Can Investment Tax Credits Alleviate Financial Constraints? Evidence from Indian States

Abhay Aneja, Nirupama Kulkarni & S. K. Ritadhi*

August 1, 2018

Abstract

This paper empirically identifies whether investment credits can alleviate firms' financial constraints and lead to aggregate efficiency gains. We exploit a unique setting in India involving the replacement of the retail sales tax with a value-added tax (VAT). The VAT structure permitted firms to reduce their final VAT liability with VAT paid on the purchase of capital inputs, lowering in the process the cost of capital. Using the differential timing in the roll-out of the VAT across states as a source of exogenous variation, the paper tests the impact of this reduction in the cost of capital on firm machinery. The results show that firms increase their stock of plant and machinery in response to the investment credit offered through the VAT framework with the effects being driven by financially constrained firms. The results also show that the increase in firm machinery amongst financially constrained firms is accompanied by higher levels of productivity, indicating that financially constrained firms use the reduction in the cost of capital to expand their stock of productive assets and adopt improved technologies. Finally, the paper also tests for aggregate industry-level effects of the investment credit and shows that industries with a high share of financially constrained firms witness increases in aggregate plant and machinery and reductions in the dispersion of firms' revenue TFP and distortion in capital allocation. The results suggest that investment credits through an alleviation of financial constraints can facilitate a reduction in the misallocation of resources in the economy.

*UC Berkeley-Haas, CAFRAL & Reserve Bank of India. The views expressed in this paper reflect those of the authors and not necessarily that of the Reserve Bank of India.

1 Introduction

A number of studies have documented the presence of financial and credit constraints as a source of friction affecting optimal firm operations (Rajan and Zingales, 1998; Bloom et al., 2010; Banerjee and Duflo, 2014; Larrain and Stumpner, 2017). The impact of financial constraints is further exacerbated in developing countries where formal markets for capital and credit are underdeveloped. A relevant question of interest in this regard to both researchers and policymakers is the extent to which financial constraints can be alleviated using policy instruments. Existing research have typically studied the impact of improved access to credit for financially constrained firms, either through reforms of existing policies targeting credit to firms likely to be financially constrained (Banerjee and Duflo, 2014), or spillovers from broader policies of capital account liberalization which provide financially constrained firms access to alternative markets for capital and credit (Larrain and Stumpner, 2017).

In contrast to these studies focusing on the improved access to credit for financially constrained firms, the present paper identifies whether investment credits through a reduction in the cost of capital enable financially constrained firms to expand their stock of firm machinery and improve their operating efficiency. We use a unique natural experiment in India involving the roll-out of an investment tax credit across Indian states. The investment credit itself was an unintended consequence, embedded within the framework of a value added tax (VAT) which replaced the existing system of retail sales taxes as the primary consumption tax in the economy.

Contrary to sales taxes levied at multiple points in the production chain, the VAT only levied taxes on the incremental value-added by a firm, thereby permitting firms to claim an "input tax credit" (ITC) for all VAT paid on inputs purchased during the firm's production process. Inputs eligible for the ITC included plant and machinery and a firm's final VAT liability was equal to the VAT levied on the firm's output, less the VAT paid by the firm while purchasing its inputs. The ITC in this regard was equivalent to an investment credit which lowered the cost of capital inputs for firms by the amount of VAT paid. This paper empirically identifies whether this reduction in the cost of capital assisted firms to overcome their financial constraints and increase their stock of productive assets.[1]

For causal identification, the paper exploits the differential timing of VAT adoption across states in India. With state governments being empowered to choose the timing of VAT adoption, the first state adopted the VAT in 2004, a further 16 in 2005, 6 in 2006, and 1 each in 2007 and 2008. This difference in timing of VAT adoption across states permits

[1] We define productive assets as the firm's plant and machinery which directly impact firm productivity.

us to implement a difference-in-difference strategy to compare firm outcomes in the pre and post-treatment (before and after VAT adoption) periods and identify the impact of firms' exposure to the treatment – treatment being the ITC provision within the VAT framework – on firm outcomes. Critically, we empirically verify that the timing of states' adoption of the VAT was independent of lagged state-level observables such as state GDP growth and lagged measures of firm-performance, aggregated to the state-level, such as the stock of firm plant and machinery or average firm profitability. This allays concerns that states were adopting the VAT in response to changes in state-level economic factors or due to strategic lobbying by firms, making states' timing of the VAT adoption a valid source of exogenous variation with regard to firm outcomes.

We use the firm-level Prowess database covering over 10,000 registered firms in India in the 1999-2012 period to determine whether the ITC-induced reduction in capital costs assisted firms in alleviating their financial constraints. The empirical results document a significant increase in firm machinery due to the treatment - firms registered a 5 percent increase in the stock of plant and machinery in the post-treatment (post VAT adoption by states) period. To identify whether the ITC alleviated firm financial constraints, we adapt a classification for financially constrained firms similar to Rajan and Zingales (1998) and test for differential treatment effects across firms which were financially constrained in the year prior to treatment. The results show that the increase in firm machinery due to the ITC is restricted to firms which were financially constrained in the year prior to VAT adoption, confirming that financially constrained firms took advantage of the reduction in the cost of capital caused by the ITC and expanded their stock of plant and machinery. Consistent with the findings of other researchers (Bloom et al. 2010; Larrain and Stumpner, 2017) that financially constrained firms are likely to be younger and have smaller firm size (measured by the firm's wage bill), we show that relatively younger (smaller) financially constrained firms witness the largest increase in firm machinery in the aftermath of the treatment. Our results are similar if we measure firm financial constraints using the debt-equity ratio of firms, reflecting firms' dependence on external borrowing, as opposed to equity capital.

Our paper also tests whether the expansion in firm machinery in response to the ITC enhanced firm productivity. We measure productivity using firms' revenue productivity (total factor productivity (TFP) measured as the residual component of firm revenues) as suggested by Hsieh and Klenow (2009) and show that the introduction of the ITC increases firms' revenue productivity (revenue TFP) by 3 percent. Consistent with the results on firm machinery, the increases in firm TFP are concentrated amongst firms which are financially constrained in the year prior to treatment. Collectively, our results support the explanation that the ITC resulted in a reduction in the cost of capital, which in turn allowed financially constrained firms to expand their stock of plant and machinery. The expansion in the stock of plant and machinery enabled financially constrained firms to adopt improved technologies and increase their operating efficiency.

Finally, the paper identifies the aggregate industry level impacts of the ITC-induced increase in firm machinery. In particular, the paper identifies whether an alleviation of financial constraints reduced aggregate misallocation of resources in the economy. In this regard, we rely on Hsieh and Klenow's (2009) seminal work which shows that aggregate misallocation of resources within an industry can be measured using the level of dispersion in the revenue TFP of firms within the industry. We adopt this approach and test the impact of the ITC on the dispersion of firms' revenue TFP at the aggregate 3-digit industry-level. The results, while not very precise, show that the treatment has a negative impact on both industry-level dispersion of revenue TFP and capital distortion as measured by Hsieh and Klenow (2009), along with a positive effect on aggregate industry-level machinery. Consistent with the firm-level results, the negative (positive) impact of the ITC on industry-level dispersion in revenue TFP (aggregate industry-level machinery) is identified in industries with a relatively high share of financially constrained firms in the pre-treatment period. This permits us to attribute the reduction in industry-level revenue TFP dispersion (distortion in capital) to the expansion in firm machinery by financially constrained firms; the ITC through an alleviation of firm financial constraints improves both firm-level productivity and reduces the aggregate misallocation of resources in the economy.

Within the literature, our findings contribute to the body of research studying financial (credit) constraints and firm performance. Our paper is related to the works of Banerjee and Duflo (2014) and Larrain and Stumpner (2017), both of which study the impact of an increase in credit access for financially constrained firms. Banerjee and Duflo (2014) exploit a change in the eligibility of small firms to access subsidized credit in India and establish the presence of credit constraints for firms with high marginal returns to capital; Larrain and Stumpner (2017) show that capital account liberalization provides financially dependent firms access to additional capital and credit markets and reduces the dispersion in marginal returns to capital in financially dependent sectors. The current paper on the contrary studies an alternative policy instrument – an investment credit which reduces the cost of capital for firms and enables financially constrained firms to increase their stock of firm machinery and improve their productivity. Similar to the findings of Larrain and Stumpner (2017), our paper finds that a reduction in the cost of capital also reduces the misallocation of resources within industries.

As our paper studies a reduction in the cost of capital through an investment credit, we also contribute to the large literature studying the role of investment incentives on firm investments. Existing empirical research have reported ambiguous results on this question. While Zwick and Mahon (2017) and Ohrn (2018) report positive impacts of accelerated depreciation provisions and a reduction in corporate tax rates on firm investments, Yagan (2015) finds no impact of the 2003 dividend tax cut – considered the biggest dividend tax cut in U.S. history – on firm investments. In an earlier paper, Goolsbee (1998) also finds no effect of tax incentives on investments and shows that such incentives only raises the price of capital goods and the income of the suppliers of capital goods. Our paper contributes to this literature by showing that an investment credit can have a positive impact on firm machinery through a reduction in the cost of capital which allows select firms to overcome their financial constraints. Importantly, the increase in firm machinery in response to the reduced cost of capital also results in higher firm productivity. This is contrary to the findings of Cerqua and Pellegrini (2014) who show that while capital subsidies in Italy increase firms' investment and employment, it has no corresponding effect on firm productivity. Moreoever, while most of the existing research studying the impact of investment incentives is situated in developed countries, our paper studies the impact of an investment credit on firm performance in a developing country setting.

Finally, our paper also contributes to a growing literature studying the overall impact of value-added taxes which have become a key source of revenues for a majority of economies in the past two decades. While much of the research on the VAT have focused on issues related to tax incidence, revenues and compliance, our paper shows how the off-setting of VAT paid during the production process serves as a reduction in the cost of capital and induces firms to expand their stock of productive capital, resulting in aggregate efficiency gains. In this regard, our paper relates closely to the work of Cai and Harrison (2011) and Liu and Lu (2015) who study the exemption of fixed assets from the VAT base in China. While the former paper finds no impact of the policy on firms' fixed investments, the latter reports a positive impact on firm exports. Importantly, the policy intervention studied by both these papers was explicitly targeted to increase the fixed assets of firms located in underdeveloped regions. In the present paper, we are unable to find any qualitative or empirical evidence to suggest that the policy intervention of interest (VAT adoption by Indian states) was correlated with prior firm performance. In this regard, by identifying the impacts of the ITC on firm performance, our paper identifies a positive spillover of the VAT on firm outcomes and efficiency.

The remainder of the paper is structured as follows: Section 2 provides a background on the VAT in India and the input tax credit, embedded within the VAT framework. We also provide a simple stylistic example to compare the respective impacts of the VAT and the retail sales tax on firm profits. Section 3 describes our data, our measurements of revenue

TFP and firm financial constraints, and also presents some descriptive trends to motivate our empirical findings. Section 4 details our difference-in-difference empirical strategy while Section 5 presents the key findings of the paper. Section 6 presents two robustness checks to validate the results and Section 7 offers some conclusions.

2 Background: VAT and the Input Tax Credit

Value-added taxes were introduced for the first time in India in 1986 with regard to import duties. With the onset of policies of economic liberalization in 1991, both the federal and the state governments increasingly began to consider replacing the existing system of retail sales taxes with a destination-based VAT to improve efficiency in revenue collections and transition to an uniform set of consumption taxes across states. As the federal structure of the Indian Constitution assigned consumption taxes to the domain of state governments, the federal government formed an "Empowered Committee" in 1999 including finance ministers from all of India's states to build consensus across states to design and adopt the VAT common to all states. After five years of delegation regarding the VAT structure, base and rates, the majority of states concurred on replacing the retail sales tax regime with a destination-based VAT. The tax base for the VAT was manufactured goods and two common rates – 4 percent and 12.5 percent – were applied with the majority of goods being assigned to the lower rate. Based on local economic factors, states were also provided the flexibility to exempt a set of 10 goods from the VAT base. Being a destination-based VAT, the VAT was collected at the point of sales, which brought select sectors within the services sector (such as trading and hospitality sectors) under the ambit of the VAT.[2] As the new VAT rates were lower than the prevailing sales tax rates for a number of commodities, the federal government agreed to partially compensate states for losses in revenue in the first three years post-VAT adoption (VAT White Paper, 2005).[3]

The VAT was adopted by states in a staggered manner. The state of Haryana in north India was the first state to adopt the VAT in 2004. In 2005, another 16 states switched from the retail sales tax to the VAT while in 2006, a further 6 states adopted the VAT.[4] In 2007, the southern state of Tamil Nadu adopted the VAT while in 2008, the last state, Uttar Pradesh in northern India, adopted the VAT. This staggered adoption of the VAT created

[2] The inclusion of retail traders under the VAT faced stiff resistance from the traders, particularly small traders, who objected to being brought under the tax net. (The Hindu, March 9, 2005).

[3] The federal government committed to 100 percent compensation for revenue losses in the first year, 75 percent in the second year and 50 percent in the third year.

[4] The total number of states in India in 2005 was 25.

natural treatment and comparison groups, conditional on the timing of VAT adoption by states being exogenous to the firm outcomes of interest. Anecdotal, the reasons for delayed VAT adoption by select states was linked to political opposition as opposed to economic factors (The Times of India, April 1, 2005). All but one state which refrained from adopting the VAT were in opposition to the federal government while two states - Tamil Nadu and Uttar Pradesh - adopted the VAT within a year of state elections which witnessed a change in the state ruling party.[5] To alleviate concerns that the timing of VAT adoption by states was driven by economic factors, we formally demonstrate in Tables (A.2) and (A.3) (Appendix) that the timing of VAT adoption by states was orthogonal to state-specific economic factors.[6]

The "VAT White Paper" (2005) issued by the Empowered Committee posits two key rationales for switching to the VAT: the first is to eliminate the cascading effect of multiple sales taxes levied at various points in the production process. The second is to harmonize consumption tax rates on identical commodities across states, eliminating in the process "unhealthy" tax competition between states. To eliminate the cascading effects of multiple sales taxes in the production process, the VAT framework introduced the input tax credit (ITC) which permitted manufacturers and retailers to receive a credit for any VAT paid on prior purchases.[7] The net VAT remitted to the state government by any firm would be equal to the VAT collected for the commodities sold by the firm, less any VAT paid by the firm for inputs purchased to manufacture these products or operate the establishment.[8] The committee expressed hope that the elimination of multiple sales taxes at various points in the production process would reduce the overall price levels for goods covered in the VAT base.

The VAT framework permitted the purchase of plant and machinery to be eligible for

[5] In Tamil Nadu, the elections in 2006 resulted in the replacement of the incumbent with the DMK party which was a coalition partner in the Congress party led federal government.

[6] In each regression reported in Tables (A.2) and (A.3) (Appendix), the outcome of is a dummy equaling 1 if a state has a VAT in place in a given year. This is regressed on lagged economic factors along with state and year fixed effects and a state-specific time trend. The covariates in Panel A of each table is lagged by 1 year; the covariates in Panel B are lagged by two years. Table (A.2) test whether lagged state-level economic covariates such as growth in state-domestic product, state capital expenditures, state tax revenue and banks per million of population affect the timing of the VAT. Table (A.3) tests whether mean firm characteristics, aggregated to the state-level (weighted by firm sales), impact the timing of VAT adoption. The firm characteristics include lagged sales, profitability and TFP. Reassuringly, out of the 26 covariates tested, only 3 report a statistically significant at the 10 percent margin.

[7] The VAT legislation in the states explicitly mention that any manufacturer or retailer which pays VAT would be eligible to apply the ITC to claim a refund for any VAT paid on prior purchases for business operations.

[8] Thus, according to our interpretation of the state tax rules, a retailer who does not engage in manufacturing activities but remits VAT to the state government for commodities sold as part of its operations would be eligible to claim the ITC for business related expenses such as the purchase of fixed assets for her retail store.

the ITC. This made the ITC provision equivalent to an investment credit as firms could now claim a refund for all VAT paid on the purchase of firm machinery, effectively lowering the cost of capital investments. Importantly, while the White Paper (2005) mentions that all VAT paying firms would be eligible to claim the ITC, it makes no mention that the ITC is designed to incentivize capital investments by firms. This is contrast to the VAT reform in China in 2004, studied by Cai and Harrison (2011) and Liu and Lu (2015) whereby the Chinese government exempted fixed assets from the VAT base in select regions in an effort to induce firms to purchase more fixed assets.[9] The lack of any official mention regarding the ITC and capital investments suggests that in the present context, policymakers did not design to ITC to boost flagging firm investments, ruling out endogeneity between the policy intervention and our primary outcome of interest.

We present in Table A.1 (Appendix A.1) an elementary stylistic example to illustrate firm tax liabilities under the respective retail sales tax and VAT regimes. The firm uses inputs x to produce output y. Both the input and the output is taxed at the rate τ; $0 < \tau < 1$. The input tax paid by the firm is τx and the value added by the firm is $y - x$. Under the retail sales tax system, the firm remits τy to the government, and earns profits equal to the value of output, less taxes and the value of inputs. The profit equals $y(1-\tau) - x$, which we re-write as $(1-\tau)(y-x)) + \tau x$. Under the VAT though, the firm receives a credit for the taxes it paid on its inputs courtesy the ITC. The firm therefore now remits tax solely on the incremental value-addition: $\tau(y - x)$. The firm's profits therefore is the sum of the value of output net of taxes and inputs, and the value of taxes paid by the firm on inputs purchased. Mathematically, the firm's profits under the VAT in this simple example equals $(1-\tau)(y-x)$, which exceeds the profits obtained under the sales tax regime by τx.

Based on this elementary example in Table A.1 (Appendix A.1), we see that the ITC provision embedded within the VAT essentially reduces the firm's cost of inputs by τx. As firms could claim the ITC for VAT paid in the purchase of plant and machinery, we interpret the ITC to serve as a reduction in the firm's cost of capital and this paper identifies whether this reduction in the firm's cost of capital enables financially constrained firms to expand their stock of machinery and subsequently, improve their productivity. The treatment intervention in this paper is the ITC, which is implemented when states adopt the VAT. In this regard, the treatment is equivalent to VAT adoption by states (and the *de facto* adoption of the ITC) and we shall interchangeably use the terms treatment, VAT adoption and ITC for the remainder of the paper.

[9] In their study, Cai and Harrison (2011) find no effect of the reform on firm capital investments. Liu and Lu (2015) on the contrary report a positive impact of the reform on firm investments and exports.

3 Data and Descriptive Trends

3.1 Data

This paper identifies whether investment credits reducing the cost of capital can alleviate firm financial constraints in a developing country. Our agent of interest is the firm and we obtain data on a large sample of Indian firms from the Prowess database.[10] This is a financial database, compiled and maintained by the Center for Monitoring the Indian Economy (CMIE). The Prowess covers both listed and unlisted firms and provides data since 1988. The data is collected primarily from firms' annual reports and quarterly financial statements – all of which are publicly available – along with information gathered from the stock markets. In addition to data on financial information, the Prowess also provides distinct firm identifiers, permitting the construction of a firm-level panel over time.[11] Firm identifiers include the date of incorporation, firms' industry of operation, and the location of firm headquarters. We use the latter information to assign firm locations to various states. Based on the timing of VAT adoption by states in which the firm is headquartered, we determine a firm's treatment status (located in a state which has a VAT in place for that year) and eligibility for ITC.

As only firms paying the VAT are eligible to claim the ITC and the VAT is collected at the point of sales, an implicit assumption is that a firm's headquarters and its centre for operations is located within the same state. While it is impossible to verify the validity of this assumption from the Prowess data,[12] we believe any violation of this assumption is most likely to occur for firms headquartered in major metropolitan cities, which might have different locations of operations. In this respect, we show in Table 7 that our core results are robust to the exclusion of firms located in 6 major metropolitan regions.[13]

We extract the firm-level data from the Prowess for 14 years between 1999 and 2012. This ensures 5 years of pre-treatment and 4 years of post-treatment data for every firm

[10] An alternative (and widely used) database which we considered is the Annual Survey of Industries (ASI) which provides detailed data on manufacturing establishments' location, capital, output, labour and sales. We however prefer the Prowess as it has aggregate firm level information which allows us to measure firm financial constraints and profitability more accurately than the ASI data. Moreover, as the ASI data combines a census and a sampling frame, the number of observations per establishment over a period of time is relatively lower than the Prowess which has annual data for firms over a longer time horizon. The three major disadvantages of the Prowess though is that a) it does not precisely locate firms' location of operations; b) it oversamples large firms; and c) it has very limited information on labour hired by the firm.

[11] This is a distinct advantage of the Prowess in comparison to the ASI. As the ASI combines data from a census and a sampling frame, the majority of firms are observed at 2-3 year intervals.

[12] Prowess unfortunately does not list the number of production or retail units a firm has. Nor does it provide any information on the whether the firm operates across multiple states

[13] The metropolitan areas excluded are Bangalore, Delhi, Hyderabad, Kolkata, Mumbai and Chennai.

(the first and last years of VAT adoption by states was 2004 and 2008 respectively). We restrict our sample to firms operating in the manufacturing, trading (include wholesale and retail trade) and transport sectors which form the bulk of firms remitting the VAT to state governments and henceforth, eligible to claim the ITC.[14] This provides us with a sample of 10,500 firms with the median firm being observed for 12 years. We convert all annual monetary values to 2012 values using the aggregate wholesale price index for manufacturing products. To minimize the impact of outliers, we winsorize our variables of interest at the top and bottom 1 percent.

As we test the impact of an investment credit on firm machinery, our primary outcome of interest is firms' plant, machinery and equipment (subsequently referred to as 'machinery'). Additionally, we also obtain data on gross fixed assets (plant, machinery and equipment is included within fixed assets), total firm assets, firm age (based on year of incorporation), income, sales, cash flow from operations, salaries and profits. The firm-level data is supplemented with time-varying state-specific demographic, fiscal and economic variables which we use as covariates in our empirical specifications. These are sourced from the decennial Census of India and the Reserve Bank of India's Handbook of Statistics on Indian States. Data from these latter sources permit us to control for factors such as state expenditures, revenues, deficits, growth in state domestic product, urbanization, share of workers and education levels – all of which might impact firm outcomes.

3.2 Measuring Financial Constraints and Firm Productivity

We use the Prowess data to create measures of firm financial constraints and firm productivity. We adopt the classification proposed by Rajan and Zingales (1998) to determine whether a firm is financially constrained. Rajan and Zingales (1998) consider a firm to be financially constrained in year t if its capital expenditures in t exceeds its cash flow from operations in year $t\text{-}1$, making the firm necessarily dependent on external sources of finance to fund its current capital investments. While the Prowess does report net cash flow from firm operations, the data is available only for 60 percent of the firm-year observations in the sample. To this extent, in place of firms' cash flow from operations, we consider profits before interest and tax payments. We choose this variable as its distribution is closest to firms' cash flow from operations.[15]

[14] Firms in the mining, financial, real estate and other services not involved in transportation or trading activities are excluded from our the sample.

[15] Comparing the two distributions in terms of millions of USD (2012 values), the mean (median) cash flow from operations was 5.539 (0.357) and mean (median) profits before interest and taxes was 5.318 (0.369). The standard deviations of the two distributions were 22.11 and 17.99. The 10th, 25th, 75th and 90th

Based on this classification, 37 percent of firms in the 1999-2003 period (prior to the VAT being adopted in any state) can be deemed to be financially constrained. This is comparable to the share of financially constrained firms in U.S. industries identified by Giroud and Mueller (2015) using the Compustat data.[16] The 2-digit industries with the highest shares of financially constrained firms (top 25 percentile) are food, textiles, wood, leather, retail trade, land transport, accommodation, publishing activities and motion pictures. The first four are in the manufacturing sector; the remaining are in the services sector.

Consistent with Rajan and Zingales (1998), we also construct a continuous measure of firm-level financial constraints – *FirmFC* – defined as:

$$FirmFC_{it} = \frac{Capex_{it} - Profits_{it-1}}{Assets_{it}} \tag{1}$$

Capex in (1) measures the capital expenditures of firm i in year t, defined as the change in gross fixed assets between year t and *t-1*. Profits is defined as before and we scale the difference between the current year's capital expenditures and lagged profits by the firm's total assets. Intituitively, *FirmFC* captures the amount of funds required by the firm to finance its current investments, in excess of existing profits, as a share of the firm's total assets. A firm is financially constrained in year t if $Capex_{it} - Profits_{it-1} > 0$ and *FirmFC* provides a continuous measure of the intensity of financial constraints.

We measure firm productivity using firms' revenue productivity – or revenue TFP – as recommended by Hsieh and Klenow (2009). To calculate firms' revenue productivity, we assume that a firm's annual production is governed by a standard Cobb-Douglas production function, defined as:

$$Y_{ij} = A_{ij} K_{ij}^{\alpha_j} L_{ij}^{\beta_j} \tag{2}$$

with Y representing the output of firm i in industry j and K and L denoting capital and labour, respectively. A is the residual productivity measure while α is capital's share of income which is invariant within industry j for a given year (Hsieh and Klenow, 2009). We multiply (2) by prices and take logs to calculate the firm's revenue TFP (Hsieh and Klenow, 2009) using the following equation:

$$ln(Sales_{ijs}) = \alpha_j ln(K_{ijs}) + \beta_j ln(L_{ijs}) + \phi_s + \mu_{ijs} \tag{3}$$

percentiles for cash flow from operations (profits before interests and taxes) were -1.50 (-0.14), .042 (0.005), 3.075 (2.409) and 13.449 (11.107).

[16] Giroud and Mueller (2015) report 36 percent of firms to be financially constrained when using the KZ index and 31 percent of firms to be financially constrained using the WW index.

In (3), *Sales* is aggregate annual sales of firm i in industry j and located in state s. Capital stock, K is measured using firms' value of plant and machinery while labour L is measured using total salaries paid by the firm.[17] We also include a state fixed effect, ϕ, to account for time-invariant differences in firm sales common to all firms within a state. We estimate 3 separately for each 3-digit industry-year combination and the residual obtained from the estimation provides us with our firm-specific measure of revenue TFP in logged terms.

3.3 Descriptive Features

Table 1 presents the summary statistics based on the Prowess data. The average firm had USD 20 million in plant and machinery (2012 values) and USD 28 million in gross fixed assets between 1999 and 2012. The distribution is pulled rightwards by large firms as the median firm's plant and machinery (gross fixed assets) was only USD 2.3 (3.7) million. The average value of plant machinery had grown at an annual rate of 2.5 percent in this period from USD 20 to 27.5 million. This was accompanied by an average annual growth in revenue TFP of 1 percent. The majority of the firms[18] in this period were profitable (profits measured before tax and interest payments) with average profits as a share of assets being 6 percent.

Figure 1 provides some descriptive features of firms as binned scatter plots across the range of our financial constraints measure in the pre-treatment period (the 1999-2003 when no state had adopted the VAT). The horizontal axis in each plot is the continuous measure of firm financial constraints – *FirmFC* – which is divided into 20 bins. Within each bin, we plot the unconditional mean for each of the seven firm characteristics of interest. The red line represents a linear fit. Consistent with the findings of Bloom et al. (2010) and Larrain and Stumpner (2017), we observe a negative correlation between firms' financial constraints and firm age and firm size (measured using log sales and log salaries). Thus, firms which are financially constrained are likely to be younger firms with lower sales (wage bills). Importantly, we find that financially constrained firms are also likely to have lower stock of plant and machinery, lower profitability[19] and lower revenue productivity. Consistent with the fact that they are financially constrained, these firms are also more reliant on external debt, as observed from the relatively high debt-equity ratios.

[17] We use value of plant and machinery to maintain consistency with our measurement of firm capital in the paper. The results remain unchanged if we use total capital stock (gross fixed assets) instead. As a handful of firms in the Prowess data provide information on labour, we use total salaries paid instead. This is also consistent with Hsieh and Klenow (2009) who consider salaries to be indicative of labour skills

[18] 75 percent of the firms in the sample in this period recorded positive profits.

[19] Profitability is measured as profits before interest and tax payments, scaled by the firm's total assets.

Prior to undertaking a rigourous examination of whether investment credits alleviate firms' financial constraints, we present some descriptive evidence to motivate our empirical results. We first present two scatter plots comparing mean firm machinery and TFP in the pre and post treatment periods for financially constrained firms. The horizontal axis for both scatter plots in Figure 2 measures the pre-treatment mean logged firm machinery (logged TFP) while the vertical axis measures the post-treatment mean. The red line denotes the 45-degree line. If the treatment indeed induced higher acquirement of firm machinery and raised firm TFP, we would expect the majority of points in the scatter plot to be located above the 45-degree line. Figure 2 shows this exactly to be the case for both firm machinery and TFP, suggesting that financially constrained firms had higher machinery and TFP in the post-treatment period.

In a similar spirit, we also present descriptive trends at the aggregate 3-digit industry level. At the industry level, to compare changes in firm machinery before and after treatment, we compare the ratio of average firm machinery (in logs) in the post and pre-treatment periods. If the reduction in the cost of capital induced firms to expand their stock of machinery, we would expect this ratio to be greater than one. To compare aggregate industry level efficiency and capital misallocation, we compute the dispersion (standard deviation) of firms' revenue TFP within each 3-digit industry, and obtain the ratio of this dispersion in revenue TFP in the post and pre-treatment periods. If the adoption of the ITC improved firms' productivity and reduced capital misallocation, we would expect a reduction in the dispersion of industry revenue TFP (Hsieh and Klenow, 2009) in the post-treatment period and a ratio lower than 1.

The results from this descriptive exercise is presented in Figure 3. The left panel presents the plot for aggregate industry-level machinery; the right panel, the dispersion of revenue TFP within industries. To ascertain whether the ITC is assisting firms in alleviating their financial constraints, we compute the mean post and pre-treatment ratios across 20 bins representing the share of financially constrained firms in the industry.[20] The horizontal axis in each plot represents the share of financially constrained firms across 20 bins and the red line plots the linear fit. If the ITC indeed reduces firm financial constraints, we would expect a positive (negative) correlation between the ratio of post and pre-treatment industry machinery (TFP dispersion) and the share of financially constrained firms in industries. The correlations presented in Figure 3 are consistent with our expectations. There is a strong positive correlation between the share of financially constrained firms and the ratio

[20] An alternative method would be to use the approach of Rajan and Zingales (1998) and obtain a industry-specific measure of firm financial constraints, based on the financial constraint measure of the median firm in each industry. The results are qualitatively unchanged if we use this measure instead.

of post and pre-treatment mean industry machinery. We also obtain a negative correlation between the share of financially constrained firms in an industry and the ratio of post and pre-treatment industry TFP dispersion. However, it is worth noting that contrary to our expectations, the ratio is in excess of 1 for the majority of industries so we reserve our judgement on whether the ITC reduced capital misallocation across industries till we obtain stronger evidence on this question from a more rigourous empirical exercise.

4 Empirical Strategy

4.1 Average Effect of Investment Tax Credit on Firm Investments

We now outline our empirical strategy to identify if the ITC induced reduction in firms' cost of capital assisted firms to overcome their financial constraints and expand their stock of firm machinery. As the ITC is embedded within the VAT framework, we exploit the differential timing of adoption of the VAT across states in the spirit of a differences-in-difference (DiD) framework. The treatment measure is the adoption of the VAT by states which enables firms operating in these states and paying the VAT to avail of the ITC. We first identify the average treatment effect of states adopting the VAT on firm machinery. We subsequently identify the differential impact of the treatment on financially constrained firms, and finally, test if the treatment reduced misallocation of resources at the aggregate industry level. Our primary DiD estimating equation takes the form:

$$\ln(Y_{ist}) = \alpha_i + \delta_t + \theta_s t + \beta VAT_{st} + \phi X_{ist} + \epsilon_{ist} \quad (4)$$

In equation (4), the unit of observation is firm-year. Y is the outcome of interest for firm i, headquartered in state s and observed in year t. Our primary outcome of interest is firm machinery but we later expand our analysis to test the impact of the treatment on firm productivity, calculated as outlined in Section 3. To verify the consistency of our main results, we also test the impact of the treatment on other related dependent variables such as firm machinery scaled by firm assets and gross fixed assets. α and δ are firm and year fixed effects while $\theta_s t$ is a state-specific time-trend controlling for state-specific time varying trends in the outcome of interest. In a more restrictive specification, we replace the year fixed effects with a 2-digit industry-year fixed effect, controlling for annual industry-specific shocks to the outcome of interest.

The independent variable of interest is the treatment indicator, VAT, which equals 1 if state s has a VAT in place in year t, due to which eligible firms can claim the ITC. Thus the VAT dummy equals 0 in all years prior to a states adoption of the VAT and equals 1 for all years subsequent to the state's adoption of the VAT (treatment period). β identifies the average treatment effect, conditional on the firm and year fixed effects, state-specific time trends, and the firm and state-level time varying covariates included in X.[21] The identifying assumption for a causal interpretation of β is that firm outcomes would have been comparable across states in the absence of VAT adoption by states (treatment).

While the parallel trends assumption is not formally testable, we compare the average effect of the VAT on firm machinery seperately for each year in the sample. This permits us to test for pre-trends in the outcome of interest in the years prior to treatment, providing suggestive evidence regarding the parallel trends assumption. Specifically, we estimate the following parsimonious equation:

$$\ln(Y_{ist}) = \alpha_i + \delta_t + \sum_{k=-8}^{8} \beta_k VAT_{st+k} + \epsilon_{ist} \tag{5}$$

Equation (5) identifies the treatment effect separately for each year - 8 years before and after the introduction of the VAT. The year prior to VAT introduction - $k = -1$ - is treated as the base year and the annual treatment effect for the remaining years is estimated relative to this base year. If we are unable to reject the null hypothesis of $\beta_k = 0; k \in \{-2, -3, .., -8\}$, it will provide suggestive evidence on the validity of the parallel trends assumption.

4.2 Differential Effects of Investment Tax Credit Across Firm Characteristics

Having outlined the basic DiD strategy used to estimate the impact of the ITC on firm machinery, we move to test the primary question of interest: whether the ITC-induced reduction in the cost of capital affected financially constrained firms' stock of plant machinery? To this effect, we first identify the firms which are financially constrained in the year prior to VAT adoption and subsequently, test for a differential impact of the treatment across firms which were financially constrained in the year prior to treatment. We use the pre-treatment

[21] We use four firm-specific covariates: a quadratic in firm age and flexible control for the pre-period firm size and firm profitability. Firm size is measured using salaries paid by the firm and profitability is based on firm profits (before taxes and interest payments) as a share of firm assets. For both variables, we identify the decile in which the firm's salaries (profit) is located in the pre-VAT period and interact each decile dummy with a time-trend. We use the pre-VAT deciles to prevent our covariates being influenced by the treatment of interest. State-specific covariates include three demographic covariate - literacy rate, rate of urbanization and the percent of workers - along with growth in the state's domestic product (inflation-adjusted), own-tax and non-tax revenues, capital and social sector expenditures, state fiscal deficit and commercial banks per million population. All the state expenditure and revenue variables are normalized by state domestic product.

year to avoid firms' financial constraints being affected by the introduction of the VAT and subsequent exposure to the ITC.[22] Financial constraints are measured akin to Rajan and Zingales (1998), as discussed in Section 3. The estimating equation is:

$$\ln(Y_{ist}) = \alpha_i + \delta_t + \theta_s t + \beta_1 VAT_{st} + \beta_2 VAT_{st} * FC_{it^{pv}-1} + \phi X_{ist} + \epsilon_{ist} \tag{6}$$

In (6), FC is a dummy equaling 1 if firm i is financially constrained in the year prior to treatment (VAT introduction) - t^{pv}. Firm i is deemed to be financially constrained if its capital expenditures in year t^{pv} exceeds its profits before taxes and interests in year $t^{pv} - 1$. If the treatment assisted firms in alleviating their financial constraints, we would expect $\beta_2 > 0$.

Both the existing literature and our data show that younger and smaller firms exhibit a greater likelihood to be financially constrained (Bloom et al. 2010; Larrain and Stumpner 2018). To this extent, we test a triple interaction to test for the differential effects of the treatment on financially constrained firms, across firm age (size). The estimating equation is:

$$\begin{aligned}\ln(Y_{ist}) = {} & \alpha_i + \delta_t + \theta_s t + \beta_1 VAT_{st} + \beta_2 VAT_{st} * FC_{it^{pv}-1} \\ & + \beta_3 VAT_{st} * FC_{it^{pv}-1} * Young_i + \beta_4 FC_{it^{pv}-1} * Young_i + \phi X_{ist} + \epsilon_{ist}\end{aligned} \tag{7}$$

In (7), our primary parameter of interest is β_3, capturing the differential effect of the treatment across young and old financially constrained firms. *Young* is a dummy equaling 1 if the firm's age is less than the median firm's age in the pre-treatment period. We use an identical equation to test for differential treatment effects across small and large financially constrained firms where firm size is measured by the firm's wage bill.[23] Specifically, instead of the dummy *Young*, we use the the dummy *Small* which equals 1 if the salaries paid by the firm is less than the median salaries paid by firms in the industry in the pre-treatment period.[24]

Finally, to have a better understanding of the firms which respond to the ITC induced reduction in capital costs, we test for two additional interactions in the spirit of equation

[22] In our data, firms switch in and out of being financially constrained. The average firm is financially constrained a third of time, (conditional on being financially constrained at least once in this period).

[23] The results (not shown) are almost identifical if firm size is measured using total sales instead of salaries.

[24] Specifically, for each firm, we calculate the pre-period average salaries paid and compare this pre-period average to the pre-period median salaries paid, computed across all firms. The advantage of adopting this approach is that it washes out any outlier observations which can be attributed to a single year.

(6). The first is to test whether firms with lower machinery in the pre-treatment period respond most to the treatment. We would expect this if firms were unable to reach their optimal level of machinery due to financial constraints as suggested in Figure 1. We also test for the differential response to treatment across firms' pre-period profitability and debt-equity ratio. The latter forms an alterantive measure of firms' financial constraints as firms in India typically finance their capital requirements using bank borrowings as opposed to equity. Thus, a high debt-equity ratio suggests that firms have a higher dependence on external finance.[25]

4.3 Aggregate Industry-Level Effects

Sections 4.1 and 4.2 outlined the empirical strategy to test the impact of the ITC on financially constrained firms. We now discus a similar empirical strategy for the aggregate impacts of the ITC at the 3-digit industry level. At the aggregate industry level, we are particularly interested to identify the impact of the ITC on the dispersion of firms' revenue TFP within industries. Hsieh and Klenow (2009) showed that a more efficient allocation of resources reduced industry-level dispersion in revenue TFP. If the reduction in the cost of capital due to the ITC facilitated financially constrained firms to obtain the optimal level of resources for their operations, we would expect it to reduce the misallocation of resources and thereby, cause a reduction in the industry-level dispersion of firms' revenue TFP. To this effect, we use the following equation to identify the impact of the ITC on aggregate industry-level outcomes:

$$Y_{jst} = \alpha_j + \phi_s + \delta_t + \theta_s t + \beta VAT_{st} + \gamma X_{jst} + \epsilon_{jst} \tag{8}$$

In (8), Y denotes the outcome of interest for industry j, in state s and year t. α now denotes industry-level fixed effects while ϕ is a state fixed effect. The remaining variables are defined as per equation (4). X contains industry and state-level time varying covariates. Standard errors are clustered at the industry-level.

We have three outcomes of interest. The first is industry-level machinery, which is an aggregation of firm machinery to the 3-digit industry level in each state. Our second outcome of interest is the standard deviation of revenue TFP within each 3-digit industry, measuring the industry-level dispersion in revenue TFP and aggregate industry-level misallocation of

[25] The broader literature treats firms' debt-equity ratio as a proxy for risk with higher debt-equity ratios indicating riskier firms. If cost of capital (borrowing) is positively correlated with ex-ante firm risk, we would expect firm's with high debt-equity ratios to face higher pre-period financial constraints, and therefore, more responsive to the ITC.

resources. The third outcome of interest is the mean level of distortion in firm capital allocation within industries, measured as per Hsieh and Klenow (2009).[26]

To verify whether the changes in industry-level outcomes in response to the treatment are driven by financially constrained firms, we identify industries with a high pre-treatment share of financially constrained firms and interact it with the treatment indicator. The estimating equation is:

$$Y_{jst} = \alpha_j + \delta_t + \phi_s + \theta_s t + \beta_1 VAT_{st} + \beta_2 VAT_{st} * HighFC_j + \gamma X_{jst} + \epsilon_{jst} \tag{10}$$

In (10), HighFC equals 1 if the share of financially constrained firms in industry j in the year prior to treatment exceeds the median share of financially constrained firms across all industries in the pre-treatment year. If the impact of the ITC on aggregate industry level outcomes is through an alleviation of firm financial constraints, we would expect the effects to be concentrated in industries with a high pre-treatment share of financially constrained firms.

5 Results

This section discusses the key results of the paper. We first test for the average effect of the treatment (firms' exposure to the ITC due to VAT adoption by states) on firm machinery and TFP. Subsequently, we test for the differential effects of the treatment across financially constrained firms. Finally, we identify if the reduction in the cost of capital for firms due to the treatment resulted in an improved allocation of resources.

5.1 Investment Tax Credit and Firm Machinery

We start with a graphical representation of the annual effects of the treatment on firm machinery, estimated using (5). The coefficients are plotted in Figure (4) and the horizontal axis shows the years post (pre) treatment. We normalize the year immediately prior to the onset of treatment – VAT adoption by the state – as our base year, $t = -1$ – and plot the average annual effect of the treatment across firms relative to this base year. Figure (4)

[26] As per Hsieh and Klenow (2009), we measure capital distortion using the following expression:

$$\tau_{ij} = \frac{\alpha_j}{1-\alpha_j} \frac{wL_{ij}}{RK_{ij}} - 1 \tag{9}$$

where α is the industry-specific return to capital, estimated using equation (3). wL is measured as the firm's salaries while R is assumed to be 0.1, as per Hsieh and Klenow (2009).

documents a sharp increase in firm machinery immediately following the onset of treatment – relative to the year immediately preceding the treatment, firm machinery was 9 percent higher in the year of treatment and 20 percent higher 4 years after the onset of treatment. Importantly, there is no evidence of any trends firm machinery in the pre-treatment period which provides evidence in support of our assumption on parallel trends. We are also unable to reject $\beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8$, implying that the impact of the treatment flattens out, 4 years after the onset of the treatment. This is expected as the maximum difference in the timing of the treatment (VAT adoption) between any two states is 4 years.

Having documented evidence in support of the parallel trends assumption, we test the average effect of the treatment on firm machinery using equation (4). The results are presented in Table 2. We begin with a parsimonious specification in column (1) including only firm and year fixed effects and subsequently expand our covariate vector. The results in column (1) suggest that the treatment increases firm machinery by almost 6 percent, which at the mean of the dependent variable is equivalent to 3 million USD of machinery. Columns (2) and (3) includes firm and state-level covariates while column (4) introduces state-specific time trends. Column (5) of Table 2 contains our most restrictive specification which includes firm and industry-year fixed effects, firm and state time-varying covariates and state-specific time-trends. The average treatment effect is stable to the expansion of our covariate vector, diminishing slightly to below 5 percent but remaining highly significant all through. The robustness of the reduced form results to the covariates and industry-year fixed effects rules out concerns that the estimated treatment effect is due to a spurious correlation between unobserved trends in firm machinery and the timing of VAT adoption.

We verify the consistency of our results to alternate dependent variables and other supporting outcomes of interest in Table A.4 (Appendix). Column (1) normalizes firm machinery by total assets while column (2) shows the impact of the treatment on gross fixed assets (logged). The latter is the sum of all fixed assets owned by the firm, inclusive of plant and machinery, land and buildings. Both these variables form alternative measures of our primary outcome of interest – firm machinery. Reassuringly, the results in columns (1) and (2) show that the treatment (VAT adoption by states) increases both firm machinery as a share of fixed assets as well as gross fixed assets.

Columns (3) and (4) of Table A.4 (Appendix) tests the impact of the treatment on two variables complementary to firm machinery – consumption of raw materials and fuels and electric power by the firm. If a firm is increasing its stock of machinery and utilizing the same in the production process, we would expect increased raw materials to be used. Similarly, as most of the machinery are powered by electricity or gasoline based fuels, we would also expect an increase in the firm's power and fuel consumption. Both dependent variables are logged and the results in columns (3) and (4) document the expected positive impact of the treatment on both outcomes. While the consumption of raw materials increases by 10 percent, the consumption of power and fuels increases by 2 percent (albeit significant at the 20 percent level).

5.2 Investment Tax Credit and Firm Productivity

Section 5.1 showed that the treatment increased firm machinery by 5 percent with the results being stable to the inclusion of firm and state-level covariates and flexible state-specific time trends. We now identify whether the increase in firm machinery impacted aggregate firm level outcomes such as firm profits and productivity. To this effect, we re-estimate specification (4) using two measures of firm profitability, along with our estimates of firms' revenue productivity and capital distortion, as outlined in Section 3.

The results are presented in Table 3. Columns (1) and (2) show the impact of the treatment (VAT adoption by states) on firm profitability, where profits are measured prior to interests and taxes. Column (1) is annual firm profits, prior to taxes and interest payments, while column (2) normalizes annual firm profits by firm assets. For both dependent variables, we identify a positive coefficient, albeit significant at the 10 percent level. In terms of magnitude, the treatment increases firm profitability by 7-8 percent.[27] Columns (3) and (4) tests the impact of the treatment on firm capital distortion as measured by Hsieh and Klenow (2009) and revenue productivity.

Column (3) shows that the treatment reduced capital distortion by 3 percent and increased firms' revenue productivity by 3 percent (column (4)). The results in Table 3 suggests that the expansion in firm machinery by firms has positive spillovers on firm operations, as seen by the increases in firms' profitability and productivity.

5.3 Can Investment Tax Credits Alleviate Firm Financial Constraints?

The previous section established that firms' exposure to the ITC as a result of states adopting the VAT increased their stock of plant and machinery and also positively affected their profitability and productivity. We now address the primary question of the paper: whether the investment credit, brought forth by the ITC, assisted firms in alleviating their financial constraints? We examine this by identifying the differential effect of the treatment

[27] At the mean of the dependent variable, the treatment increases profits by 7 percent (0.361/5.39) and profits as a share of assets by 8 percent.

across financially constrained and non-constrained firms. If the increase in firm machinery is restricted to financially constrained firms, it would provide evidence in support of the hypothesis that investment credits reduces firms' financial constraints. If only financially constrained firms' machinery responds to the treatment and the positive treatment effect on firm TFP identified in Section 5.2 is due to firms expanding their stock of productive capital, we would expect the TFP gains to also be concentrated within financially constrained firms. To validate this channel, we also identify the differential effects of the treatment on firm TFP across financially constrained and unconstrained firms.

We classify a firm as financially constrained if it's current year's capital expenditures exceed previous year's profits (before interest and taxes). Using this classification of financial constraints, we test the differential impact of the ITC across firms who are financially constrained in the year prior to treatment using equation (6). As the existing literature (and our descriptive statistics) inform that younger firms and those with smaller firm sizes will be most affected by financial constraints, we also test the triple interaction between the treatment indicator, the indicator for financial constraints and the dummy for young firms (small size) using equation (7).

The results are shown in Table 4. The dependent variable in columns (1)-(3) is firm machinery while the dependent variable in columns (4)-(6) is firm TFP. Columns (1) and (4) estimate the differential effect of the treatment across firm machinery and TFP. The interaction between the treatment indicator and firm financial constraints (FC) in the year prior to treatment is in both cases positive and statistically significant, suggesting that only financially constrained firms respond to the investment credit provided by the ITC and increase their stock of plant and machinery. The increase in firm TFP in response to the ITC is also restricted to financially constrained firms (column (4)). This supports our contention that the impact of the treatment on firm productivity is due to firms increasing their stock of plant and machinery and switching to a more efficient production technology.

Columns (2) and (4) of Table 4 contains the results from the triple interaction which tests for the differential effect of the treatment across "young" and "old" financially constrained firms; columns (3) and (6) perform the same test across "large" and "small" financially constrained firms. Young firms (dummy $Young = 1$) are firms whose age in the pre-treatment period is less than the median age across all firms in the pre-treatment period. Similarly, small firms (dummy $Small = 1$) are those whose salary payments are less than that of the median firm in the pre-treatment period.

As anticipated, the results show that younger and smaller financially constrained firms respond most to the ITC. The triple interaction for young (small) firms is positive and statistically significant in both columns (2) and (3) suggesting that the increase in firm machinery is concentrated within these young financially concentrated firms. Consistent with the increase in firm machinery, the increase in firm TFP (columns (5) and (6) is also concentrated within younger (smaller) financially concentrated firms, underlining that the increase in firm TFP due to the treatment is an upshot of the treatment's positive effect on firm machinery. The results in this regard are consistent with those obtained by Larrain and Stumpner (2017) who show that amongst financially constrained firms, the younger firms who are most affected by the financial constraints respond most to capital liberalization policies which provides them increased access to finance and increase their investments.

5.4 Investment Tax Credits and Firm Outcomes by Pre-Period Firm Characteristics

The previous section tested the differential effects of the ITC across financially constrained and non-constrained firms and showed that financially constrained firms alone respond to the ITC. The results were also amplified in case of financially constrained firms which were relatively younger (smaller). In support of the results obtained till now, we test for the differential effects of the ITC on firm outcomes across two additional firm characteristics - pre-treatment stock of plant and machinery and pre-treatment debt-equity ratio. Like the previous section, the outcomes of interest are both firm machinery and firm TFP.

Section 4.1 discussed that if financial constraints were precluding firms in acquiring the optimal level of machinery and the ITC facilitated in the reduction of these financial constraints, we would expect firms with initially low levels of machinery to be most responsive to the ITC. The descriptive analysis in Section 3.3 also informed us of a negative correlation between firm financial constraints and firm machinery. We thereby test this hypothesis in columns (1) and (3) and identify the impact of the treatment across firms with "low" and "high" machinery in the pre-treatment period. Firms with "low" pre-treatment machinery are those whose pre-treatment machinery is lower than the pre-treatment median machinery across all firms in that industry. Consistent with our expectations, the impact of the ITC on firm machinery and TFP is present only for the firms with relatively low levels of machinery in the pre-treatment period.[28]

Firms' debt-equity ratio serves as an alternate measure of firm financial constraints;

[28] The relatively large coefficients on the interaction term is possibly due to the skewed distribution of firm machinery. As mentioned in Section 3.1, the mean firm machinery in this period is USD 20 million while the median firm machinery is USD 3 million. As the firms with high and low capital are classified based on the pre-period industry-specific medians, the firms with "low" capital in the pre-treatment period are possibly those with very low values of firm machinery and thereby, the treatment effect is considerably magnified for these firms.

a high debt-equity ratio reflects higher levels of borrowing and a dependence on external sources of finance. This is supported by the positive correlation in our data between firms' intensity of financial constraints and their debt-equity ratios (Section 3.3).[29] Columns (2) and (4) test for differential effects of the treatment across firms with high and low debt-equity ratios in the pre-treatment period. Firms with high debt equity ratios are those whose debt-equity ratio in the pre-treatment period exceeds the pre-treatment industry-specific median debt-equity ratio. The results are consistent with our findings in Section 5.3 – firms with relatively higher pre-period debt-equity ratios respond most to the treatment and see an increase in their firm machinery (productivity).

5.5 Can Investment Tax Credits Reduce Capital Misallocation? Aggregate Industry Effects

Till now, we have identified that the ITC induces firms to expand their stock of plant and machinery. The results are concentrated amongst firms which are financially constrained and are relatively younger (smaller). We have also shown that the increase in firm machinery is accompanied with increases in firm productivity, suggesting overall gains in efficiency due to the ITC. In this section, we aggregate our firm data to the level of industry (3-digit) to identify the aggregate economic effects of the ITC.[30] In particular, as existing studies have shown that financial constraints cause an aggregate misallocation of resources across firms (for instance, Bloom et al. (2010)), we test whether the ITC induced reduction in financial constraints also causes a corresponding reduction in the aggregate misallocation of resources in the economy.

We have three outcomes of interest at the industry level - aggregate plant and machinery within industries, the dispersion of firms' revenue TFP within industries and the mean distortion in capital allocation across firms within industries. As shown in Hsieh and Klenow (2009), a reduction in capital misallocation (possibly due to financial constraints) due to a more optimal allocation of resources across firms leads to a reduction in the dispersion of revenue TFP within industries and lower distortion of capital allocation allocation across firms. Thus, if the ITC indeed reduced the misallocation of machinery across firms by increasing financially constrained firms' access to plant and machinery, we would expect to see a reduction in the both the dispersion of firms' revenue productivity and the mean levels of capital distortion within industries.

[29] The debt-equity ratio can also proxy for higher risk, which can increase the interest cost for these firms and create a borrowing constraint.

[30] The industrial classifications are based on the 2008 National Industrial Classifications (NIC).

Finally, we also verify that firm financial constraints is the mechanism through which the ITC affects industry-level outcomes. The firm-level results showed that financially constrained firms responded to the ITC and increased their stock of firm machinery. In this regard, we would expect the impact of the ITC to be enhanced in industries which have a high share of financially constrained firms in the pre-treatment period. To test this hypothesis, we identify the differential effects of the ITC across industries with relatively high and low share of financially constrained firms in the year prior to treatment. Industries with a high concentration of financially constrained firms are ones where the share of financially constrained firms in the year prior to the treatment (VAT adoption by states) exceeds the median share of financially constrained firms in the pre-treatment period. The estimation is undertaken using equation (10).

The aggregate industry level results are in Table 6. Column (1) suggests that the ITC increased industry-level plant and machinery by 4 percent although the coefficient is not statistically significant. Column (2) tests for differential effects by interacting the treatment with a dummy indicating industries which have a relatively high share of financially constrained firms in the pre-treatment period. Consistent with our expectations, the interaction term is positive although not statistically significant. The sum of the coefficients is significant at the 20 percent level (p-value 0.16). The results suggest that the ITC had a positive impact on plant and machinery in industries with a relatively high share of financially constrained firms, supporting our argument that the ITC assisted firms in overcoming their financial constraints and increasing their stock of plant and machinery.

Columns (3) and (4) of Table 6 test the impact of the ITC on logged industry-level dispersion of revenue TFP. Column (3) suggests that the treatment reduced industry-level TFP dispersion by 4 percent although the coefficient is not statistically significant. Column (4) tests for differential treatment effects across industries with a relatively high share of financially constrained firms and the interaction term is negative as expected but not significant. The sum of the coefficients however are significant at the 15 percent level (p-value of 0.12), suggesting that the dispersion in revenue TFP fell by 5 percent in industries with a relatively high share of financially constrained firms. While the lack of precision calls for a cautious interpretation of the coefficients, the results provide suggestive evidence to the claim that the reduction in firms' cost of capital due to the ITC assisted financially constrained firms in expanding their stock of plant and machinery, resulting in lower misallocation of capital, as seen through a reduction in the dispersion in industry-level revenue TFP.

Finally, columns (5) and (6) show that the treatment significantly lowered capital distortion within industries. At the aggregate industry level, capital distortion within industries (measured as the mean capital distortion across firms in that industry) declined by 5 percent in response to the treatment (column (5)). Column (6) shows that the treatment effect is concentrated within industries with a relatively high share of financially constrained firms in the pre-treatment period: the interaction between the treatment indicator and the indicator for industries with a relatively high share of financially constrained firms is negative (albeit statistically insignificant) and the sum of the coefficients is highly significant, suggesting that industry-level capital distortion across firms declined by 8 percent in response to the treatment in industries with a relatively high share of financially constrained firms in the pre-treatment period.

Collectively, the industry-level results indicate that the ITC induced reduction in the cost of capital increased aggregate industry level plant and machinery and led to an improved allocation of resources in the economy, as suggested by the negative impact on the dispersion of revenue TFP and capital distortion. The effects are driven by industries with a relatively high share of financially constrained firms in the year prior to treatment, thereby confirming that the reduction in capital costs due to the ITC assist firms in overcoming their financial constraints and expanding their stock of plant and machinery. This eventually reduces distortion in capital allocation across firms and lowers aggregate misallocation of resources in the economy.

6 Robustness

This section undertakes two tests the assess the robustness of the results discussed in Section 5. We first test the sensitivity of the results to the exclusion of metro cities from the sample. As discussed in Sections 2 and 3, VAT paying firms are eligible to claim the ITC and VAT payments by a firm depends on its location of operations (since the VAT is levied at the point of sales). The Prowess data informs us about the location of firm headquarters but does not inform us about the firm's location of operations. For the purposes of this paper, we assume that the state in which a firm is headquartered is also the state of its operations and match this with the state's adoption of the VAT to determine a firm's treatment status in any given year. However, if this assumption is violated, and a firm operates in a state where it is not headquartered, we would be erroneously assigning treatment status to firms which are possibly not being treated and vice-versa. While we cannot directly test this in the Prowess data, one robustness check we undertake is to exclude firms located in the 6 major metropolitan cities in India. We believe these firms would have the highest probability of operating in a state other than where their headquarters are registered. Moreoever, some of the metropolitan cities are located very close to state boundaries,[31] increasing the likelihood of firms operating in a state but choosing to locate their headquarters in the closest metropolitan city in an adjacent state. To verify that our results are not being driven by firms in metropolitan cities with a higher likelihood of operating in states other than the one in which they are headquartered, we re-run our key specifications after excluding firms in the 6 largest metropolitan areas of India.[32]

The results are presented in Table 7. The dependent variable in the first two columns is firm machinery; the dependent variable in the last two columns is firm TFP. Columns (2) and (4) test the differential impact of the treatment across financially constrained firms not located in major metropolitan areas. Even though we lose almost half of our observations, the results are comparable to those obtained with the full sample with the exception of the average treatment effect on firm TFP. While the treatment effect is significant at the 15 percent level for firm machinery (column (1)), the interaction between the treatment and the indicator for firm financial constraints is positive and statistically significant for both outcomes. This reassures us that our results are not being driven only by firms in metropolitan areas for whom there is a greater likelihood in mismatch in the location of firm headquarters and firm operations.

We also a conduct a placebo test by randomly assigning states alternate years of VAT adoption and re-estimating specification (4) with this set of placebo treatment years instead of the true treatment years. If the results in Section 5 are not driven by a spurious correlation of unobservable factors correlated with the timing of VAT adoption in states, we would expect the coefficients estimated from this placebo test to be statistically insignificant.

We undertake this placebo test 1000 times for both firm machinery and TFP and plot the empirical CDF of the coefficients in Figure 5. The red line represents the parameter estimate, estimated using the states' true years of VAT adoption. Reassuringly, for both firm machinery and firm TFP, over 85 percent of the estimated coefficients from the placebo test are less than the "true" coefficient. For firm machinery, only 94 out of 1000 specifications report a positive and statistically significant coefficient at the 5 percent level; the corresponding statistic for firm TFP was 147.

[31] This is particularly true for Mumbai, Bangalore and Chennai. These cities are located in the states of Maharashtra, Karnataka and Tamil Nadu respectively but are very close to the state's border with Gujarat, Tamil Nadu and Andhra Pradesh. Anectodal evidence suggest a number of firms in southern Gujarat are headquartered in Mumbai.

[32] These are namely Delhi (including the satellite cities of Noida and Gurgaon, located in Uttar Pradesh and Haryana respectively), Mumbai (including Pune, Kalyan, Thane and Navi Mumbai), Kolkata (including North and South 24 Parganas), Hyderabad and Bangalore.

7 Conclusion

This paper empirically identifies whether investment credits can enable firms to overcome their financial constraints through a reduction in the cost of capital. We use a natural experiment in India which introduced an input tax credit (ITC) within the structure of a VAT. The ITC permitted firms to offset their final VAT liability with VAT payments made during the purchase of inputs. We argue that this reduction in overall VAT liability serves as an investment credit and the paper tests the whether this investment credit assisted firms in overcoming their financial constraints.

Exploiting the roll-out of the VAT across states as a source of exogenous variation, we identify that firms expanded their stock of plant and machinery in response to the investment credit. The increase in plant and machinery however was limited only to firms which were financially constrained in the year prior to the adoption of the VAT by states, suggesting that financially constrained firms alone responded to the treatment. We also show that states' adoption of the VAT increased firms' revenue TFP and this too was driven by firms which were financially constrained in the year prior to treatment. Finally, we provide suggestive evidence at the industry level that the investment credit increased aggregate plant and machinery in industries and reduced both the dispersion of firms' revenue TFP and capital distortion within industries. The results underline that in addition to assisting financially constrained firms in expanding their stock of plant and machinery, the investment credit reduced aggregate misallocation of resources in the economy.

8 References

Banerjee, A. and E. Duflo (2014). Do Firms Want to Borrow More? Testing Credit Constraints Using a Directed Lending Program. *Review of Economic Studies 81(2)*: 572-607.

Banerjee, A., E. Duflo and K. Munshi (2003). The (Mis)allocation of Capital. *Journal of the European Economic Association 1(2-3)*: 484-494.

Benzarti, Y., D. Carloni, J. Harju and T. Kosonen (2017). What Goes Up May Not Come Down: Assymetric Incidence of Value-Added Taxes *Unpublished Working Paper*.

Bloom, N., A. Mahajan, D. McKenzie and J. Roberts (2010). Why do Firms in Developing Countries Have Low Productivity. *American Economic Review: Papers and Proceedings 100(2)*: 619-623.

Cai, J. and A. Harisson (2011). The Value-Added Tax Reform Puzzle. *NBER Working Paper 17532*.

Cerqua, A. and G. Pellegrini (2014). Do Subsidies to Private Capital Boost Firms' Growth? A Multiple Regression Discontinuity Approach. *Journal of Public Economics 109(C)*: 114-126.

Giroud, X. and H. M. Mueller (2015). Capital and Labor Reallocation Within Firms. *The Journal of Finance 52(4)*: 1767-1804.

Goolsbee, A. (1998). Investment Tax Incentives, Prices and the Supply of Capital Goods. *The Quarterly Journal of Economics 113(1)*: 121-148.

Hall, R. E. and D. W. Jorgenson (1967). Tax Policy and Investment Behaviour. *The American Economic Review 57*: 391-414.

Hsieh, C. and P. J. Klenow (2009). Misallocation and Manufacturing TFP in China and India. *The Quarterly Journal of Economics 124(4)*: 1403-1448.

Larrain, M. and S. Stumpner (2017). Capital Account Liberalization and Aggregate Productivity: The Role of Firm in Capital Allocation. *The Journal of Finance 72(4)*: 1825-1858.

Liu, Q. and Y. Lu (2015). Firm Investment and Exporting: Evidence from China's Value-Added Tax Reform. *Journal of International Economics 97(2)*: 392-403.

Metcalf, G. E. (1995). Value-Added Taxation: A Tax Whose Time Has Come? *Journal of Economic Perspectives 9(1)*: 121-140.

Ohrn, E. (2018). The Effect of Corporate Taxation on Investment and Financial Policy: Evidence from the DPAD. *American Economic Journal: Economic Policy 10(2)*: 272-301.

Rajan, R. and L. Zingales (1998). Financial Dependence and Growth. *The American Economic Review 88(3)*: 559-586.

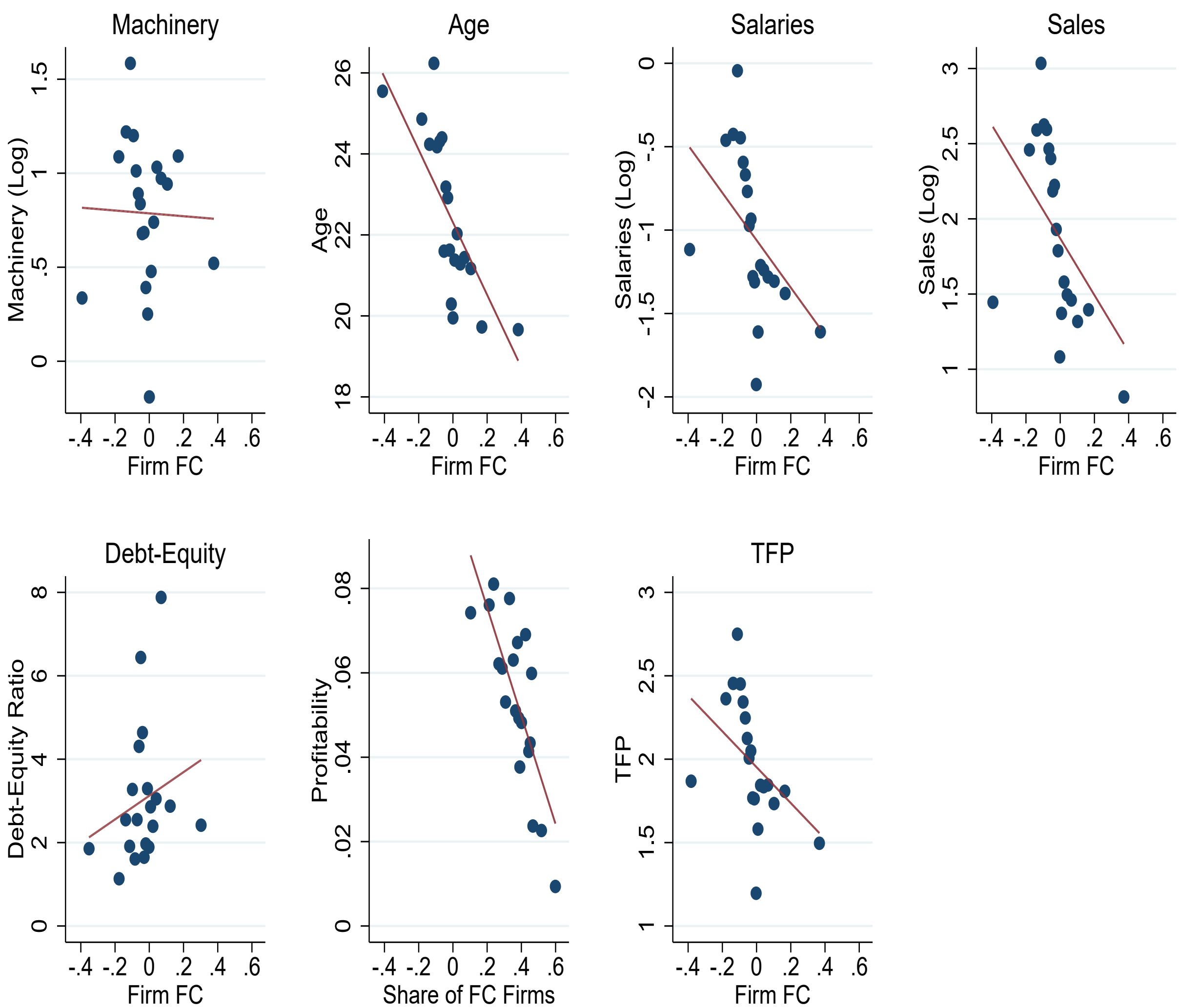
The Empowered Committee of State Finance Ministers (2005). A White Paper on

State-Level Value Added Tax. *Ministry of Finance, Government of India*.
Yagan, D. (2015). Capital Tax Reform and Real Economy: The Effects of the 2003 Dividend Tax Cut. *The American Economic Review 105(12)*: 3531-3563.
Zwick, E. and J. Mahon (2017). Tax Policy and Heterogenous Investment Behaviour. *The American Economic Review 107(1)*: 217-248.

9 Figures

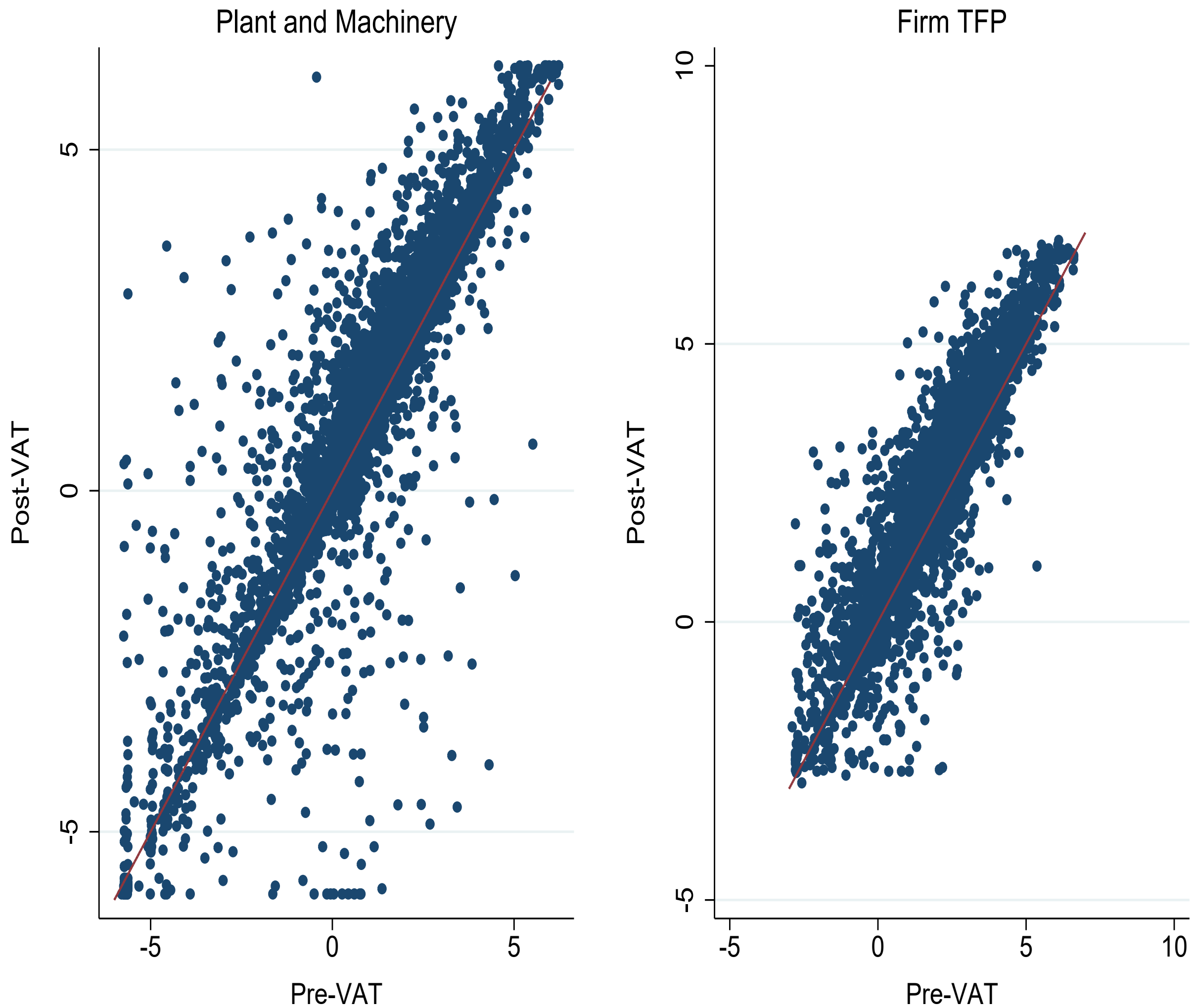
Figure 1: Characteristics of Financially Constrained Firms

Acemoglu, D. and J. Robinson



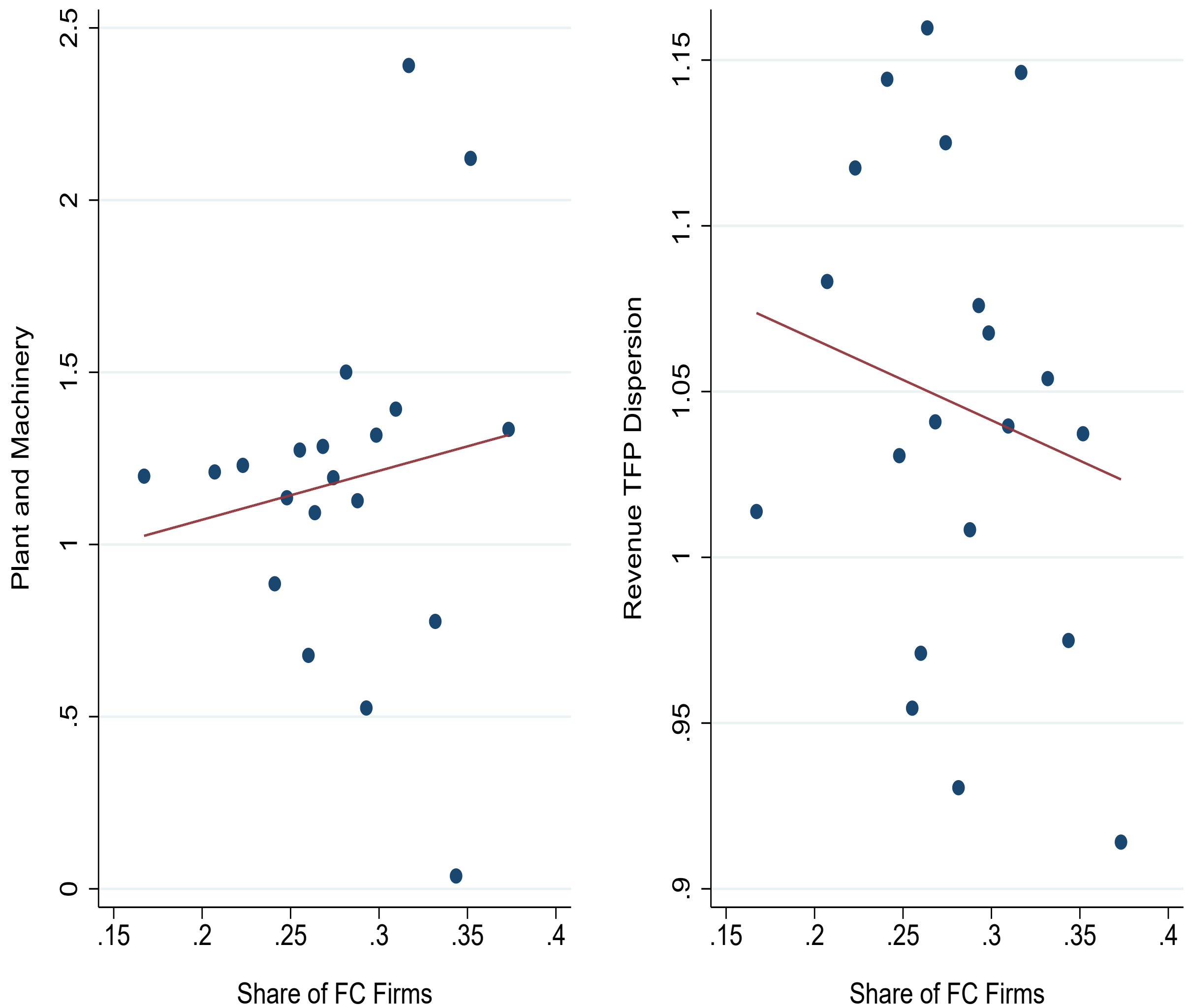
Notes: This figure depicts the correlation between financial constraints and select firm characteristics. The x-axis is a continuous measure of firm financial constraints, defined as the difference between firm capital expenditures and firm profits before interest and taxes, scaled by firm assets. The x-axis is divided into 20 bins based on the measure of firm financial constraints. In each picture, the blue cirlces represent the average value of the firm characteristic of interest in each bin of firm financial constraint.

Figure 2: Comparison of Average Firm Machinery and TFP Pre and Post Treatment for Financially Constrained Firms



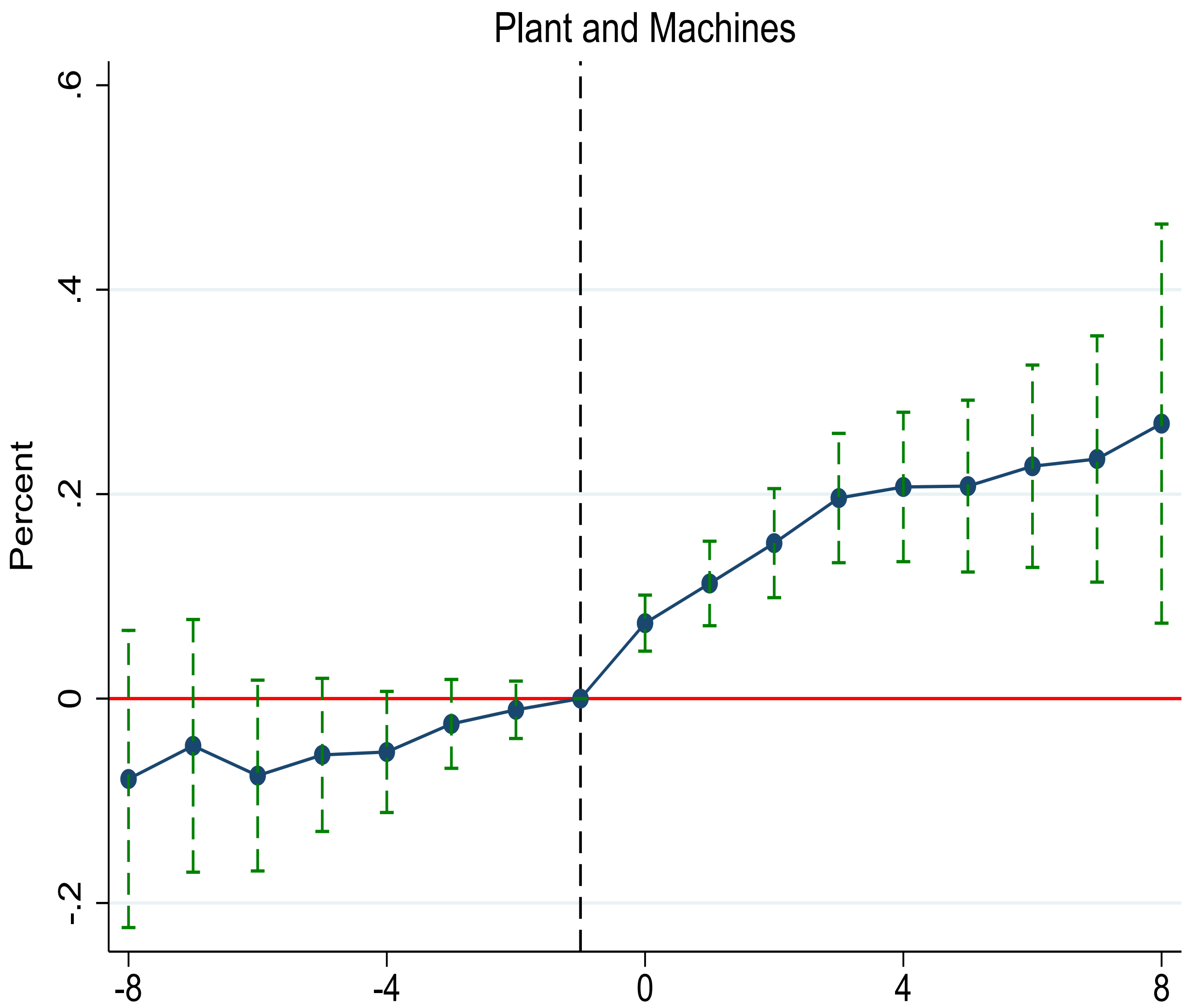
Notes: This figure compares the pre and post-treatment levels of firm plant and machinery and firm TFP for financially constrained firms. The vertical axis represents the average firm machinery (TFP) in the post-treatment period; the horizontal axis represents the average firm machinery (TFP) in the pre-treatment period. The red line is the 45 degree line, where average pre-treatment firm machinery (TFP) equals average post-treatment firm machinery (TFP).

Figure 3: Aggregate Industry-Level Comparisons by Share of Financially Constrained Firms in Industry: Pre and Post-Treatment Industry Machinery and TFP Dispersion



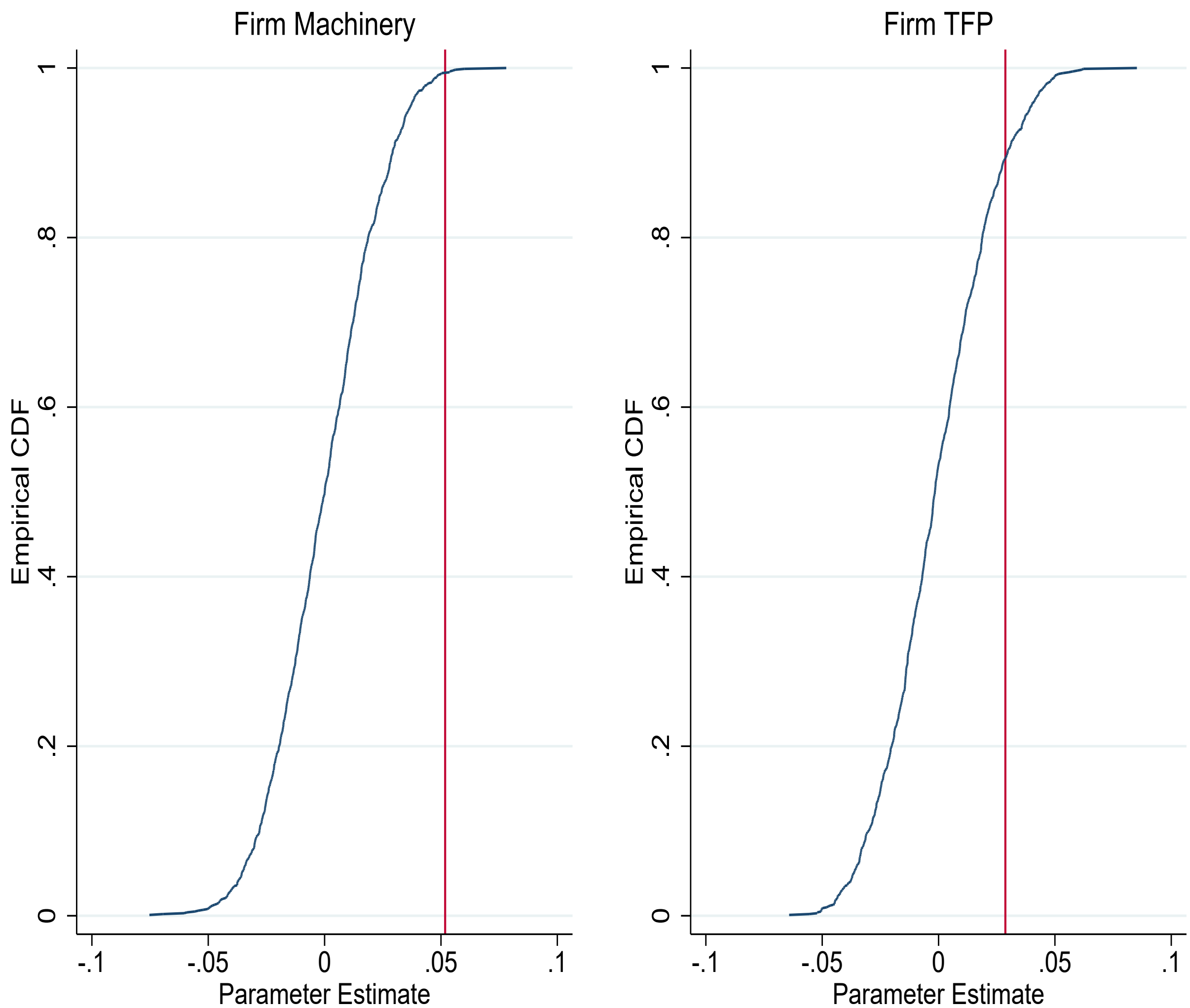
Notes: This figure compares the pre and post-treatment levels of industry plant and machinery and revenue TFP dispersion. The vertical axis measures the ratio between the average post-treatment and pre-treatment industry machinery (revenue TFP dispersion). The horizontal axis measures the share of financially constrained firms in each industry, across 20 bins. Each blue circle represents the average ratio between post and pre-treatment industry machinery (revenue TFP distortion) corresponding to the share of financially constrained firms in an industry for that bin.

Figure 4: ITC and Firm Plant and Machinery - Difference-in-Difference



Notes: This figure presents the coefficient plots from a regression of logged firm machinery on a set of dummies corresponding to the year post (pre) treatment. Each coefficient represents the average value of firm machinery in the post (pre)-treatment year, relative to the year prior to treatment.

Figure 5: Empirical CDF of Placebo Effect



Notes: These figures present empirical CDFs plotting the distribution of placebo treatment effects for firm plant and machinery and firm TFP. The red line represents the true treatment effect.

10 Tables

Table 1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Plant and Machinery (2012 USD millions)	20.29	63.87	0	507.23	85305
Gross Fixed Assets (2012 USD millions)	28.56	87.18	0	689.17	91690
Assets (2012 USD millions)	56.52	170.87	0.01	1296.65	100140
Sales (2012 USD millions)	56.7	153.17	0	1152.24	83814
Salaries (2012 USD millions)	2.58	7.02	0	51.54	85438
Profits Before Interest and Taxes (2012 USD millions)	5.39	18.15	-6.05	139.59	93974
Profits After Taxes (2012 USD millions)	2.17	10.15	-18.57	76.64	93937
Debt (2012 USD millions)	23.99	70.02	0	511.91	85178
Revenue TFP	2.09	2	-2.89	6.87	75544
Capital Distortion	-0.76	0.57	-1.16	5.03	75544
Raw Materials (2012 USD millions)	30.85	75.56	0	516.72	64968
Power and Fuels (2012 USD millions)	2.57	8.24	0	65.51	72514
Machinery as a Share of Assets	0.39	0.41	0	2.27	85286
Profits as a Share of Assets	0.06	0.13	-0.5	0.6	93828
Debt Equity Ratio	5.60	191.97	0	32357	83894
Financially Constrained Firm	0.28	0.45	0	1	79366

Table 2: VAT and Firm Plant and Machinery

	(1) Plant Machines	(2) Plant Machines	(3) Plant Machines	(4) Plant Machines	(5) Plant Machines
VAT	.057***	.052***	.041**	.052***	.046***
	(.018)	(.017)	(.018)	(.016)	(.016)
Observations	85305	84663	84602	84587	84587
R^2	.91	.92	.92	.92	.92
Dep Var Mean	20.29	20.29	20.29	20.29	20.29
Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	No	No	No	No	Yes
State-Time Trend	No	No	No	Yes	Yes
Covariates	No	Yes	Yes	Yes	Yes

The above specifications test the impact of VAT adoption on firms' plant and machinery. The unit of observation is firm-year. The dependent variable in each specification is the firm's plant and machinery, measured in 2012 millions of USD. The independent variable of interest is a dummy equaling 1 if the state in which the firm is headquartered has a VAT in place in the given year. All specifications include firm and year fixed effects. Columns (2) includes firm-level controls. Column (3) includes both firm-level controls and state-specific covariates. Column (4) adds state-specific time trends while column (5) includes 2-digit industry-time fixed effects. Firm-level controls include a quadratic in firm age and flexible time-varying controls for initial firm size and profitability. State-level time-varying covariates include a) capital spending; b) tax and non-tax revenues; c) fiscal deficit; d) social expenditures; e) constant NSDP growth rate; f) commercial bank branches per million of population; g) share of workers; h) share of literates; i) rate of urbanization. Standard errors are in parentheses, clustered at the firm level.

Table 3: VAT and Firm Profits, Capital Distortion and TFP

	(1) Pre-Tax Profits	(2) Pre-Tax Profits Share of Assets	(3) Capital Distortion	(4) TFP
VAT	.361*	.005*	-.031***	.029**
	(.208)	(.003)	(.009)	(.013)
Observations	93228	93084	74943	74943
R^2	.80	.39	.64	.92
Dep Var Mean	5.39	.06	-.76	45.76

The above specifications test the impact of VAT adoption on firm profits, capital distortion and TFP. The unit of observation is firm-year. The dependent variable in column (1) is profits before taxes and interest payments, measured in 2012 millions of USD. The dependent variable in column (2) is the share of firms profits (before taxes and interest payments) to assets. The dependent variable in column (3) is the firm' capital distortion, defined as per Hsieh and Klenow (2009) ; and the dependent variable in column (4) is firm TFP. The independent variable of interest is a dummy equaling 1 if the state in which the firm is headquartered has a VAT in place in the given year. All specifications include firm and year fixed effects along with firm and state-level covariates and a state-specific time-trend. Standard errors are in parentheses, clustered at the firm level.

Table 4: Differential Effects of VAT Adoption by Firm Financial Constraints

	(1) Plant Machines	(2) Plant Machines	(3) Plant Machines	(4) TFP	(5) TFP	(6) TFP
VAT	-.074***	-.147***	-.026	-.026*	-.062***	-.004
	(.017)	(.022)	(.019)	(.015)	(.018)	(.017)
VAT*FC	.294***	.228***	.265***	.132***	.062*	.095***
	(.032)	(.040)	(.040)	(.025)	(.032)	(.031)
VAT*Young		.171***			.080***	
		(.034)			(.027)	
VAT*FC*Young		.129**			.148***	
		(.063)			(.051)	
VAT*Small			-.123***			-.062**
			(.029)			(.024)
VAT*FC*Small			.080			.107**
			(.064)			(.053)
Observations	76841	76841	76841	68826	68826	68826
R^2	.93	.93	.93	.92	.92	.92
Dep Var Mean	20.29	20.29	20.29	45.76	45.76	45.76

The above specifications test the differential impact of VAT adoption by firm financial constraints. The unit of observation is firm-year. The dependent variable in columns (1)-(3) is the firm's plant and machinery, measured in 2012 millions of USD; the dependent variable in columns (4)-(6) is firm TFP. A firm is considered financially constrained (FC) if capital expenditures exceeds firm profits (before taxes and interests) in the year prior to VAT adoption. A firm is considered to be young (Young) if the firm's age is less than the median age of firm's in the sample. A firm is considered to be small if salaries to workers in the pre-VAT period is less than that of the median firm (within 3-digit industry) in the sample. All specifications include firm and year fixed effects along with firm and state-level covariates and a state-specific time-trend. Standard errors are in parentheses, clustered at the firm level.

Table 5: Differential Effects of VAT Adoption by Pre-Period Firm Characteristics

	(1) Plant Machines	(2) Plant Machines	(3) TFP	(4) TFP
VAT	-.195***	-.065***	-.075***	-.054***
	(.018)	(.024)	(.016)	(.019)
VAT*Low Capital	.617***		.255***	
	(.027)		(.021)	
VAT*High Debt-Equity		.185***		.124***
		(.028)		(.022)
Observations	84587	84587	74943	74943
R^2	.92	.92	.92	.92
Dep Var Mean	20.29	20.29	45.76	45.76

The above specifications test the differential impact of VAT adoption by pre-period firm characteristics. The unit of observation is firm-year. The dependent variable in columns (1)-(2) is the firm's value of plant and machinery, measured in 2012 millions of USD; the dependent variable in columns (3)-(4) is the firm's TFP. In each specification, the VAT dummy is interacted with a firm characteristic dummy. The dummy indicates whether the firm's pre-period mean is higher or lower than the 3-digit industry-specific pre-period median for each characteristic. the CAPITAL dummy is based on the value of plant and machines as a share of firm assets. Debt-Equity is the firm's debt-equity ratio, which serves as an alternative measure of financial constraints. The dummy is based on a comparison to the pre-period 3-digit industry median. All specifications include firm and year fixed effects along with firm and state-level covariates and a state-specific time-trend. Standard errors are in parentheses, clustered at the firm level.

Table 6: VAT and Industry Level Outcomes

	(1) Plant Machines	(2) Plant Machines	(3) TFP Dispersion	(4) TFP Dispersion	(5) Capital Distortion	(6) Capital Distortion
VAT	.038	-.030	-.044	-.036	-.042**	-.017
	(.051)	(.070)	(.034)	(.046)	(.021)	(.031)
VAT*High Share FC Firms		.127		-.015		-.048
		(.094)		(.042)		(.038)
Observations	10854	10854	6544	6544	8580	8580
R^2	.49	.49	.19	.19	.21	.21
Dep Var Mean	153.63	153.63	1.58	1.58	-.78	-.78

The above specifications test the impact of VAT adoption on aggregate industry-level outcomes. The unit of observation is industry-state-year, at the 3-digit level of industry classifications. The dependent variable in columns (1) and (2) is logged industry level plant and machinery; the dependent variable in column (2) is logged gross fixed assets; the dependent variable in columns (3) and (4) is logged dispersion in firms' revenue TFP within industries; the dependent variable in columns (5) and (6) is average capital distortion in firms within the industry, measured as per Hsieh and Klenow (2009). The dependent variable in columns (1) and (2) are measured in 2012 millions of USD. The interaction term in columns (2), (4) and (6) interacts the VAT indicator with an indicator representing whether the industry had a relatively high share of financially constrained firms in the pre-treatment period. All specifications include industry, state and year fixed effects along with state-level covariates and a state-specific time trend. Standard errors are in parentheses, clustered at the industry level.

Table 7: VAT Adoption by Firm Financial Constraints

	(1) Plant Machines	(2) Plant Machines	(3) TFP	(4) TFP
VAT	.027	-.101***	.007	-.068***
	(.018)	(.019)	(.015)	(.017)
VAT*FC		.304***		.196***
		(.037)		(.031)
Observations	44390	41080	39056	36581
R^2	.92	.93	.93	.93
Dep Var Mean	20.29	20.29	45.76	45.76

The above specifications test impact of VAT adoption on firm machinery and TFP for firms located in non-metro cities. The unit of observation is firm-year. The dependent variable in columns (1)-(2) is firm machinery, measured in 2012 millions of USD; the dependent variable in columns (3)-(4) is firm TFP. Columns (1) and (3) test the average effect of VAT adoption on firm machinery (TFP); columns (2) and (4) test the differential effect of VAT adoption across financially constrained firms. All specifications include firm and year fixed effects along with firm and state-level covariates and a state-specific time-trend. Standard errors are in parentheses, clustered at the firm level.

11 Appendix

11.1 Firm Performance Under Retail Sales Taxes and VAT - Illustrative Example

Table A.1: Firm Performance Under Retail Sales Taxes and VAT - An Illustrative Example

	Sales Tax	VAT
Inputs	x	x
Tax on Inputs	τx	τx
Output	y	y
Value Added	y-x	y-x
Tax on Output	τy	τy
Tax Remitted	τy	$\tau(y\text{-}x)$
Profit	$(1-\tau)(y-x)-\tau x$	$(1-\tau)(y-x)$

11.2 Do State Level Covariates Predict VAT Adoption by States?

Table A.2: Lagged State Covariates and VAT Adoption

	Lag 1 Year						
	(1) VAT =1	(2) VAT =1	(3) VAT =1	(4) VAT =1	(5) VAT =1	(6) VAT =1	(7) VAT =1
GDP Growth, Lag1	.049						
	(.225)						
Capital Spending		-.023					
		(.041)					
Social Spending, Lag1			-.181*				
			(.098)				
Tax Revenue, Lag1				-.045			
				(.061)			
Non-Tax Revenue, Lag1					-.012		
					(.030)		
Fiscal Deficit, Lag1						-.034	
						(.026)	
Banks, Lag1							1.446
							(1.384)
Observations	324	323	323	323	323	311	224
R^2	.91	.91	.91	.91	.91	.90	.87
	Lag 2 Years						
	(1) VAT =1	(2) VAT =1	(3) VAT =1	(4) VAT =1	(5) VAT =1	(6) VAT =1	(7) VAT =1
GDP Growth, Lag2	-.463*						
	(.223)						
Capital Spending		-.047					
		(.073)					
Social Spending, Lag2			-.157				
			(.108)				
Tax Revenue, Lag2				-.077			
				(.064)			
Non-Tax Revenue, Lag2					.001		
					(.049)		
Fiscal Deficit, Lag2						-.024	
						(.024)	
Banks, Lag2							1.611
							(1.457)
Observations	305	304	304	304	304	293	205
R^2	.91	.90	.91	.90	.90	.90	.85

This table presents the results from a regression of the timing of VAT adoption by states on lagged state level economic characteristics. The unit of observation is state-year. The first table shows the impact of state-level covariates, lagged by 1 year. The second table shows the impact of state-level covariates lagged by 2 years. The state-level covariates considered are: a) annual growth in constant state domestic product; b) capital expenditures; c) social sector spending; d) own tax revenue; e) non-tax revenue; f) gross fiscal deficit and g) banks per million population. The state level expenditure, revenue and deficit measures are scaled by state domestic product. All covariates except for growth in state domestic product is logged. All specifications include state and year fixed effects, along with state-specific time-trends. Standard errors are clustered at the state-level.

Table A.3: Aggregate State-Level Firm Performance and VAT Adoption by States

	Lag 1 Year					
	(1) VAT =1	(2) VAT =1	(3) VAT =1	(4) VAT =1	(5) VAT =1	(6) VAT =1
Machinery	-.039					
	(.078)					
Salaries		-.066				
		(.050)				
Income			-.062			
			(.066)			
Profits				.170		
				(.324)		
Debt-Equity					.011	
					(.019)	
TFP						-.007
						(.076)
Observations	244	244	244	244	244	244
R^2	.88	.88	.88	.88	.88	.88
	Lag 2 Years					
	(1) VAT =1	(2) VAT =1	(3) VAT =1	(4) VAT =1	(5) VAT =1	(6) VAT =1
Machinery	-.017					
	(.063)					
Salaries		-.064				
		(.042)				
Income			-.047			
			(.047)			
Profits				.316		
				(.285)		
Debt-Equity					.013	
					(.022)	
TFP						-.002
						(.077)
Observations	225	225	225	225	225	225
R^2	.87	.87	.87	.87	.87	.87

This table presents the results from a regression of the timing of VAT adoption by states on lagged firm characteristics, aggregated to the state-level. The unit of observation is state-year. The first table shows the impact of covariates lagged by 1 year. The second table shows the impact of covariates lagged by 2 years. The aggregated firm performance covariates considered are: a) machinery; b) salaries; c) income; d) profits as a share of assets; e) debt-equity ratio; and f) TFP. All the firm covariates are logged state-year averages, weighted by aggregate firm sales. All specifications include state and year fixed effects, along with state-specific time-trends. Standard errors are clustered at the state-level.

11.3 Alternate Dependent Variables

Table A.4: VAT and Firm Outcomes

	(1) PM, Share of Assets	(2) Gross Fixed Assets	(3) Raw Materials	(4) Power Fuels
VAT	.039***	.038**	.100**	.022
	(.014)	(.016)	(.041)	(.017)
Observations	84568	90912	64422	71912
R^2	.87	.91	.78	.91
Dep Var Mean	.39	28.56	30.85	30.85

The above specifications test the impact of VAT adoption on firms. The unit of observation is firm-year. The dependent variable in column (1) is logged firm plant and machinery as a share of total assets; the dependent variable in column (2) is logged gross fixed assets; the dependent variable in column (3) is logged raw materials; the dependent variable in column (4) is logged value of power and fuels consumed. The dependent variables in columns (2)-(4) are measured in 2012 millions of USD. The independent variable of interest is a dummy equaling 1 if the state in which the firm is headquartered has a VAT in place in the given year. All specifications include firm and year fixed effects, along with firm and state-level covariates and state-specific time trends. Standard errors are in parentheses, clustered at the firm level.