

INTERNATIONAL MONETARY FUND

Public Administration Digitalisation and Microenterprise Productivity in India

Prepared by Somnath Sharma and Kenichi Ueda

WP/26/86

IMF Staff Discussion Notes (SDNs) showcase policy-related analysis and research being developed by IMF staff members and are published to elicit comments and to encourage debate. The views expressed in Staff Discussion Notes are those of the author(s) and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

**2026
MAY**



WORKING PAPER

IMF Working Paper
Regional Office for Asia and the Pacific

Public Administration Digitalisation and Microenterprise Productivity in India
Prepared by Somnath Sharma and Kenichi Ueda*

Authorized for distribution by Chad Steinberg
May 2026

IMF Working Papers describe research in progress by the author(s) and are published to elicit comments and to encourage debate. The views expressed in IMF Working Papers are those of the author(s) and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

ABSTRACT: We find that public administration digitalisation, carried out state-by-state in India between 2010 and 2015, led to an improvement in micro-enterprise productivities, based on the Unincorporated Non-Agricultural Enterprises Surveys. We categorise the digitalisation of public administration into six groups: tax filing and payments, construction permits, environment and labour regulations, inspections, commercial disputes, and single-window systems. States are ranked according to the subsets of digitalisation carried out by them. Using the difference-in-difference estimations with propensity score matching, we find that the average firm-level productivities have risen in the states carrying out more digitalisation. There, also, dispersions in productivities have become narrower.

RECOMMENDED CITATION: Sharma, S., and K. Ueda. 2025. Public Administration Digitalisation and Microenterprise Productivity in India. Working Paper WP/26/86. International Monetary Fund, Washington D.C.

JEL Classification Numbers:	D24, L60, O53, P21
Keywords:	Productivity growth; productivity dispersion public administration digitalisation; business environments reforms; propensity score matching
Authors' email addresses:	somnathsharma@rbi.org.in uedak@e.u-tokyo.ac.jp

* This paper was written while Kenichi Ueda was a visiting scholar at the IMF's Regional Office for Asia and the Pacific. It is based on a chapter of Ph.D. thesis of Somnath Sharma, whose study at the University of Tokyo was supervised by Kenichi Ueda and funded by the Japan-IMF Scholarship Program for Asia. The views expressed in this paper are those of the authors and should not be attributed to any institutions that the authors have been affiliated with. We were greatly benefited from our discussions with Kosuke Imai, Taisuke Nakata, Rodney Ramcharan, Takafumi Kawakubo and Takafumi Suzuki. We are also thankful to the comments from participants of the Econometric Society Asia Meeting in Tokyo, CompNet Conference on Innovation and Productivity, Tokyo, the Asia KLEMS Conference at Lonavala, a seminar at the University of Southern California, and CAFRAL Annual Conference in Mumbai.

WORKING PAPERS

Public Administration Digitalisation and Microenterprise Productivity in India

Prepared by Somnath Sharma and Kenichi Ueda¹

¹ This paper was written while Kenichi Ueda was a visiting scholar at the IMF's Regional Office for Asia and the Pacific. It is based on a chapter of Ph.D. thesis of Somnath Sharma, whose study at the University of Tokyo was supervised by Kenichi Ueda and funded by the Japan-IMF Scholarship Program for Asia. The views expressed in this paper are those of the authors and should not be attributed to any institutions that the authors have been affiliated with. We were greatly benefited from our discussions with Kosuke Imai, Taisuke Nakata, Rodney Ramcharan, Takafumi Kawakubo and Takafumi Suzuki. We are also thankful to the comments from participants of the Econometric Society Asia Meeting in Tokyo, CompNet Conference on Innovation and Productivity, Tokyo, the Asia KLEMS Conference at Lonavala, a seminar at the University of Southern California, and CAFRAL Annual Conference in Mumbai.

Contents

Acronyms	3
1. Introduction	4
2. Business Environment Reforms 2014-15	6
2.1 Definition of Reforms	6
2.2 Randomness of Reforms across States	7
3. Data	9
4. TFPR	10
4.1 Estimation of TFPR	10
4.2 Illustrative Examples: Single Window Systems and Tax related Reforms Estimation of TFPR ...	11
5. Estimation of Reform Gains	15
5.1 Reform Ordering	15
5.2 Matching Firms Across States and Years	15
5.3 Difference-in-Difference Estimation.....	16
5.4 Benchmark Results	17
6. Matching Firms in Border Districts	18
6.1 Finding Information on Border Districts of Two States	18
6.2 Results based on Firms in Border Districts	19
7. Impact of Reform Differences	21
7.1 Impact of Reform Difference on TFPR Gains.....	21
7.2 Impact of Reform Difference on TFPR Dispersion Reduction	22
7.3 Robustness Check: Using Different Estimates of TFPR	23
7.2 Impact of Reform Difference on TFPR Dispersion Reduction	22
8. Conclusion	28
References	29
Appendix 1. Theoretical Background: Total Factor Productivity Estimation	31
Appendix 2. Bordering Districts of Adjoining States in India	33

Acronyms

CPR - Construction Permit Reforms

CST - Central Sales Tax

CDR - Commercial Dispute Reforms

DID - Difference-in-Differences

ELR - Environment and Labour Standard Reforms

GDP - Gross Domestic Product

IMF - International Monetary Fund

IR - Inspection Reforms

InTFPR - Log of the TFPR

MPK - Marginal Product of Capital

MPL - Marginal Product of Labour

MRPK - Marginal Revenue Product of Capital

MRPL - Marginal Revenue Product of Labour

MSME - Micro, Small, and Medium Enterprises

NIC - National Industrial Classification

NPI - Non-Profit Institution

NSS - National Sample Survey

NSSO - National Sample Survey Office

OLS - Ordinary Least Squares (regression)

SGDP - State Gross Domestic Product

SHG - Self-Help Group

SWR - Single Window System Reform

TFP - Total Factor Productivity

TFPR - Total Factor Productivity – Revenue-based

TR - Tax Related Reforms

VAT - Value Added Tax

1. Introduction

We investigate whether public administration digitalisation, which eases regulatory and policy burdens on business, leads to higher productivity growth and lower productivity dispersion among firms in India. We focus on the micro-enterprises covered in the two rounds of the Unincorporated Enterprise Surveys of India conducted in 2010-11 and 2015-16, respectively. We use the Assessment of State Implementation of Business Reforms Report of 2015 to identify the reforms carried out by each state, and we assess the public administration digitalisation undertaken in each state.

We find that states that undertake more public administration digitalisation experience higher productivity growth and lower productivity dispersion among firms. Specifically, for a firm located in a state with more digitalisation, we search for a firm with similar characteristics but located in the other state with fewer reforms, and, then compare their total factor productivities (TFPs). Moreover, we compare the dispersion of TFP across firms for the pairwise states. For a robustness check, we conduct the same analyses but using only firms located in bordering districts of neighbouring pairs of states.

Digitalisation of public administration scaled up in the mid-2010s, building on institutional initiatives and technological infrastructure developed in earlier years. In 2014, State and Union Territory governments finalised a 98-point action plan on ease of doing business to benchmark and advance the implementation of business-related regulatory reforms, many of which involved process re-engineering and digital enablement to improve transparency and reduce compliance frictions. An assessment of implementation was done with support from the World Bank Group and was used to identify reform priorities and encourage competitive federalism across States/UTs. This broader reform momentum coincided with improvements in India's position in the World Bank's Doing Business rankings, including movement from 142 (Doing Business 2014) to 130 (Doing Business 2016).

Much of India's manufacturing output depends on micro, small, and medium enterprises (MSMEs). They contribute around 35 percent of manufacturing outputs. They also employ around 110 million workers (around 25 percent of the total workforce) and contribute about 45 percent of the overall exports from India.

Most MSMEs are not formally registered as companies under India's Companies Act of 1956.² However, only a few studies have been done on the impact of the business environment reforms on these unincorporated enterprises, which are supposed to benefit significantly from the reforms in a business environment.

In our view, digitalisation of administrative processes can significantly reduce compliance costs. For large enterprises, these fixed costs should represent a small fraction of total expenses due to economies of scale; however, microenterprises often face substantial burdens from

² Companies Act 1956 details the procedures necessary for setting up a company. This act also explains practices essential for winding up and liquidating a business.

administrative costs. Digitalisation streamlines activities such as obtaining permits, filing taxes, and accessing government schemes, greatly benefiting smaller firms.

Moreover, digitalisation reduces corruption and informal cost variations. In traditional systems, connections often allow certain individuals quicker access to permits, disadvantaging microenterprises. By automating and making processes more transparent, digitalisation levels the playing field for all businesses. At the macro-level, digitalisation can enhance aggregate productivity by better allocating resources and supporting higher-productivity firms, leading to overall economic growth.

At the same time, microenterprises are unlikely to move or expand their businesses in other states that go through more reforms. We can, thus, assume no direct spillover effects across different states, except for potential arbitrageurs if prices vary due to reforms.

Some recent papers find that the digital transition of public administration leads to desirable outcomes. Banerjee et al. (2023) find that in Indonesia, the transition from in-kind rice to an equivalent electronic voucher reduced poverty by increasing adherence to the program design. Lewis-Faupel et al. (2016) also find that e-procurement in India and Indonesia leads to quality improvements. In India, e-procurement led to improvements in road quality, while in Indonesia, it helped reduce delays in project completion. Their results suggest that e-procurement removed entry barriers and enabled firms from outside the home regions, which tended to be of higher quality. This led to improvements in road quality and timeliness, but no detectable change in prices.

The business environment is generally found to be an important determinant of economic growth in the literature. Hall and Jones (1999) documented in their cross-country study that productivity is mainly driven by differences in institutions and government policies. Tighter regulations caused substantial reductions in the growth rates of both outputs and TFP, explaining, especially, the productivity slowdown of the 1970s in many countries (Dawson and Seater, 2013). Djankov et al. (2006) studied business regulations across 135 countries and found that countries with better regulations grow faster. They find that countries that improve their business regulations from the worst quartile to the best quartile gain 2.3 percentage points in annual GDP growth. Haidar (2012), in a cross-country study of 172 countries, finds that business regulatory reforms result in greater economic growth. On average, each business regulatory reform is associated with a 0.15 percent increase in the growth rate of GDP. Shleifer and Vishny (1997) show, based on cross-country regressions, that governance problems are widely recognized as the leading cause of poor firm performance, especially in developing countries.

Micro firms tend to remain informal, that is, unregistered firms. Literature suggests that heavier regulation of entry, labour-market restrictions, and the tax burden increase the share of the informal sector in an economy. This is because by being informal, firms can avoid getting into the fulfilment of the regulatory obligations (Djankov and Freund (2002), Antunes and Cavalcanti (2007), Perry et al. (2007), and Ordonez (2014)). There is also a sizable literature analyzing the determinants of the informal sector's size. A salient finding is that the informal sector share decreases as credit availability improves in the formal sector (Straub, 2005; Antunes and

Cavalcanti, 2007). Beck and Demirguc-Kunt (2006) conclude from their empirical study that obstacles to the growth of small firms include inadequate enforcement of property rights, inefficient regulation and taxation, political instability, insufficient infrastructure provision, and an underdeveloped financial system. Schneider and Enste (2000) and Perry et al. (2007) argue that other factors may affect the informal sector, such as labour market segmentation, inequality, low human capital, trade restrictions, audit policies, and rent-seeking bureaucracies.

2. Business Environment Reforms 2014-15

2.1 Definition of Reforms

On 29th December 2014, during the *Make in India* workshop, the Chief Secretaries of States (the secretaries to the political heads of States in India) finalized a 98-point Action Plan on *Ease of Doing Business*. Digitalisation of public administration was a key part of the reforms. An evaluation of the implementation and progress of the business environment reforms was done in June 2015. We classify the 98 points into six broad reform categories. These six operational and procedural improvements in doing business are as follows:

- Tax filing and payments
- Construction permits
- Environment and labour standards
- Inspections
- Commercial dispute
- Single Window Systems

Tax filing and payments: Some states have made progress in operational aspects of business-related taxes. Most of these tax-related reforms made e-registration mandatory for Value Added Tax (VAT), Central Sales Tax (CST), Professional Tax, Entry Tax, and so forth. These reforms typically allow business owners to file and pay taxes online. Also, e-filing can be done with the service centres' support and helpline. It often provides for risk-based tax compliance inspections.

States that carried out tax-related reforms until 2015 are Bihar, Karnataka, Madhya Pradesh, Chhattisgarh, Gujarat, Maharashtra, Odisha, Uttar Pradesh, Punjab, Rajasthan, Uttarakhand, and West Bengal.

Construction permits: Many states allowed applicants to apply online and upload building plans for automated construction permit approval. In addition, several states developed software-based systems that automatically scan building plans and monitor compliance with the building bylaws and building codes.

States that implemented construction permit-related reforms until 2015 include Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Rajasthan, Telangana, and Uttarakhand.

Environment and labour standards: Some states introduced online systems for applications related to environmental and labour standards. These automated solutions provide 24/7 access for businesses to apply online, track their applications, file returns and statements, and get online permissions related to environmental and labour standards and regulations.

States that carried out administrative reforms related to the environment and labour standards until 2015 are Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Jharkhand, Odisha, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand, and West Bengal.

Inspections: Some states have reformed inspections related to tax, labour standards, and environmental regulations. These reforms make inspections more user-friendly for business owners, for example, through online self-certification. Also, a centralised inspection system is sometimes introduced by establishing an agency to synchronise inspections conducted by different agencies into a single joint inspection. Some states have also published comprehensive procedures and checklists for various inspections. A few states have also implemented online systems to allocate inspectors, increasing the efficiency and effectiveness of the procedures.

States that carried out inspection-related reforms until 2015 include Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Odisha, Jharkhand, Punjab, Rajasthan, Punjab, Telangana, Uttar Pradesh, and Uttarakhand.

Commercial disputes: Some states have made significant progress in business-related judicial reforms, mainly due to the passage of the Commercial Courts, Commercial Divisions, and Commercial Appellate Divisions Act by the Indian parliament in 2015. Even this type of reform, backed by nationwide laws, is implemented by each state at different times. A few states filled vacancies in the District Courts and Commercial Courts to ensure adequate capacity to handle the numerous cases. E-filing of cases and e-summons have also been introduced in some District Courts to address concerns about the time and costs associated with legal processes.

States that carried out reforms related to commercial dispute resolutions until 2015 are Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Jharkhand, Rajasthan, and Telangana.

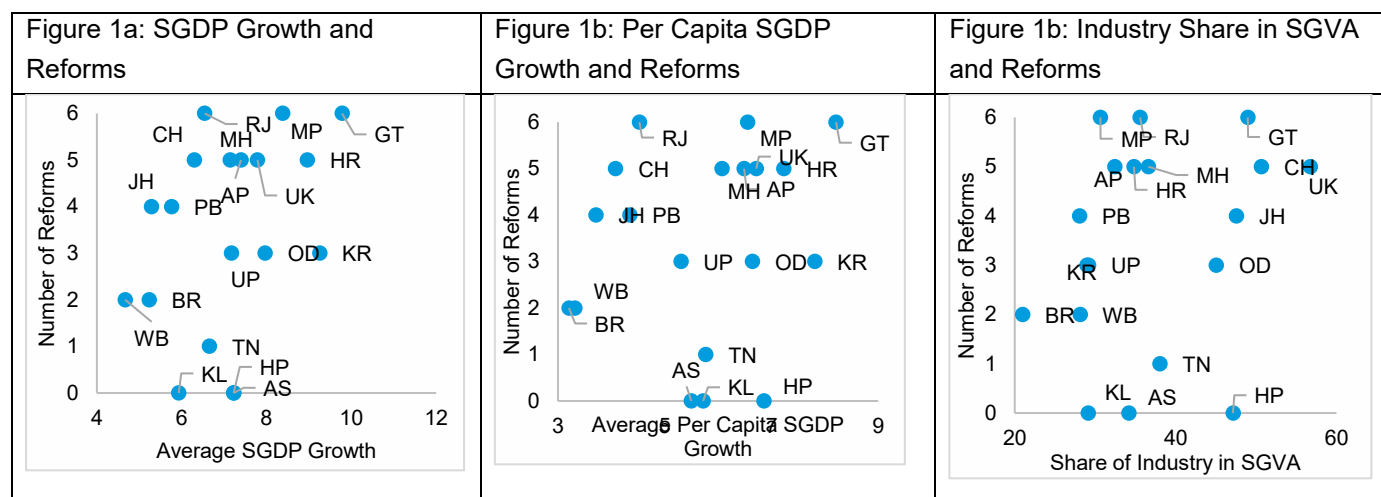
Single Window System: A few states created bodies or bureaus, which act as a one-stop system for approval of various state-level regulations and subsidies regarding doing business. A Single Window System provides a dedicated window (online and/or physical) for the filing, tracking, and approval of applications, as well as payment of charges, inquiry, and verification.

Without this system, a business owner often needs to visit several government webpages or offices to obtain permits.

States that carried out this type of reform until 2015 are Andhra Pradesh, Chhattisgarh, Jharkhand, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Rajasthan, Telangana, Punjab, and Uttarakhand.

2.2 Reform Implementations were Not Systematically Associated with Baseline State Characteristics

We find no systematic relationship between the implementation of reforms and states' stage of development (Figures 1a–1c). Using average SGDP growth, average per-capita SGDP growth, and the degree of industrialisation (industry share in state GVA) as proxies for development, states with higher or lower values of these indicators adopted a similar number of reforms.



Source: RBI.

Note: 1. Average SGDP Growth is the average of the State Gross Domestic Product Growth from 2010-11 to 2014-15.

2. Average Per-Capita SGDP Growth is the average of the Per-Capita State Gross Domestic Product Growth from 2010-11 to 2014-15.

3. SGVA is state gross value added.

4. UK-Uttarakhand, CH-Chhattisgarh, GT-Gujarat, JH-Jharkhand, HP-Himachal Pradesh, OD-Odisha, TN-Tamil Nadu, MH-Maharashtra, RJ-Rajasthan, HR-Haryana, AS-Assam, AP-Andhra Pradesh, MP-Madhya Pradesh, UP-Uttar Pradesh, KL-Kerala, KR-Karnataka, WB-West Bengal, PB-Punjab, BR-Bihar.

Consistent with the scatter plots, OLS regressions of the number of reforms on these development proxies yield statistically insignificant coefficients (Table 1). This indicates that, along these observables, reform implementation is not systematically related to states' pre-reform development conditions, supporting our interpretation of reforms as plausibly exogenous variation for empirical purposes.

Table 1: OLS Regression of Number of Reforms on Per-capita SGDP

	Reforms	Reforms	Reforms
Average SGDP Growth	0.546 (1.620)		
Average Per-Capita SGP Growth		0.234 (0.700)	
Share of Industry in State GVA			0.054 (1.070)
Constant	-0.453 (-0.190)	2.090 (1.060)	1.410 (0.730)
N	19	19	19
adj. R-sq	0.083	0.029	0.008

3. Data

For our firm-level empirical investigation, we use the National Sample Surveys (NSS) on unincorporated microenterprises, restricted to non-agricultural enterprises and excluding construction. We further restrict our attention to the non-financial enterprises. National Sample Survey Office (NSSO) conducts this periodic random stratified sample survey. This survey is nationally representative and a primary source of information on the economic and operational characteristics of microenterprises in India. The survey data are also used for planning, policy formulation, decision support, and as a necessary input for further economic and statistical analysis by various government organizations and academia in India.

We take the two most comparable rounds of the survey— the 67th round (covering July 2010 to June 2011) and the 73rd round (covering July 2015 to June 2016). The NSS 67th round was the first NSS round that covered the entire unincorporated non-agricultural sector (excluding construction) in a focused way as a follow-up survey of the Economic Census. The NSS 73rd round was conducted as a repeat of the NSS 67th round. Below, we focus on the non-financial sector and often limit our attention to manufacturing. Table 3 shows our regression sample.

Table 2: Distribution of Active MSMEs by Type (in 1000)

Enterprises	Registered	Unregistered	Total	% of Unregistered Enterprises
Proprietary	1409	32745	34154	95.87
Partnership	63	365	428	85.28
Private Company	43	6	49	12.24
Co-operative	5	116	121	95.87
Others	44	765	809	94.56
Not recorded	0	615	615	100
Total	1564	34612	36176	95.68

Source: All India Census of MSME, Fourth Round, 2006-2007

Note that, according to the latest All-India Census of MSMEs (2006-07), unregistered enterprises constitute around 96 percent of the total number of MSMEs.³ Unincorporated enterprises include proprietaries, partnerships (excluding limited liability partnerships), Self Help Groups (SHGs), and Non-Profit Institutions (NPIs). The data used for our regressions does not include NPIs and non-financial SHGs.⁴

Table 3: National Sample Survey Data on Unincorporated Enterprises

Rounds	Period	Total Enterprises	Non-financial Enterprises	Manufacturing Enterprises
67th Round	July 2010–June 2011	334,475	329,280	96,414
73rd Round	July 2015–June 2016	288,676	285,389	79,966

³ Recall that, the unincorporated enterprises are those enterprises which are not registered under the Companies Act 1956.

⁴ An entity formed as an SHG and engaged in non-financial activities is considered as a partnership enterprise with members not all from the same household. For our purpose, we are focus on the nonfinancial sector, and the non-financial SHGs are already included as partnerships. The rest of the SHGs are dropped. A NPI is a legal or social entity created for the purpose of producing goods and services whose status does not permit it to be a source of income, profit, or other financial gains for the other entities that establish, control, or finance it. For our purpose, we drop the NPIs from the analysis.

4. TFPR

4.1 Estimation of TFPR

For the years 2010-11 and 2015-16, following Hsieh and Klenow (2009), we compute the revenue-based total factor productivity (TFPR) at the firm level as the product of price p_{ijt} times physical productivity A_{ijt} , assuming the Cobb-Douglas production function:

$$TFPR_{ijt} = p_{ijt}A_{ijt} = \frac{p_{ijt}y_{ijt}}{k_{ijt}^{\alpha_{jt}} l_{ijt}^{1-\alpha_{jt}}} \quad (1)$$

where k_{ijt} is the capital of the firm i in industry j at time t , l_{ijt} is labour, A_{ijt} is the physical total productivity, and α_{jt} is the capital share, which is one minus the labour share. We estimate the labour share in each industry in each year by the average as:

$$1 - \alpha_{jt} = \text{mean} \left(\frac{\text{labour cost}_{jt}}{\text{net value added}_{jt}} \right) \quad (2)$$

We use wage payments as labour costs. We measure the nominal net value added as the difference between total output and the value of total inputs, net of total fixed asset depreciation during the year.

We use state-wise minimum daily wage rates for unskilled labour in 2010 and 2015 from Indiastat (a commercial data source), then approximate the daily wage rates to monthly data, assuming 20 workdays per month. Later, as a robustness check, we also use actual wage payments for each firm that employs 10 or more workers. For the benchmark, however, we would like to use more samples by using the industry-average wage as the labour cost.

This is because a key issue we face in handling data on micro and small enterprises is that many of these enterprises operate as self-employed units, for which wage data are unavailable. In such cases, we also use the state government's minimum wage as the wage. That is, we estimate the productivity of small and micro-enterprises, accounting for self-employed labour using the state-wise minimum wage as the imputed wage. Also, for many other enterprises, the data contains the number of employees but does not count the owners as workers. For such cases, we add 1 to the number of workers. More details on estimating the TFPR are provided in the Appendix.

The estimates of state-wise firm-level average TFPR (in logarithms) for 2010-11 and 2015-16 are given in Table 4. We find that, between 2010-11 and 2015-16, there is an improvement in the overall TFPR across the states. Note that inflation is not adjusted, but it is taken care of in the regression.

Table 4: State-wise average of log of Enterprise TFPR in 2010-11 and 2015-16

States	Mean (2010- 11)	Std. Dev	Min.	Max.	Mean (2015-16)	Std. Dev	Min.	Max.
Andhra Pradesh	-0.847	2.617	-11.891	18.975	0.32	1.791	-7.703	10.101
Bihar	0.425	2.369	-11.482	28.344	1.047	1.604	-7.611	12.861
Chhattisgarh	-0.237	2.219	-10.634	10.168	0.288	1.438	-5.788	5.032
Gujarat	-0.685	2.443	-15.965	16.406	-0.219	1.583	-6.72	6.595
Haryana	-1.312	2.573	-12.933	15.321	0.707	1.306	-4.883	4.689
Himachal Pradesh	-1.4	2.672	-13.022	15.769	0.074	1.929	-15.345	6.051
Jharkhand	0.802	2.473	-7.528	24.875	0.676	1.376	-6.437	6.397
Karnataka	-0.26	2.581	-13.273	14.146	0.317	1.525	-6.146	7.276
Kerala	0.167	2.865	-11.38	25.826	0.549	1.667	-5.868	8.8
Madhya Pradesh	0.073	2.681	-10.776	26.998	0.318	1.833	-7.412	12.872
Maharashtra	-0.676	2.916	-17.654	29.009	0.041	1.77	-8.664	9.336
Odisha	1.52	2.794	-7.888	27.815	1.083	1.43	-4.724	9.605
Punjab	-1.293	2.652	-13.933	24.675	0.43	1.368	-6.912	5.298
Rajasthan	-1.158	2.301	-12.544	9.632	0.363	1.472	-6.639	4.453
Tamil Nadu	-0.916	2.528	-14.634	14.3	0.326	1.652	-7.351	10.215
Uttar Pradesh	-0.457	2.717	-12.471	29.203	0.309	1.508	-6.448	12.27
Uttarakhand	-1.18	2.317	-10.027	8.32	0.369	1.285	-5.457	4.26
West Bengal	0.762	2.944	-13.232	28.592	1.276	1.835	-6.233	12.773

Source: Authors' estimations based on survey data.

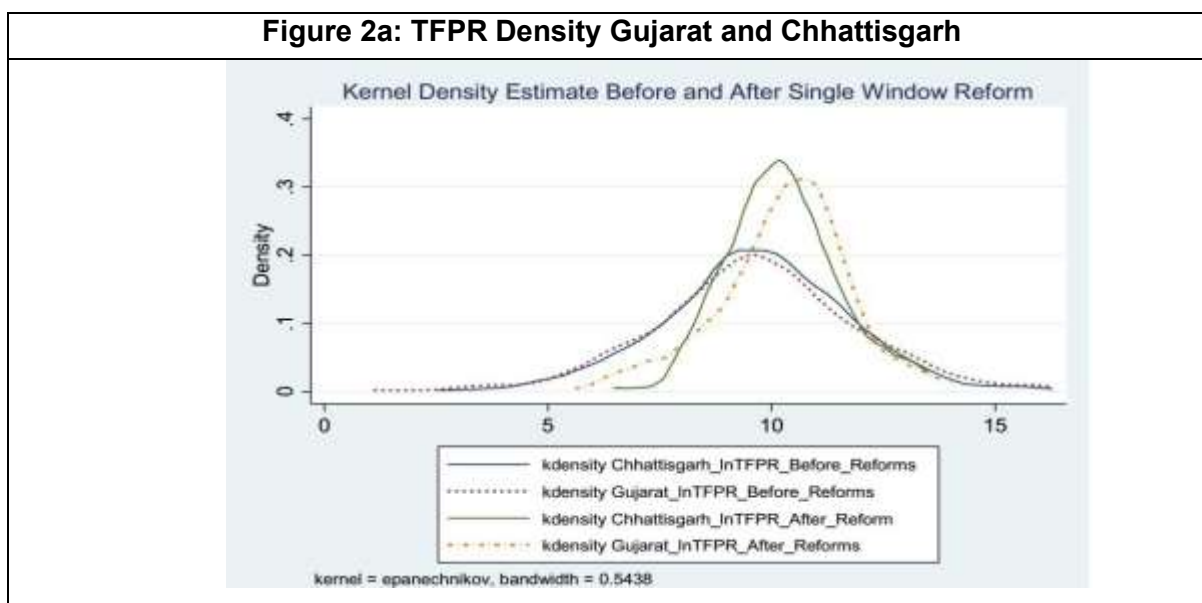
4.2 Illustrative Example: Single Window Systems and Tax related Reforms Estimation of TFPR

Hsieh and Klenow (2009) compare the dispersion of the TFPR in India, China, and the US using kernel density plots. They graphically show that dispersion in TFPR in India and China is greater than in the US and conjecture that the differences stem largely from misallocations of factors of production. We show that there is heterogeneity in the dispersion of the TFPR across states in India. More importantly, the dispersion seems to change with reforms.

To graphically see the improvements in the TFPR dispersion due to one reform, we examine the kernel density plots of the TFPR for a few pairs of states, in which the number of reforms differs only by one. Note that the greater the dispersion of the TFPR, the greater the misallocation, and that a shifting of the density curve towards the right means a positive improvement in the TFPR.

In the state of Gujarat, all six reforms were carried out. In the state of Chhattisgarh, five reforms were carried out, but the Single Window System was not. We plot the TFPR kernel density of Gujarat and Chhattisgarh in Figure 2a. We find that, compared to 2010-11, both Gujarat and Chhattisgarh saw improvements in allocation in 2015-16, as the dispersion of the TFPR has come down.⁵ At the same time, the mean TFPR improvement in Gujarat is more than that of Chhattisgarh, as the shift in the mean TFPR is greater in Gujarat than in Chhattisgarh.⁶

Similarly, we compare the states of Madhya Pradesh and Chhattisgarh in Figure 2b. In Madhya Pradesh, all six reforms were carried out, and again, the only difference between Madhya Pradesh and Chhattisgarh is the Single Window Reform. We again find that there are overall improvements in the TFPR in both Madhya Pradesh and Chhattisgarh. The mean improvement in the TFPR is again greater in Madhya Pradesh. While the dispersion of TFPR in Madhya Pradesh was more than that of Chhattisgarh before reforms, the dispersion of TFPR in Madhya Pradesh has decreased by a greater amount than that of Chhattisgarh.

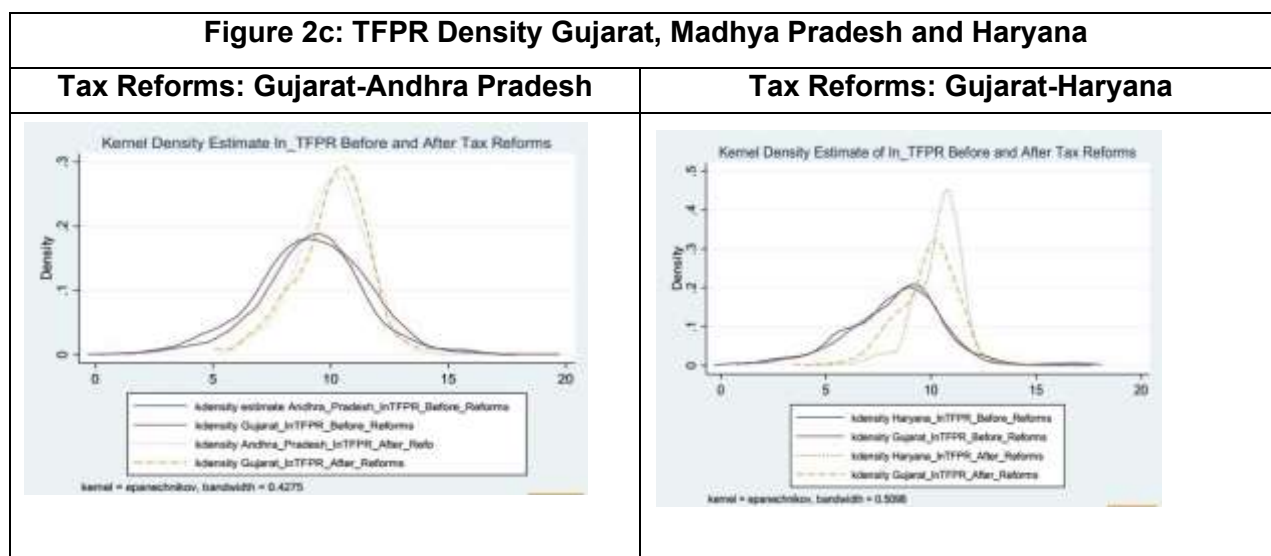
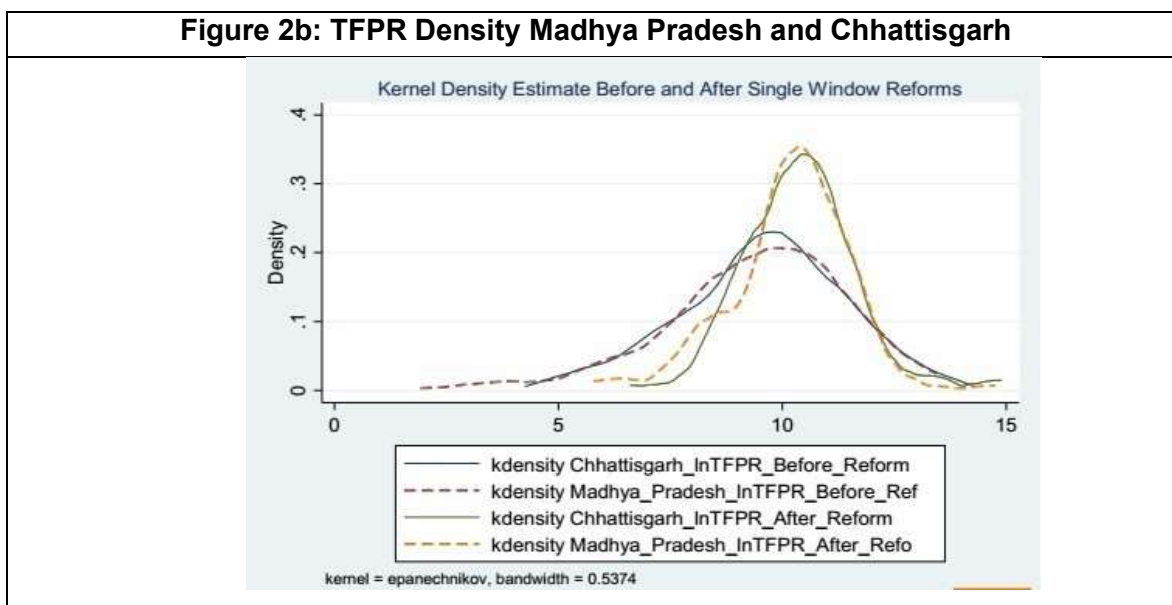


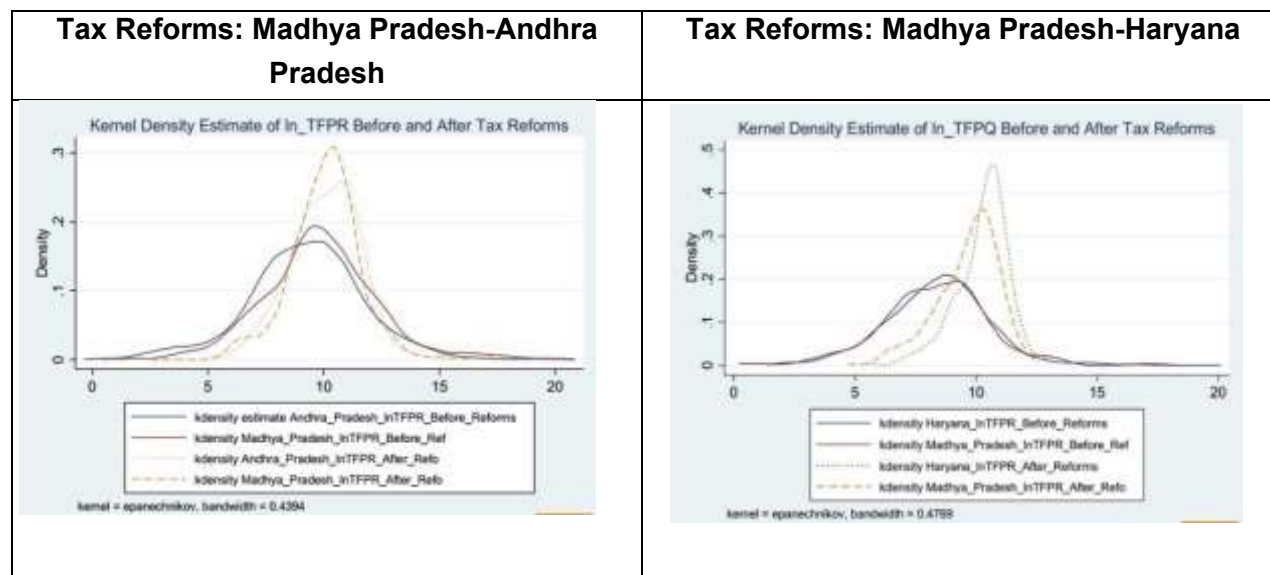
⁵ The comparison drawn here is based on the matched firms data matched using the propensity score matching technique discussed in the later section.

⁶ The mean shift may be due to inflation. However, in the formal regression analysis below, we take care of it by the year-fixed effect. As for dispersion, inflation may widen the distribution but should be taken care of by the same year fixed effect.

Also, we plot pairs of TFPR kernel densities for Gujarat-Andhra Pradesh, Madhya Pradesh-Andhra Pradesh, and Madhya Pradesh-Haryana. Between these three states, there is only one reform difference: tax-related reforms. Among the three pairs, Andhra Pradesh and Haryana did not implement the tax-related reforms. Figure 2c shows that the states implementing the tax-related reform are better off in terms of the TFPR. Specifically, the kernel density plots reveal that public administration reforms lead to both an increase in the mean and a reduction in the dispersion of firm-level TFPR in states where reforms were implemented.

These casual observations suggest that improvements in the mean and reductions in dispersion vary across states and the number of reform differences. Therefore, a detailed investigation is needed to understand the underlying mechanisms driving these variations and to identify the conditions that maximize the effectiveness of such reforms.





5. Estimation of Reform Gains

5.1 Reform Ordering

We could simply count reform numbers, 1 to 6, to make an index to figure out the reform impacts. However, two sets of three possibly different reforms cannot be expected to have the same impacts. We, thus, construct a partial ordering in the set of reforms. We define the set of reforms as:

$$Reforms = \{TR, CPR, ELR, IR, CDR, SWR\}, \quad (3)$$

where *TR* stands for Tax Related Reforms, *CPR* is Construction Permit Reforms, *ELR* is Environment and Labour Standard Reforms, *IR* is Inspection Reforms, *CDR* is Commercial Dispute Reforms, and *SWR* denotes Single Window System Reform.

We categorise the states according to the reforms they undertook. That is, for state *k*, the set of carried-out reforms is expressed as:

$$Reforms_k = \{x | x \in Reforms \text{ that are carried out in state } k\} \quad (4)$$

We identify pairs of states *k, l* such that state *k* has carried out strictly more reforms than state *l*. In this case, we write:

$$Reforms_k > Reforms_l \quad (5)$$

This means that any reforms carried out in state l are carried out in state k and that at least one more reform are also carried out in state k . This is a partial ordering.

5.2 Matching Firms Across States and Years

At the firm level, we would like to compare reform impacts across similar firms within a specific pair of states and eliminate any average effect stemming from compositional differences between pairs of states. As our sample is a repeated cross-section covering 2010-11 and 2015-16, we match firms across states and years to obtain the doubly matched firms. Based on size (total fixed assets), age (after adjusting for age in 2010-11, that is, subtracting 5 years from each firm's age in 2015-16), sector (rural/urban), and three-digit industry classification, we use propensity scores to match the firms.⁷ We confirm that covariates are well-balanced in matched samples.

We match the firms across states and across years to obtain the doubly matched firms (Blundell and Dias, 2009, and Binci et al., 2018). More specifically, we use the following steps to match firms across states k and l , for years 2010-11 and 2015-16, to arrive at the matched sample:

1. Match firms in state k in 2010-11 with firms in state k in 2015-16 based on the propensity score of being in 2010-11.
2. Use step-1 restricted firms in more reform state k in 2010-11 to match with firms in less reform state l in the year 2010-11 based on the propensity scores of being in more reform state k .
3. Use step-2 restricted firms in state l in 2010-11 to match with firms in state l in year 2015-16 based on the propensity scores of being in 2010-11.
4. Use step-1 restricted firms in state k in 2015-16 to match with step-3 restricted firms in state k in 2015-16 based on propensity scores of being in state k .

In the end, all firms in the sample for a specific pair of states are subject to all four steps described above.

5.3 Difference-in-Difference Estimation

Based on the formal estimation, we confirm that states carrying out a strictly greater number of reforms gain more in terms of $TFPR$. We use the difference-in-difference (DID) specifications, using the above-defined matched sample. We use the natural log of the $TFPR$ ($\ln TFPR$) as the dependent variable, and the additional reforms as the treatment for the state A paired with the state B if $Reforms_A > Reforms_B$, controlling for the firm *size*, *age*, *ownership*, *location*, and the *three – digit level industry* classification.

In summary, we perform the following regression for all the relevant pairs of states with the one carrying out a strictly greater number of reforms than the other, as defined in (5) above.

⁷ We use STATA 14 command `psmatch2` with caliper 0.1.

$$\begin{aligned}
\ln TFPR_{ijkt} = & \mu_j + \gamma D_k + \delta t + \tau(D_k \times t) \\
& + \beta_1 Size_{ijkt} \\
& + \beta_2 Age_{ijkt} \\
& + \beta_3 Ownership_{ijkt} \\
& + \beta_4 location_{ijkt} \\
& + \epsilon_{ijkt} \quad ,
\end{aligned} \tag{6}$$

where i , j , k , and t refer to firm, industry, state, and year, respectively. We run this regression for two partially ordered states ($j = 1$ or 2). We do this for all those pairs of states. The coefficient of interest is τ for the cross-term ($D_k \times t$).

Year $t = 0$ refers to 2010-11 (before the Action plan was adopted) and $t = 1$ refers to 2015-16 (after the Action plan was adopted). This year-fixed effect takes care of the nation-wide business cycle and inflation that affect $t = 0$ estimates. D is a dummy variable that takes the value 1 for the state that has carried out a strictly greater number of reforms (in our example, state A) than the other state (state B). Note that $k = A$ or B . So, the cross-term coefficient τ captures the impact of the reform difference between the two states.

As for the control variables, *Size* is measured by the log of total assets. *Ownership* refers to the type of firm ownership (i.e., 1 is for male ownership, 2 for female, 3 for transgender, 4 for partnership in the same household, 5 for partnership in a different household, 7 for trusts, and 8 for others)⁸, *Location* stands for rural or urban. We also include an industry fixed-effect, μ_j . Firms are not weighted in the specifications. We estimate standard errors clustered at the state level.

5.4 Benchmark Results

We find that, on an average, the enterprises in the states that have carried out a strictly greater number of reforms do better in terms of the TFPR. Table 5 presents the number of estimations in which the DID coefficients (τ) are found to be positive and statistically significant at a 5 percent or 10 percent level of significance out of all pairwise estimations.⁸ For example, row 6 and column 5 in Table 5a shows 10/15, which means there are 15 pairs of 6 reform states and 5 reform states, and, out of those 15 pairwise estimations, 10 pairs show significant TFPR gains by states with more reforms. We present the tables separately for overall non-financial (excluding construction) firms (Table 5a) and manufacturing firms (Table 5b).

The results show that enterprises located in states that have carried out more reforms perform better than those in all other states in terms of TFPR, except perhaps for states with 2 or 3 reforms. In particular, Gujarat, Madhya Pradesh, and Rajasthan are the states that have carried out all six

⁸ Number 6 which stands for Self-Help Groups have been dropped from our study.

⁸Detailed pair-wise results are omitted but available upon request.

reforms and do better in terms of TFPR compared to almost all other states, both for overall firms and manufacturing firms.

Table 5a: Positive and Statistically significant DID coefficients (non-financial enterprises)

		State B Number of Reforms						
		0	1	2	3	4	5	6
State A Number of Reforms	0							
	1	2/2						
	2	0/4	0/1					
	3	0/6	0/5					
	4	1/2	0/1	2/2	1/3			
	5	5/11	4/6	6/6	6/8			
	6	3/6	2/2	5/5	11/11	0/2	10/15	

Table 5b: Positive and Statistically significant DID coefficients (manufacturing enterprises)

		State B Number of Reforms						
		0	1	2	3	4	5	6
State A Number of Reforms	0							
	1	2/2						
	2	0/4	0/1					
	3	0/6	0/5					
	4	1/2	0/1	2/2	2/3			
	5	5/11	2/6	6/6	6/8			
	6	4/6	2/2	5/5	10/11	0/2	12/15	

6. Matching Firms in Border Districts

6.1 Finding Information on Border Districts of Two States

As each state has different characteristics, the difference in the impacts of reforms on TFPR may reflect the natural environment, endogenous industry composition, income levels, and so forth. In this case, overestimation may violate the parallel trend assumption. To minimize such possibilities, we now focus narrowly on firms in a similar environment, that is, those in the border districts of paired states. Along the neighbouring districts of paired states, almost all the spatial characteristics should be more similar. The remaining differences can be mostly, if not entirely, attributed to the business environments on both sides of the border. In other words, border-district-based estimates should be more consistent with the parallel trend assumption.

Using the state-wise maps, we find the information on the districts along the shared border of two states.⁹ We prepare pairs of neighbouring states in which reforms have been carried out in one but not in the other. We then choose the firms located along the border districts of these two states. We match those firms based on propensity scores, following the same procedure described in Section 5.1.

A caveat with neighbouring districts is that businesses may migrate to the district with more reforms. This means the border-district-based regressions underestimate the impacts of reforms. So, we treat these results as robustness checks. However, anecdotal evidence suggests that small businesses' sales depend on clients with long-term relationships and that they are unlikely to change their locations. Unskilled workers may migrate to better places. But the firm TFPR would not be influenced by the total number of workers in a district. In any case, we have already reported the results for all districts.

6.2 Results based on Firms in Border Districts

Tables 6a and 6b present the results for overall firms and manufacturing firms below. Note that the sample size decreases because the number of pairs of neighbouring states with reforms that have absolute strict ordering is smaller.

We find that our results broadly hold for this narrow sample too, at least for the manufacturing sector (Table 6b). That is, we find that, on average, states that implement a strictly greater number of reforms do better on the TFPR.

⁹ We are grateful to Dr. Ramanuj Kaushik, Assistant Professor of Geography and Geopolitics, D.A.V. (PG) College, Siwan, Bihar for providing us with the neighbouring district map of the states.

Table 6a: Positive and Statistically significant DID coefficients (Border District: non-financial)

		State B Number of Reforms						
		0	1	2	3	4	5	6
State A Number of Reforms	0							
	1							
	2							
	3	0/1						
	4	0/1						
	5	0/2	1/1		2/2			
	6				0/2	1/1	1/3	

Table 6b: Positive and Statistically significant DID coefficients (Border District: manufacturing)

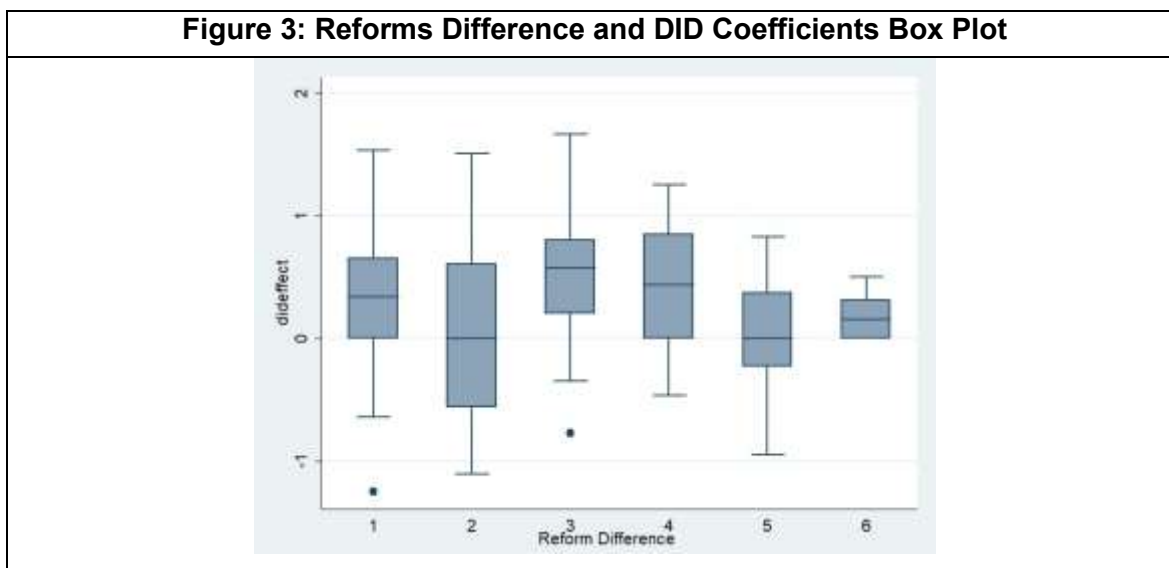
		State B Number of Reforms						
		0	1	2	3	4	5	6
State A Number of Reforms	0							
	1							
	2							
	3	1/1						
	4	1/1						
	5	0/2	1/1		2/2			
	6				0/2	1/1	1/3	

7. Impact of Reform Differences

7.1 Impact of Reform Difference on TFPR Gains

In our benchmark analysis, each pairwise effect is different. And, depending on pairs of states, the difference in the number of reforms varies. Figure 5 shows the estimated reform effects in candle plots. The top and bottom lines show the maximum and minimum estimates. The top and bottom of the box show the 75th and 25th percentiles. The median is shown as the line within the box.

We find that the median reform effect is non-negative for any difference in the number of reforms (Figure 3). Notably, for pairs of all 6 reforms and no reforms, the effects are all positive.

Figure 3: Reforms Difference and DID Coefficients Box Plot

Here, using the benchmark regression results, we conduct a simple regression of the pairwise TFPR effect coefficient estimates on the pairwise reform differences.

$$\hat{\tau}_{kl} = \Delta_{kl}\Delta_t TFPR_{kl} = \alpha_1 + \alpha_2\Delta_{kl}\Delta_t Reform_P + \alpha_3(\Delta_{kl}\Delta_t Reform_P)^2 + \varepsilon_{kl} \quad (7)$$

where Δ_{kl} is the difference operator, k_{th} state values minus l_{th} state values, and Δ_t is the difference operator, after (2015-16) values minus before (2010-11) values. We investigate how the difference in the number of reforms and its square affects the effect coefficient estimates ($\hat{\tau}_{kl}$) for a pair of states (k, l). The results based on the simple OLS are presented in Table 7.

Table 7: Reform Differences on TFPR Gains

	TFPR gain			
	[1]	[2]	[3]	[4]
	All Firms	All Firms	Manufacturing Firms	Manufacturing Firms
Reforms Differences	0.047*	0.233**	0.088*	0.181
	(1.760)	(1.980)	(1.940)	(0.880)
Reforms Difference Square		-0.043*		-0.042
		(-2.440)		(-1.340)
Constant	0.664***	0.319*	1.025***	0.693**
	(7.370)	(1.920)	(6.610)	(2.370)
N	97	97	97	97
Adjusted R-squared	0.022	0.07	0.028	0.036

t statistics in parentheses

Note: Dependent variables are the pairwise differences of log TFPR estimated using the DID. The regressors are Reform Difference of pair of states.

Table 7 shows the specifications [1], [2], and [3] where we take into account all the pairs of states. We find that the greater the number of reforms, the larger the TFPR gains. In other words, the states with more reforms compared to those with less reforms have significantly higher TFPR gains. However, with increasing differences in the number of reforms, the marginal benefits from reforms diminish.¹⁰

7.2 Impact of Reform Difference on TFPR Dispersion Reduction

Hsieh and Klenow (2009) argue that the observed dispersion in the TFPR reflects the presence of distortions that affect the aggregate productivity via misallocation of factor inputs. The business environment reforms are expected to help in alleviating such distortions and lead to a reduction in dispersion in the TFPR, defined as follows. We compare the dispersion of $\log(\text{TFPR})$ in the matched firms in the pairs of states before the business environment reforms and after the business environment reforms.

Here, we conduct a difference-in-difference regression, similar to the $\log\text{TFP}$ level.

$$\Delta_{kl}\Delta_t\text{Dispersion}_{kl} = \gamma_1 + \gamma_2\Delta_{kl}\Delta_t\text{Reform}_{kl} + \gamma_3(\Delta_{kl}\Delta_t\text{Reform}_{kl})^2 + \varepsilon_{kl} \quad (8)$$

for a pair of states (k, l) . Note that we use the Theil's index as the measure of dispersion, based on matched firms following the same procedure explained in Section 5.

Table 8: Reform Difference and $\log(\text{TFPR})$ Dispersion Gain (All State Pairs)

	All Pairs of States			
	[1]	[2]	[3]	[4]
	All Firms	All Firms	Manufacturing Firms	Manufacturing Firms
Reforms Differences	-0.017*	-0.018*	-0.026**	-0.026**
	(-1.840)	(-1.950)	(-3.030)	(-3.060)
Reforms Difference Square		0.003*		0.001
		(2.350)		(1.000)
Constant	0.055*	0.019	-0.031	-0.046
	(1.680)	(0.540)	(-1.060)	(-1.380)
N	101	101	101	101
Adjusted R-squared	0.023	0.066	0.076	0.076

t statistics in parentheses

Note: The dependent variable is the $\log(\text{TFPR})$ Dispersion Gain. The Dispersion Gain is measured here as the difference of the change in the Theil's Index in the pair of states pre-and post-reforms. The Theil's Index is estimated for the matched firms in the pair of States. The regressors are the Reform Difference of pair of states.

¹⁰ For the subset of firms in the neighbouring pairs of states, we do not find any statistically significant relationship between the reform difference and the TFPR gains (report omitted), likely due to much smaller sample numbers (19 pairs).

Table 8 shows the results consistent with our prediction. The reforms lower the productivity dispersion across firms.¹¹

7.3 Robustness Check: Using Different Estimates of TFP

Instead of using an industry-average wage rate, we estimate the wage rate w for each firm as the marginal product of labour.

$$\omega_{ijt} = MPL_{ijt} = \frac{\text{Compensation to employees}_{ijt}}{\text{Total number employees}_{ijt}} \quad (9)$$

As for capital, we estimate

$$\text{Capital Cost}_{ijt} = GVA_{ijt} - \text{compensation to employees}_{ijt} \quad (10)$$

where GVA_{it} is the gross value added by firm i in the time period t . We then construct

$$\text{Total capital}_{ijt} = \text{Owned Asset}_{ijt} + \frac{\text{Leased Asset}_{ijt} + \text{Added Asset}_{ijt}}{2} \quad (11)$$

Note, the Owned asset is the beginning of the period stock value, while the Leased assets and Added assets are flow values which appear during the year, so the half of them are counted as the average total assets.

We estimate r_{ijt} as the marginal product of capital for each firm as below:

$$r_{ijt} = MPK_{ijt} = \frac{\text{capital cost}_{ijt}}{\text{Total capital}_{ijt}} \quad (12)$$

Finally, we estimate the TFP_{ijt} from MPK_{ijt} and MPL_{ijt} as below, following Hsieh and Klenow (2009). Note that we stick to the same production function as before, using the capital share α_{jt} is the industry average, as we did in equation (2).

$$TFP_{ijt} = \left(\frac{MPK_{ijt}}{\alpha_{jt}} \right)^{\alpha_{jt}} \left(\frac{MPL_{ijt}}{1-\alpha_{jt}} \right)^{1-\alpha_{jt}} \quad (13)$$

11 Although the power is lost for border districts samples, perhaps due to small samples ($N = 22$), for all pairs of states, the results are as predicted, that is, more reforms reduces TFP dispersion across firms (report omitted).

As Compensation to Employees data does not exist for the self-employed and is likely to be misreported in case of small family-run businesses, we utilise only enterprises that employ at least 10 workers.¹² With this restriction, the sample size reduces to 141,423 from 473,178.

We run regressions as in equation (6), and we find that the enterprises in the states that have carried out a strictly greater number of reforms show more TFP gains. Table 9a (all firms) and 9b (manufacturing only) present the number of states in which the DID coefficients are found to be positive and statistically significant out of the total DID coefficients. We cannot analyse neighbouring districts' cases because many observations drop out due to our restriction on the sample of firms having at least 10 workers.

Table 9a: Positive and statistically significant DID coefficients (all matched non-financial enterprises)

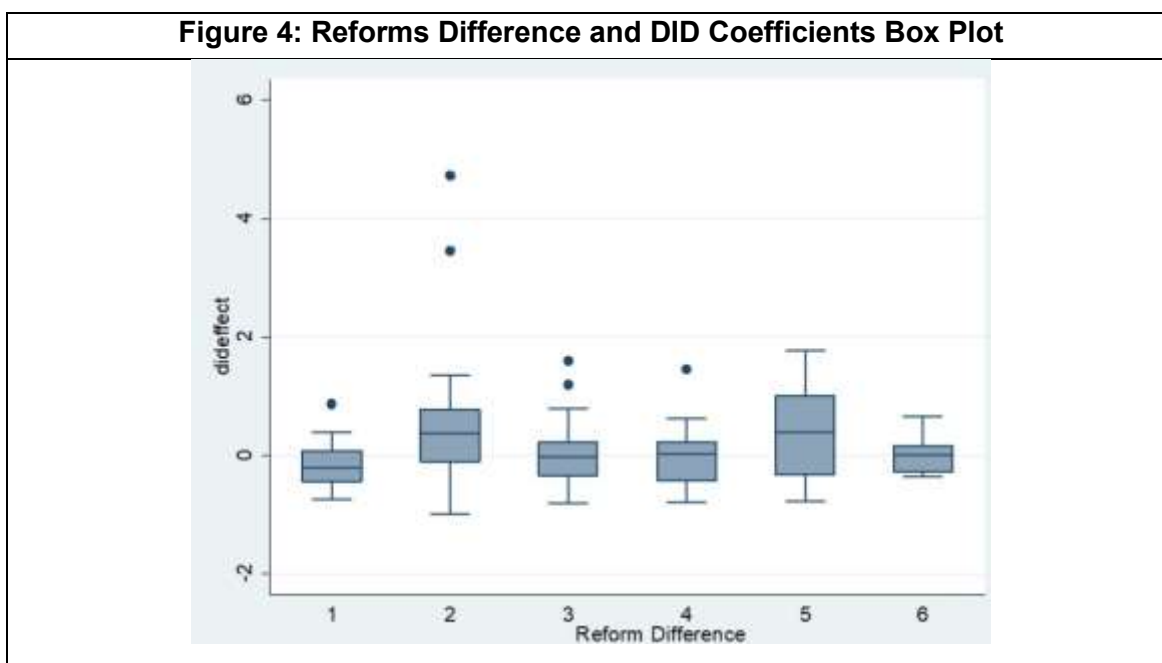
		State B Number of Reforms						
		0	1	2	3	4	5	6
State A Number of Reforms	0							
	1	1/1						
	2	1/4	0/1					
	3	0/6	2/5					
	4	1/2	0/1	2/2	1/3			
	5	4/11	4/6	4/6	4/8			
	6	2/6	1/2	3/5	6/11	0/2	8/15	

¹² Recall that, the analysis so far, we have utilised all the data including self-employed by taking the minimum wages existing (by law) in the given state as the measure of the imputed wage rate for the self-employed individual.

Table 9b: Positive and Statistically significant DID coefficients (matched manufacturing enterprises)

		State B Number of Reforms						
		0	1	2	3	4	5	6
State A Number of Reforms	0							
	1	1/1						
	2	2/2	1/2					
	3	1/1	1/2					
	4	1/1						
	5	3/4	2/2	2/4	2/4			
	6	1/4	3/4	2/4	1/6	0/2	1/5	

We conduct a regression similar to equation (7), that is, LogTFP gain on Reform differences for pairs of states (i.e., \hat{t}_{kl}). We find that the median reform effect on TFP is non-negative for any difference in the number of reforms except for 1 reform difference (Figure 4).



To see the impact of reforms on TFP gains (\hat{t}_{kl}) we run a regression similar to equation (6). However, we do not find a statistically significant relationship between the number of reforms on

TFP gains (Table 10). Again, the effects are likely large in the dropped firms, which are microenterprises with less than 10 workers.

Table 10: Reform Differences on TFPR Gains

	Pairs of Neighboring States along Bordering Districts			
	[1]	[2]	[3]	[4]
	All Firms	All Firms	Manufacturing Firms	Manufacturing Firms
Reforms Differences	-0.006 (-0.080)	0.187 (0.510)	0.035 (0.350)	0.21 (0.510)
Reforms Difference Square		-0.031 (-0.540)		-0.027 (-0.440)
Constant	0.298 (1.060)	0.055 (0.100)	-0.049 (-0.150)	-0.276 (-0.450)
N	42	42	42	42
Adjusted R-squared	0.025	0.043	0.022	0.043

t statistics in parentheses

Note: Robust standard errors are reported in parentheses.

Regarding the TFP dispersion, we conduct the difference-in-difference regression like equation (7). This time, we are able to conduct the similar regressions for dispersion in *MPK* and *MPL*, not just *TFP*. We find that TFP and MPK dispersions declined more in the states where more reforms were carried out (Table 11a), though at a 10 percent significance level, although the effects are weaker for the manufacturing-only sample of firms (Table 11b). So, the sources of the reduction of the TFP dispersion appear mainly through the reduction in MPK dispersion. The results suggest a more efficient allocation of capital across firms after the reform, indicating a better-functioning financial system.¹³

¹³ Abiad, Oomes and Ueda (2008) find similar results of country-wide *MPK* dispersion following financial liberalisation in several emerging market economies.

Table 11a: Reform Difference and Dispersion Reduction (All Matched Firms)

	[1]	[2]	[3]	[4]	[5]	[6]
	TFP	TFP	MPK	MPK	MPL	MPL
Reforms Differences	-0.008 (-1.450)	-0.038* (-1.690)	-0.053 (-0.280)	-1.563* (-2.010)	-0.022 (-0.060)	0.369 (0.230)
Reforms Difference Square		0.005 (1.390)		0.243* (2.000)		-0.063 (-0.290)
Constant	-0.033* (-1.710)	0.004 (0.140)	0.506 (0.810)	2.369* (2.350)	-0.793 (-0.620)	-1.275 (-0.520)
N	42	42	42	42	42	42
Adjusted R-squared	0.012	0.02	0.024	0.018	0.025	0.05

t statistics in parentheses

Note: The Dispersion Gain is measured here as the difference of the change in the Theil's Index in the pairs of states pre-and post-reforms. The Theil's Index is estimated for the matched firms in the pairs of States.

Table 11b: Reform Difference and Dispersion Reduction (All Matched manufacturing Firms)

	[1]	[2]	[3]	[4]	[5]	[6]
	TFP	TFP	MPK	MPK	MPL	MPL
Reforms Differences	0.021 (-1.350)	-0.007 (-0.120)	0.003 (0.370)	0.056 (1.560)	-0.016 (-0.870)	0.082 (0.860)
Reforms Difference Square		0.005 (0.450)		-0.008 (-1.510)		-0.016 (-1.020)
Constant	-0.012 (-0.260)	0.022 (0.280)	-0.033 (-1.140)	-0.098* (-2.200)	0.009 (0.120)	-0.111 (-0.990)
N	42	42	42	42	42	42
Adjusted R-squared	0.029	0.01	0.023	0.014	0.018	0.027

t statistics in parentheses

Note: The Dispersion Gain is measured here as the difference of the change in the Theil's Index in the pairs of states pre-and post-reforms. The Theil's Index is estimated for the matched firms in the pairs of States.

8. Conclusion

The business environment reforms undertaken in India between 2010-11 and 2014-15 were mainly through digitalisation of business-related public administration. The cost of dealing with bureaucratic hurdles is likely negligible for big firms, but may be sizeable for small firms. Thus, these reforms can be considered to help improve the productivities of firms, in particular, small- and micro-manufacturing enterprises.

We have found the gains from these business environment reforms empirically. Using the cross-section data of two rounds of nationally representative survey data on the unincorporated manufacturing enterprises, we conduct the difference-in-difference estimations based on propensity score matching (i.e., controlling for firms' characteristics). We identify the positive TFP growth by business environment reforms among the small- and micro-manufacturing enterprises. For robustness, we restrict our attention to the firms located in the border districts of paired states to control for potentially other factors, though the results may be underestimated due to possible movements of customers and firms over the borders. We broadly find the robustness of our benchmark results.

Moreover, we empirically examine whether increasing the difference in reforms imply a better TFPR outcome. We find the gains in the average total factor productivities of firms from the reforms are significantly larger in the states that carry out a strictly greater number of reforms among the paired states. Also, we find that the greater the difference in business environment reforms, the greater the gains in the total factor productivity.

Furthermore, dispersions of the TFPR across firms are reduced, thanks to the business environment reforms. For a restricted sample of more than 10 employees, we are also able to estimate firm-wise *MPL* and *MPK*, not just *TFP*. Though with weak evidence, we can conclude that improvements in *TFP* dispersion by reforms are mainly due to the improvements in *MPK* dispersion, indicating better capital allocations among firms.

References

- Abiad, A., Oomes, N., and Ueda, K. (2008). The quality effect: Does financial liberalization improve the allocation of capital? *Journal of Development Economics*, 87(2):270–282.
- Antunes, A. R. and Cavalcanti, T. V. d. V. (2007). Startup costs, limited enforcement, and the hidden economy. *European Economic Review*, 51(1):203–224.
- Banerjee, A., Hanna, R., Olken, B. A., Satriawan, E., and Sumarto, S. (2023). Electronic food vouchers: Evidence from an at-scale experiment in Indonesia. *American Economic Review*, 113(2):514–547.
- Beck, T. and Demirguc-Kunt, A. (2006). Small-and medium-size enterprises: Access to finance as a growth constraint. *Journal of Banking & Finance*, 30(11):2931–2943.
- Beck, T., Demirgüç-Kunt, A., and Maksimovic, V. (2008). Financing patterns around the World: Are small firms different? *Journal of Financial Economics*, 89(3):467–487.
- Binci, M., Hebbbar, M., Jasper, P., and Rawle, G. (2018). Matching, differencing on repeat.
- Blundell, R. and Dias, M. C. (2009). Alternative approaches to evaluation in empirical microeconomics. *Journal of Human Resources*, 44(3):565–640.
- Broda, C. and Weinstein, D. E. (2006). Globalization and the gains from variety. *The Quarterly Journal of Economics*, 121(2):541–585.
- Dawson, J. W. and Seater, J. J. (2013). Federal regulation and aggregate economic growth. *Journal of Economic Growth*, 18:137–177.
- Djankov, S. and Freund, C. (2002). New borders: Evidence from the former Soviet Union. *Weltwirtschaftliches Archiv*, 138(3):493–508.
- Djankov, S., McLiesh, C., and Ramalho, R. M. (2006). Regulation and growth. *Economics letters*, 92(3):395–401.
- Foster, L., Haltiwanger, J., and Syverson, C. (2008). Reallocation, firm turnover, and efficiency: Selection on productivity or profitability? *American Economic Review*, 98(1):394–425.
- Haidar, J. I. (2012). The impact of business regulatory reforms on economic growth. *Journal of the Japanese and international economies*, 26(3):285–307.
- Hall, R. E. and Jones, C. I. (1999). Why do some countries produce so much more output per worker than others? *The quarterly journal of economics*, 114(1):83–116.
- Hsieh, C.-T. and Klenow, P. J. (2009). Misallocation and manufacturing TFP in China and India. *The Quarterly Journal of Economics*, 124(4):1403–1448.
- Lewis-Faupel, S., Neggers, Y., Olken, B. A., and Pande, R. (2016). Can electronic procurement improve infrastructure provision? Evidence from public works in India and Indonesia. *American Economic Journal: Economic Policy*, 8(3):258–283.
- Ordonez, J. C. L. (2014). Tax collection, the informal sector, and productivity. *Review of Economic Dynamics*, 17(2):262–286.
- Perry, G. E., Arias, O., Fajnzylber, P., Maloney, W. F., Mason, A., and Saavedra-Chanduvi, J. (2007). *Informality: Exit and exclusion*. The World Bank.

Schneider, F. and Enste, D. H. (2000). Shadow economies: size, causes, and consequences.

Journal of economic literature, 38(1):77–114.

Shleifer, A. and Vishny, R. W. (1997). A survey of corporate governance. *The journal of finance*, 52(2):737–783.

Straub, S. (2005). Informal sector: The credit market channel. *Journal of Development Economics*, 78(2):299–321.

Appendix 1: Theoretical Background: Total Factor Productivity Estimation

In the productivity literature, a conventional method (e.g., Foster et al. (2008) and Hsieh and Klenow (2009)) uses industry-level deflators because plant-level deflators are often difficult to obtain in many countries. Foster et al. (2008) emphasize that, when industry-level deflators are used, differences in plant-specific prices show up in the customary measure of plant-level Total Factor Productivity (TFP). They stress the distinction between physical productivity, which they denote TFPQ, and revenue productivity, which they call TFPR. We use industry-level deflators and estimate TFPR. Similarly, Marginal Product of Capital and Labour are estimated based on revenues and referred to as MRPK and MRPL, respectively.

To estimate TFPR, MRPK, and MRPL we follow Hsieh and Klenow (2009). We set the rental price of capital as $R = 0.1$ (assuming real interest rate r of 5 percent and depreciation δ of 5 percent). We take elasticity of substitution between the plant value added as $\sigma = 3$. Elasticity of substitution may range between 3 to 10 (Broda and Weinstein (2006)) but we take it as 3, as has been done in most of the empirical literature.

We consider an industry s at time t populated by a large number N_{st} of monopolistically competitive firms. We define industries in the data by the three-digit industry classification (NIC-87)¹⁴. Following Hsieh and Klenow (2009), total industry output is given by a CES production function:

$$Y_{jt} = \left[\sum_{i=1}^{N_{jt}} \left(y_{ijt} \frac{\sigma-1}{\sigma} \right) \right]^{\frac{\sigma}{\sigma-1}} \quad (14)$$

where y_{it} denotes a firm's real output, in industry j at time t , σ denotes the elasticity of substitution between different kinds of output. Firms output is given by a Cobb-Douglas production function:

$$y_{ijt} = A_{ijt} k_{ijt}^{\alpha_{jt}} l_{ijt}^{1-\alpha_{jt}} \quad (15)$$

where k_{ijt} is the capital of firm i in industry j and time t , l_{ijt} is labor, A_{ijt} is physical productivity, and α_{jt} is the elasticity of output with respect to capital in industry j . We estimate the wage-to-value-added as the ratio of labour cost to the net value added. We estimate the labour share in each industry $\alpha_{j,t}$ as the average of wage-to-value-added within each industry.

$$\alpha_{j,t} = \text{mean} \left(\frac{\text{labour cost}_{jt}}{\text{net value added}_{j,t}} \right) \quad (16)$$

We measure the nominal net value added, $p_{ijt}y_{ijt}$ as the difference between the total output and the value of total input net of total fixed asset depreciation during the year. We measure the labor input, l_{ijt} as the total labour cost. We measure the capital stock, k_{ijt} as the average of the

¹⁴ In India, manufacturing establishments are classified using the National Industrial Classification (NIC), which is similar to industrial classifications used in other countries. The NICs were revised on several occasions, that is, in 1987, 1998, 2004, and 2008. Using the concordance tables provided by the Ministry of Statistics and Programme Implementation (MOSPI), we convert all industry classifications to the NIC-1987 scheme.

beginning and the end of the year book value of the fixed capital. In fixed assets we include both tangible and intangible fixed assets.

Firms choose their price, capital, and labor to maximize their profits as follows:

$$\max_{p_{ijt}, k_{ijt}, l_{ijt}} \pi_{ijt} = (1 - \tau_{ijt}^y) p_{ijt} y_{ijt} - (1 + \tau_{ijt}^k) (r_t + \delta_{jt}) k_{ijt} - w_{jt} l_{ijt} \quad (17)$$

where w_{jt} denotes the wage, r_t denotes the real interest rate, δ_{jt} denotes the depreciation rate, τ_{ijt}^y denotes a firm-specific wedge that distorts output, and τ_{ijt}^k denotes a firm-specific wedge that distorts capital relative to labour.

The first-order conditions with respect to labor and capital are given by:

$$MRPL_{ijt} = \left(\frac{(1 - \alpha_{jt})(\sigma - 1)}{\sigma} \right) \left(\frac{p_{ijt} y_{ijt}}{l_{ijt}} \right) = \left(\frac{1}{1 - \tau_{ijt}^y} \right) w_{jt} \quad (18)$$

$$MRPK_{ijt} = \left(\frac{\alpha_{jt}(\sigma - 1)}{\sigma} \right) \left(\frac{p_{ijt} y_{ijt}}{l_{ijt}} \right) = \left(\frac{1 + \tau_{ijt}^k}{1 - \tau_{ijt}^y} \right) (r_t + \delta_{jt}) \quad (19)$$

Following Hsieh and Klenow (2009), we define the revenue-based total factor productivity (TFPR) at the firm level as the product of price p_{ijt} times physical productivity A_{ijt} .

$$TFPR_{ijt} = p_{ijt} A_{ijt} = \left(\frac{p_{ijt} y_{ijt}}{k_{ijt}^{\alpha_{jt}} l_{ijt}^{1 - \alpha_{jt}}} \right) = \frac{\sigma}{\sigma - 1} \left(\frac{MRPK_{ijt}}{\alpha_{jt}} \right)^{\alpha_{jt}} \left(\frac{MRPL_{ijt}}{1 - \alpha_{jt}} \right)^{1 - \alpha_{jt}} \quad (20)$$

$$= \frac{\sigma}{\sigma - 1} \frac{(1 + \tau_{ijt}^k)^{\alpha_{jt}}}{\alpha_{jt}^{\alpha_{jt}} (1 - \alpha_{jt})^{1 - \alpha_{jt}} (1 - \tau_{ijt}^y)} (r_t + \delta_{jt})^{\alpha_{jt}} w_{jt}^{1 - \alpha_{jt}} \quad (21)$$

If there are no idiosyncratic distortions in output or capital relative to labour (i.e. distortions are same across industry $\tau_{ijt}^y = \tau_{jt}^y$ and $\tau_{ijt}^k = \tau_{jt}^k$, in other words, if there are idiosyncratic distortions τ_{ijt}^y or τ_{ijt}^k , there would exist dispersion of marginal revenue products and TFP across firms.

Appendix 2: Some additional results

Table A2.1: OLS Regression of Number of Reforms on Other Development Indicators

	Reforms	Reforms	Reforms
Literacy Rate	-0.112 (-1.740)		
Infant Mortality Rate		0.053 (1.510)	
Per Capita Power Availability			0.001 (1.310)
Constant	11.873 (2.430)	1.108 (0.690)	2.309 (2.38)
N	19	19	19
adj. R-sq	0.101	0.067	0.038



PUBLICATIONS

Public Administration Digitalisation and Microenterprise Productivity in India
Working Paper No. WP/2026/086