332)
Leverage	0.001***	0.016*	0.000	0.084***	0.001***	0.002	–0.000	0.084***
	(0.000)	(0.009)	(0.000)	(0.014)	(0.000)	(0.003)	(0.000)	(0.014)
Tax rate	–0.042***	–0.612**	–0.160***	–43.737***	–0.048***	–0.596**	–0.161***	–44.047***
	(0.012)	(0.289)	(0.022)	(2.915)	(0.012)	(0.289)	(0.022)	(2.914)
Human capital	0.005***	0.013***	0.007***	0.424***	0.005***	0.014***	0.005***	0.438***
	(0.000)	(0.003)	(0.000)	(0.034)	(0.000)	(0.003)	(0.000)	(0.034)
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ownership fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	185,457	185,457	164,052	185,343	185,457	185,457	164,052	185,343
R^2	0.164	0.022	0.065	0.089	0.164	0.022	0.065	0.089

R&D = research and development, TFP = total factor productivity.

Notes: Robust standard errors reported in parentheses are clustered at the city level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Source: Author's calculations based on National Bureau of Statistics of China. 1998–2008. "Chinese Industrial Enterprises Database."

Table 3 examines the effects of computer and information technology on the quality of firm growth. Again, I use the number of computers and personal computers per 100 workers as key explanatory variables in the two panels. Both variables have a positive impact on the quality of growth and most of the coefficients on them are statistically significant at the 1% level. Specifically, one more computer per 100 workers will increase R&D intensity by 0.02 percentage points, or over one-tenth of the mean of the R&D intensity change (see Table 1 for the mean of the indicators of growth quality). The share of new products increases by 0.01 percentage points, or approximately 2% of the mean, with an additional computer; TFP increases by 0.002 percentage points (5% of the mean); and labor productivity increases by 1.265 percentage points per worker (3% of the mean). Therefore, computer and information technology not only boosts firm growth as shown in Table 2, but it also improves the quality of growth.

A glance at the control variables gives a slightly different picture. Firm size has a significantly positive effect on the quality of growth. Although large firms grow more slowly, they put more emphasis on the quality of growth such as R&D expenditure and productivity improvements. Younger firms spend less on R&D and sell fewer new products than older firms, but they typically are more productive. Tax rates and leverage have similar effects on the quality of growth as they do on the growth rate. Access to finance increases R&D intensity and improves labor productivity significantly, while a lighter tax burden is beneficial for all measurements of growth quality. As in Table 2, an increase in human capital has a positive impact on the quality of growth in the next period.

C. Robustness Checks

Cross-sectional analysis can suffer from endogeneity problems due to reverse causality. The positive correlation between computer use and growth does not necessarily prove the causal effect of computer and information technology on firm growth. On the contrary, the positive correlation may stem from the fact that firms with higher growth rates are more inclined to adopt computer and information technology. To address this problem, I conducted two sets of robustness checks.

The first set restricts regressions to a subsample of firms that were newly established in 2004.[9] Reverse causality is no longer a concern because all firms in this subsample commenced operations in 2004 and therefore have no prior history. The empirical results based on this subsample are reported in Tables 4 and 5, with growth rates and quality of growth as the dependent variables, respectively.

Table 4 investigates the relationship between computer and information technology and different measurements of growth. All coefficients on computer use (Panel A) and personal computer use (Panel B) are statistically significant

[9] CIED data include the first year of operation for each firm.

Table 4. **The Effects of Computer Use on Growth among Newly Opened Firms**

	Employment (1)	Asset (2)	Value Added (3)	Sales (4)	Profit (5)
Panel A					
Computer use	1.943***	0.757***	2.118***	0.208***	0.708***
	(0.139)	(0.266)	(0.480)	(0.044)	(0.146)
Observations	9,676	9,674	9,665	9,676	9,671
R^2	0.117	0.152	0.105	0.152	0.151
Panel B					
Personal computer use	1.971***	0.876***	2.102***	0.188***	0.895***
	(0.145)	(0.278)	(0.479)	(0.044)	(0.173)
Observations	9,676	9,674	9,665	9,676	9,671
R^2	0.116	0.153	0.105	0.152	0.151
Control variables	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Ownership fixed effects	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors reported in parentheses are clustered at the city level. The coefficients and standard errors for control variables are not presented to save space.***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Author's calculations based on National Bureau of Statistics of China. 1998–2008. "Chinese Industrial Enterprises Database."

Table 5. **The Effects of Computer Use on the Quality of Growth among Newly Opened Firms**

	R&D Intensity (1)	Share of New Products (2)	TFP (3)	Labor Productivity (4)
Panel A				
Computer use	0.014**	0.008**	0.002**	1.677***
	(0.007)	(0.005)	(0.001)	(0.338)
Observations	9,676	9,676	8,371	9,675
R^2	0.158	0.088	0.133	0.140
Panel B				
Personal computer use	0.017**	0.007***	0.003*	1.590**
	(0.009)	(0.002)	(0.002)	(0.349)
Observations	9,676	9,676	8,371	9,675
R^2	0.161	0.088	0.133	0.140
Control variables	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Ownership fixed effects	Yes	Yes	Yes	Yes

R&D = research and development, TFP = total factor productivity.
Notes: Robust standard errors reported in parentheses are clustered at the city level. The coefficients and standard errors for control variables are not presented to save space. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Author's calculations based on National Bureau of Statistics of China. 1998–2008. "Chinese Industrial Enterprises Database."

and positive, implying that the causal effect of (personal) computer use on firm growth is still robust. The difference lies in magnitude, however, as there are larger coefficients for the new firm subsample on all growth measurements except for sales. When computer use rises by one computer per 100 workers, the growth rates of employment and value added increase by around 2 percentage points each and the growth rates of assets and profits increase by about 0.7 percentage points each. This is partly because the regressions using the full sample suffer from bias and partly because newly established firms grow more rapidly than older ones (Table 3). Personal computer use has similar effects on the quality of growth measurements as shown in Panel B.

The effects of computer and information technology on the quality of growth among newly opened firms are shown in Table 5, with computer use in Panel A and personal computer use in Panel B. The effects on R&D expenditure and share of new products are lower than those observed for the full sample in Table 3. A plausible explanation is that new firms rely less on innovation. Thus, an increase of 0.014 percentage points in R&D intensity and 0.008 percentage points in the share of new products are still significant economically, considering that the mean growth of R&D intensity and the share of new products for new firms are only 0.15 percentage points and 0.36 percentage points, respectively. Table 5 shows the relatively larger effects of personal computer use on productivity, implying that new firms benefit even more from personal computer use.

In the subsample of new firms, personal computer use exerts a significantly positive influence on growth rates and the quality of growth. Therefore, the results shown in Tables 4 and 5 further alleviate concerns about reverse causality.

When attempting to identify the correlation between computer and information technology and growth rates and growth quality as a causality relationship, the heterogeneity of firms is an important factor. Specifically, there may be some heterogeneous features that determine a firm's computer use on one hand and impact its future development on the other. Examples of such heterogeneous features include a firm's prior growth rates and the quality indicators of growth. By using only newly opened firms, I remove some of the possible biases resulting from these sources of heterogeneity. As a second robustness check, I use a propensity score matching technique to address potential bias stemming from other kinds of heterogeneity. If the correlation between computer use and firm growth rates and growth quality might only reflect the impact of heterogeneous features, comparing firms that share similar features with each other is necessary. The propensity score matching technique, first proposed by Rosenbaum and Rubin (1983), provides a standard procedure to choose firms with features in common to give a matched sample in which observations are similar in terms of these specified features.

Table 6 presents the results for propensity score matching. The left panel reports the results of a probit regression in which the dependent variable is a dummy

Table 6. **Propensity Score Matching Regression and Postestimation Test**

Results of Probit Regression		Test for Balance			
			Mean		
Variable	**Coefficient (Standard Error)**	**Sample**	**Control Group**	**Treatment Group**	**Absolute Value of Difference**
Profit rate	0.011***	BM	8.31	9.97	1.66***
	(0.003)	AM	8.15	8.54	0.40
Grow rate of profit	0.125	BM	86.69	97.89	11.20***
	(0.175)	AM	96.63	98.60	1.98
Size	0.270***	BM	8.74	9.62	0.88**
	(0.006)	AM	9.08	9.42	0.34*
Age	–0.002***	BM	10.17	8.04	2.13**
	(0.001)	AM	8.47	7.97	0.49
Tax rate	–0.031***	BM	0.55	0.66	0.11**
	(0.006)	AM	0.61	0.67	0.06
Leverage	0.001***	BM	55.11	59.92	4.82***
	(0.000)	AM	57.64	58.85	1.21
Human capital	0.440***	BM	9.02	12.86	3.84***
	(0.040)	AM	10.48	12.78	2.31*
Female share	0.387***	BM	33.50	36.25	2.75**
	(0.057)	AM	35.18	36.21	1.03
Ownership dummies	Yes				
City dummies	Yes				
Industry dummies	Yes				
Observations	250,799				
Pseudo R^2	0.209				

AM = after matching sample, BM = before matching sample.
Notes: The dependent variable in the left panel is a dummy that measures whether a firm has a computer. The right panel shows results from testing the difference between two groups (AM and BM). The p-value (indicated by stars) in the last column is for the null hypothesis, which states that there is no difference between the two groups. The coefficients and standard errors for dummies are not presented to save space. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Author's calculations based on National Bureau of Statistics of China. 1998–2008. "Chinese Industrial Enterprises Database."

to measure whether a firm owns computer(s) or not. The primary determinants for computer use include a firm's profits and annual average growth rate during 2001–2004, lagged firm size, age, tax rate, leverage, and the employment share of skilled workers (workers with at least a college education) and female workers. I also control for the mode of ownership, urban versus rural areas, and 2-digit industry fixed effects to eliminate the impacts of unobservable heterogeneity. Most of the coefficients are statistically significant. Typically, firms with higher profits and growth rates, lower tax rates, and more leverage are more likely to adopt computer and information technology. Larger and younger firms are also inclined to adopt computer and information technology. In addition, computer use is highly correlated with human capital and the share of female workers, which is consistent with the capital–skill complementarity hypothesis (Goldin and Katz 1998) and

Table 7. **The Effects of Computer Use on Firm Growth: Matched Sample**

	Employment (1)	Asset (2)	Value Added (3)	Sales (4)	Profit (5)
Panel A					
Computer use	1.201**	0.553**	1.690***	0.303***	0.375***
	(0.499)	(0.259)	(0.638)	(0.040)	(0.145)
Observations	128,421	128,418	128,332	128,428	128,392
R^2	0.088	0.080	0.068	0.098	0.111
Panel B					
Personal computer use	1.202**	0.554***	1.681***	0.257***	0.391***
	(0.499)	(0.206)	(0.638)	(0.027)	(0.097)
Observations	128,421	128,418	128,332	128,428	128,392
R^2	0.088	0.080	0.068	0.098	0.111
Control variables	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Ownership fixed effects	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors reported in parentheses are clustered at the city level. The coefficients and standard errors for control variables are not presented to save space. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Source: Author's calculations based on National Bureau of Statistics of China. 1998–2008. "Chinese Industrial Enterprises Database."

the skill-biased technical progress hypothesis (Autor, Katz, and Krueger 1998; Acemoglu 2003).

The right panel of Table 6 shows results for a test of the difference between a control group (firms without computers) and a treatment group (firms using computers) both before and after the propensity score matching. The two groups are much more similar to each other after the matching. For example, before matching the mean profit rate is 8.31% for firms without a computer and 9.97% for firms with a computer. The difference is statistically significant at the 1% level. In the matched sample, the mean profit rates of the two groups are 8.15% and 8.54%, respectively, and the difference is no longer significant, indicating that the control group and treatment group have become comparable in terms of profit rates. The same logic applies to other variables, which together make the two groups comparable in almost all important dimensions.

I can now reestimate equation (3) using the matched sample from Table 6. The results are presented in Tables 7 and 8.[10] Table 7 tests the correlation between

[10]The usual propensity score matching results compare firms with and without computers rather than estimating the effect of computer intensity in a firm. In this paper, however, the propensity score matching method is used in a slightly different way. In the first step, I run a probit regression to get a matched subsample, which is a standard propensity score matching procedure. In the second step, I use the matched sample to run regressions of firm performance on computer intensity rather than a dummy for computer use. I view the coefficient as the effect of computer intensity on a firm. The adjusted propensity score matching in this paper is right only when the following assumption is satisfied: there is a difference between firms with computers and those without; but for firms with more computers and those with less computers, the difference in other aspects is not crucial. I thank an anonymous referee for reminding me of this point.

Table 8. **The Effects of Computer Use on the Quality of Firm Growth: Matched Sample**

	R&D Intensity (1)	Share of New Products (2)	TFP (3)	Labor Productivity (4)
Panel A				
Computer use	0.038***	0.012**	0.003***	1.570***
	(0.014)	(0.006)	(0.001)	(0.253)
Observations	128,428	128,428	111,862	128,334
R^2	0.176	0.051	0.091	0.114
Panel B				
Personal computer use	0.039***	0.011**	0.003***	1.572***
	(0.013)	(0.005)	(0.001)	(0.256)
Observations	128,428	128,428	111,862	128,334
R^2	0.176	0.051	0.091	0.114
Control variables	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Ownership fixed effects	Yes	Yes	Yes	Yes

R&D = research and development, TFP = total factor productivity.
Notes: Robust standard errors reported in parentheses are clustered at the city level. The coefficients and standard errors for control variables are not presented to save space. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Author's calculations based on National Bureau of Statistics of China. 1998–2008. "Chinese Industrial Enterprises Database."

computer use and the growth rates of matched firms. Most of the coefficients are again statistically significant at the 1% level, verifying the robust causality relationship. The magnitude of the coefficients in both panels A and B are smaller than when using the full sample (except for column 3). This is partly because of a potential upward bias from an estimation of the full sample and partly because the firms in the matched sample grow more slowly on average. The economic significance does not change much. For example, regarding the growth rate of employment, one more computer per 100 workers contributes an additional 1.2 percentage points to the growth rate, or 5% of the mean (mean growth rate of employment for the matched sample is 23.8%). This is slightly larger than the 4.8% recorded in column 1 in Table 3.

When I test the causal effect of computer and information technology on the quality of growth using a matched sample in Table 8, I get slightly larger coefficients compared with those in Table 3. The economic significance is also larger because the mean quality of growth in the matched sample is lower. For example, one more computer per 100 workers causes a 0.01 percentage point increase in the share of new products, accounting for less than 2% of its mean in the full sample (Tables 1, 3). For the matched sample, the same increase in computer use contributes to 3% of its mean share of new products, which is 0.41 percentage points. The estimation from the full sample suffers little, if any, downward bias.

IV. The Effects of Computer and Information Technology on Industrial Restructuring

The previous section provided evidence that computer and information technology boosts growth rates and improves the quality of growth for industrial firms. By aggregating the firm-level data, it can be shown that industries and regions with high levels of computer use will grow more rapidly and industrial restructuring will accelerate in comparison to other industries and regions. Since industrial structure adjustment plays a crucial role in economic growth, especially in developing economies (Chenery et al. 1986, Lin 2009), I empirically test the role of computer use in two steps.

First, I examine the effects of computer and information technology on industry growth at the city–industry level. I estimate equation (4) as follows:

$$ICI_{ic,04\_07} = \alpha + \beta Computer_{ic,2004} + X_{ic,2004}\gamma + city_c + ind_i + own_o + u_{ic} \qquad (4)$$

where the change in the ICI for industry i in city c during 2004–2007 ($ICI_{ic,04\_07}$) is the dependent variable. The key explanatory variable is the mean of (personal) computers per 100 workers within the city–industry cluster. As for the control variables, I aggregate the firm-level controls at the city–industry level and use the means of firm size, age, tax rate, leverage, and human capital as controls.[11] In addition, I control for market structure by using a Herfindahl–Hirschman Index, control for government power by using the share of state-owned enterprises, and control for openness of the city–industry cluster by using mean foreign direct investment shares.

The results presented in Table 9 support the hypothesis that industries using more computers will grow faster relative to their peers in the same city. Almost all coefficients on computer use are positive and statistically significant at the 1% level, except when measuring the ICI using employment. A reasonable explanation for this involves the relationship between labor and computer technology as production factors. On one hand, computers improve productivity and growth, encouraging firms to hire more labor. This scale effect, as it is called in standard labor economics, is consistent with what I find at the firm level as shown in Tables 2, 4, and 7. On the other hand, the substitution effect also has an impact; that is, computers work well for some routine tasks and can crowd out labor (Acemoglu 2002). Because the scale effect and substitution effect work in opposite directions, an aggregation at the city–industry level generates less significantly positive coefficients. For the other measures of the ICI, I can safely conclude that computer and information technology plays a huge role in city–industry growth. Furthermore, the coefficients are very similar to each other. Taking the ICI of assets, for example, one more

[11] The share of labor with a college degree or above is again used as a proxy for human capital.

Table 9. **The Effects of Computer Use on the Industry Concentration Index**

	Employment (1)	Asset (2)	Value Added (3)	Sales (4)	Profit (5)
Panel A					
Computer use	0.009*	0.033***	0.031***	0.031***	0.031***
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Observations	6,358	6,358	6,358	6,358	6,358
R^2	0.305	0.265	0.265	0.272	0.267
Panel B					
Personal computer use	0.010**	0.037***	0.037***	0.036***	0.036***
	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)
Observations	6,358	6,358	6,358	6,358	6,358
R^2	0.305	0.264	0.265	0.271	0.267
Control variables	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Ownership fixed effects	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors are reported in parentheses. The coefficients and standard errors for control variables are not presented to save space. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Author's calculations based on National Bureau of Statistics of China. 1998–2008. "Chinese Industrial Enterprises Database."

computer per 100 workers boosts the ICI by over 2%. The coefficients on the control variables are also reasonable and there is no reason to explain them again.

The empirical analysis at the city–industry level implies that the more industries adopt computer and information technology, the faster they grow relative to other industries within the same city. Differences in the use of computer and information technology across industries result in uneven growth rates, which in turn lead to industrial restructuring within manufacturing. To test this hypothesis, I run regressions of the SCI of all kinds on computer use at the city level. In addition to the control variables of city–industry level regressions, I further control for more city-level variables, including gross domestic product per capita, population density, and the employment shares of secondary industry and services. All of these covariates come from the China City Statistical Yearbook (National Bureau of Statistics of China 2004).

$$SCI_{c,04\_07} = \alpha + \beta Computer_{c,2004} + X_{c,2004}\gamma + prov_p + u_c \quad (5)$$

Table 10 presents results for estimating equation (5). Again, I use two panels to mark the difference between computer and personal computer use, which are measured as the combined number of computers per 100 workers within a city. In brief, computer use is highly correlated with structural changes within manufacturing, no matter which index is used. Furthermore, the coefficients are extremely close to each other, ranging between 0.0027 and 0.0029 in Panel A and between 0.0060 and 0.0096 in Panel B. This means that an additional computer per 100 workers can boost

Table 10. **The Effects of Computer Use on the Structural Change Index**

	Employment (1)	Asset (2)	Value Added (3)	Sales (4)	Profit (5)
Panel A					
Computer use	0.0028***	0.0028***	0.0027***	0.0028***	0.0029***
	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Observations	275	275	275	275	275
R^2	0.620	0.547	0.460	0.566	0.562
Panel B					
Personal computer use	0.0096***	0.0078***	0.0060*	0.0080***	0.0082***
	(0.0027)	(0.0029)	(0.0033)	(0.0029)	(0.0029)
Observations	275	275	275	275	275
R^2	0.576	0.501	0.368	0.494	0.494
Control variables	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors are reported in parentheses. The coefficients and standard errors for control variables are not presented to save space. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Author's calculations based on National Bureau of Statistics of China. 1998–2008. "Chinese Industrial Enterprises Database."

structural change in employment by 0.0028 percentage points, or approximately 14% of its mean, which has huge economic implications for cities that need resource allocation to boost growth.[12] The effect of personal computer is even larger. In addition, the direction of the reallocation of production factors shifts resources from low-efficient industries toward industries with more R&D activity and higher productivity, according to the results in the previous section. In summary, the more computers that are used in a city, the faster structural change will occur.

V. Conclusions

While people regularly enjoy the benefits brought about by computer and information technology, its economic effects have not been fully explored. To narrow this gap in the literature, this paper first studies the effects of computer and information technology on firm growth and industrial change in the manufacturing sector in the PRC. Using data from CIED, I empirically examine the correlation between computer use and firm performance. The main finding is that firm growth—both in terms of the growth rate and growth quality—heavily benefits from computer and information technology. This finding is robust when I use different measures and restrict the regression to newly opened firms or a matched sample to rule out possible disturbances caused by heterogeneous features. As a straightforward extrapolation, industries with a high level of computer use grow faster and cities with a high level of computer use also experience more rapid

[12] When other indicators are used to measure structural change, the economic effects become smaller because the means of these other indicators are relatively larger. Nevertheless, one more computer per 100 workers can increase the SCI by over 10%.

industrial structural change. That is, computer and information technology has been observed to accelerate restructuring in the manufacturing sector in the PRC.

The findings in this paper have both theoretical importance and policy implications. In theory, this paper points out two channels through which computer and information technology can contribute to economic development. At the micro level, computer and information technology boosts firm growth and improves the quality of growth in terms of increased innovation and higher productivity. At the macro level, computer and information technology accelerates industrial restructuring and helps production resources flow from low-productivity industries to high-productivity ones, which in turn enhances average productivity. As for policy implications, the empirical findings in this paper underlie the PRC's development strategy as outlined in the New Four Modernizations, especially the interaction between industrialization and informatization.[13] Computer and information technology have impacted and changed many sectors, including manufacturing, during the current digital era. This paper provides evidence of the positive effects of informatization on industrialization and offers guidance for governments on simultaneously boosting both industrialization and informatization.

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Gender Discrimination in Education Expenditure in Nepal: Evidence from Living Standards Surveys

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There is a significant amount of literature on the role of parental gender preferences in determining the level of education expenditure for children. In this study, I examine the effects of such preferences on parents' education expenditure in Nepal. Using longitudinal data from three Nepal Living Standards Surveys, I apply several decomposition methods to determine the level of bias that parents display in spending on their children's education. I find that parents indeed spend more on boys than girls in both rural and urban areas in Nepal. I also find that this bias is reflected in the higher enrollment levels of boys than girls in private schools.

Keywords: decomposition, education expenditure, gender discrimination, household decisions, Nepal Living Standards Surveys
JEL codes: H52, I24

I. Introduction

Nepal has made remarkable progress in achieving a degree of gender parity in the field of education. Net enrollment rates have achieved parity at all levels of schooling, reflecting the government's success in ensuring the equal participation of girls in schools. However, while improvements in enrollment rates are a positive first step, this does not imply gender parity in the education sector. Various forms of discrimination—such as the reproduction of discriminatory norms in the process of socialization and in the classroom (e.g., a curriculum that favors traditional gender roles), encouragement for continuing traditional course selection (Collins 2009), and at times outright discriminating behavior—have been observed in schools (Hickey and Stratton 2007, Bandyopadhyay and Subhramaniam 2008). At the household level as well, girls are expected to spend more time on chores rather than on education (Mason and Khandker 1996, Levison and Moe 1998); are more likely to drop out of school (Sabates et al. 2010); and are less likely to continue their

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education at higher levels. Another form of household discrimination, which forms the topic of this study, is differential treatment in education expenditure in which parents spend more on boys' education than they do on girls' education.

Gender parity is a basic precondition for a just and equitable society. Arguments for gender equality also go beyond reasons of justice and equality. Empowering women is crucial for the socioeconomic development of any country. Studies report that higher levels of education in women lead to higher economic growth (Coulombe and Tremblay 2006); reductions in child and infant mortality rates (Cochrane 1982, LeVine 1987); and better outcomes for all children in the family (Schultz 1961; Alderman and King 1998; Strauss, Mwabu, and Beegle 2000). Yet, despite governments promoting the participation of women in schooling and education, societies continue to observe disparities in women's access to education and the labor force. The feminist movement attributes this phenomenon to (i) the existing sexual division of labor that assigns women to domestic tasks; and (ii) men's control over women's sexuality, which includes strict supervision of movements outside the home and limits on societal interactions (Stromquist 1992). Economic models explain that such disparities arise out of differential parental preferences (assuming parents to be rational economic agents) due to differences in children's cognitive endowment, birth order, and (more importantly) variations in expected returns on investment between boys and girls (Behrman, Pollak, and Taubman 1982; Lehmann, Nuevo-Chiquero, and Vidal-Fernandez 2012).

In Nepal, societal norms dictate that women after a certain age are married away. Additionally, patriarchy is pervasive in Nepal's legal and socioeconomic environments, a fact substantiated by the widespread inequality observed in legal outcomes (Nowack 2015); wealth (Bhadra and Shah 2007); employment opportunities (ADB 2010, Bhadra and Shah 2007); and education (UNESCO 2015). The incentives for parents to pay for girls' education are lower compared with boys not only because women are likely to face unequal opportunities in the labor force, but also because boys are expected to look after their parents and the family estate when the parents grow old.

While much has been written on gender discrimination in education in Nepal, very little empirical work has been done to analyze the extent of the discrimination. This paper tries to fill that gap by examining the nature and extent of one form of discrimination—inequality in household expenditure—faced by women in the education sector by comparing expenditure on education for girls versus boys, and then decomposing the observed gap in expenditure into explained and unexplained components. The paper is organized as follows. Section II presents the motivation behind the research, including an identification of the research gap that this paper addresses. The methodology and the data set used in this study are described in section III. Section IV details the major results and the findings. Section V consists of conclusions and policy recommendations.

II. Motivation

The right to an education is a fundamental human right. Yet, women in the developing world are underrepresented at all levels of education (see, for example, Annex 1 of the Global Campaign for Education 2012). While progress has been made globally in improving the net enrollment ratio at primary levels, a noticeable decline is observed in girls' participation at higher levels of education (Global Campaign for Education 2012). Inequality is not only observed in terms of ability to participate in schooling, but also in terms of quality of schooling.[1] The participation of girls is also found to be lower in private schools compared with public schools in developing economies (Harma 2011; Maitra, Pal, and Sharma 2011; Woodhead, Frost, and James 2013; Sahoo 2014).

As was mentioned earlier, one of the reasons behind the ineffective inclusion of girls in educational opportunities is the unequal investment made by parents in their male and female children's education. The prevalence of unequal returns to education in terms of wages and work opportunities in the labor market implies that parents are likely to invest more in boys' education than in girls' (Garg and Morduch 1998 as cited in Sahoo 2014, Leclercq 2001). Results are further skewed in favor of boys if women are expected to leave their parents' home after they get married while men are expected to remain at home to eventually take care of their elderly parents.[2] Various studies have found differential treatment resulting from parents' investment decisions. For example, Burgess and Zhuang (2000) and Gong, van Soest, and Zhang (2005) find significant bias in favor of boys in education expenditure in the People's Republic of China. Similarly, in India, Kingdon (2005) and Saha (2013) find evidence of differential education expenditure between boys and girls in certain states. Similar findings were presented in the cases of Pakistan (Aslam and Kingdon 2008), Paraguay (Masterson 2012), and Bangladesh (Shonchoy and Rabbani 2015).

Considering the cultural and socioeconomic similarities between many of the above-mentioned countries and Nepal, and the existence of widespread patriarchy in Nepal, we can expect to find significant levels of gender bias in education expenditure patterns among Nepalese households. Unequal access to and outcomes in education with respect to gender are characteristic features of the Nepalese education system. School enrollment has long skewed in favor of boys (World Bank 2014). More recently, there has been a drive to make education (along with other social services) equitable and inclusive. The Constitution of Nepal 2015 has made

[1] Discrimination against girls is also pervasive in a school environment. However, the focus of analysis in this study concerns parental expenditure choices that are biased in favor of boys.

[2] In the Indian subcontinent, men are expected to live with their parents and look after them in their old age, while women are expected to live with their husbands. This practice contributes significantly to the unequal treatment of women and girls in terms of human capital development, marriage, and other critical life decisions including inheritance.

the right to an education an inalienable right for all (Government of Nepal 2015). Gender equality and social inclusion guidelines have been formulated across all government sectors to make policies, strategies, and outcomes gender sensitive. The *Education for All* initiative and the *School Sector Reform Plan* prioritize equal participation for girls at all levels of education (Ministry of Education and Sports 2003). As a consequence, net enrollment ratios have risen for all children and are now comparable for both boys and girls at primary and secondary schools (National Planning Commission 2013). Yet, the participation of boys in private education and higher education remains higher when compared with girls (Department of Education 2015). Therefore, while the gender gap in terms of school enrollment at primary and secondary levels has almost disappeared, instances of gender discrimination can still be observed among Nepalese households both in terms of education quality and expenditure.[3]

Decomposing such discrimination can provide policy makers with valuable insights into understanding and minimizing the extent of such bias and incentivizing households to achieve better education outcomes for girls. However, studies on gender discrimination and education in Nepal are scarce. Most reports on discrimination typically analyze participation rates and do not consider other forms of discrimination (see, for example, Unterhalter 2006, Herz 2006, and Huxley 2009).

Similar patterns can be observed in academic studies. One of the earliest studies in the field incorporating historical data was conducted by Stash and Hannum (2001), who find evidence of a significant gender gap in primary school participation rates. Using data from the 1991 Nepal Fertility, Family Planning, and Health Survey, they find that the educational attainment of head of households and rural–urban households bore no effect on school participation rates for girls. Therefore, they conclude that traditional indicators of development had little impact on discriminatory educational outcomes. LeVine's (2006) ethnographic study of Nepal examines the determinants of school attendance of girls and the reasons behind their dropping out of school. The study finds that since the 1990s, profound socioeconomic transformations have led to a more equitable attitude of parents toward their children's education, although girls were still less likely to complete their education or attain higher education because of marriage. A recent study by Devkota and Upadhyay (2015) examines inequality in education outcomes owing to various household factors like income, sex, ethnicity, and location of the household

[3]Private schools are generally considered to provide higher quality education in Nepal than public schools. They are more expensive to attend, spend more on children's education per student, have lower rates of teacher absenteeism, have better school management systems, and exercise more stringent grade promotion systems. As a consequence, private schools produce better results in School Leaving Certificate exams. In 2012, the success rate of private school students taking School Leaving Certificate exams was 93.1% compared with only 28.2% for public school students (Sharma 2012). Parents prefer private schools provided they can afford them. Therefore, the higher rate of participation of boys in private schools is indicative of discriminatory expenditure decisions at the household level.

and the school. They find that while men in Nepal were likely to attain a higher level of education, their advantage had significantly declined between 1996 and 2004.

Some studies have looked at the effects of migration on education outcomes in Nepal. Bontch-Osmolovski (2009) studies the role of migration in education and finds significant positive effects of parental migration on their children's enrollment in school. However, the author finds no significant difference, on average, of the effect of migration by the gender of the child, which is contrary to Nepal (2016), who finds higher levels of school enrollment, greater incidence of private schooling, and shorter working hours for boys in migrant households when compared with girls. Bansak and Chezum (2009) also find that remittances positively affect school attendance, with a greater positive impact among boys than girls.

The aforementioned studies rely primarily on enrollment and school participation rates as the basis of analysis of gender discrimination, assuming parental decisions only affect the participation of children at school and ignore other forms of discrimination between boys and girls already enrolled in schools. This discussion becomes even more pertinent given rising enrollment and participation rates for both boys and girls at the primary and secondary school levels. Considering the clear evidence of unequal expenditure in favor of boys' education in comparable societies, there is a need to investigate whether this trend exists in Nepal as well. Vogel and Korinek (2012) were the first to evaluate the expenditure allocation decisions of households on education in Nepal. Their study examines how remittance income is allocated in terms of schooling expenditure for boys and girls within the same family. They find that households that receive substantial remittances tend to increase education spending for boys but not for girls. Therefore, more remittances do not necessarily result in increased investment in girls' education. However, the study primarily limits itself to remittance-based households and does not take nonmigrating households into consideration.

This paper aims to build on the findings of Vogel and Korinek (2012) by looking at the education expenditure allocation decisions of Nepalese households. It focuses on the extent of discrimination practiced against girls in terms of expenditure patterns on education and examines the possible reasons behind such inequality. Using the Blinder–Oaxaca decomposition method (along with decomposition using quantile regressions), the study examines the extent of explained differences and unexplained differences (proxied as discrimination) in education expenditure for families across Nepal.

III. Data and Methodology

Data for the study comes from the three rounds of the Nepal Living Standards Survey (NLSS) conducted in 1995–1996, 2003–2004, and 2010–2011.[4]

[4]Henceforth, NLSS I, NLSS II, and NLSS III will imply surveys conducted in 1995–1996, 2003–2004, and 2010–2011, respectively.

The surveys follow the methodology developed by the World Bank in its Living Standards Measurement Study and collect information from all over Nepal on wide-ranging variables including, among others, poverty; income, wealth, and expenditure sources; household composition; and migration. The latest survey collected data from 5,988 households (in addition to 1,032 households used for the panel sample) from 71 districts (499 primary sampling units) across Nepal over a 12-month period. For the study, I use samples from both rural and urban households from all three geographical regions surveyed in the study. Due to a lack of observations among students of higher studies and for schools under other systems of education, I have confined the samples for the regression analysis to include students until the 10th standard of their schooling and who have studied in either community schools or private schools.[5] To arrive at total education expenditure per student, I have calculated total school fees of individual children by adding the costs of uniforms, text books, transportation, private tuition, and other fees, and then deducting the monetary value of any scholarships. Fees are presented on a nominal basis and have not been converted to real terms. The sample for education expenditure per child was trimmed by the top 0.1% and the bottom 0.1% to remove potential outliers.

Two methods have been popularly used to disaggregate biases in education expenditure in popular research. The first methodology makes use of Engel Curves, which observes household-level expenditure data and analyzes the relationship between changes in household gender composition and patterns of expenditure. In the absence of individual-level data on expenditure patterns, this method can provide valuable insights into inferring the level of bias from the overall household expenditure data (Aslam and Kingdon 2008). However, the validity of this methodology has also been challenged (Kingdon 2005).

Where individual-level data are available, the use of decomposition provides far more useful results. First used by Blinder (1973) and Oaxaca (1973), this method decomposes the expenditure gap into an endowment gap and a coefficient gap. The endowment gap explains differences in expenditure based on differences in endowments and the coefficient gap is the discrimination coefficient (Madheswaran and Attewell 2007). While the Blinder–Oaxaca decomposition is popularly used to decompose bias in wage gaps in the labor market, the methodology is as effective in understanding the bias in education expenditure as well, and has been

[5]The education system in Nepal is classified into primary (1st–5th grade), lower secondary (6th–8th grade), secondary (9th–10th grade), higher secondary (11th–12th grade), and tertiary levels. Classification is made based on national level examinations and students are required to attend. All students must clear the School Leaving Certificate examinations in 10th grade to qualify for higher-level studies in which students can choose boards and areas of interest. School Leaving Certificate examinations are traditionally considered the entry gate for higher education in Nepal. The government has prioritized the elimination of gender disparity in education through the secondary level under the Education for All Initiative (Ministry of Education and Sports 2003). The NLSS classifies primary and secondary schools into four categories: (i) community or government-owned schools, (ii) institutional or private schools, (iii) technical schools, and (iv) religious schools. As can be observed from Table 1, the share of students studying in the latter two categories is extremely small.

used in studies analyzing decomposition of education expenditure. Here, I use the Blinder–Oaxaca decomposition method to disaggregate bias in the expenditure gap that can be explained by differences of endowments and the unexplained gap.

The basic equation can be represented as

$$\begin{aligned}\log{(Exp)}_{ijt} &= \alpha_{ijt} + \beta_1 poor_{jt} + \beta_2 rural_{jt} + \beta_3 ethni_{ijt} + \beta_4 Income_{jt} \\ &+ \beta_5 Schooltype_{it} + \beta_6 Currentclass_{ijt} + \beta_7 distschool_{ijt} \\ &+ \beta_8 birthorder_{ijt} + \beta_9 Motheredu_{ijt} + \beta_{10} Fatheredu_{ijt} \\ &+ \beta_{11} HHsize_{jt} + \beta_{12} Female_{ij} + \varepsilon_{ijt} \qquad (1)\end{aligned}$$

where Exp_{ijt} is the expenditure by household j on child i in year t. $Female_{ij}$ is the dummy variable where $Female_{ij}$ has a value of 1 if the child is a girl and 0 if the child is a boy. Similarly, $Female_{ij}$, $poor_{jt}$, $rural_{jt}$, and $ethni_{ijt}$ are dummy variables for families that are poor, live in rural areas, or belong to upper castes, respectively, in year t.[6] $Income_{jt}$ is the total income of the household in thousands of Nepalese rupees (NRs). $Schooltype_{it}$ is a dummy variable where 0 equals government school and 1 equals private school. $Currentclass_{ijt}$ is a vector of grade levels ranging from 1st until 10th grade. $Distschool_{ijt}$ represents the distance from the child's house to the school (measured in kilometers for NLSS III and in hours for NLSS I and NLSS II). $Birthorder_{ij}$ is a categorical variable that quantifies the order of the child's birth in the family where a value of 1 represents the firstborn child, 2 is the second child, and so on. $Motheredu_{ij}$ and $Fatheredu_{ij}$ represent the level of the parents' education with a value of 10 signifying completion of 10th grade. Additionally, $HHsize_{jt}$ describes the total size of the household of the student under consideration. For the ordinary least squares (OLS) regression, I have included $Female_{ij}$ as a dummy variable where a value of 1 implies a girl student and 0 implies a boy.

I use the Blinder–Oaxaca decomposition where the gross education expenditure differential for years t can be defined as

$$G_t = \frac{Exp_{mt} - Exp_{ft}}{Exp_{ft}} \qquad (2)$$

where Exp_m and Exp_f represent education expenditure on boys and girls, respectively. In the absence of any discrimination, the differences in expenditure could be explained only by the household-related variables where

$$Q_t = \frac{Exp^0_{mt} - Exp^0_{ft}}{Exp^0_{ft}} \qquad (3)$$

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[6]For the purpose of this study, Brahmin (hills and terai) and Chettris (hills and terai) are considered to be members of the upper castes.

The discrimination coefficient D_t can therefore be understood as

$$D_t = \frac{\left(Exp_{mt}/Exp_{ft}\right) - \left(Exp^0_{mt}/Exp^0_{ft}\right)}{\left(Exp^0_{mt}/Exp^0_{ft}\right)} \tag{4}$$

The logarithmic transformation of gross differential $\ln(G_t + 1)$ can therefore be equated as

$$\ln\left(G_t + 1\right) = \ln\left(Q_t + 1\right) + \ln\left(D_t + 1\right) \tag{5}$$

Following equation (1),

$$\ln\left(Exp_{mt}\right) = \sum \beta_{mt} X_{mt},$$

$$\ln\left(Exp_{ft}\right) = \sum \beta_{ft} X_{ft},$$

where $\sum \beta X$ represents a vector of determinants of education expenditure as elaborated in equation (1):

$$\ln\left(G_t + 1\right) = \ln\left(Exp_{mt}\right) - \ln\left(Exp_{ft}\right) = \sum \beta_{mt} X_{mt} - \sum \beta_{ft} X_{ft} \tag{6}$$

Then, the explained and unexplained expenditure gaps can be divided into

$$\ln\left(\overline{Exp}_{mt}\right) - \ln\left(\overline{Exp}_{ft}\right) = \left(\overline{X}_{mt} - \overline{X}_{ft}\right)\hat{\beta}_{mt} + \overline{X}_{ft}\left(\hat{\beta}_{mt} - \hat{\beta}_{ft}\right) = E + D \tag{7}$$

where the first term E is considered the difference in endowment and D represents the difference in expenditure between girls and boys with identical endowments, which can be interpreted as the bias (Madheswaran and Attewell 2007).

While the Blinder–Oaxaca decomposition method is very popular, it tends to ignore what is referred to as the common support problem in which chances of misspecification can arise because characteristic features of two cohorts being examined are generally ignored while computing the outcomes. In such cases, nonparametric decomposition methods like Black et al. (2008) and Ñopo (2008) have been used to simulate results for subsamples with comparable characteristics (Fortin, Lemieux, and Firpo 2010). Here, I also employ the Ñopo (2008) nonparametric estimation where the difference in education expenditure is given by

$$\ln\left(\overline{Exp}_{mt}\right) - \ln\left(\overline{Exp}_{ft}\right) = D_{xt} + D_{mt} + D_{ft} + D_{0t} \tag{8}$$

where D_x represents differences in expenditure due to uneven distribution of gender-specific characteristics across the two gender cohorts; D_m represents differences in expenditure due to differences in endowment between males and females, and the possibility of extent of an increase in expenditure provided that females have

Table 1. **Summary Statistics of Education Enrollment and Fees across School Categories**

	Boys			**Girls**		
School Category	**1995–1996**	**2003–2004**	**2010–2011**	**1995–1996**	**2003–2004**	**2010–2011**
			Enrollment (%)			
Community or government	86.61	77.07	71.80	87.37	78.50	77.89
Institutional or private	11.39	21.59	27.32	10.88	19.78	21.06
Technical or vocational	–	0.21	0.26	0.61	0.26	0.07
Gurukul–madrasa–gumba	0.73	–	0.55	0.09	–	0.90
Other	1.27	1.13	0.07	1.05	1.45	0.07
Total students	1,650	2,835	2,720	1,140	2,270	2,673
			Expenditure (NRs)			
Community or government	911.57	1,290.12	2,867.21	869.98	1,137.01	2,454.53
Institutional or private	6,522.88	10,151.52	16,450.57	7,148.99	10,459.88	18,264.95
Technical or vocational	–	12,309.17	23,820.71	2,100	1317.5	14,015
Gurukul–madrasa–gumba	1257.67	–	857	383.71	–	1,982.3
Other	391.43	715.63	9,558	183.75	237.18	2,739.33
Total expenditure	1,546.82	3,219.89	6,864.54	1,543.83	2,968.45	5,978.48

Note: NLSS I does not contain the gurukul–madrasa–gumba category but instead includes a category for community schools. Similarly, NLSS II only categorizes government schools, private schools, technical schools, and other schools.
Source: Author's calculation based on Nepal Living Standards Surveys.

male characteristics; D_f represents differences in the characteristics of males and females, and the potential decline in male expenditure if they had female endowments; and D_0 represents unexplained discrimination.

Considering the possibility of differential effects of various control variables across the expenditure distribution, I also use the quantile decomposition methodology of Melly (2005) to evaluate levels of discrimination across various points in the distribution of the education expenditure. The methodology goes beyond the mean and decomposes differences in education expenditure between the two groups (girls and boys) at different quantiles of the variable of interest.

IV. Findings

Analysis of the descriptive summary of the variables suggests the existence of a discrepancy in spending between boys and girls, with the total expenditure pattern showing that education expenditure on boys is slightly greater than that on girls (Table 1). While there is not much difference in the fees paid among various school categories,[7] in fact expenditure in private schools is higher in the case of

[7] Since the proportion of schools other than government schools and private schools is less than 2%, the focus in the remainder of this paper will be on community (public) and institutional (private) schools. Policy documents, including the *Education for All Initiative* and the annual *Flash Report* of the Department of Education, also focus on these two school structures. Therefore, leaving out religious schools and vocational schools will not detract from the analytical discussion (Ministry of Sports and Education 2003, Department of Education 2015).

Table 2. **Summary Statistics on Enrollment and Fees across School Categories in Rural Areas**

	Boys			Girls		
School Category	**1995–1996**	**2003–2004**	**2010–2011**	**1995–1996**	**2003–2004**	**2010–2011**
			Enrollment (%)			
Community or government	93.39	88.59	80.74	95.44	89.42	87.13
Institutional or private	4.30	9.95	18.33	2.34	8.41	11.45
Technical or vocational	–	0.05	0.18	0.86	0.19	0.05
Gurukul–madrasa–gumba	0.80	–	0.71	0.12	–	1.24
Other	1.51	1.40	0.04	1.23	1.98	0.14
Total students	1,256	1,999	2,258	811	1,569	2,175
			Expenditure (NRs)			
Community or government	746.36	976.22	2,477.87	612.34	844.42	2,056.99
Institutional or private	3,507.80	5,648.92	10,906.9	2,956.37	4,476.68	10,984.11
Technical or vocational	–	1,500	18,136.25	2,100	1,000	4830
Gurukul–madrasa–gumba	783.7	–	711.63	383.71	–	1,982.3
Other	418.95	378.21	3,024	181.5	248.29	2,739.33
Total expenditure	860.43	1,433.28	4,038.86	661.80	1,138.53	3,080.28

Note: NLSS I does not contain the gurukul–madrasa–gumba category but instead includes a category for community schools. Similarly, NLSS II only categorizes government schools, private schools, technical schools, and other schools.
Source: Author's calculation based on Nepal Living Standards Surveys.

girls,[8] the representation of boys in private schools is much higher than that of girls.[9] Worryingly, the overall difference in expenditure between boys and girls increased over the course of the three surveys. The mean of actual expenditure shows that while the difference in expenditure per student was only NRs3 in 1995–1996, it had risen to NRs886 by 2010–2011. Since mean expenditure in private schools is almost 8 times the mean expenditure in government schools, the faster rate of private school enrollment among boys when compared with girls over the last 15 years has proved to be the major source of expenditure bias and discrimination against girls.

The rural–urban classification of enrollment and expenditure echoes the findings of the national aggregate (Tables 2 and 3). While in absolute terms the amount of expenditure on education (for both girls and boys) is higher in urban areas, the share of girls' fees to boys' fees is significantly lower in rural areas (0.76) than in urban areas (0.93), suggesting a higher degree of discrimination among rural populations.[10] However, over time while the inequality in terms of expenditure has

[8]The declassification of expenditure, which is not shown in Table 1, reveals that parents spend more for girls' transportation and other costs compared with boys' in private schools, leading to higher expenditure per student for girls among private schools. It is not clear why this is the case. An examination of school distances and modes of transportation do not provide an answer.

[9]See footnote 3.

[10]After accounting for all categories of schools, differences in expenditure in rural areas could be observed in terms of textbook and supplies, private tuition fees, and other fees not described in the NLSS. This suggests corrective measures require not only making schools more attractive for girls but a more thorough approach of changing parental mindsets by discouraging patriarchy and promoting equality of girls at the household level.

Table 3. **Summary Statistics on Enrollment and Fees across School Categories in Urban Areas**

School Category	Boys 1995–1996	Boys 2003–2004	Boys 2010–2011	Girls 1995–1996	Girls 2003–2004	Girls 2010–2011
Enrollment (%)						
Community or government	64.97	49.52	38.17	67.78	54.07	46.33
Institutional or private	34.01	49.40	60.92	31.91	45.22	53.15
Technical or vocational	–	0.60	0.39	–	0.43	0.13
Gurukul–madrasa–gumba	0.51	–	0.26	–	–	0.39
Other	0.51	0.48	0.26	0.61	0.29	–
Total students	394	836	765	329	701	762
Expenditure (NRs)						
Community or government	1,668.60	2632.90	5,297.97	1,768.25	2,220.13	4,588.66
Institutional or private	7,737.93	12,321.05	21,375.64	7,907.66	12,951.31	22,741.32
Technical or vocational	–	14,471	31,400	–	1,635	23,200
Gurukul–madrasa–gumba	3,627.5	–	2020	–	–	1,983.3
Other	130	3,077.5	12,735	195	65	–
Total expenditure	3,734.92	7,064.96	15,204.92	3718.07	7,064.23	14,250.89

Note: NLSS I does not contain the gurukul–madrasa–gumba category but instead includes a category for community schools. Similarly, NLSS II only categorizes government schools, private schools, technical schools, and other schools.
Source: Author's calculation based on Nepal Living Standards Surveys.

remained fairly stable in rural areas, there has been a marginal rise in expenditure on boys in urban centers (with the share of girls' fees to boys' fees dropping from 0.99 to 0.93). This trend is noticeable in rising gaps across the years in expenditure levels in both private and public schools in addition to a faster rate of growth in private school participation for boys (from 34% to 61%) compared with girls (from 32% to 51%). In rural areas, rising gaps in expenditure in public schools were observed over time, although surprisingly the average expenditure gap in private schools became negative. However, this negative expenditure gap is offset by a disparity in private school participation growth rates with the enrollment of boys in private schools increasing from 4% to 18% compared with the rate of girls increasing from 2% to 11%.[11]

The first set of regressions were simple OLS models with gender as a dependent variable (Table 5). The coefficient of the major variable of interest (female) was significant with the semi-elasticity of fees at between –0.098 and –0.202, indicating lower levels of education expenditure for girls. Other control variables showed the expected outcomes. The semi-elasticity of total family income was positive and significant, but the level of influence on total education expenditure

[11] Inequality in private school enrollment extends far beyond gender. Spatially, private schools constitute only 1% and 20% of all secondary schools in mountainous areas of the far-western and mid-western regions in Nepal, respectively. Similarly, enrollment of other marginalized groups such as Dalits, ethnic minorities, and the disabled—is also found to be disproportionately low in private schools (Department of Education 2015). Differences in rural–urban private school enrollment rates can be observed in Tables 2 and 3.

Table 4. **Descriptions of Control Variables**

Variable	**Description**
Exp	Total expenditure on education
Female	Dummy variable where 1 is girl and 0 is boy
Income	Total income of the households in thousands of Nepalese rupees
Poor	Dummy variable where 1 implies a household is poor and 0 implies it is not[a]
Birthorder	Ordinal variable where 1 represents a firstborn child, 2 represents a second child, and so on
HHsize	Size of the household
Fatheredu	Education qualification of father with 10 representing 10th grade
Motheredu	Education qualification of mother with 10 representing 10th grade
Ethni	Dummy variable where 1 represents member of the upper caste and 0 represents other ethnicities
Currentclass	Current grade of the student
Distschool	Distance from home to school (in kilometers in 2010–2011 and hours in 1995–1996 and 2003–2004)
Schooltype	Dummy variable where 1 and 0 mean enrollment in private and public schools, respectively
Rural	Dummy variable where 1 represents rural and 0 represents urban

[a]The poverty line has been drawn based on nutritional requirements included in the NLSS.
Source: Author's compilation.

Table 5. **Ordinary Least Squares Regression with Gender as a Dependent Variable**

Log(exp)	**1995–1996**	**2003–2004**	**2010–2011**
Female	-0.105^{***}	-0.098^{***}	-0.202^{***}
Income	0.011	0.021^{***}	0.003^{***}
Poor	-0.609^{***}	-0.708^{***}	-0.601^{***}
Birthorder	0.024	-0.017	-0.054^{***}
HHsize	-0.027^{***}	-0.004	-0.021^{***}
Fatheredu	0.037^{*}	0.026^{***}	0.029^{***}
Motheredu	0.121	0.048^{***}	0.034^{***}
Ethni	0.096^{**}	0.123^{***}	0.054^{*}
Currentclass	0.221^{***}	0.203^{***}	0.158^{***}
Schooltype	0.502^{***}	1.067^{***}	0.882^{***}
Distschool	0.006	0.073^{***}	-0.0005^{***}
Rural	-1.153^{***}	-0.698^{***}	-0.483^{***}

Note: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. See Table 4 for a description of the variables.
Source: Author's calculations based on NLSS Surveys.

was very low. This perhaps is indicative of the poor quality of income data collected in the survey since data on income are notoriously unreliable (see, for example, Deaton 1997, 29–31). As expected, poverty has a strong negative influence on total education expenditure, with poor families expected to spend up to 50% less on education expenditure than nonpoor families. Expenditure fell as household size increased and rose with the educational attainment of parents. Similarly, the grade of students and type of school had the expected strong and positive impact on

Table 6. **Ordinary Least Square Regressions with Separate Results for the Population Cohorts**

	Boys			Girls		
	1995–1996	**2003–2004**	**2010–2011**	**1995–1996**	**2003–2004**	**2010–2011**
Income	0.247***	0.0153***	0.005**	−0.001	0.092***	0.002
Poor	−0.589***	−0.719***	−0.596***	−0.611***	−0.682***	−0.587***
Birthorder	0.022	−0.004	−0.080***	0.028	−0.026	−0.033
HHsize	−0.028***	0.002	−0.016*	−0.037***	−0.014**	−0.025**
Fatheredu	0.040	0.025***	0.029***	0.025	0.023***	0.028***
Motheredu	0.139	0.036	0.026***	0.057	0.062**	0.041***
Ethni	0.056	0.103**	0.034	0.173***	0.138***	0.073*
Currentclass	0.213***	0.198***	0.147***	0.223***	0.209***	0.168***
Schooltype	0.430***	1.071***	0.944***	0.574***	1.022***	0.805***
Distschool	−0.007	0.071**	−0.0005***	0.037	0.078**	−0.015***
Rural	−0.979***	−0.710***	−0.430***	−1.213***	−0.640***	−0.494***

Note: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. See Table 4 for a description of the variables.
Source: Author's calculation based on NLSS Surveys.

education expenditure. Interestingly, regressions also showed that members of the upper caste were more likely to spend more on education than people from other ethnicities.[12]

Gender-wise classification of the OLS regression also provided interesting insights (Table 6). For variables like poverty, grade, and school types, the coefficients were comparable for boys and girls, while other variables impacted the two cohorts unequally. The impact of the size of the household was found to be relatively insignificant for boys but was highly significant and negative for girls, suggesting that a reduction in education expenditure per child due to an increase in household size primarily impacts girls. Therefore, a focus on family planning measures would lead to increased education opportunities for girls.[13] The importance of the mother's education was also reflected unequally. A woman's level of education is likely to play a more important role in a daughter's education compared with a son's; that is, the semi-elasticity of a mother's education on education expenditure is higher for girls than boys.[14] Distance from school had

[12]This discrepancy is explained both by differences in school preferences and expenditure categories. Not only were upper caste households more likely to send their children to private schools (22% private school enrollment for households from other ethnicities compared to 28% for members of the upper caste), but they also were more likely to spend on other educational expenditure and tuition fees. The cultural reasons behind these differences are beyond the purview of this study. However, basic analysis reveals that parents from the upper caste earn more than everyone else and are more likely to be educated than counterparts from other ethnicities.

[13]The average household size in the sample was 5.94 persons, which provides sufficient space for family planning interventions.

[14]The reasons behind this phenomenon are not clear but evidence suggests that mothers prefer allocating educational resources to daughters and fathers to sons (Glick and Sahn 2000). Education empowers women and increases their bargaining power in the family, thus allowing them to spend more resources on girls. This finding is supported by additional evidence from Africa and Asia (King and Lillard 1987, Lillard and Willis 1992, Tansel 1997).

Table 7. **Results from Blinder–Oaxaca Decomposition**

Log(exp)	1995–1996	2003–2004	2010–2011
Difference	−0.045	−0.098**	−0.264***
Explained	0.054	−0.008	−0.020
Unexplained	−0.099**	−0.089***	−0.243***

Note: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Author's calculation based on NLSS Surveys.

Table 8. **Results from Ñopo Decomposition**

Log(exp)	1995–1996	2003–2004	2010–2011
Difference	−0.007	−0.014	−0.030
D_x	0	0	0.0003
D_m	0.014	−0.025	−0.179
D_f	−0.013	0.032	−0.190
D_o	−0.008	−0.021	−0.018

Source: Author's calculation based on NLSS Surveys.

a larger negative impact on girls than boys, suggesting proximity to school is an important factor contributing to a better education for children.[15]

To differentiate the roles of endowments and discrimination in explaining the differences in education expenditure between boys and girls, I conducted a Blinder–Oaxaca decomposition analysis on the same observations (Table 7). Results from NLSS II show that in log terms, expenditure on boys was 0.098 higher than on girls, of which only about 9% could be explained by differences in the control variables and about 90% could be attributed to discrimination. Similarly, results from NLSS III show that expenditure on girls is lower than expenditure on boys by around NRs0.264 per child in log terms. Only about 8% of this gap can be explained via differences in household characteristics and the remaining 92% can be attributed to discrimination.

Results from the Ñopo decomposition also display an incidence of discrimination, although the extent of discrimination appears to be much smaller (Table 8). This technique shows that in 2010–2011, almost 60% of the expenditure gap was due to unexplained factors (discrimination). The results were more dramatic in 1995–1996 and 2003–2004, when in both cases the endowment effects of men and women constituted more than 100% of the expenditure gap. Therefore, if boys and girls were to have the same distribution across the controlled variables, the expenditure gap would be even higher, suggesting that, given prevailing conditions, socioeconomic status and other factors are more favorable in households incurring girls' expenditure compared to boys'. The Blinder–Oaxaca and Ñopo

[15]The distance needed to travel to attend school is an important impediment to educating girls. In developing societies, girls' safety is a crucial consideration. The United Nations Girls' Education Initiative (2014) has made reducing the distance to the nearest school an important component of its activities.

Table 9. **Decomposition Results Based on Quantile Regressions**

Log(exp)	**1995–1996**	**2003–2004**	**2010–2011**
Quantile 0.2			
Raw difference	−0.100	−0.084**	−0.306***
Endowment	0.027	−0.015	−0.070**
Coefficients	−0.127**	−0.069*	−0.235***
Quantile 0.4			
Raw difference	−0.045	−0.031	−0.228***
Endowment	0.029	−0.017	−0.088***
Coefficients	−0.075*	−0.014*	−0.140***
Quantile 0.6			
Raw difference	0.024	−0.024	−0.211***
Endowment	0.048	−0.019	−0.113***
Coefficients	−0.024	−0.004	−0.098***
Quantile 0.8			
Raw difference	0.063	−0.102**	−0.325***
Endowment	0.072	−0.062	−0.186***
Coefficients	−0.009	−0.040	−0.138***

Note: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Author's calculation based on NLSS Surveys.

methodologies both demonstrate the existence of widespread gender discrimination in household education expenditure, albeit to different degrees.

The results of the quantile decomposition reinforce the findings of the Blinder–Oaxaca decomposition method by using four quantiles (20th, 40th, 60th, and 80th percentiles) of education expenditure (see Table 9). While in NLSS I and II, there are significant differences in expenditure, large differences are observed in NLSS III. Among all four quantiles, education expenditure on girls was lower and significant in comparison with boys. Differences in expenditure were found to be the largest among the highest and the lowest spenders, and smallest among the 60th percentile. The ratio of unexplained to total differences fell among the higher quintiles, with the largest share of unexplained differences found in the poorest population segments.[16] The regressions suggest that, despite controlling for factors such as school enrollment (which already displays a significant source of discrimination in favor of boys), parents still choose to spend more on boys' education than on girls' education, which is clearly indicative of the differential

[16]In the lower quintiles, the participation of students in private schools is almost negligible, with only about 4% of boys and 3% of girls enrolled in private schools at these income levels. In the upper two quintiles, the participation ratio of boys in private schools is about 62% compared with 56% for girls. Therefore, while the unexplained differences are larger in poorer segments of the population, discrimination is also prevalent at higher income levels, primarily through the school selection process.

treatment of boys and girls in Nepalese households. Worryingly, this phenomenon is new and coincides with rising average costs of education in Nepal.

V. Conclusions

Discrimination in school participation has been widely reported in the literature as a major source of gender inequality in Nepal. Even with improving participation rates for girls at all grade levels, the inequality persists. This study has explored discrimination among school-going boys and girls by analyzing the expenditure behavior of their parents and found that boys are better represented in private schools and girls are better represented in public schools, which stands as the most important form of discrimination. This phenomenon is more pronounced in rural Nepal, although a noticeable difference in participation is observed in urban areas as well.

Through simple OLS regressions, the effects of various control variables on total education expenditure across two genders were investigated. The data substantiate the findings of existing literature, including Vogel and Korinek (2012), that parental expenditure patterns in education are discriminatory. My analysis finds that even after controlling for school type, parents spend as much as 20% less on girls compared with boys. The data show that differences in expenditure comprise unequal spending on private tuition, textbooks and supplies, and other education-related expenditure. The paper also found that while the mother's education is an important equalizer, household size and distance to the school disproportionately affect household expenditure on a girl's education.

The Blinder–Oaxaca decomposition method, the Ñopo decomposition method, and a decomposition based on quantile regressions were used to further investigate the level of gender discrimination in education expenditure. All three of these methods revealed a high level of discrimination in education expenditure in favor of boys among households in Nepal. At times, more than 60% of the difference in education expenditure between genders could be explained by such bias. Findings from the quantile decomposition show that discrimination has risen over time and that households in the lowest and highest quintiles of income were the ones most likely to discriminate between boys and girls. The latter result is counterintuitive and therefore should be a matter of further research. Another area for further research could be the impact of such differential treatment on the performance of children at schools.

The study finds sufficient evidence to conclude that discrimination in education expenditure is prevalent among Nepalese households. It also suggests that such discrimination might be on the rise. Therefore, it is imperative for the government to improve the quality of education at public schools to not only provide better quality education for girls, but also to encourage parents to review the decision-making processes in which they are more likely to send boys than girls to private schools. I also find that educating parents (especially mothers) and improving access to schools can potentially reduce unequal expenditure, albeit to a small extent. To the extent that unexplained differences (discrimination) still account for the largest share of differences in education expenditure, I conclude that parental choices are still largely governed by a patriarchal mindset within Nepalese society, even among families at the highest income levels. Therefore, the medium-term approach should be accompanied by a longer-term strategy of changing the perception of women's roles in Nepalese society so that household investment decisions are not biased against girls.

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Empowering Cities: Good for Growth? Evidence from the People's Republic of China

MEGHA MUKIM AND T. JUNI ZHU*

This paper utilizes a countrywide process of county-to-city upgrading in the 1990s to identify whether extending the powers of urban local governments leads to better firm outcomes. The paper hypothesizes that since local leaders in newly promoted cities have an incentive to utilize their new administrative remit to maximize gross domestic product and employment, there should be improvements in economic outcomes. In fact, aggregate firm-level outcomes do not necessarily improve after county-to-city graduation. However, state-owned enterprises perform better after graduation, with increased access to credit through state-owned banks as a possible explanation. Importantly, newly promoted cities with high capacity generally produce better aggregate firm outcomes compared with newly promoted cities with low capacity. The conclusions are twofold. First, relaxing credit constraints for firms could lead to large increases in their operations and employment. Second, increasing local government's administrative remit is not enough to lead to better firm and economic outcomes; local capacity is of paramount importance.

Keywords: capacity, credit allocation, decentralization, firm-level data, People's Republic of China, urbanization
JEL codes: G21, H81, L11, R11, R51

I. Introduction

To promote urbanization in the 1980s, the Government of the People's Republic of China (PRC) began upgrading the status of counties to that of county-level cities. This practice persisted until 1997. Counties were eligible to

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Table 1. **County to County-Level City Minimum Upgrading Requirements**

Population Density (person/km^2)		**>400**	**100–400**	**<100**
Percentage of counties in this category		25%	45%	30%
Industrialization level	Industrial output	CNY1.5 billon	CNY1.2 billion	CNY0.8 billion
	Share of industrial output value in gross value of industrial and agricultural output	80%	70%	60%
Population engaged in nonagricultural activities	Size of nonagricultural population	150,000	120,000	100,000
	Share of nonagricultural population in total population	30%	25%	20%
Fiscal strength	Fiscal revenues	CNY60 million	CNY50 million	CNY40 million
	Per capita fiscal revenues	CNY100	CNY80	CNY60

CNY = yuan, km^2 = square kilometer.

Source: Fan, Shenggen, Lixing Li, and Xiaobo Zhang. 2012. "Challenges of Creating Cities in China: Lessons from a Short-Lived County-to-City Upgrading Policy." *Journal of Comparative Economics* 40 (3): 476–91.

Table 2. **County to County-Level City Upgrades, 1994–1997**

Number of county-year observations by upgrading status and number of requirements satisfied					
Number of requirements satisfied	**Total**	**0**	**1**	**2**	**3**
Nonupgrading cases	6,401	4,583	1,317	465	36
Upgrading cases	99	24	30	39	6

Source: Fan, Shenggen, Lixing Li, and Xiaobo Zhang. 2012. "Challenges of Creating Cities in China: Lessons from a Short-Lived County-to-City Upgrading Policy." *Journal of Comparative Economics* 40 (3): 476–91.

graduate to county-level cities if they met certain minimum requirements (Ministry of Civil Affairs 1993). An English language version of this policy document can be found in Zhang and Zhao (1998). To become cities, counties needed to show that (i) their level of industrialization was above a certain threshold; (ii) the share of the population engaged in nonagricultural activities was above a certain threshold; and (iii) their fiscal status, as measured by total fiscal revenues and per capita fiscal revenues, was sound (Table 1).

In practice, these requirements were not strictly enforced, partly because of large regional disparities across the country, wherein even after accounting for factors such as population density, counties in the western PRC and inland regions had trouble meeting these requirements. Instead, it seems that the decision to upgrade a county to a county-level city was based on rates of economic growth as well as the central government's discretion (Li 2011). This led to a situation in which counties that did not meet any of the three requirements were upgraded, while some counties that met all three requirements were not (Table 2).

Table 3. **Select Benefits of Being a City**

Category	**Benefits**
Taxes and fees	• Cities enjoy a higher urban construction tax than counties (7% versus 5%). • Cities can collect surcharges levied on the issuing of motorcycle registration. • In Liaoning province, cities can receive CNY1 million–CNY2 million in additional subsidies each year after upgrading.
Land-related policies	• Cities generally convert more land to construction use and retain a larger share of revenues from land sales.
Administrative powers	• Cities have more authority over foreign trade and foreign exchange management. • Cities can establish branches of customs offices and large state-owned banks. • Cities can approve projects with a higher investment cap. • Cities have authority over police recruitment and vehicle administration. • After achieving the status of *shengji jihua dalie* (line item under province), cities report directly to the provincial administration to ask for investment projects.
Government size, rank and salary, reputation	• Cities can establish more branches of government and have a larger number of government employees. • In some cases, the bureaucratic rank and salary of officials is raised after upgrading. • Cities generally carry greater prestige and are more attractive to outside investors.

Source: Fan, Shenggen, Lixing Li, and Xiaobo Zhang. 2012. "Challenges of Creating Cities in China: Lessons from a Short-Lived County-to-City Upgrading Policy." *Journal of Comparative Economics* 40 (3): 476–91.

Graduation to city status came with a number of benefits relating to four main categories: (i) taxes and fees; (ii) land-related policies; (iii) administrative powers; and (iv) local government size, rank, salary, and reputation (Table 3).

In this paper, we investigate if newly promoted county-level cities in the PRC utilize these new powers to attract additional firms and help existing firms grow. We study macrolevel city outcomes and microlevel firm outcomes. We hypothesize that since local government officials want to achieve high gross domestic product (GDP) and employment growth, they have an incentive to utilize their new administrative remit to promote firm growth. Hence, we should observe better firm-level outcomes in the newly upgraded cities versus similar counties. We exploit the ad hoc nature in which the city upgrading takes place to identify the effect of an increase in city powers on firms' economic outcomes. The paper adds to the existing literature in two ways. First, it identifies whether and to what extent firm-level outcomes improve postupgrading; importantly, it attempts to identify the channels through which these outcomes take place. Second, this paper uses two proxies to measure local government capacity and documents the extent to which local government capacity matters for firm and job growth in the PRC. The rest of the paper is organized as follows. Section II describes the data sets and how these were prepared. Section III presents the empirical strategy used to identify the effects of city upgrading on firm outcomes. Section IV reports the econometric results for city-level outcomes and firm-level outcomes. Section V concludes.

II. Data Sets and Data Treatment

This paper utilizes two panel data sets, one at the level of counties and the other at the level of firms. We use variables for the period 1993–2004 from the annual series of the Public Finance Statistical Materials of Prefectures, Cities, and Counties published by the Ministry of Finance of the PRC to construct a county-level public finance data set. As of 1998, when the county-to-city upgrading policy came to an end, there were 99 counties that had been upgraded from county to county-level cities between 1994 and 1997.

The firm-level data set spans from 1998 to 2009 and was compiled from the Annual Survey of Industrial Firms (ASIF) collected by the National Bureau of Statistics of China. This data set is often referred to as the "CNY5-million data set" since it contains all state-owned enterprises (SOEs), regardless of sales volume, and non-SOEs with main operating revenues (sales) of more than CNY5 million. Thus, the ASIF survey data set tracks the performance of all SOEs and all large non-SOEs. The ASIF data set details all operational, financial, and managerial facts of firms in three broad categories—mining; manufacturing; and production and distribution of electricity, gas, and water—and classifies each firm to the level of 6-digit industries. This data set represents 89.5% of the total main operating revenues (sales) from all enterprises included in the PRC's 2004 Economic Census (Nie, Jiang, and Yang 2012).

The 1998–2009 ASIF data set covers a period when major structural reforms were under way in the PRC, including SOE reforms in the mid-to-late 1990s. Following the end of the county-to-city upgrading policy in 1997, the PRC carried out a major reform of SOEs between 1998 and 2000. The aim was to either privatize or close small and unprofitable SOEs (Song and Hsieh 2013). The PRC's 2004 Economic Census collected more detailed information on all firms regardless of size.[1] To mitigate some of the adverse effects of the SOE reforms, and since we are only interested in understanding the effects of county-to-city upgrading, we restrict our analysis to incumbents from 1998–2004, thereby excluding all firms entering or exiting the market during this period. We create a balanced panel of 36,778 firms located in 793 counties and 58 newly promoted county-level cities. Table 4 summarizes the breakdown of firms by ownership.

[1]For example, the breakdown of employment by education level, gender, and technical titles was collected (Brandt, Van Biesebroeck, and Zhang 2014).

Table 4. **Number of Firms by Ownership Type**

Firms	Number of Firms	Share of Total
SOE	15,413	42.1%
Non-SOEs (e.g., collective, private, mix)	21,183	57.9%
Total	36,596	100.0%

SOE = state-owned enterprise.
Source: Authors' compilation.

III. Empirical Strategy

To properly identify the effects of a change in city-level powers on economic outcomes, we need to control for selection bias. Simply put, if better-performing or better-managed counties were more likely to be upgraded to county-level cities, then a comparison of outcomes across counties and cities would be upwardly biased. Our aim is to evaluate the causal effect of city upgrading on economic outcomes.

We exploit the ad hoc nature of county-to-city upgrading to find an appropriate counterfactual. We do this by matching newly promoted cities with counties that are similar to these cities and would have been promoted if the upgrading requirements were properly applied. The counterfactual allows us to analyze how economic outcomes within a city would have evolved if it had not been upgraded to city status.

Propensity Score Matching

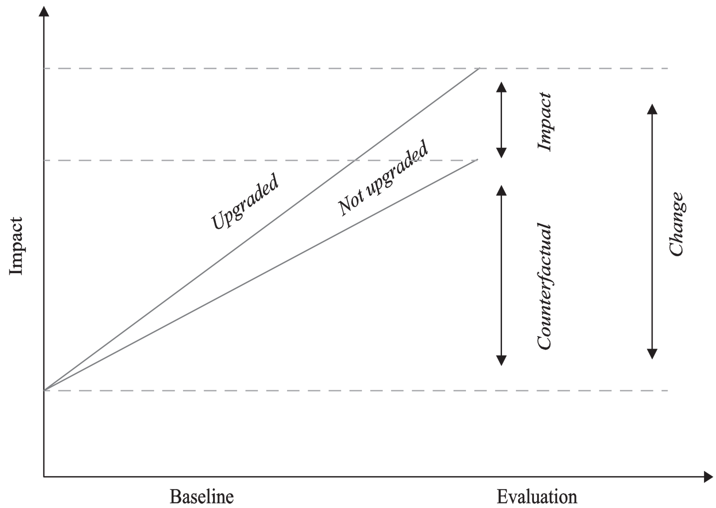
Assuming that a county is promoted to a county-level city at time $s = 0$, let ω_{is} be the economic outcome at time s (the outcome for county i at period s) following upgrading to city status at $s = 0$, while the variable $CITY_i$ takes on the value of 1 if county i becomes a city. The causal effect can be verified by looking at the difference, $(\omega_{is}^1 - \omega_{is}^0)$, where the superscript denotes the promotion. The crucial problem is that ω_{is}^0 is not observable. We follow the microeconometric evaluation literature (Heckman, Ichimura, and Todd 1997) and define the average effect of upgrading on economic outcomes as

$$E\left[\omega_{is}^1 - \omega_{is}^0 | CITY_i = 1\right] = E\left[\omega_{is}^1 | CITY_i = 1\right] - E\left[\omega_{is}^0 | CITY_i = 1\right] \tag{1}$$

The key difficulty is to identify a counterfactual for the last term in equation (1). This is the economic outcome that a city would have experienced, on average, had it not been promoted from a county to a city. What is primarily of interest is the magnitude of the impact in Figure 1, and the main problem is the calculation of the counterfactual that is to be deducted from the total change.

This counterfactual is estimated by the corresponding average value of counties that remain as counties and are not upgraded: $E[\omega_{is}^o | CITY_i = 0]$. An important feature of the construction of the counterfactual is the selection of a

Figure 1. **Identification of Impact of Upgrading to City Status**



Source: Authors' illustration.

valid comparison group. In order to identify this group, it is assumed that all the differences in economic outcomes, except those caused by upgrading, between cities and the appropriately selected county comparison group are captured by a vector of observables, including the pre-upgrade county economic outcomes. The intuition behind selecting the appropriate comparison group is to find a group that is as close as possible to the upgraded county in terms of its predicted probability to be upgraded.

Following Fan, Li, and Zhang (2012), we control for the selection bias by matching cities that were upgraded with similar counties that could have been upgraded but were not. Since the county-to-city upgrading policy came to an end in 1997, we use county-level variables from 1993 to 1997 to carry out the matching. We drop cities that were upgraded before 1994 since the public finance data only start from 1993. We carry out the matching exercise using observable county-level economic outcomes in 1994; we match cities (counties that will be promoted to county-level cities) with counties (counties that were not promoted to cities).

More formally, we apply the propensity score matching (PSM) method as proposed by Rosenbaum and Rubin (1984). This boils down to estimating a probit model with a dependent variable, equal to 1 if the county is upgraded and 0 otherwise, on lagged variables. The probability of being upgraded is modeled as follows. $CITY$ is a dummy variable that equals 1 if a county is upgraded. The probability of being promoted (the propensity score) can be represented as

$$\Pr(CITY_{i,1994} = 1) = F(x_{i,1993}) \qquad (2)$$

where *F*(.) is the normal cumulative distribution function. The *x* variables used in this exercise correspond to the three upgrading requirements mentioned in Table 1. Since these upgrading requirements were not strictly enforced, we used these upgrading requirements variables as a general indicator of the economic development level of a county in 1993 to predict the probability of a county being upgraded to a city in 1994.

We use the first and second moments of the three upgrading requirements as our specification to predict propensity scores. If they can pass the common support test, which is that the covariates in each stratified block are balanced, then we will use this specification to predict the effects of city upgrading by comparing outcomes between treatment (cities) and comparison (counties) groups (Rosenbaum and Rubin 1984). We find that there are no significant differences in covariates between counties and cities within each stratified block using this specification. Hence, we use this specification to estimate the city upgrading treatment effect on city-level and firm-level outcomes.

Since the public finance data set is a panel data set, we obtain one propensity score for each jurisdiction-year pair. Hence, each county or city will have multiple propensity scores. To mitigate the potential problem of counties inflating their economic figures right before the upgrading (Li 2011), we used the earliest data point possible from the public finance data set to conduct the matching exercise. Thus, a county or city's 1994 predicted propensity score is used to match a city with its similar county.

Li (2011) pointed out that the rate of economic growth is one of the key factors in determining which counties can be upgraded to cities. Therefore, in addition to variables corresponding to the three upgrading requirements, we should ideally include the growth rate of GDP as a control in predicting upgrading probability. However, GDP at the county level is only available starting in 1997 when there was a major change in statistical standards in the PRC. Before 1997, we have official statistics on gross value of industrial and agricultural output. We therefore include these variables in our PSM model as an alternative measure of economic development at the county level.[2]

The PSM method also assumes that there exists a region of common support where the treated and control propensity scores overlap and over which a robust comparison can be made. Cities that fall outside of the region of common support are disregarded and for these cities the treatment effect cannot be estimated. With matching, the proportion of such cities is small. Only two city-year observations using the specification that we described earlier fall into this case (Table 5). Since the region of common support is vastly improved and the balancing test is passed between the treatment and control groups, the estimated effect on the remaining

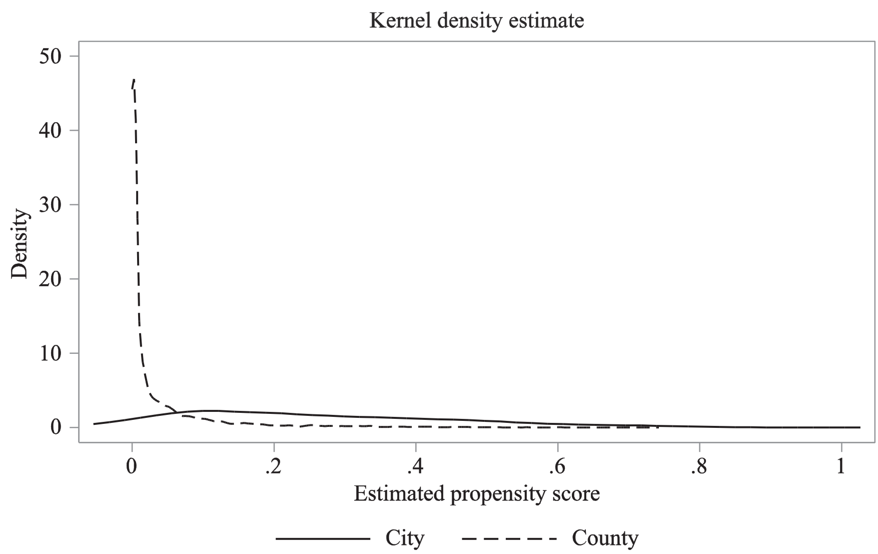
[2] Variables that can potentially have extreme values are transformed into logs to minimize distortions.

Table 5. **Matched Counties and Cities by Blocks of 1994 Propensity Scores**

Blocks of Propensity Scores	County (comparison)	City (treatment)	Total
0	2,953	1	2,954
0.003125	470	3	473
0.00625	501	4	505
0.0125	522	16	538
0.025	541	14	555
0.05	532	34	566
0.1	387	73	460
0.2	239	92	331
0.4	64	57	121
0.6	6	19	25
0.8	0	2	2
Total	6,215	315	6,530

Source: Authors' calculations.

Figure 2. **Kernel Density Distribution Comparison between Cities and Counties**



Source: Authors' calculations.

cities can be viewed as representative. Figure 2 presents a kernel density distribution comparison.

Identification of City-Level and Firm-Level Treatment Outcomes

We use the treatment and counterfactual groups to carry out two distinct exercises to identify the effect of city-level upgrading. First, we identify changes in city-level outcomes postupgrading. Fan, Li, and Zhang (2012) used a county and year fixed effects model to identify the postupgrading effect. We use a PSM

Table 6. **City-Level Outcome of City Upgrading Using Propensity Score Matching**

	PSM Model	**PSM + Fixed Effects**	**Fan, Li, and Zhang (2012)**
City-Level Govt. Activities Outcome			
Number of public employees	414.9000**	407.5000**	995***
Share of productive expenditure	−0.0058**	−0.0058**	−0.026***
Share of agriculture tax	−0.0586***	−0.0588***	−0.053***
Post-upgrade average GDP growth	−0.0007	−0.0008	-
Number of firm births	4.3710***	4.8440***	-
Log tax from business income	0.5150***	0.5170***	-
Controls	Block FE	Block FE Year FE	County FE Year FE

FE = fixed effects, GDP = gross domestic product, PSM = propensity score matching.
Notes:
1. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
2. The PSM model uses variables of the three upgrading requirements and their interactions to generate a propensity score.
Source: Authors' calculations.

model and compare our results with their findings. To identify city-level outcomes, we stratify the county-level data according to their propensity scores, compare outcomes between treatment and comparison groups within each block, and identify the average upgrading effect (Dehejia and Wahba 1999).[3]

Second, we identify changes in firm-level outcomes postupgrading. We compare the performance of firms located in cities versus the performance of firms located in matched counties. Ideally, we would have liked to use a difference-in-difference estimation in addition to the PSM; however, we are constrained by data limitations since firm-level data begin in 1998 after counties had already been upgraded. We try to minimize the selection bias problem by limiting the results to incumbents (firms that were already operating in 1997).[4] We also control for year fixed, industry fixed, and time-varying industry fixed effects in addition to the PSM method to compare the robustness of our firm-level outcomes.

IV. Econometric Results

City-Level Outcomes

Table 6 reports the city upgrading effects on city-level outcomes, especially government activities since the upgrading. Compared with the fixed-effects model of Fan, Li, and Zhang (2012), the PSM model, with or without year fixed effects,

[3] We considered weighting the samples to identify the average treatment effect. However, since there is not a consensus on which weighting method is the best in identifying the average treatment effect, we decided not to weight the samples, simply controlling for block and year fixed effects.

[4] This assumes that firms in counties and newly promoted counties were similar to one another prior to the upgrade.

Table 7. **Descriptive Statistics of Mean Aggregate Firm-Level Outcomes**

	All Firms	Firms in Cities	Firms in Counties	t-test
Firm-Level Outcome				
Log main operating revenues	9.462	9.866	9.380	0.487***
Log main operating cost	9.228	9.649	9.142	0.507***
Log main operating profit	7.330	7.624	7.270	0.355***
Log number of employees	5.153	5.300	5.123	0.177***
Log labor vocational	2.502	2.439	2.514	−0.075
Log wage per employee	8.792	8.871	8.776	0.095***
Log paid-in capital	8.349	8.425	8.334	0.091***
Log export output value	9.489	9.613	9.456	0.157***

Note: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
Source: Authors' calculations.

yields similar results. Thus, we confirm the findings in Fan, Li, and Zhang (2012) that government spending's share in productive activities, as defined by spending in construction and providing support to agricultural production, decreases following upgrading. The share of agricultural tax in total tax also falls, which is intuitive since cities begin to shift away from agricultural production postupgrading.

In addition, newly upgraded cities do not necessarily outperform similar counties in terms of rates of GDP growth in the post-upgrade period of 1998–2004. Similar to Fan, Li, and Zhang's (2012) fixed-effects model, findings using a PSM method suggest that at the county level, upgrading does not necessarily lead to higher growth.

We also try and identify the rate of new firm entrants in newly promoted counties compared to the counterfactual counties that were not promoted. We find that there is a significant difference between the two, suggesting that new firms favor cities to counties, even if the former were only recently promoted. Correspondingly, taxes from business income in cities increased more significantly than in their similar counties.

Firm-Level Outcomes

We are also keen to understand how upgrading to city status affects firm-level outcomes. Before we employ the PSM method to identify the upgrading effects on firms, Table 7 provides a summary of descriptive statistics between firms located in county-level cities versus firms located in counties. At first glance, firms located in newly upgraded cities seem to have significantly outperformed, on average, firms located in counties.

In the following sections, we report firm-level outcomes using the PSM method. City-level outcomes suggest that firms tend to favor cities over counties. To avoid the distortion of statistical results, we first restrict our firm sample to

Table 8. **Firm-Level Outcomes of City Upgrading Using Propensity Score Matching for Incumbents**

Incumbent Firms	**(1)**	**(2)**	**(3)**
Firm-Level Outcome			
Log main operating revenues	0.1260	0.1090	0.1090
Log main operating cost	0.1270	0.1080	0.1080
Log main operating profit	0.0673	0.0275	0.0275
Log number of employees	−0.0195	−0.0859	−0.0859
Log labor vocational	−0.0780	−0.0531	−0.0531
Log wage per employee	−0.0528	−0.0409	−0.0395
Log paid-in capital	−0.1160	−0.1170	−0.1170
Log export output value	−0.1020	−0.1180	−0.1260
Controls	Block FE	Block FE Industry FE Year FE	Block FE Industry × Year FE

FE = fixed effects.
Notes:
1. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
2. The firm-level results after propensity score matching control for block fixed effects where samples are stratified and compared against each other in each block.
3. Analysis is restricted to firms opened before 1997.
4. Vocational labor data are only available in 2004.
Source: Authors' calculations.

incumbents (firms that were established before 1997) and report their firm-level outcomes after the upgrade. To better understand the full extent of firm-level outcomes, we also look at new firms' performance and examine whether locating in cities improves their performance. Since there is an inherent selection bias when studying new entrants to cities versus counties, we also study the effect of city upgrading on incumbents.

Firm-Level Outcomes (Incumbents)

By matching county-level cities with similar counties using propensity scores, Table 8 shows that, at the aggregate level, firms located in upgraded cities do not necessarily perform better than firms located in similar counties. Standard errors are clustered at the county level. Although Fan, Li, and Zhang (2012) do not use firm-level data, our estimates for aggregate firm-level outcomes are in line with their findings that upgrading from county to county-level city does not necessarily generate better city-level economic performance and public service provision. Our results suggest that newly formed cities are not using their increased powers to help Chinese firms perform better.

To ensure that the above aggregate results are not sensitive to different matching methods, Table 9 reports the aggregate firm-level outcomes using three different matching methods commonly used in the propensity score literature. We used the same propensity scores generated above to conduct the matching. We can

Table 9. **Firm-Level Outcomes Using Different Propensity Score Matching Methods**

Incumbent Firms	Kernel	Local Linear Regression	5-Nearest Neighbor
Firm-Level Outcome			
Log main operating revenues	0.116***	0.340	0.457***
Log main operating cost	0.125***	0.378	0.552***
Log main operating profit	0.052	0.162	0.077
Log number of employees	−0.027	−0.096	−0.308***
Log labor vocational	−0.108	−0.114	−0.206
Log wage per employee	−0.064***	0.085	0.206***
Log paid-in capital	−0.158***	−0.214	−0.452***
Log export output value	−0.062	0.206	0.359

Notes:
1. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
2. Average treatment on treated effects are reported; that is, upgraded cities and their counterfactual counties are compared to obtain the upgrading effects.
Source: Authors' calculations.

see that compared with Table 8, similar conclusions can be reached. Upgrading counties into county-level cities alone has very limited effect on aggregate firm-level outcomes in terms of firm profits, exports, and employment.

Are There Winners and Losers?

Next, we try and disaggregate this result using data on firm ownership. In Table 10, firms are classified as either an SOE or other, which includes collectives, private firms, and firms with mixed ownership. We are interested in understanding if SOEs outperform their non-SOE counterparts after upgrading to city status. We find that although the aggregate results across all firms suggest that cities are not using their powers to help firms, it turns out that SOEs in newly upgraded cities do significantly better than non-SOEs when compared to those in matched counties. SOEs sell more and employ more (skilled) labor, although they are no more profitable.

Why Do SOEs Outperform Their Private Counterparts?

In this subsection, we try to solve the puzzle of why SOEs gain disproportionately from city upgrading compared with other types of firms. Going back to Table 3, one of the main benefits of city upgrading is that a city can establish branches of state-owned banks. According to Wei and Wang (1997), bank loans made from state-owned banks clearly favor SOEs. In the 1990s, many state-owned banks imposed softer budget constraints on SOEs than in the 1980s, such that bank finance and firm productivity were no longer linked (Cull and Xu 2000). In other

Table 10. **Firm-Level Outcomes of City Upgrading by Ownership Type Using Propensity Score Matching for Incumbents**

Incumbent Firms	Log Main Operating Revenues	Log Main Operating Cost	Log Main Operating Profit	Log Number of Employees	Log Labor Vocational	Log Wage per Employee	Log Export
City	−0.0828	−0.0827	−0.118	−0.268***	−0.241**	−0.0776	−0.160
	(0.106)	(0.106)	(0.125)	(0.0812)	(0.0978)	(0.0519)	(0.233)
SOE	−0.911***	−0.908***	−0.573***	−0.0435	−0.00604	−0.293***	−0.630***
	(0.0720)	(0.0730)	(0.0740)	(0.0559)	(0.0713)	(0.0326)	(0.157)
City × SOE	**0.305****	**0.304****	**0.249**	**0.390*****	**0.404*****	**0.0584**	**0.332**
	(0.150)	(0.151)	(0.163)	(0.102)	(0.143)	(0.0552)	(0.368)
Constant	11.10***	10.64***	9.303***	6.038***	2.724***	8.623***	9.259***
	(0.600)	(0.576)	(0.690)	(0.256)	(0.149)	(0.563)	(0.469)
Observations	32,517	32,428	21,283	18,193	3,892	17,496	4,759
R^2	0.296	0.304	0.186	0.203	0.169	0.197	0.152
Block FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

FE = fixed effects, SOE = state-owned enterprise.
Notes:
1. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
2. Standard errors are in parentheses and clustered at the county level.
3. Analysis is restricted to firms opened before 1997.
4. Vocational labor data are only available in 2004.
Sources: Authors' calculations.

words, the literature provides evidence of favorable lending from state-owned banks to SOEs.

We go back to firm-level data and examine whether SOEs receive more credit from state-owned banks than other firms. Ideally, we would like to identify the source of the increase in credit to SOEs; however, the data do not provide a breakdown of the sources of debt financing. Instead, we use current debt and total debt as proxies to measure credit from state-owned banks and assume that most of the debt financing in counties and county-level cities comes from state-owned banks. This assumption is not without foundation. The fact that the establishment of state-owned banks is one of the major benefits associated with city upgrading indicates that commercial banks and other credit channels are very limited at the county level in the PRC.

In Table 11, the first two columns show that compared with non-SOEs, SOEs located in cities saw a big increase in both current debt and total debt following an upgrade. This suggests that part of the SOE performance differential observed in Table 10 could be explained by improved postupgrading access to credit among SOEs when compared to non-SOEs.

As a robustness check of this possible channel, we compare the debt profile of negative-profit SOEs in cities versus counties. Our hypothesis is that if underperforming SOEs can access credit more easily than underperforming

Table 11. **Debt Financing of Incumbent State-Owned Enterprises**

	Full Sample		Negative Profit SOEs Only	
Incumbent Firms	**Log Current Debt**	**Log Total Debt**	**Log Current Debt**	**Log Total Debt**
City	−0.273*	−0.207	0.442	0.421
	(0.147)	(0.142)	(0.276)	(0.280)
SOE	0.261***	0.248***		
	(0.0819)	(0.0801)		
City × SOE	**0.356****	**0.341***		
	(0.172)	(0.174)		
Constant	10.49***	10.77***	9.706***	10.10***
	(0.529)	(0.513)	(0.255)	(0.277)
Observations	32,240	32,732	1,494	1,515
R^2	0.201	0.188	0.388	0.350
Block FE	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes

FE = fixed effects, SOE = state-owned enterprise.
Notes:
1. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
2. Standard errors are in parentheses and clustered at the county level.
3. Analysis is restricted to firms opened before 1997.
Source: Authors' calculations.

non-SOEs, then the debt is probably being financed by state-owned banks that have branches in cities since commercial banks or other lending agents would not lend to these underperforming firms. The last two columns of Table 11 report this result. Although the coefficient is positive for cities, it is not significant even if its p-value is not far from 0.1.

There is a vast literature showing how firms in developing countries are more likely to report limited access to finance as a major obstacle to their growth, especially for small firms (Bloom et al. 2010). Results from randomized control trials giving credit to small and medium-sized enterprises in Sri Lanka (de Mel, McKenzie, and Woodruff 2008) and India (Banerjee and Duflo 2014) illustrate that access to credit is indeed a big problem for disadvantaged firms in developing countries.

There is also cross-country evidence showing that if banks are concentrated, with a relatively large share being government-owned banks, then financing obstacles will increase and the likelihood of smaller firms being able to access credit will decrease (Beck, Demirgüç-Kunt, and Maksimovic 2004). With the new micro firm-level data from the PRC, it seems the argument is even stronger that, compared with SOEs, even large non-SOEs are disadvantaged in accessing credit at the county level.

Does Capacity Matter?

Even though the city-level outcomes do not show that cities with an enlarged scope of power outperform their similar counties, we are worried that the reason we observe this result is because city governments do not have the capacity to carry out these new powers and not because the new powers themselves are not useful. In urban governance literature, the powers of a city government for managing economic development depend on factors not only of operational scope, but capacity as well (Davey 1993). Therefore, we want to test whether newly promoted cities with expanded capacity help firms perform better. Regional disparities in human capital are vast in the PRC and we include province fixed effects to partly offset this regional difference when evaluating firm-level outcomes, in addition to the time and industry fixed effects we have controlled for.

Since there is not a unified measure of city capacity, we propose using two proxies to measure capacity to conduct this analysis due to data limitation and availability. We propose using the percentage of public employees supported by public finance out of the total city population as a measure of city capacity. Adequate and institutionalized human capital is often cited as one of the key factors in determining city capacity (World Bank 2009). A recent paper by Acemoglu, García-Jimeno, and Robinson (2014) also used a similar measure of capacity: the number of municipality-level bureaucrats excluding police officers, judges, all other judicial employees, and public hospital employees.

Alternatively, we propose using total tax revenues, excluding land sales revenues, as a share of total city GDP as a proxy of city capacity.[5] Fukuyama (2013) proposed using tax revenues as a share of GDP as a proxy for state capacity since the ability to extract tax not only indicates a government's capability, but also means the government has revenues to carry out public functions; hence, tax extraction can be a good proxy for capacity.[6]

From previous results, we have shown that at the aggregate firm level, simply being located in a newly promoted city does not help firms perform better. However, Table 12, which takes into account capacity as measured by more institutionalized human capital available to public services, shows that firms located in newly promoted cities with strengthened capacity perform better in terms of sales, profits, and employee wages.

Table 10 showed that SOEs located in newly promoted cities outperform non-SOEs. However, once we account for city capacity, this result no longer holds (Table 13). This might suggest that cities with more power but less capacity are more likely to exploit their extra power to favor certain types of firms such as SOEs.

We rerun the above exercise using another proxy for city capacity: total tax collection as a proportion of city GDP. We find similar results in that only cities

[5] The two proxies of city capacity are by no means perfect. In an ideal world, the proper understanding and measurement of capacity would require a combination of quantitative proxies supplemented by qualitative data.

[6] We are interested in whether city upgrading itself leads to a jump in capacity postupgrading. Plotting the two proxies during the period 1996–2004 shows us that city capacity does not change much after an upgrade. Therefore, we are essentially comparing cities with different initial capacity levels here and reporting how capacity matters.

Table 12. **Firm-Level Outcomes of City Upgrading and City Capacity for Incumbents**

Incumbent Firms	**Log Main Operating Revenues**	**Log Main Operating Cost**	**Log Main Operating Profit**	**Log Number of Employees**	**Log Labor Vocational**	**Log Wage per Employee**	**Log Export**
City	−1.210**	−1.216**	−1.311**	−0.580	−0.252	−0.452*	−0.348
	(0.504)	(0.501)	(0.537)	(0.390)	(0.357)	(0.262)	(0.925)
Capacity	−21.560***	−22.010***	−17.690***	−14.790***	−15.430***	−0.127	−7.195
	(4.616)	(4.775)	(4.695)	(3.426)	(4.028)	(1.640)	(12.580)
City × Capacity	**46.610****	**46.650****	**49.130****	**18.570**	**8.353**	**17.370***	**8.777**
	(20.330)	(20.120)	(21.800)	(15.020)	(13.860)	(10.380)	(37.080)
Constant	11.850***	11.430***	10.120***	6.673***	3.117***	8.353***	9.227***
	(0.672)	(0.658)	(0.752)	(0.385)	(0.219)	(0.509)	(0.990)
Observations	32,517	32,428	21,283	18,193	3,892	17,496	4,759
R^2	0.330	0.336	0.228	0.245	0.221	0.251	0.179
Block FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

FE = fixed effects.
Notes:
1. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
2. Standard errors are in parentheses and clustered at the county level.
3. Analysis is restricted to firms opened before 1997.
4. Vocational labor data are only available in 2004.
Source: Authors' calculations.

with both the scope and capacity to carry out their additional remit are able to help firms grow and increase employee wages (Table 14).

Similarly, SOEs are less likely to outperform private firms in cities with relatively more capacity when an alternative measure of city capacity is used.

Tax collection represents only a subset of total revenues that are available to a local government in the PRC. Land sales and transfers from the central government are also major sources of revenues. As a robustness test, we use total government spending as a proportion of city GDP as a proxy to measure the extent to which public services are being delivered using public funding. We obtain similar results: firms in high-capacity cities tend to create more jobs, especially skilled labor jobs, and SOEs are less likely to outperform private firms in these cities (Table 15).

Firm-Level Outcomes (New Entrants)

We have shown that for incumbent firms, city status does not necessarily lead to better aggregate firm-level outcomes, unless this newfound status is accompanied by commensurate capacity. Now, we study new firms that are established in newly upgraded cities. Counties tend to attract more firms after they upgrade to cities. We examine whether these new firms also outperform new firms located in similar

Table 13. **Reexamining Incumbent SOE Outcomes while Accounting for City Capacity**

Incumbent Firms	**Log Main Operating Revenues**	**Log Main Operating Cost**	**Log Main Operating Profit**	**Log Number of Employees**	**Log Labor Vocational**	**Log Wage per Employee**	**Log Export**
City	−0.704	−0.685	−0.848	−0.255	−0.208	−0.209	0.0498
	(0.760)	(0.767)	(0.906)	(0.443)	(0.444)	(0.294)	(1.045)
Capacity	−4.061	−5.576	4.035	8.095	−2.814	0.945	−5.989
	(6.818)	(7.159)	(8.218)	(5.278)	(6.852)	(3.019)	(13.560)
SOE	−0.176	−0.206	0.263	0.721***	0.425**	−0.201**	−0.772
	(0.218)	(0.226)	(0.242)	(0.172)	(0.213)	(0.0874)	(0.565)
City × Capacity	23.630	22.640	29.110	−0.644	−0.324	8.319	−7.217
	(31.100)	(31.280)	(36.520)	(16.480)	(17.690)	(11.620)	(42.600)
Capacity × SOE	−19.840***	−18.570**	−25.010***	−26.820***	−15.12**	−1.173	10.270
	(7.134)	(7.401)	(8.443)	(5.719)	(6.890)	(2.958)	(20.070)
City × SOE	−0.649	−0.721	−0.521	−0.138	0.173	−0.508	−1.901
	(1.010)	(0.996)	(1.232)	(0.640)	(0.783)	(0.334)	(2.101)
City × Capacity × SOE	**30.700**	**33.600**	**22.800**	**17.640**	**6.978**	**18.520**	**80.490**
	(39.360)	(38.630)	(47.660)	(24.260)	(30.54)	(12.77)	(80.460)
Constant	12.090***	11.700***	9.979***	6.097***	2.671***	8.573***	9.736***
	(0.676)	(0.667)	(0.760)	(0.442)	(0.265)	(0.520)	(0.873)
Observations	32,517	32,428	21,283	18,193	3,892	17,496	4,759
R^2	0.351	0.356	0.236	0.252	0.225	0.264	0.190
Block FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

FE = fixed effects, SOE = state-owned enterprise.
Notes:
1. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
2. Standard errors are in parentheses and clustered at county level.
3. Analysis is restricted to firms opened before 1997.
4. Vocational labor data are only available in 2004.
Source: Authors' calculations.

counties. Admittedly, this exercise is fraught with selection bias. However, we remain interested in knowing if new firms in cities outperform new firms in similar counties, especially since this finding has policy implications. Cities care about better economic outcomes, which could be generated by a better performance by incumbents or by better-performing entrants.

New firms in cities tend to operate on a larger scale than new firms in counties in terms of operating revenues (sales) and operating costs (Table 16). However, they are not necessarily more profitable nor do they generate more or better-paying jobs. Thus, city status does not necessarily attract better, more competitive firms to locate in the city postupgrading. We also tried to break down new firms located in high-capacity cities versus low-capacity cities and see whether there is a difference. Unfortunately, we do not have enough data on entrants to carry out a robustness test.

Table 14. **Firm-Level Outcomes of City Upgrading and City Capacity for Incumbents Using an Alternative Measure of Capacity**

Incumbent Firms	Log Main Operating Revenues	Log Main Operating Cost	Log Main Operating Profit	Log Number of Employees	Log Labor Vocational	Log Wage per Employee	Log Export
City	−0.606**	−0.560*	−0.642***	−0.457**	−0.496	−0.340***	−0.734
	(0.301)	(0.306)	(0.234)	(0.228)	(0.302)	(0.114)	(0.530)
Capacity	−0.00236	−0.00171	0.00730	0.00318	−0.00427	0.000172	−0.0136
	(0.00674)	(0.00672)	(0.00841)	(0.00387)	(0.00519)	(0.00173)	(0.00899)
City × Capacity	**16.22***	**14.70**	**16.29****	**9.629**	**12.46**	**9.621*****	**16.91**
	(8.977)	(9.032)	(7.336)	(6.678)	(8.363)	(3.185)	(16.13)
Constant	11.07***	10.64***	9.474***	6.081***	2.779***	8.356***	8.822***
	(0.682)	(0.658)	(0.776)	(0.201)	(0.190)	(0.504)	(0.917)
Observations	32,517	32,428	21,283	18,193	3,892	17,496	4,759
R^2	0.325	0.330	0.225	0.240	0.218	0.252	0.180
Block FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

FE = fixed effects.
Notes:
1. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
2. Standard errors are in parentheses and clustered at county level.
3. Analysis is restricted to firms opened before 1997.
4. Vocational labor data are only available in 2004.
Source: Authors' calculations.

V. Conclusion

This paper utilizes a countrywide county-to-city upgrade in the 1990s in the PRC to explore whether expanding a city's power leads to better firm performance. When counties are upgraded to cities, their remit expands and they gain additional administrative and fiscal powers. A postupgrading increase in power should provide these former counties with the ability to provide greater support to or, at a minimum, a better business environment for, firms, thereby helping to ensure more growth and employment.

Unfortunately, in this paper we find that this is not always the case. Increasing the policy space controlled by a city does not necessarily translate into better city and firm performance. This does not suggest that cities could not utilize their new powers effectively; indeed, we find evidence that certain types of firms, SOEs, begin to outperform their non-SOE counterparts as soon as their credit constraints are relaxed. Newly established state-owned banks within cities might help explain better access to credit for SOEs, leading to higher levels of employment and increased sales among SOEs. This suggests that if access to finance were a market-based decision, then the gains from the city-upgrading policy could be expanded to all firms rather than just SOEs.

Table 15. **Incumbent State-Owned Enterprise Outcomes of City Upgrading (with an alternative measure of capacity)**

Incumbent Firms	Log Main Operating Revenues	Log Main Operating Cost	Log Main Operating Profit	Log Number of Employees	Log Labor Vocational	Log Wage per Employee	Log Export
City	−0.298	−0.251	−0.302	−0.512**	−0.418	−0.338**	−0.515
	(0.340)	(0.339)	(0.412)	(0.236)	(0.284)	(0.147)	(0.687)
Capacity	0.00895**	0.00875*	0.0241***	0.00706***	0.00505	0.00402	−0.0114
	(0.00401)	(0.00446)	(0.00579)	(0.00252)	(0.00508)	(0.00701)	(0.00845)
SOE	−0.708***	−0.706***	−0.394***	0.00481	0.0168	−0.230***	−0.501***
	(0.0689)	(0.0709)	(0.0699)	(0.0535)	(0.0709)	(0.0261)	(0.156)
City × Capacity	4.205 (11.15)	2.606 (11.06)	4.621 (13.31)	6.125 (6.679)	4.677 (8.124)	10.16** (4.378)	10.44 (21.20)
Capacity × SOE	−0.0148*** (0.00379)	−0.0137*** (0.00343)	−0.0215*** (0.00309)	−0.00400 (0.00243)	−0.0105 (0.0107)	−0.00508 (0.00826)	−0.0159*** (0.00380)
City × SOE	−0.340	−0.339	−0.448	0.222	−0.0435	0.00244	−0.0611
	(0.410)	(0.403)	(0.555)	(0.317)	(0.413)	(0.174)	(1.158)
City × Capacity × SOE	**16.10** (12.48)	**16.16** (12.15)	**16.56** (16.50)	**4.236** (9.334)	**13.08** (12.06)	**−1.310** (4.969)	**5.910** (31.68)
Constant	11.74***	11.30***	9.851***	6.061***	2.650***	8.602***	9.209***
	(0.666)	(0.643)	(0.766)	(0.206)	(0.195)	(0.513)	(0.944)
Observations	32,517	32,428	21,283	18,193	3,892	17,496	4,759
R^2	0.346	0.350	0.231	0.243	0.221	0.264	0.189
Block FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

FE = fixed effects.
Notes:
1. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
2. Standard errors are in parentheses and clustered at county level.
3. Analysis is restricted to firms opened before 1997.
4. Vocational labor data are only available in 2004.
Source: Authors' calculations.

We also examine the effects of an increased "city wedge" and take into account not just increased powers, but also city capacity.[7] Governance literature shows that in order for a government to manage its economic development goals, both its operational scope and capacity matter. Therefore, granting additional powers to newly promoted cities does not necessarily translate into better economic performance unless these cities also have the capacity to utilize the additional remit and benefits. We measure city capacity by local government's human capital level as well as tax extraction ability. We find that incumbent firms located in newly promoted cities with high capacity tend to outperform firms in similar counties. Interestingly, SOEs in cities with high capacity do not necessarily outperform

[7]The "city wedge" refers to the range of policies that city leaders can hope to influence, including those that are predetermined by higher levels of government. City leaders and governments can manage growth effectively only if they have the functional mandate, revenue base, and capabilities to target local economic development.

Table 16. **Firm-Level Outcomes of City Upgrading Using Propensity Score Matching for New Firms**

New Firms	**(1)**	**(2)**	**(3)**
Firm-Level Outcome			
Log main operating revenue	0.297	0.344*	0.344*
Log main operating cost	0.378*	0.423**	0.427**
Log main operating profit	0.0845	0.294	0.322
Log number of employees	0.113	0.154	0.140
Log wage per employee	−0.0004	−0.0564	−0.0572
Log paid-in capital	−0.111	−0.0189	−0.0180
Controls	Block FE	Block FE Industry FE Year FE	Block FE Industry × Year FE

FE = fixed effects.
Notes:
1. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.
2. There are not enough observations for new firms' vocational labor data and export value data. To avoid using an underrepresentative sample and generalizing results from comparing between new firms located in only a few cities and counties, we do not report the results of these two firm-level outcomes.
3. Analysis is restricted to new firms opened after 1997, which is after the upgrading was finished.
Source: Authors' calculations.

non-SOEs, indicating that low-capacity cities are more likely to abuse their additional remit to favor certain groups of firms.

The World Bank Group and other development institutions are increasingly dealing with subnational governments to improve economic outcomes. In addition, many developing countries have devolved powers to subnational regions. However, there is a lack of evidence about how changing the powers available to local government policy makers relates to economic outcomes. This paper attempts to address this gap and provide some rigorous evidence in support of administrative decentralization accompanied by commensurate increases in capacity.

Governments are making employment their main priority, and job creation, both in modern sectors and in the informal sector, is overwhelmingly urban. This paper adds to the empirical evidence linking the ability of city governments to implement proactive policies to actual economic outcomes. It sheds light on how and under what conditions city leaders can utilize the policy instruments at their disposal to actively target firm growth and job creation in cities. The lessons learned in the PRC point overwhelmingly to the importance of local government capacity. To be an effective strategy for economic development, decentralization should be accompanied by large and commensurate increases in capacity.

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Assessing Fiscal Risks in Bangladesh

Leandro Medina*

This paper identifies, quantifies, and assesses fiscal risks in Bangladesh. By performing sensitivity analysis and using stochastic simulations, it measures risks arising from shocks to gross domestic product growth, the exchange rate, commodity prices, and interest rates. It also analyzes specific fiscal and institutional risks, including those related to the pension system, issuance of guarantees, state-owned commercial banks, and external borrowing and debt management strategies. The paper finds that fiscal aggregates are particularly sensitive to shocks to commodity prices and the exchange rate. Other factors that could affect fiscal aggregates are the unfunded pension system and limited institutional capacity.

Keywords: Bangladesh, commodity prices, contingent liabilities, exchange rate, fiscal risks, guarantees, pensions, sovereign debt
JEL codes: E62, H63, H68

I. Introduction

Fiscal risks are factors, often outside a government's control, that can lead to fiscal aggregates differing from forecasts. As noted in Cebotari et al. (2009), these differences can be large and may result from a variety of shocks such as deviations of macroeconomic variables from expectations (e.g., shocks to economic growth, interest rates, the exchange rate, and terms of trade); natural disasters; calls on government guarantees; and institutional weaknesses. The 2008–2009 global financial crisis and its aftermath illustrated that the materialization of fiscal risks can lead to significant fiscal liabilities.

These risks are likely to continue to be a root of tension for economies in all income groups, and their size, timing, and nature will have substantive implications for policy making, particularly in low-income economies, which tend to have less degrees of freedom in terms of policy buffers (IMF 2016).

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Even though most South Asian economies are commodity importers (particularly oil) and have underdeveloped and/or unfunded pension systems and weak state-owned enterprises, there has been limited progress in analyzing, assessing, and managing fiscal risks in these economies.

In the case of Bangladesh, which is a commodity-importing economy with an unfunded pension system, weak state-owned enterprises and state-owned banks, and a substantive amount of sovereign guarantees issued in recent years, such an assessment is extremely valuable as it would not only quantify the fiscal risks facing Bangladesh and therefore help authorities hedge against those risks, but also set the tone for other South Asian economies facing similar risks.

This paper intends to help close this gap by assessing fiscal risks in Bangladesh following both analytical and descriptive approaches. First, it identifies the different sources of fiscal risks in Bangladesh. Second, using analytical methodologies, it assesses the sensitivity of the fiscal balance and public debt to macroeconomic shocks and conducts stochastic analyses of the impacts of such shocks on the public debt-to-gross domestic product (GDP) ratio. Third, it evaluates the impact of specific sources of fiscal risks such as those originating from contingent liabilities and the pension system. Finally, it assesses risks that emerge from the government's institutional capacity limitations, including budget forecasting errors, external debt management, and data discrepancies. Based on this analysis, the paper also proposes measures to mitigate some of the most severe risks that Bangladesh faces.

Results suggest that in Bangladesh a variety of factors may cause fiscal outturns to diverge from forecasts. The fiscal balance is particularly sensitive to shocks to macroeconomic variables such as commodity prices and the exchange rate. Additionally, specific factors, such as calls on government guarantees or the recapitalization of state-owned banks, could negatively impact fiscal aggregates. Results also highlight the impact of risks derived from the unfunded pension system and limited institutional capacities.

The paper draws on two strands of the literature covering fiscal risks and debt sustainability. Regarding the former, the results are consistent with Cebotari et al. (2009) who, building on experience from different economies, conclude that macroeconomic shocks and calls on contingent liabilities often have major implications for fiscal sustainability. In addition, Hemming (2006) assesses the impact of guarantees and other instruments on debt, arguing that greater use should be made of scenario analysis to stress test debt projections under alternative assumptions about calls on guarantees.

This paper also builds on the extensive literature on debt sustainability and its determinants (see, for example Chalk and Hemming 2000; Gali and Perotti 2003; Wyplosz 2005; Celasun, Debrun, and Ostry 2006). When debt rises, in particular external debt, beyond certain thresholds, an economy's fiscal balance becomes more vulnerable to shocks, leading in extreme cases to a debt crisis as explained by Obstfeld and Rogoff (1996). Celasun, Debrun, and Ostry (2006) study debt sustainability in emerging economies and find that an explicit quantification of risks could help in designing consolidation strategies. Furthermore, debt sustainability is of particular relevance for low-income economies, given that they generally have high levels of vulnerability to exogenous shocks, suffer from political instability and weak institutions, and their debt structure is usually denominated in foreign currency.

The rest of the paper is organized as follows. Section II presents the main classifications for analyzing fiscal risks. Section III assesses the impacts of macroeconomic risks by quantifying budget sensitivity to different shocks and conducting stochastic analyses (fan charts) for the path of public debt. Section IV and section V deal with different contingent and policy-specific risks facing Bangladesh. Section VI discusses policy implications and section VII concludes.

II. Classification of Fiscal Risks

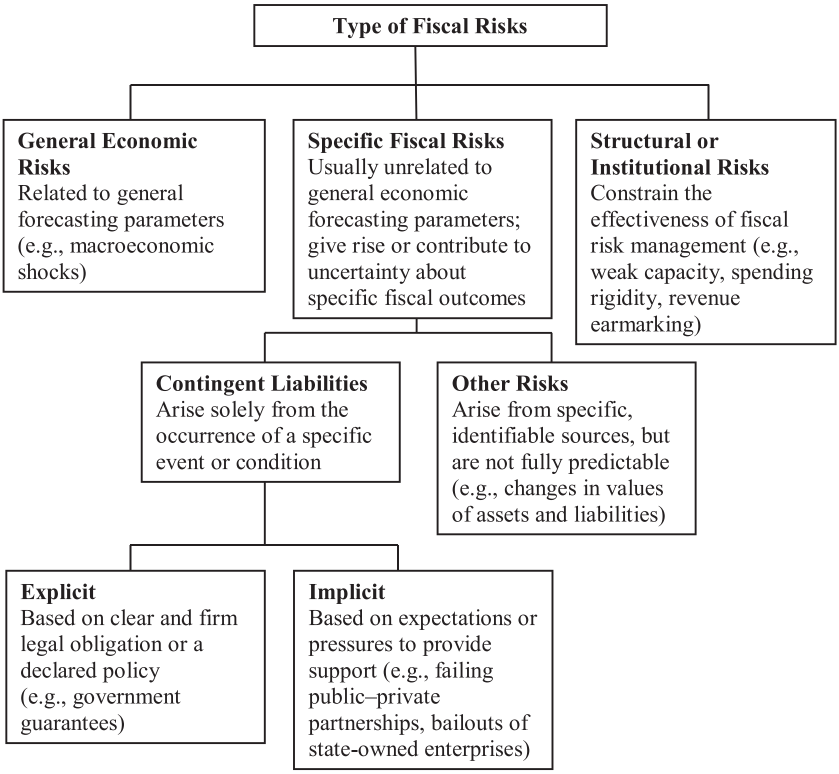
As mentioned above, fiscal risks are factors that may cause fiscal outcomes to deviate from expectations. These can result from a variety of shocks such as deviations of macroeconomic variables from projections, natural disasters, calls on government guarantees, and institutional weaknesses. It is helpful to organize fiscal risks in a manner that differentiates between (i) general economic risks such as those arising from shocks to macroeconomic variables (e.g., commodity prices, GDP growth, exchange rates); (ii) specific fiscal risks, mainly from contingent liabilities, whether explicit or implicit; and (iii) structural or institutional risks, such as weak institutional capacity and spending rigidity (Budina and Petrie 2013). These risks are then assessed based on their impacts on the budget and debt stock (Figure 1).

General economic risks operate through a variety of channels such as shocks to GDP growth, inflation, the exchange rate, interest rates, and commodity prices. These shocks affect expenditure (e.g., through the subsidy bill), revenue, and consequently the stock and dynamics of public debt.

Realizations of contingent liabilities (that is, obligations triggered by an uncertain event), can also create substantial fiscal risks. A contingent liability can be explicit or implicit. In the first case the conditions are clearly stipulated in policies or legal obligations, while in the second case the obligation arises from the expectation that the government will provide support should a particular event occur.[1] Fiscal risk analysis has traditionally focused on explicit contingent liabilities arising from the contractual or legal obligations of the government. However, noncontractual commitments are also critical for fiscal sustainability (Cottarelli 2014), particularly those emanating from the financial sector. A feature of implicit contingent liabilities

[1]For an analysis of the fiscal implications of contingent liabilities, see Brixi and Schick (2002), Irwin (2003), and Hemming (2006).

Figure 1. **Types of Fiscal Risks**



Source: Author's compilation.

is that their hidden and/or uncertain nature can tempt governments to avoid dealing with them in a timely fashion. However, this may exacerbate the problem when they are eventually realized as the size of the liabilities may have grown in the interim.

Structural or institutional weaknesses can also create policy risks and constrain the effectiveness of fiscal risk management. Coordination problems between different levels of government can impede the government's ability to implement the desired fiscal policy or hamper its ability to respond to shocks. Limited capacity to identify and manage fiscal risks can exacerbate an economy's exposure to existing fiscal risks. When policy makers lack good information, fiscal management becomes more difficult, increasing the likelihood of policy errors. As noted by Budina and Petrie (2013), this situation can be compounded if the institutions and actors responsible for specific risk management functions are not clearly identified, if those responsible lack the necessary authority, or if budgeting systems undermine effective management.

The benchmarks of fiscal risk magnitude vary with the risk and the government, as well as the macroeconomic situation and buffers. Some of these risks are related to an unfunded pension system in an economy with a growing population, while others have to do with increasing the amount of sovereign guarantees in foreign currency or with weak state-owned enterprises.

It is important to be able to disclose, analyze, and assess these fiscal risks. The benchmark will change from economy to economy, though it is very difficult to propose a threshold above which fiscal risks are high. Based on historical evidence, IMF (2016) aimed at addressing this issue by performing a battery of tests.

The framework outlined above will guide the identification of fiscal risks in Bangladesh in this paper.

III. Quantitative Macro-Fiscal Sensitivity and Debt Dynamics

Macroeconomic shocks (e.g., shocks to GDP growth, commodity prices, and interest rates) can be a source of significant risk to a government's budget at a given point in time as well as to the evolution of public debt. This section assesses the sensitivity of Bangladesh's fiscal balance and public debt to macroeconomic shocks, and conducts stochastic analysis of the impacts of such shocks on the public debt-to-GDP ratio.[2]

A. Sensitivity Analysis

Bangladesh's fiscal aggregates are sensitive to variations in macroeconomic variables, including commodity prices, the exchange rate, interest rates, and GDP growth. Shocks to these variables impact fiscal performance and some of these variables have been particularly volatile in the past few years.

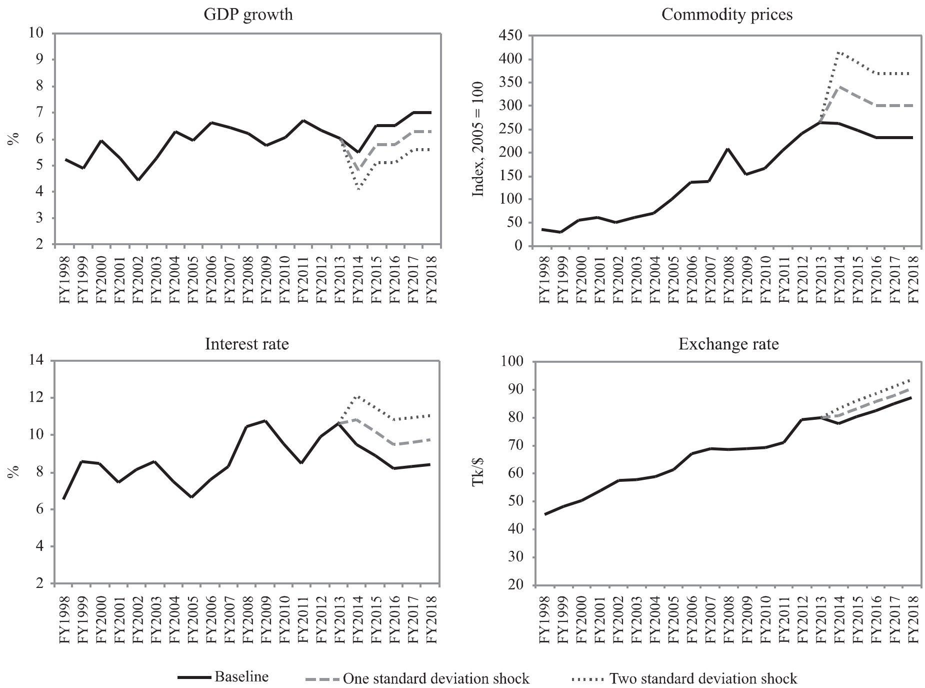
This section examines the impacts on fiscal outcomes of changes in the forecast values of key variables.[3] The analysis focuses individually on 1 standard deviation permanent shock to commodity prices (oil and urea), the exchange rate, the domestic interest rate, and GDP growth (Figure 2).[4] The shocks are assumed to have taken place from the start of fiscal year (FY) 2014. The near- and medium-term effects of the shocks are illustrated through their impact on the overall fiscal balance and total public debt (deviations from baseline) in Table 1.

[2]The analysis uses GDP from FY1996 as the base year. Bangladeshi authorities have started publishing a rebased GDP series, with FY2006 as the base year. Nominal GDP in FY2013 was about 16% higher under the rebased series compared with FY1996.

[3]For a full description of the data, see Appendix 2.

[4]Permanent shocks are defined as permanent deviations with respect to the baseline. See Appendix 2 for a full description.

Figure 2. **Shocks to Macroeconomic Variables**



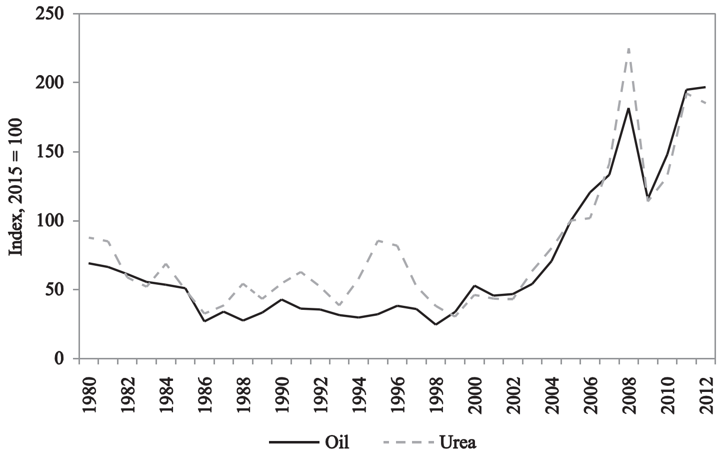
FY = fiscal year, GDP = gross domestic product.
Source: Author's calculations.

Table 1. **Budget Sensitivity to Macroeconomic Shocks**
(deviation from baseline as share of GDP), 2014–2018

	FY2014	FY2015	FY2016	FY2017	FY2018
Scenario A (30% increase in commodity prices or 1 SD)					
Overall balance	−0.9	−0.8	−0.6	−0.4	−0.4
Total debt	0.9	1.8	2.4	2.8	3.1
Scenario B (10% depreciation in exchange rate)					
Overall balance	−0.9	−0.9	−0.8	−0.6	−0.6
Total debt	3.6	4.6	5.4	6.0	6.6
Scenario C (130-basis-points increase in domestic interest rate or 1 SD)					
Overall balance	−0.2	−0.2	−0.3	−0.3	−0.3
Total debt	0.2	0.5	0.7	1.0	1.3
Scenario D (0.7% decrease in real GDP growth or 1 SD)					
Overall balance	−0.1	−0.1	−0.1	−0.1	−0.1
Total debt	0.1	0.2	0.3	0.4	0.5

FY = fiscal year, GDP = gross domestic product, SD = standard deviation.
Sources: Bangladesh authorities and author's calculations.

Figure 3. **Commodity Prices, 1980–2012**



Source: IMF Commodity Prices Database.

Commodity Prices

Bangladesh's fiscal position is sensitive to commodity prices, particularly oil and urea, that tend to move together and whose volatility has recently increased (Figure 3).[5] Shocks to these commodity prices operate through both the revenue and expenditure sides. On the revenue side, an increase in commodity prices results in a rise in import-related tax revenue, which in total accounts for over 30% of tax collections.[6] On the expenditure side, the same shock would translate into an increase in the subsidy bill, specifically payments related to fertilizer (urea) and fuel subsidies, such as those to the Bangladesh Chemical Industry Corporation and Bangladesh Petroleum Corporation (BPC).[7]

Consumption of fuel and urea is subsidized in Bangladesh.[8] In FY2013, total subsidies were 3.1% of GDP, of which energy-related subsidies reached 1.7% of GDP and fertilizer subsidies were 1% of GDP.

The impact on revenue of the rise in import-related tax collections is not enough to offset the much larger effect on expenditure; therefore, the overall effect is negative. The analysis suggests that a 1 standard deviation increase in the prices of oil and urea (roughly a 30% price increase) would reduce the overall fiscal balance (that is, increase the fiscal deficit) by 0.6% of GDP above the baseline on average

[5]Urea is used as a basic input in the production of rice fertilizers.

[6]For simplicity, this analysis assumes zero elasticity of commodity import volumes with respect to prices.

[7]The analysis here assumes that the authorities do not adjust retail energy or fertilizer prices and therefore the fiscal balance absorbs the entirety of the shock. This is clearly a worst-case scenario.

[8]For the purposes of this analysis, it is assumed that shocks to oil prices are transmitted on a one-to-one basis to international fuel prices.

each year. It would also lead to a cumulative increase in the stock of debt of 3.1% of GDP above the baseline over 5 years.

Exchange Rate

While the exchange rate has been very stable over the past few years in Bangladesh, a shock to the exchange rate would affect the fiscal balance and debt stock through a variety of channels.[9] A depreciation in the taka–dollar exchange rate has an impact on domestic prices and (through them) on nominal revenue and expenditure. Beyond that, depreciation has a direct impact on both revenue and expenditure. In the case of revenue, the impact is associated with import-related taxes. On the spending side, the main items affected are (i) the fertilizer subsidy bill, (ii) payments to BPC for oil imports (constant volumes assumed), (iii) the externally financed portion of the Annual Development Program (capital spending), and (iv) interest payments on external debt.[10] Additionally, there is a valuation effect on external debt: the nominal taka equivalent value of public debt denominated in foreign currency would move on a one-to-one basis with the exchange rate change.[11]

Results show that a permanent 10% depreciation in the taka–dollar exchange rate would reduce the overall fiscal balance (that is, increase the deficit) by 0.8% of GDP on average annually with respect to the baseline and increase the stock of debt by around 6.6% of GDP over 5 years.

Domestic Interest Rates

Interest expenses are a small share of total fiscal expenditure in Bangladesh.[12] Therefore, shocks to interest rates have a limited impact: a 1 standard deviation rise in domestic interest rates (130 basis points) would reduce the overall fiscal balance by 0.3% of GDP with respect to the baseline and push up the stock of debt by 1.3% of GDP over 5 years.[13]

Gross Domestic Product Growth

In terms of its direct impact, economic growth mainly affects the revenue side of fiscal aggregates in Bangladesh, including value-added tax (import and

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[9] The exchange rate has been very stable in Bangladesh and therefore shocks measured in terms of 1 standard deviation are small. This study will focus on the impact of a more realistic large shock: a 10% depreciation, which is slightly below the largest depreciation that has occurred over the past 10 years.

[10] Following Ahmed and Islam (2004a), this paper assumes a low pass-through from exchange rate movements to inflation, specifically a coefficient of 0.2.

[11] External debt at the end of 2013 stood at about 45% of total debt and about 16% of GDP.

[12] Shocks to interest rates on external debt are not assessed in this paper as interest payments on external debt are low in Bangladesh, reflecting the prevalence of concessional external debt.

[13] Ahmed and Islam (2004b) find that investment spending at the aggregate level does not respond to changes in interest rates in Bangladesh.

domestic), import tax, supplementary duties, and income tax. As is standard in studies for other developing and emerging market economies, and following IMF (2009), this paper assumes the elasticity of revenue with respect to growth to be equal to 1 and the elasticity of expenditure with respect to growth to be equal to 0.[14]

Results show that a 1 standard deviation decline in GDP growth (around 0.7 percentage points) would reduce the overall fiscal balance by 0.1% of GDP with respect to the baseline and push up the stock of debt by 0.5% of GDP over 5 years.

The relatively small effect is the reflection of two factors: (i) a small tax base as tax revenue collections in Bangladesh are among the lowest in the world at around 9% of GDP; and (ii) the low volatility of growth in the past few years, which implies that shocks to growth measured in terms of 1 standard deviation are small. Of course, the tail event of a larger and more sustained shock to growth would produce a larger deterioration in fiscal aggregates.

B. Stochastic Analysis of External Debt Dynamics

In some cases, macroeconomic shocks do not hit an economy in isolation but occur simultaneously. In crisis episodes (tail events), a negative shock to real GDP may occur in parallel with a shock to the exchange rate, interest rates, and inflation. The cumulative impact of such shocks on public debt may be significant.

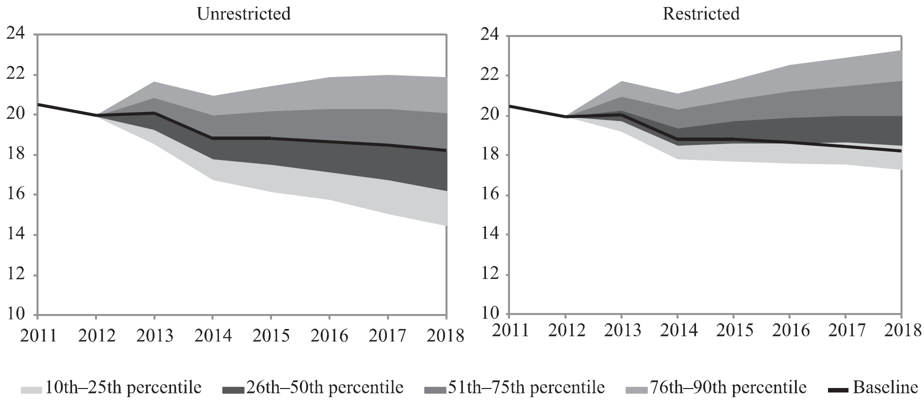
It is important to assess the effects of these shocks on external debt for three reasons. First, exchange rate fluctuations generate volatility that affect debt servicing as well as the debt burden in local currency terms. Second, a default on external obligations can freeze access to international markets. Finally, an increase in macroeconomic volatility could reduce foreign investors' willingness to roll over external debt.[15]

Using fan chart analysis, this section illustrates the frequency distribution of projected external public debt-to-GDP ratio paths generated by shocks to key macroeconomic variables. Fan charts are a tool to depict the possible evolution of the public debt ratio over the medium term and to visually assess fiscal risks from macroeconomic shocks. Sample statistics based on historical data (1996–2012) for the real GDP growth rate, effective real interest rate on government debt, primary balance, and real exchange rate are used to generate the sample means and the variance–covariance matrix that defines a joint normal distribution of these macroeconomic variables. Draws for each one of the variables from the joint normal distribution are used to generate the shocks—calculated as the value drawn minus the sample mean—that are applied to the baseline projections for each of

[14]These assumptions are admittedly simplistic: the elasticity of revenue could be higher than 1 as some types of revenue (e.g., income taxes) tend to move more than proportionately with income, while some expenditure (e.g., social transfers) may well increase when growth falters, even in Bangladesh.

[15]Risks on domestic debt are lower because domestic debt is not as large as foreign debt and because monetary and fiscal authorities have more control over the domestic debt market.

Figure 4. **Evolution of External Debt-to-Gross Domestic Product Ratio**



Sources: Bangladesh authorities and author's calculations.

the macroeconomic variables. These "shocked" series of macroeconomic variables are then introduced into the debt dynamics equation to calculate a distribution of projected debt paths (see Appendix 1 for details on the derivation).

The results suggest that Bangladesh has a low risk of debt distress. After a combined shock to key macroeconomic variables, there is a 50% probability that the external debt-to-GDP ratio would remain between 15% and 20% (Figure 4, left-hand side). If the draws were restricted to only negative shocks (e.g., only draws of negative primary balance), then the probability of higher debt levels would increase (Figure 4, right-hand side). Even under these assumptions, debt levels would remain below reasonable thresholds.[16]

IV. Specific Fiscal Risks in Bangladesh

Fiscal risks in Bangladesh do not only arise from disturbances to general economic variables; they also arise from specific sources such as the realization of contingent liabilities. This section assesses the impact on fiscal aggregates of the hypothetical realization of all government loan guarantees and contingent liabilities from state-owned banks. It also examines the potential long-term impact from the unfunded pension system.

A. Government Loan Guarantees

The Government of Bangladesh customarily provides guarantees for loans contracted by the different state-owned financial and nonfinancial enterprises. Most

[16]For a discussion on public debt management and debt sustainability in Bangladesh, see Islam and Biswas (2005).

loans finance the implementation of diverse public policies and programs. If the contracting organization fails to pay the loan in time, the guarantees are invoked and the liabilities for payment are passed on to the government. Consequently, these guarantees could eventually turn into outright government debt.

The stock of government guarantees issued before FY2004 was mainly related to agricultural programs. From FY2004 until FY2012, the issuance of guarantees was very small and related to agricultural credit. In FY2012, there was a steep increase in guarantees, mainly those provided to state-owned commercial banks for lending to nonfinancial public enterprises, particularly BPC. As a result, the stock of government guaranteed debt (both external and domestic) rose from 3.5% of GDP in FY2004 to 5.7% of GDP (Tk592 billion) at the end of June 2013 (Table 2), of which guarantees provided to state-owned commercial banks represented around 30% of the total.

Risks emanating from government guarantees are sizable. Should they materialize in full, they could noticeably increase Bangladesh's public debt.

B. State-Owned Banks

The weak balance sheets of state-owned banks represent a tangible fiscal risk (contingent liability) for the Government of Bangladesh. There are eight state-owned banks in Bangladesh, comprising four commercial banks and four specialized banks (development banks), which represent around 32% of the banking system's assets or roughly 24% of GDP (Figure 5). These banks account for the majority of outstanding nonperforming loans (NPLs) in the banking sector.[17]

The state-owned banks have come under renewed stress since 2012, reflecting different factors such as a slowdown in economic activity, increasing competition, and weak internal governance. Recent cases of financial fraud have highlighted significant weaknesses in oversight, internal controls, and risk management in state-owned banks. At the end of 2013, the capital shortfall at these banks, compared to the regulatory minimum, stood at 2.5% of GDP.[18]

C. The Pension System

There are two potential sources of fiscal risks arising from Bangladesh's current pension arrangements. First, there are those associated with the Civil Servant Retirement Scheme (CSRS) and the General Provident Fund (GPF). A

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[17]Lending to state-owned enterprises, even to loss-making ones, does not give rise to NPLs, as nearly all of these loans are guaranteed by the government.

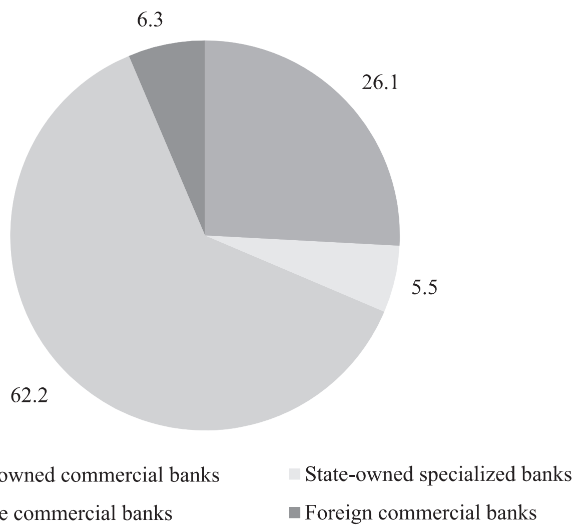
[18]The estimates adjust for (i) past due loans shown as "valuation adjustments" in the balance sheets of state-owned commercial banks, and (ii) additional loan loss provisions that would arise from an assumption of no recovery of the NPLs. This is therefore a conservative estimate. Capital shortfall estimates are a moving target; as the NPLs and capital change, so do the estimates.

Table 2. **Government of Bangladesh Guarantees Valid beyond June 2013**
(Tk billion)

	FY2004 and previously signed	**FY2005**	**FY2006**	**FY2007**	**FY2008**	**FY2009**	**FY2010**	**FY2011**	**FY2012**	**FY2013**	**Stock at end-June 2013**	**Stock at end-June 2013 (% of GDP)**
Agricultural Credit	59.3	1.3	0.0	7.0	0.0	7.0	2.0	0.0	0.0	0.0	76.6	0.7
Oil (BPC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.8	245.6	67.2	341.6	3.3
Air (Biman)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.0	14.6	0.0	35.6	0.3
Power	27.8	5.3	0.0	0.0	0.0	0.0	0.0	0.0	33.6	15.4	82.2	0.8
Trade	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.8	2.1	0.0
Miscellaneous	34.9	0.0	0.0	6.1	0.0	0.2	12.4	0.0	0.0	0.2	53.8	0.5
Total	122.0	6.6	0.0	13.1	0.0	7.2	14.4	49.8	294.1	84.6	591.8	5.7
of which												
SOCBs	9.1	0	0	0	0	0	12.38	0	159.73	1.76	183.0	1.8

BPC = Bangladesh Petroleum Corporation, FY = fiscal year, GDP = gross domestic product, SOCB = state-owned commercial banks.
Sources: Bangladesh authorities and author's calculations.

Figure 5. **Composition of Banking System Assets as of December 2012**
(% of total)



Sources: Bangladesh authorities and author's calculations.

second (more hypothetical) long-term risk arises from potential pressures from the absence of an organized pension system for workers in the private sector, whether formal or informal.

Civil Servant Retirement Scheme

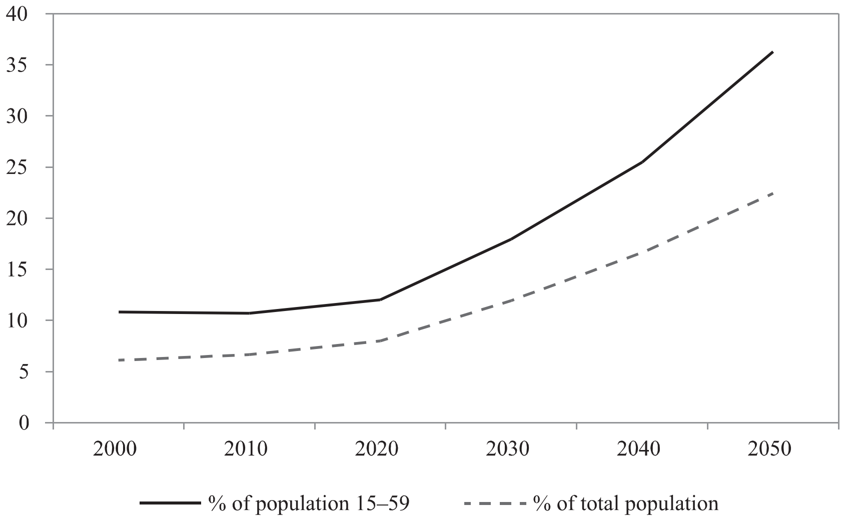
As in other South Asian economies, the Government of Bangladesh provides its employees with a noncontributory defined benefit pension, including survivor benefits. Civil servants are eligible to receive a pension at the age of 59.[19] Pensions depend on the length of an employee's public service. The civil servants' salary structure is divided into 20 grades or categories, with the basic annual salary ranging between Tk5,000 and Tk40,000, with an average of Tk20,000. After 25 years of service (or at the age of 59) a civil servant is entitled to a pension of 80% of his or her prorated last basic salary (with proration based on years of service if less than 25), half of it as a pension payment every month and the other half in a lump sum.

Pension spending on the CSRS is captured in fiscal aggregates under current expenditure. In FY2013, the government assigned Tk60 billion to the pension bill (0.57% of GDP).

The Government of Bangladesh employs roughly 1.2 million civil servants, of which around 35,000–40,000 retire every year. Demographic trends will drive up

[19]See Kim and Bhardwaj (2011). The retirement eligibility age increased from 57 to 59 in 2011.

Figure 6. **Actual and Projected Population over 60**



Source: United Nations. World Population Prospects. https://esa.un.org/unpd/wpp/.

the number of retirees per year, with an impact on pension expenditure. Current United Nations projections estimate that the elderly (individuals aged 60 years and above) will more than triple as a share of Bangladesh's total population by 2050 from the current 6% (Figure 6). As the figure also shows, the increase in the ratio of the elderly population to the working-age population (known as the old-age dependency ratio) is even more dramatic.

To estimate the potential fiscal impact (via spending on the CSRS) from expected changes in demographics, it is helpful to decompose the pension spending-to-GDP ratio into three factors:

$$\frac{Spending}{GDP} = \underbrace{\left(\frac{Pop60+}{Pop15-59}\right)}_{\text{old-age dependency ratio}} * \underbrace{\frac{\left(\frac{Spending}{pensioners}\right)}{\left(\frac{GDP}{Pop15-59}\right)}}_{\text{benefit ratio}} * \underbrace{\left(\frac{pensioners}{Pop60+}\right)}_{\text{eligibility ratio}}$$

The first term is the old-age dependency ratio. The second term is the benefit ratio, defined as the ratio of spending per pensioner to GDP per worker, which provides a measure of the generosity of pension benefits. Absent any changes in the benefits formula, this ratio is assumed to remain constant at its value at the end of 2013 (about 1.32). The final term is the eligibility ratio, defined as the ratio of the number of individuals receiving a pension to the population aged 60 years and above, which provides a measure of pension system coverage. This is assumed to

Table 3. **Projected Evolution of Pension Spending Due to Population Aging, 2013–2050**

	2010	2011	2012	Average 2010–2012	2013	2020	2030	2040	2050
Old-age dependency ratio (population aged 60 years and older per population aged 15–59 years)	0.11	0.11	0.11	0.11	0.11	0.12	0.18	0.25	0.36
Benefits ratio (spending per pensioner relative to GDP per worker)					1.32	1.32	1.32	1.32	1.32
Eligibility ratio (pensioners per population aged 60 years and older)	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04
Spending (% of GDP)[a]	0.54	0.50	0.55	0.53	0.53	0.60	0.90	1.27	1.81

GDP = gross domestic product.
[a]Pension for retired government employees and their families.
Note: The old-age dependency ratio is based on United Nations World Population Prospects data and projections, while benefits and eligibility ratios are calculated for 2013 and then assumed to remain constant. Spending and GDP are measured in billions of takas and population aggregates in millions of takas.
Sources: United Nations. World Population Prospects. https://esa.un.org/unpd/wpp/; Bangladesh authorities; and author's calculations.

be constant at 0.04 (civil service pensioners were 4% of the elderly population at the end of 2013), under the assumption that the covered population, in this case civil servants, and eligibility conditions for a pension, such as the retirement age or minimum years of service, will not change over time.

Based on these parameters, pension spending is projected to increase from 0.5% of GDP in 2013 to 0.9% of GDP in 2030 and to 1.8% of GDP in 2050 in line with the expected acceleration of aging after 2030 (Table 3).

General Provident Fund

In addition to the CSRS, there is the GPF for civil servants, which is a mandatory, defined contribution system in which civil servants contribute a minimum of 10% of their salaries (there is no upper limit). The notional accounts accrue interest of around 12% of the GPF stock at year-end. When civil servants retire, they can withdraw the whole amount plus interest. At any point in time before retirement, civil servants can borrow up to 80% of their cumulative contributions from the fund. As of the end of FY2013, the GPF stock of contributions amounted to Tk204 billion plus Tk24 billion in interest (2.2% of GDP). Unfortunately, despite its name, the GPF is unfunded; the cash flow it generates is not being saved, but rather it is used to finance the deficit.[20] Indeed, the GPF is currently generating sizable annual surpluses (contributions to the fund minus withdrawals) of around

[20]For more details, see Alam (2012).

Table 4. **Universal Age Pensions around the World**

Economy	**From Year**	**Qualifying Age**	**Pension (% of per capita GDP)**	**Benefits Transferred (% of GDP)**
New Zealand	1940	65	46	4.3
Mauritius	1958	60	16	1.7
Brunei Darussalam	1984	60	10	0.4
Namibia	1990	60	16	0.9
Samoa	1990	65	22	1.4
Nepal	1995	75	10	0.1
Botswana	1996	65	10	0.5
Bolivia	1996	65	26	1.2
Mexico City	2001	70	11	0.2
Kosovo	2002	65	50	2.7

GDP = gross domestic product.
Source: Willmore, Larry. 2007. "Universal Pensions for Developing Countries." *World Development* 35 (1): 24–51.

Tk30 billion. However, as civil servants age and start to retire in larger numbers, the net cash flow may become negative, posing a clear financial risk.[21]

Potential Pressures from the Absence of Pension Coverage for the Private Sector

Bangladesh does not have a formal pension program for the vast majority of the population. First, most of the workforce (an estimated 89% of the total and an even higher proportion for women) is employed in the informal sector, mainly in agriculture (ADB 2010). Also, other than a gratuity benefit at retirement, employees of formal private sector firms do not have access to any formal old-age benefits program. Overall, only around 4% of the population over the age of 60 is covered by the pension system in Bangladesh. The rest rely on their own savings to sustain themselves in retirement.

The absence of a formal pension scheme for most of the population in Bangladesh might eventually lead to pressures on the government to provide a minimum pension. To illustrate the potential costs involved, it would be useful to estimate the costs of setting up a universal scheme. The best way to do this is to draw from international experience.

A number of economies—both developed and developing—have put in place universal pension schemes (Table 4). These pension schemes are often affordable, simple to administer, and have been successful in tackling old-age poverty (Willmore 2007).

[21] Public servants contribute to this fund by a certain percentage of their salary. There is no other source of receipt for this fund.

Table 5. **Fiscal Cost of a Universal Pension Scheme in Bangladesh, 2012**

	Universal Pension from Age			
	60	**65**	**70**	**75**
Average monthly benefit (Tk)	1,500	1,500	1,500	1,500
Beneficiaries (million)	9.9	6.7	4.1	2.1
Fiscal cost				
% of GDP	1.9	1.3	0.8	0.4
% of total government expenditure	11.9	8.0	4.9	2.5

GDP = gross domestic product, Tk = taka.
Sources: Bangladesh authorities and author's calculations.

To illustrate how much it would cost to institute a universal pension scheme in Bangladesh, two key parameters need to be taken into consideration:

- **Age of eligibility (the age at which people get entitled to the pension; the higher the age, the lower the overall cost of the scheme)**. The illustrative exercise below considers the costs of a universal coverage system under different eligibility ages (over 60, over 65, over 70, and over 75). The number of potential beneficiaries, using 2012 population estimates, ranges from 2.1 million to 9.9 million.[22]

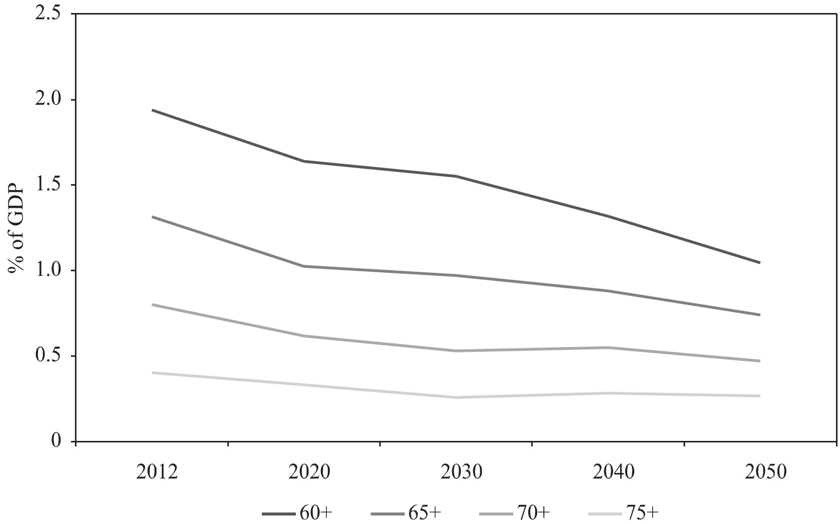
- **Size of grant (the amount provided to beneficiaries)**. It is common to use the poverty line as a benchmark. In Bangladesh, the poverty line was calculated in 2005 at Tk861.6 per month. Applying the Consumer Price Index inflation rate, that poverty line translates into roughly Tk1,500 per month by the end of FY2013. As shown in Table 6, a universal pension scheme that provides such an amount would cost between 0.4% and 1.9% of GDP, depending on the age threshold.

Of course, the fiscal cost of a universal pension will increase over time as the population ages.

Assuming an initial poverty line of Tk1,500 per month (Table 5), a constant inflation rate of 6% (equal to the average for the last 20 years), and nominal GDP growth of 12%, Figure 5 shows the fiscal cost of the universal scheme by age of eligibility (Figure 7a). Alternatively, it is possible that the poverty line increases faster than inflation over the long term as the basic needs basket widens with development. Figure 7b shows that path, allowing the pension per capita to grow in line with GDP per capita. Since the qualifying population is expected to grow as a share of the total population, total pension spending would grow as a share of

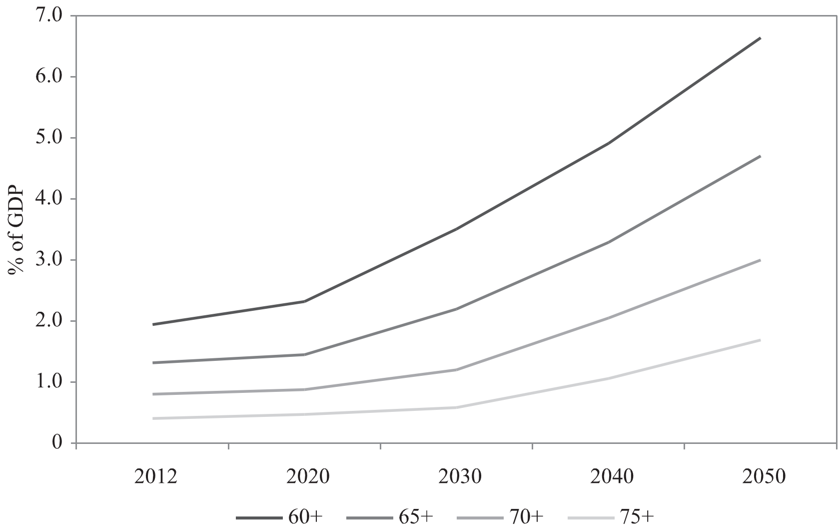
[22]This exercise takes into consideration the number of people over a certain age in 2012 (specifically, over the ages of 60, 65, 70, and 75) and then subtracts the number of retired civil servants.

Figure 7a. **Fiscal Cost of Universal Pension for Different Minimum Retirement Ages, 2012–2050**



GDP = gross domestic product.
Note: Assumed annual inflation rate of 6%.
Sources: United Nations. World Population Prospects. https://esa.un.org/unpd/wpp/; Bangladesh authorities; and author's calculations.

Figure 7b. **Fiscal Cost of Universal Pension for Different Minimum Retirement Ages, 2012–2050**



GDP = gross domestic product.
Note: Pension increases at same annual rate as GDP per capita.
Sources: United Nations. World Population Prospects. https://esa.un.org/unpd/wpp/; Bangladesh authorities; and author's calculations.

GDP. For the most expensive case (aged 60 years and above), the fiscal costs would be almost 7% of GDP in the long term.

As stated in previous paragraphs, the costs of different universal pension schemes vary between 1% and 7% of GDP in the medium term. To contain these costs, the literature generally suggests means testing to target only the needy and that such programs provide benefits that are sufficient to alleviate poverty but low enough to minimize incentives to remain outside of the formal pension system.[23]

V. Institutional Capacity

Risks to the budget and public debt also emerge from the government's institutional capacity. This section focuses on three specific areas that may pose risks to fiscal aggregates in Bangladesh: (i) budgeting practices, (ii) external debt management, and (iii) data discrepancies.

Budget Practices and Forecasting

Significant deviations in outturns vis-à-vis budget figures have been observed in recent years in Bangladesh. Consistently, both revenue and expenditure outturns have fallen behind budget target numbers. During the last 4 years, total revenue was below the budget target by around 4% on average (0.5% of GDP). The highest difference has been in nontax revenue, with an average deviation of 16%. Similarly, expenditure outturns fell 8.5% behind the budget (1.4% of GDP). The main driver has been underexecution in capital spending, which falls an average of more than 19% below target every year (Table 6).

Figure 8 shows the revenue and expenditure deviations from the budget as a percentage of GDP over the last 12 years. The horizontal axis shows deviations in revenue and the vertical axis shows deviations in expenditure. A negative number indicates that the outturn was below what was forecasted at the time of budget preparation. For 11 of the last 12 years, both revenue and expenditure have underperformed.

The main problem associated with this pattern is that while revenue forecasts in a budget document are merely projections, the expenditure allocations are legal spending authorizations. Thus, if revenue fails to materialize, there is a risk that line ministries may still execute in full their spending envelopes, leading to larger-than-expected fiscal deficits and financing needs.

External Borrowing and Debt Management

Efficient debt management strategies are important to mitigate the effects of shocks to fiscal aggregates such as macroeconomic shocks and contingent

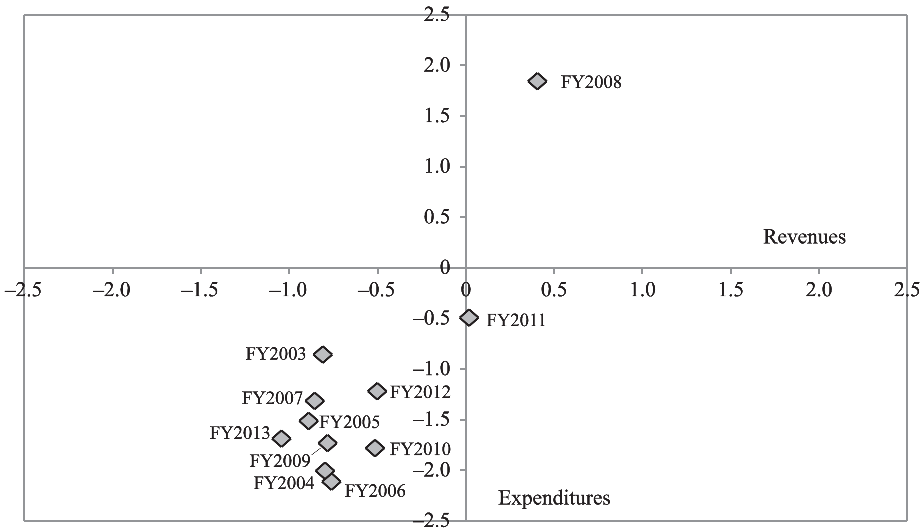
[23]See Cottarelli (2014).

Table 6. **Differences between Outturn and Original Budget, 2009–2012**
(% of initial budget)

	FY2009	FY2010	FY2011	FY2012	Average	Median	% of GDP Average	% of GDP Median
Total revenue	−7.0	−4.7	0.0	−4.1	−4.0	−4.4	−0.5	−0.5
Tax revenue	−6.9	−2.3	4.7	−0.6	−1.3	−1.4	−0.1	−0.1
Nontax revenue	−7.2	−14.8	−21.3	−21.3	−16.1	−18.0	−0.3	−0.4
Total expenditure	−10.7	−11.0	−3.3	−8.4	−8.4	−9.6	−1.4	−1.6
of which								
Current expenditure	0.6	−6.8	0.7	−1.8	−1.8	−0.6	−0.2	−0.1
Annual Development Program	−24.1	−16.0	−13.1	−21.1	−18.6	−18.5	−0.8	−0.9
Non-ADP capital spending	−36.5	−16.6	−41.5	−40.1	−33.7	−38.3	−0.5	−0.6

ADP = Annual Development Program, FY = fiscal year, GDP = gross domestic product.
Note: Negative numbers reflect an outturn smaller than the budget target.
Sources: Bangladesh authorities and author's calculations.

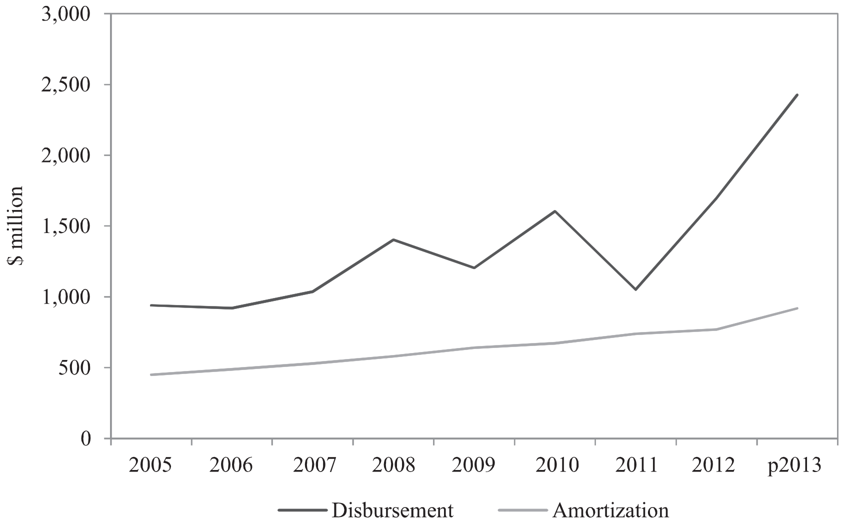
Figure 8. **Deviation from the Annual Budget**
(% of GDP)



FY = fiscal year, GDP = gross domestic product.
Source: Author's calculations.

liabilities, and to keep borrowing under control. This is particularly true of external debt, which is more likely to suffer shocks to the exchange rate or international interest rates. While Bangladesh's total public debt remains below 40% of GDP, there has been a rapid increase in nonconcessional external borrowing: the annual average external debt disbursement in FY2012 and FY2013 was around 180% higher than the annual average for the period FY2005–FY2011 (Figure 9).

Figure 9. **External Debt Disbursement and Amortization**



Note: Borrowing by state-owned enterprises that are supported by government guarantees are not included.
Sources: Bangladesh authorities and author's calculations.

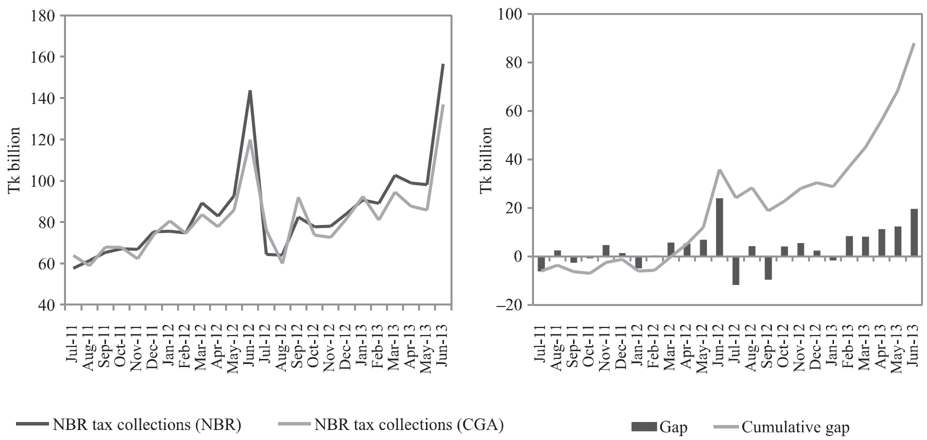
Bangladesh's government has taken significant steps toward improving the monitoring and contracting of external debt, including through the creation of a Technical Committee on Nonconcessional Borrowing. Continued efforts to strengthen the assessment, approval, and monitoring of external loan contracts and guarantees are needed.

Data Discrepancies

Problems associated with fiscal data quality and timeliness may also pose fiscal risks. One significant example is the discrepancy between revenue collection data provided by the National Board of Revenue (NBR) and that provided by the Office of the Controller General of Account (CGA). Part of this discrepancy reflects a timing issue. Taxes are registered by the NBR when they are effectively paid, but they are only booked by the CGA when the amount is deposited into the Treasury Single Account. If the definition of revenue is the same and the only difference is one of timing, at year-end the numbers should be reconciled. However, this is not the case and the gap between the reported series is increasing. As shown in Figure 10, the cumulative gap between NBR and CGA data over the period FY2012–FY2013 was roughly Tk90 billion (almost 1% of GDP), with the CGA data typically well below that of the NBR data.

These inconsistencies produce uncertainty for fiscal policy making and undermine transparency and accountability.

Figure 10. **Revenue Discrepancies between the National Board of Revenue and the Office of the Controller General of Account**



CGA = Controller General of Account, NBR = National Board of Revenue.
Note: The gap is calculated as NBR tax collections as per NBR minus NBR tax collections as per CGA.
Sources: Bangladesh authorities and author's calculations.

VI. Policy Implications

Policies that could help mitigate the incidence and impact of fiscal risks could include the following:

- Full integration of risks into government policy decision making, both in fiscal management and in the design of an integrated asset and liability management strategy in coordination with Bangladesh Bank.[24]

- Building government capacities to analyze and measure fiscal risks.[25] To achieve this, a system of Treasury cash flow forecasts should be implemented. Even though there have been attempts to do so, no formal mechanism is in place yet.

- Measures to reduce currency risks in the government liability structure. For example, a cap in the amount of foreign-denominated debt as well as on foreign-denominated government guarantees.

- A full set of policies and procedures for issuance of loan guarantees, as well as prioritization and limitation on the amounts of new guaranteed obligations.

---

[24]The current fragmentation among debt management entities adds costs to any planning strategy by the Ministry of Finance and Bangladesh Bank.

[25]The evidence suggests that the introduction of fiscal rules and the setting up of independent fiscal councils to monitor fiscal developments can help reduce fiscal risks (Debrun, Hauner, and Kumar 2009).

- Implementation of a contributory pension scheme for civil servants to replace the current noncontributory regime, and reforms to the GPF such as the creation of notional accounts and an investment fund to accumulate the system's assets. Consideration could also be given to institutionalizing a noncontributory pension regime for the poor, as existing transfer mechanisms to the elderly poor are very low. Additionally, Bangladesh could aim to develop a voluntary defined contribution retirement scheme for all adults regardless of their employment status. These schemes are important sources of long-term investment funds in the domestic financial markets in developed and developing economies.

VII. Conclusions

Several factors have the potential to drive actual fiscal aggregates away from projections in Bangladesh. These include (but are not restricted to) macroeconomic shocks, contingent liabilities, and institutional weaknesses. This section summarizes the paper's key findings and draws policy implications.

The analysis in this paper suggests that the fiscal balance in Bangladesh is sensitive to macroeconomic shocks, particularly shocks to commodity prices and the exchange rate. A 1-standard deviation increase in commodity prices or a 30% devaluation in the exchange rate could raise the deficit by 0.6%–1% of GDP on average per year when compared to the baseline.

Specific factors, such as calls on government guarantees or increased recapitalization needs among state-owned banks, could also have a significant negative impact. Should they materialize in full, calls on government guarantees and further recapitalization needs could add pressure to the budget and increase Bangladesh's public debt.

In addition to the most immediate risks of shocks to macroeconomic variables and calls on contingent liabilities, risks arising from the CSRS and the GPF could materialize in the medium to long term. If no changes were made to the system, the fiscal cost of the unfunded pension scheme could increase from 0.5% of GDP in 2013 to 2% of GDP by 2050. Furthermore, if a universal pension system were to be implemented (only 4% of the old-age population is covered by the current system), the fiscal cost would rise to about 6% or more of GDP per year by 2050.

Finally, risks derived from the government's institutional capacity could also take a toll on Bangladesh's fiscal aggregates. Risks emerge from budget practices, the management of external debt, and data discrepancies. Bangladesh has a tradition of overstating expected revenue and expenditure in the budget, which could lead to excessive spending pressures in the short term. Weaknesses in debt management could lead to riskier debt structures, while data discrepancies produce uncertainty for fiscal policy making and undermine transparency and accountability.

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Appendix 1. Methodology for the Production of the Fan Charts

Generating a Distribution for the Debt Path

The sample statistics based on the historical data over the period FY1996–FY2012 are used to define the joint normal distribution (normality assumed for simplicity).

First, a fiscal reaction function depending on the primary surplus, domestic real interest rate, real gross domestic product (GDP) growth rate, and real effective exchange rate is defined. Second, an unrestricted autoregression model (VAR) with these four variables is estimated (using Choleski decomposition factorization) to generate projections for each of the four variables using (i) a deterministic projection from the VAR, and (ii) a random shock drawn from a multivariate normal distribution with the same variance–covariance matrix as the one estimated in sample errors of the VAR.

The shocks are added to the baseline projected values of the growth, interest rate, exchange rate, and primary balance in the calculation of the debt evolution equation for periods $t + 1$ to $t + k$ (where k is the length of projection period) to recursively generate the debt-to-GDP ratio projections, producing 1,000 simulated debt-to-GDP ratios in each year for which we are projecting.

Once the debt ratio projections are generated, the ratios for each year are ranked from highest to lowest and the correspondent percentile of the 1,000 simulations is assigned to each ratio in each year. The 10th, 25th, 50th, 75th, and 90th percentiles are extracted and used to produce the fan chart. The increasing spread of the distribution over the projection period is due to the increased uncertainty over time since shocks can compound over the years.[26]

Debt Dynamics

In its most basic form, the evolution of public debt can be characterized as

$$D_{t+1} = \frac{E_{t+1}}{E_t}(1 + i^f_{t+1})D^f_t + (1 + i^d_{t+1})D^d_t - PB_{t+1} + O_{t+1} \tag{1}$$

[26]Shocks are drawn, taking into account only the contemporaneous correlations between variables, but a 90th percentile debt ratio path can be considered to reflect the impact of a sequence of bad shocks each year on the public debt ratio.

Table A2. **Baseline Scenario**

	Mean	Median	Standard Deviation	25th	75th	Minimum	Maximum
GDP growth (%)	6.0	6.1	0.7	5.5	6.5	4.4	7.0
Commodity prices (index, 2005 = 100)	151.6	152.6	84.2	62.4	231.5	29.2	265.3
Interest rate (%)	8.6	8.4	1.2	8.1	9.5	6.5	10.7
Exchange rate (taka–dollar)	67.6	68.8	12.6	57.9	79.1	45.4	87.3
Total public debt (% of GDP)	44.4	43.4	5.1	40.0	48.9	37.6	53.0

GDP = gross domestic product.
Source: Author's compilation.

Subscripts refer to time periods and superscripts f and d refer to foreign currency- and domestic currency-denominated debt, respectively. D_t^f is the stock of foreign currency-denominated debt at the end of period t. D_t^d is the stock of local currency-denominated debt at the end of period t. E_t is the nominal exchange rate (taka–dollar) at the end of period t. i_{t+1}^f is the effective nominal interest rate on foreign currency-denominated debt at the end of period $t+1$. i_{t+1}^d is the effective nominal interest rate on domestic currency-denominated debt at the end of period $t+1$. PB_{t+1} is the government fiscal primary balance in period $t+1$. O_{t+1} are other factors and the stock-flow residual that ensures that the identity holds.

$$\frac{E_{t+1}}{E_t} = (1 + \varepsilon_{t+1}) \tag{2}$$

where E_t is the nominal taka–dollar exchange rate of period t.

Dividing equation (1) by Y_{t+1} and replacing (2) into (1)

$$d_{t+1} = \left(\frac{1}{1+g}\right)\left[(1+\varepsilon_{t+1})(1+i_{t+1}^f)\,d_t^f + (1+i_{t+1}^d)d_t^d\right] - pb_{t+1} + o_{t+1} \tag{3}$$

where lower letters represent the contemporaneous ratio to GDP.

Appendix 2. Descriptive Statistics

This appendix aims at describing the baseline scenario data used in this paper. The main descriptive statistics are presented in Table A2, including each variable's mean, median, standard deviation, 25th and 75th percentile, maximum, and minimum.

GDP growth. Economic growth has been robust in recent years. The baseline projection of resilient gross domestic product growth is supported by demand- and supply-side effects of strong public investment to address infrastructural bottlenecks, favorable demographics, and reforms to enhance the investment climate and improve education and skills.

Commodity prices. Commodity price projections are taken from the International Monetary Fund's *World Economic Outlook*.

Interest rate. Interest rates are assumed to decrease in the medium term in response to an easing in balance of payment related pressures and ample liquidity. They are expected to reach an equilibrium at higher levels than the historical minimum.

Exchange rate. In the baseline scenario, it is expected that the exchange rate continues to appreciate, consistent with fundamentals. However, in case of adverse shocks of a prolonged nature, such as a sustained trade shock, the exchange rate should be allowed to adjust. Tightened monetary policy to support the currency and contain pass-through effects from exchange rate depreciation to domestic inflation should be put in place, while also ensuring an adequate supply of liquidity. These policies should be complemented with moderate fiscal easing, including the expansion of well-targeted safety net schemes to protect the most vulnerable.

Public debt. The downward path of public debt over the medium term assumes a moderate consolidation path, anchored by reducing the deficit, including grants.

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