Tax Distortions, Financial Constraints and Firm Performance: Evidence from India's VAT Implementation

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Abstract

This paper studies whether the elimination of tax distortions on capital goods through an investment tax credit induces financially constrained firms to expand their stock of plant and machinery. 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, eliminating in the process the cascading effect of sales taxes levied at multiple points in the production chain, and lowering the cost of plant and machinery for firms. Using the differential timing in VAT roll-out across Indian states as a source of exogenous variation, the paper identifies the causal impact of this reduction in the cost of capital on firms' plant and machinery. The results show that firms increase their stock of plant and machinery in response to the investment tax credit offered through the VAT framework with the effects being driven by firms operating in industries with a high dependence on external finance, and firms which have a higher likelihood of being financially constrained based on observable characteristics. The results also document an increase in firm productivity post VAT adoption by states, but limited to firms operating in industries with a high dependence on external finance and firms most likely to be financially constrained based on observable characteristics. Collectively, the results suggest that financially constrained firms respond to the VAT-induced reduction in the cost of capital to expand their plant and machinery and adopt improved production technologies.

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1 Introduction

The role of financial and credit constraints as a source of friction affecting optimal firm operations has been well-established by a large body of literature (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 economies where formal financial markets for capital and credit are underdeveloped. A relevant question of interest in this regard for 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 such as capital account liberalization which can 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 the elimination of tax distortions resulting in a reduction in the cost of capital induces financially constrained firms to expand their stock of firm machinery and improve their operating efficiency. We exploit a unique natural experiment in India involving the roll-out of the value-added tax (VAT) across Indian states, replacing 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 eliminated the distortion created due to the cascading effect of multiple sales taxes levied along the production chain and 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 the impact of this reduction in the cost of capital on the stock of plant and machinery and productivity of firms which have a higher likelihood of being financially constrained.

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 us

to implement a differences-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 ability of firms to avail of the ITC 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 aggregate measures of firm performance (aggregated at the state-level), such as the stock of 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.

To identify the impact of states' VAT adoption on financially constrained firms, we adopt a two-step approach similar to Larrain and Stumpner (2017). We first test for the differential impact of the treatment – VAT adoption by states – on firm machinery across industries with a relatively higher dependence on external finance and where financial constraints have a higher likelihood of binding (Rajan and Zingales, 1998; Larrain and Stumpner, 2017). If the treatment effect is concentrated amongst financially constrained firms, we would expect the results to be driven by firms operating in industries with a higher dependence on external finance. Subsequently, we divide our sample by observable firm characteristics – namely firm age, tangibility, debt-equity ratio, availability of a credit rating, and whether the firm is publicy listed – which have been identified in the literature of being predictive of a firm being financially constrained, and test the differential impact of the treatment across industries' dependence on external finance separately for each sub-sample. In effect, the latter specification tests for the differential impact of the treatment on firms operating in industries with a relatively higher dependence on external finance, for the sub-sample of firms which have a higher likelihood of being financially constrained, based on observable firm characteristics.

Our empirical results using the firm-level Prowess database covering over 10,000 registered firms in India in the 1999-2012 period show that VAT adoption by states resulted in a 5 percent increase in the stock of plant and machinery in the post-treatment period, with the results being robust to 2-digit industry-year fixed effects, flexible state-specific time trends, and a battery of state and firm-level covariates. The treatment effect however is fully driven by firms in industries with a high dependence on external finance. While the treatment has no impact on firms operating in industries with a relatively low dependence on external finance, it increases firm machinery by 9 percent in industries with a relatively high dependence on external finance. Upon disaggregating our sample by firm characteristics predictive of a firm being financially constrained, we find that the impact of the treatment is concentrated within the sub-sample of firms which have a higher likelihood of being fi-

nancially constrained - namely younger firms, firms with low tangibility, high debt-equity ratios, lacking a credit rating and not publicly listed. Thus, the treatment has no impact on firms which have a low likelihood of being financially constrained, based on observable characteristics, or on firms operating in industries with a relatively lower dependence on external finance. The treatment only impacts firm machinery for firms with a high likelihood of being financially constrained *and* operating in industries with a relatively higher dependence on external finance.

Our paper also identifies whether the expansion in firm machinery in response to the treatment affected firms' 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 exposure to the ITC increases firms' revenue productivity (revenue TFP) by 5-10 percent but only for firms which have a high likelihood of being financially constrained (as determined from observed firm characteristics) and also operating in industries with a relatively higher dependence on external finance. This is consistent with the impact of the treatment on firm machinery and in this regard, our results collectively support the explanation that exposure to the VAT allowed financially constrained firms to expand their stock of plant and machinery and adopt improved production technologies which increased their operating efficiency.

Importantly, using data from the Annual Survey of Industries (ASI) on the unit prices of manufacturing commodities, we verify that exposure to the VAT results in a reduction in the price of manufactured commodities. This in essence forms the "first stage" of the paper and validates that VAT adoption by states indeed reduced the cost of capital by permitting firms to avail of the ITC and reduced the distortionary impact of multiple sales taxes. Finally, we document that the treatment does not impact firm cash flows, which negates the alternative explanation that the VAT is affecting firm machinery through an increase in firm cash flows due to the ITC.

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 in Eastern European economies provided financially dependent firms with access to wider capital and credit markets and reduced the dispersion in marginal returns to capital in financially dependent sectors. The current paper on the contrary studies an alternative policy instrument – the elimination

of tax distortions on manufactured commodities through an investment tax 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.

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 tax credit can have a positive impact on firm machinery through a reduction in the cost of capital for financially constrained firms. 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 economies, our paper studies the impact of an investment tax credit on firm performance in a developing economy.

Finally, our paper also contributes to a growing literature studying the broader impact of value-added taxes which have become a key source of revenue for over 130 economies in the past two decades (Kleen and Lockwood, 2007). While much of the research on the VAT have focused on issues pertaining to tax incidence, revenues and compliance, our paper shows how the off-setting of the VAT paid during the production process serves as a reduction in the cost of capital and induces financially constrained firms to expand their stock of productive capital and improve their operating efficiency. In this regard, our paper relates closely to the works 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 VAT on firm performance, our paper identifies a positive

spillover of the VAT on firm outcomes and productivity.

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 details our empirical strategy to identify whether states' adoption of the VAT impacts firm machinery for financially constrained firms. Section 4 describes our data and presents some descriptive trends regarding firms operating in industries with a relatively high dependence on external finance while Section 5 presents the key findings of the paper. Section 6 presents a placebo test 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 tariffs. 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 collectively design and adopt a VAT structure common to all states.

After five years of deliberation 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 (such as trading and hospitality sectors) under the ambit of the VAT.[1] 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 revenue losses in the first three years post-VAT adoption (VAT White Paper, 2005).[2]

[1] 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).

[2] The federal government committed to 100 percent compensation for revenue losses in the first year, 75

The VAT was adopted by states in a staggered manner. The state of Haryana in north India was the first 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.[3] 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 natural treatment and comparison groups, conditional on the timing of VAT adoption by states being exogenous to the firm outcomes of interest. Anecdotally, 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.[4] 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.[5]

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.[6] 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

percent in the second year and 50 percent in the third year.

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

[4] 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.

[5] In each regression reported in Tables (A.2) and (A.3) (Appendix 11.2), 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.

[6] 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.

firm for inputs purchased to manufacture these products or operate the establishment.[7] 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 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 expand their purchase of fixed assets.[8] 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, alleviating endogeneity concerns 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 stylistic example equals $(1-\tau)(y-x)$, which exceeds the profits obtained under the sales tax regime by τx.

Based on this stylistic 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

[7] 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.

[8] 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.

firms could claim the ITC for VAT paid in the purchase of plant and machinery, we treat the ITC as a reduction in the firm's cost of capital and this paper identifies whether this reduction in the cost of capital enables financially constrained firms – which are unable to raise the optimal level of capital for financing their operations – to expand their stock of plant and 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.

3 Empirical Strategy

The previous section outlined why we might expect firms' plant and machinery to increase in response to a VAT-induced investment tax credit. We now layout our empirical strategy to rigorously test for the causal impact of the VAT-induced investment tax credit on firm machinery. We first present the specification to identify the impact of the VAT on the prices of manufactured commodities. Next, we identify the average treatment effect of VAT adoption by states on firm machinery and subsequently, present the empirical strategy to test whether the response to the VAT-induced investment tax credit is driven by firms in industries dependent on external finance and firms which are most likely to be financially constrained.

3.1 Average Effect of Investment Tax Credit on Manufacturing Prices

We first test the impact of the VAT on the prices of manufactured commodities using the following specification:

$$\ln(Price_{cfst}) = \alpha_c + \gamma_f + \delta_t + \theta_s t + \beta VAT_{st} + \phi X_{fst} + \epsilon_{cfst} \tag{1}$$

Price in (1) is the unit price of commodity c, produced in factory (establishment) f, located in state s, in year t. The unit of observation is commodity-factory with α, γ and δ denoting commodity, factory and year fixed effects. $\theta_s t$ is a state-specific time-trend, controlling for state-specific trends over time in manufacturing prices. We obtain the commodity prices from the ASI and normalize them using the wholesale price index for manufactured

goods to 2012 rupees.[9]

The independent variable of interest is the treatment indicator, VAT, which equals 1 if state s has the VAT structure operational in year t, due to which eligible establishments can claim the ITC. Thus the VAT dummy equals 0 in all years prior to states' adoption of the VAT and equals 1 for all years after the state's adoption of the VAT (treatment period). X is a set of factory and state-level covariates and standard errors are clustered at the level of the commodity.[10] If the ITC provision in the VAT resulted in a reduction in the prices of manufactured goods, we would expect $\beta < 0$, as anticipated by the government issued White Paper (2005) pertaining to the VAT.[11] Specification (1) essentially tests the first stage of the paper and verifies our preliminary hypothesis that VAT adoption by states results in a reduction in the manufactured commodities courtesy the ITC.

3.2 Average Treatment Effect of Investment Tax Credit on Firm Investments

We now presents the reduced form empirical strategy to identify whether VAT adoption by states resulted in an increase in firm machinery due firms' exposure to the ITC which was expected to reduce the cost of manufactured commodities. As the ITC is embedded within the VAT framework, we exploit the differential timing of VAT adoption 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. Our primary DiD specification takes the form:

$$\ln(Y_{ist}) = \alpha_i + \delta_j t + \theta_s t + \beta VAT_{st} + \phi X_{ist} + \epsilon_{ist} \tag{2}$$

In equation (2), the unit of observation is the firm. Y is the outcome of interest for firm i, headquartered in state s and observed in year t. Our primary outcome of interest

[9] The ASI provides a consistent list of commodities produced by establishments between 1999 and 2007 and their prices.

[10] At the firm-level, we control for a quadratic in the factory's age, based on its year of establishment. 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 bank branches per million population. All the state expenditure and revenue variables are normalized by state domestic product.

[11] Along with the ITC, the VAT could also affect prices of the tax rates were significantly different than the prevailing sales tax rates. This would require a commodity-specific analysis which is beyond the purview of the current paper. As the VAT White Paper (2005) does not mention a reduction in the marginal consumption tax rates as being the goal of the VAT introduction, we do not consider the lowering of marginal tax rates under the VAT to be confounding the effect of the ITC on commodity prices.

is firm machinery but we later expand our analysis to test the impact of the treatment on firm productivity. 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 total assets and gross fixed assets. α and δ are firm and industry-year fixed effects (2-digit industries) while $\theta_s t$ is a state-specific time-trend controlling for state-specific linear trends in the outcome of interest.

The independent variable of interest is the treatment indicator, VAT, defined as in specification (1). β identifies the average treatment effect, conditional on the firm and industry-year fixed effects, state-specific time trends, and the firm and state-level time varying covariates included in X.[12] 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 estimate 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 specification:

$$\ln(Y_{ist}) = \alpha_i + \delta_t + \sum_{k=-8}^{8} \beta_k VAT_{st+k} + \epsilon_{ist} \tag{3}$$

Equation (3) 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.

[12] 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.

3.3 Investment Tax Credits and Firm Investments - Differential Effects Across Industries' Dependence on External Finance

Section 3.2 outlined the basic DiD strategy to estimate the impact of the treatment on firm machinery. We now seek to identify which firms respond most to the treatment to precisely evaluate the mechanism through which VAT adoption by states affect firm machinery. In particular, we seek to test whether financially constrained firms responded to this ITC-induced reduction in the cost of capital and expanded their firm machinery. To this effect, we adopt an approach similar to Larrain and Stumpner (2017). We first test for the differential effects of the treatment across industries with a relatively higher dependence on external finance. This strategy is motivated by Rajan and Zingales (1998), who showed that financial constraints for firms were most likely to bind in industries with a high dependence on external finance. We therefore first compare the impact of the VAT across industries' dependence on external finance.

To measure industries' dependence on external finance, we adopt the methodology proposed by Rajan and Zingales (1998). First, for each firm i in industry j, we define its dependence on external finance – *ExtFinDep* – in the five year period between 1999 and 2003, as:

$$ExtFinDep_{ij} = \frac{Capex_{ij} - CashFlow_{ij}}{Capex_{ij}} \tag{4}$$

Capex in (4) is the aggregate capital expenditures undertaken by the firm in the five-year period between 1999 and 2003 while *CashFlow* is the total cash flow accruing to the firm in this period. We base the measurement of industries' dependence on external finance in the 1999-2003 period to avoid the introduction of the VAT from affecting firms' dependence on external finance. Capital expenditures is measured as the change in gross fixed assets between 1999 and 2003 while cash flow is the difference between the firm's total income and expenses in this period. Thus, *ExtFinDep* measures the capital expenditures undertaken by a firm between 1999 and 2003, in excess of its net earnings during this period. To account for heterogeneity in the magnitude of capital expenditures and cash flows across firms, we scale the difference between capital expenditures and cash flow by the level of capital expenditures incurred by the firm. According to (4), firm i in industry j is considered to be dependent on external sources for finance if its capital expenditures exceeded its overall cash flows between 1999 and 2003 or $ExtFinDep_{ij} > 0$.

As suggested by Rajan and Zingales (1998), we obtain industry j's dependence on ex-

ternal finance as the median value of $ExtFinDep$ across all firms within industry j.[13] Based on this formulation, the five industries with the highest dependence on external finance (at the 3-digit industry level) are: manufacture of wood; manufacture of chemical fibres; manufacture of structured metal products; manufacture of medical instruments; and the manufacture of dairy products.[14] To ease the interpretation of our empirical coefficients, we classify industries into high and low dependence on external finance based on the median value of $ExtFinDep_j$ across all industries j between 1999 and 2003. To test whether firms responding to the treatment are also located in industries with a high dependence on external finance (by virtue of which they face a higher likelihood of being financially constrained), we test the following specification:

$$\ln(Y_{ijst}) = \alpha_i + \delta_j t + \theta_s t + \beta_1 VAT_{st} + \beta_2 VAT_{st} * HighFinDep_j + \phi X_{ist} + \epsilon_{ist} \qquad (5)$$

In (5), j denotes the 3-digit industry in which firm i operates. *HighFinDep* is a dummy equaling 1 if industry j's dependence on external finance exceeds the median industry's dependence on external finance in the 1999-2003 period. The remaining variables in specification (5) are defined analogous to specification (2). β_1 now estimates the impact of the treatment on firm outcomes for firms belonging to industries with a relatively low dependence on external finance while β_2 estimates the differential effects of the treatment on firms in industries with a relatively higher dependence on external finance. The net impact of the treatment on firms in industries with a relatively high dependence on external finance is estimated by the sum of β_1 and β_2.

Specification (5) tests whether the impact of the treatment on firm outcomes differ across firms in industries with relatively high dependence on external finance. However, operating in an industry with a relatively high dependence on external finance is not a sufficient condition for a firm to be financially constrained. Firms in industries with a high dependence on external finance can still be financially unconstrained if they are able to raise resources to fund their capital expenditures (in excess of cash flows) through external borrowings or equity. In this regard, the collection of financially constrained firms is a subset of the firms located in industries with a high dependence on external finance. Specifically, financially constrained firms need to be both dependent on external sources for finance and

[13] Rajan and Zingales (1998) prefer to consider the median value of $ExtFinDep$ within an industry as opposed to the mean to preclude the industry-specific measure of external financial dependence from being driven by outlier values within industries.

[14] In contrast, the five industries with the least dependence on external finance are: meat processing; manufacture of coke oven products; ship building; apparels; and manufacture of electrical equipment.

also be *constrained* in their ability to obtain their optimal level of capital from external sources.

In this respect, to ascertain whether the impact of the treatment on firm outcomes is indeed emanating from financially constrained firms, we split our sample based on observable firm characteristics which are predictive of firms being financially constraints, and subsequently test for the differential impact of the treatment across industries' dependence on external finance. If the impact of the treatment on firm machinery is indeed driven by financially constrained firms, we would expect $\beta_2 > 0$ for the sub-sample of firms which have a higher likelihood of being financially constrained based on their ex-ante characteristics (and be unable to reject the null hypothesis of $\beta_2 = 0$ for the sub-sample of firms with a lower likelihood of being financially constrained).

We rely on the existing literature to select the firm-level indicators suggestive of financial constraints. Larrain and Stumpner (2017) show that relatively younger firms face a higher likelihood of being financially constrained while Giroud and Mueller (2015) show that firms' exposure to debt and the lack of an external credit rating are indicators of being financially constrained. Finally, Almeida and Campbello (2007) contend that capital expenditures in firms with a high level of tangible assets would not be sensitive to firm cash flows as they can pledge their tangible assets and secure debt to finance their investments. This suggests that firms with a high level of tangible assets would have a lower likelihood of being financially constrained, even if they are located in industries with a relatively high dependence on external finance.

In this regard, our characteristics of interest are firm age, tangibility, debt-equity ratio, the availability of an external credit rating, and whether a firm is publicly listed (and able to raise capital through the equity markets). We split our sample based on these characteristics and re-estimate specification (5) separately for each sub-sample to test whether the impact of the treatment on firm machinery is driven by firms which have a higher likelihood of being financially constrained and are also in industries with a relatively high dependence on external finance.

For firm age, tangibility and debt-equity ratio, we classify firms as "high" and "low" based on the pre-treatment period median across all firms. Thus, "low" tangibility firms are those who have relatively low tangible assets as a share of total assets, relative to the median share of tangible assets across all firms between 1999 and 2003.[15] With regard to whether the firm has an external credit rating (is publicly listed), we split the sample based on whether a firm is rated (publicly listed).

[15] Tangible assets is the sum of the firm's plant and machinery, land and buildings.

4 Data and Descriptive Trends

4.1 Data

This paper identifies whether a reduction in the cost of capital through a VAT-induced investment tax credit can alleviate firms' financial constraints in a developing economy. Our agent of interest is the firm and we obtain data on a large sample of Indian firms from the Prowess database.[16] This is a financial database, compiled and maintained by the Centre 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 parameters, the Prowess also provides distinct firm identifiers, permitting the construction of a firm-level panel.[17] 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.

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 state (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.[18] This provides us with a sample of 10,500 firms with the median firm being observed for 12 years. We convert all annual

[16] 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 observe firm characteristics indicative of a firm being financially constrained. 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 the number of workers employed by the firm.

[17] 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.

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

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 tax 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 assets, firm age (based on year of incorporation), income, sales, expenses, salaries and profits. The firm-level data is supplemented with time-varying state-specific demographic, fiscal and economic variables which are employed as covariates in the 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, fiscal deficit, growth in state domestic product, urbanization, share of workers and education levels – all of which might impact firm outcomes.

4.2 Measuring Firm Productivity and Capital Distortion

We measure firm productivity using firms' revenue productivity – or revenue TFP – as recommended by Hsieh and Klenow (2009).[19] To calculate firms' revenue productivity, we assume that a firm's annual production is governed by a standard Cobb-Douglas production function:

$$Y_{ij} = A_{ij} K_{ij}^{\alpha_j} L_{ij}^{\beta_j} \tag{6}$$

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 (6) by prices and take logs to calculate the firm's revenue TFP (Hsieh and Klenow, 2009) using the following equation:

$$ln(Sales_{ijs}) = ln(A_{ij}) + \alpha_j ln(K_{ijs}) + \beta_j ln(L_{ijs}) + \phi_s + \mu_{ijs} \tag{7}$$

In (7), *Sales* denote 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

[19] The Prowess data only provides information on annual firm sales and not annual firm output, thereby forcing us to use the revenue TFP measure to assess firm productivity.

using total salaries paid by the firm.[20] 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 (7) separately for each 3-digit industry-year combination and the residual obtained from this estimation – $ln(A_{ij})$ – provides us with our firm-specific measure of logged revenue TFP.

Based on Hsieh and Klenow (2009), we also measure an individual firm's capital distortion as the difference between the firm's observed capital and the firm's optimal level of capital where its marginal product of capital equals the marginal product for labour. Specifically, capital distortion of firm i in industry j, in any year t, *CapDist* is measured as:

$$CapDist_{ij} = \frac{\alpha_j}{1-\alpha_j}\frac{L_{ij}}{R_{ij}K_{ij}} - 1 \tag{8}$$

In (8), α is computed from (7) and allowed to vary across each 3-digit industry-year combination. L and K are also defined as per (7) while R is the rental rate of capital, defined as the rate of depreciation, added to the real interest rate. The former is the ratio of net fixed assets to gross fixed assets for each firm while the real interest rate considered to be 0.05 and invariant across firms (Hsieh and Klenow, 2009). Based on (8), $CapDist_{ij} > 0$ if a firm's capital-labour ratio is less than the optimal ratio, as prescribed by the share of capital and labour in firm output.

4.3 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 and 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[21] in this period were profitable (profits measured before tax and interest payments) with average profits as a share of assets being 6 percent. While 31 percent of the firms are publicly listed in our sample, only 11 percent of them have an external credit rating.

Our paper draws on the studies of Rajan and Zingales (1998) and Larrain and Stumpner

[20] 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

[21] 75 percent of the firms in the sample in this period recorded positive profits.

(2017) who show that financial constraints have a higher likelihood of being binding for firms in industries with a relatively higher dependence on external finance. In this regard, we present some preliminary descriptive evidence in support of this hypothesis. Figures 2 and 3 present the correlation between firm characteristics and industries' dependence on external finance. The correlations are presented in the form of binned scatter plots where the horizontal axis represents 20 bins of industries' dependence on external finance and the vertical axis represents the unweighted mean of the firm characteristic of interest in each corresponding bin.

Figure 2 shows that firms in industries with a relatively high dependence on external finance have lower firm machinery, sales, profits and productivity. Expectedly, firms in industries with a relatively high dependence on external finance also have lower cash flows. If the negative correlation between industries' dependence on external finance and firm machinery is generated due to firms being financially constrained and unable to obtain the requisite funds to finance their optimal capital expenditures, we would expect such firms to be most responsive to a reduction in the cost of capital due to the ITC induced by the VAT.

Figure 3 presents the correlation between industries' dependence on external finance and the five firm characteristics discussed in Section 4 which are predictive of firms being financially constrained. Based on Figure 3, we see that firms in industries with a high dependence on external finance have a higher likelihood of being unrated and not publicly listed. As external credit ratings are often used by lenders to ascertain a borrower's creditworthiness, the lack of a credit rating can restrict a firm's ability to obtain credit. Similarly, being publicly unlisted limits the firm's ability to raise capital through the equity markets. Consistent with these observations, firms in industries with a high dependence on external finance are also more likely to have higher debt-equity ratios, signaling their reliance on external borrowings as opposed to equity. Contrary to our expectations though, we are unable to find any unconditional relationship between industries' dependence on external finance and firm age and there is an unexpected positive relationship between industries' dependence on external finance and firm tangibility. This however can be a signal of reverse causality. As firms in industries dependent on external finance are more reliant on external borrowings, we would expect such firms to hold a high level tangible assets which could be pledged as collateral, leading to the observed positive relationship. This also underlines that being in an industry with a relatively high dependence on external finance is not a sufficient condition for a firm to be financially constrained; the set of financially constrained firms is but a subset of firms located in industries with a high dependence on external finance.

5 Results

We now present the key empirical results of the paper. We first verify that the VAT led to a reduction in the price of manufacturing commodities. This is equivalent to the first stage in our empirical strategy. After establishing the first stage, we test for the average effect of the treatment (firms' exposure to the ITC due to VAT adoption by states) on firm machinery. Subsequently, we identify the differential effects of the treatment on firm machinery and TFP across industries' dependence on external finance. Finally, we re-estimate the differential impact of the treatment across industries' dependence on external finance but separately for firms with a relatively higher likelihood of being financially constrained based on observed firm characteristics.

5.1 Investment Tax Credits and Manufacturing Prices

Prior to identifying the impact of the treatment on firm machinery, we first verify that VAT adoption by states and the exposure of manufacturing establishments to the ITC indeed led to a reduction in the cost of capital. We test this hypothesis using specification (1). The prices of manufacturing commodities is obtained from the ASI in the 2000-2007 period which provides unique identifiers for commodities produced by establishments and also the manufacturing establishment. We restrict our analysis to 2007 as the ASI altered their commodity product code after 2007 which would constrain us from using commodity fixed effects.

The results are presented in Table 2. Column (1) presents the results from a parsimonious specification including only commodity, factory and year fixed effects and no other covariates. We identify a negative correlation between VAT adoption by states and commodity prices but the coefficient is imprecisely estimated. Column (2) includes state-specific time-trends while column (3) includes state-specific covariates and a quadratic in establishment age. We now detect a negative and statistically significant impact of VAT adoption by states on the price of manufacturing goods. The coefficient in column (3) shows that VAT adoption reduces the price of manufactured goods by 7 percent and the result is stable to weighting (column 4) by the sampling probability.[22] The

The results in Table 2 confirms our hypothesis that the adoption of the VAT resulted in a reduction in the price of manufactured commodities and resultantly, in firms' cost of capital. In particular, the results rule out concerns regarding firms not passing through to consumers the reduction in the cost of inputs due to the ITC provision in the VAT. Additionally, the

[22] The weights provided by the ASI reflect the inverse of the establishment's sampling probability.

results also rule out concerns expressed by Goolsbee (1998) that investment incentives have a muted effect on firms' investment as it raises the cost of capital and increases the income of capital suppliers. The results in Table 2 show that such a situation is not occurring in the present scenario and permits us to treat the ITC provision of the VAT as an investment tax credit which reduced the cost of capital for firms.

5.2 Investment Tax Credit and Firm Machinery

We now test for the average effect of the treatment (VAT adoption by states resulting in firms' exposure to the ITC) on firm machinery. We begin with a graphical representation of the average annual treatment effects on firm machinery, estimated using (3). 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 treatment effect across firms relative to this base year. Figure (4) documents a sharp increase in firm machinery immediately following the onset of treatment. In comparison to the year preceding the treatment, firm machinery was 9 percent higher in the treatment year and 20 percent higher 4 years after the onset of treatment. Importantly, there is no evidence of any pre-trends firm machinery in the years prior to treatment which provides evidence in support of our assumption on parallel trends. This is consistent with Figure 1 which shows that key firm level characteristics of interest changed comparably in the pre-period across both early and late VAT adopting states. We are also unable to reject $\beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8$, implying that the treatment effect 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 specification (2). The results are presented in Table 3. 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 firm machinery. As seen in columns (2) and (3), the results are robust to the inclusion of state-specific time trends, 2-digit industry-year fixed effects and firm and state-level covariates. The average treatment effect diminishes slightly to below 5 percent but remains highly significant all through. The robustness of the reduced form coefficient to the industry-year fixed effects and firm and state-specific covariates assuages concerns that the estimated treatment effect is due to a spurious correlation between unobserved trends in firm machinery and states'

timing of VAT adoption.

Columns (4) and (5) tests specification (5) to estimate the differential effect of the treatment across industries' dependence on external finance. While we use the continuous measure of industries' dependence on external finance in column (4), column (5) interacts the VAT treatment with a dummy equaling 1 for industries whose dependence on external finance exceeds the median industry's dependence on external finance in the pre-treatment period. The coefficient on the base term is now a null effect while the coefficient on the interaction term in both columns (4) and (5) is positive and highly significant, suggesting that the positive effect of the VAT on firm machinery is driven entirely by firms located in industries which are dependent on external sources for finance. In terms of economic significance, the coefficient in column (5) suggests that exposure to the treatment increases firm machinery by 9 percent for firms located in industries with a relatively higher dependence on external finance.

Having established that the positive impact of the treatment on firm machinery is driven by firms in industries dependent on external finances, we now test whether this expansion in firm machinery led to an increase in firm profitability, productivity and operational efficiency. The results are estimated using specification (5) and shown in Table 4. Consistent with Table 3, columns (2) and (3) document that the positive effect of the treatment on firm profitability and productivity is driven by firms in industries which are relatively more dependent on on external finance. While the interaction term between the VAT dummy and *FinDep* is not statistically significant, the sum of the coefficients is both positive and highly significant, suggesting that the exposure to the VAT increased profits for firms in industries with a relatively higher dependence on external finance by 7 percent.[23] In terms of productivity (column (3)), we see that exposure to the VAT increased firm TFP by 5 percent for firms located in industries with a relatively higher dependence on external finance. These results suggest that the reduction in the cost of capital induced by the VAT facilitated firms in industries dependent on external finance to expand their stock of machinery and improve their productive efficiency.

This inference is supported by the results in column (4) where we test the impact of the VAT on the firm's capital distortion, defined in (8) and consistent with Hsieh and Klenow (2009). The coefficient shows that exposure to the VAT reduced capital distortion for firms in industries with relatively high dependence on external finance by 5 percent, implying that reduction in the cost of capital enabled firms to increase their capital-labour ratio closer to the optimal level, as suggested by the respective income shares of capital and labour. Finally,

[23] This is calculated at the mean of the dependent variable - profits as a share of total assets - as 0.004/0.06.

column (1) of Table 4 shows that exposure to the treatment has no impact on firm cash flows, regardless of whether they are located in industries with relatively high or low dependence on external finance. This rules out that the impact of the ITC on firm machinery is occurring through its impact on firm cash flows, and not through the reduction in the firm's cost of capital.

Table A.4 (Appendix 11.3) tests the impact of the treatment on alternate outcomes of interest. Column (1) shows that the results are consistent if the dependent variable is normalized by firm assets. While the interaction term for industries with relatively high dependence on external finance is not statistically significant, the sum of the coefficients is highly significant, suggesting that exposure to the treatment increases firm machinery as a share of total assets by 5 percent for firms located in industries with a relatively high dependence on external finance. We obtain similar results when the dependent variable is defined as gross fixed assets. The coefficient on the interaction term is both positive and statistically significant and suggests that exposure to the treatment increased gross fixed assets of firms in industries with a relatively high dependence on external finance by 9 percent.

If firms are taking advantage of the reduction in the cost of capital due to the ITC and installing additional machinery, we would expect an increase in firms' consumption of electricity and fossil fuels as most heavy machinery rely on either one of these power sources to operate. Consistent with this hypothesis, we see in column (3) that exposure to the treatment increases firms' consumption of electric power and fuel, but only for the firms in industries with a relatively dependence on external finance, for whom we document a positive impact on firm machinery.

Finally, columns (4) and (5) of Table A.4 (Appendix 11.3) show that the treatment had a positive impact on sales, salaries and expenditures of firms in industries with relatively high dependence on external finance (and no impact on industries with relatively low dependence). While the coefficients on the interaction term are noisy for both sales and expenses (p-values of 0.08 and 0.17), it is highly significant for salaries. Unfortunately, the Prowess does not provide data on firm hiring, precluding our ability to precisely state whether the increase in salaries paid by firms is driven by additional hiring – which would be the case if capital and labour are complementary – or through an increase in wages – which would be expected if the expansion in firm machinery raised workers' productivity (and consistent with overall impact of the treatment on firm TFP).

5.3 Investment Tax Credit, Firm Machinery and Productivity - Are the Effects Driven by Firms Most Likely to Be Financially Constrained

Section 5.2 established that the ITC induced reduction in the cost of capital resulted in an expansion in firm machinery, but only for firms in industries with a relatively high dependence on external finance. As discussed in Section 3.3, we would expect the set of financially constrained firms to be a subset of the firms located in industries with a high dependence on external finance. Specifically, these firms would have to be both dependent on external sources for finance, and constrained in their ability to raise the required level of funds to finance their optimal capital expenditures. To test whether the results in Section 5.2 are indeed driven by firms which are financially constrained, we split our sample by firm characteristics which are identified in the literature to be indicative of a firm being financially constrained.

As described in Section 3.3, the firm characteristics of interest are a) whether a firm is relatively young; b) has low share of tangible assets; c) lacks a credit rating; d) is not publicly listed; and e) has a high debt-equity ratio. For each of the above-mentioned characteristics, we split the sample into high and low, based on the pre-period median value for the characteristic, and re-estimate specification (5). This identifies whether the treatment affected the sub-sample of firms most likely to be financially constrained across industries' relative dependence on external finance.

The results are presented in Tables 5 and 6. The outcome of interest in Table 5 is firm machinery while the outcome of interest in Table 6 is firm TFP. In each table, the top panel (Panel A) presents the estimates for firms which have a high likelihood of being financially constrained while the bottom panel (Panel B) presents the estimates for firms with a low likelihood of being financially constrained. From Table 5, we see that exposure to the treatment had a positive effect on firm machinery for firms with a high likelihood of being financially constrained, but only if they belonged to industries which also had a relatively high dependence on external finance. Thus, for relatively young firms (Table 5, Panel A, column (1)) in industries with a relatively high dependence on external finance, firm machinery increases by 13 percent or an additional USD 2 million in response to the treatment. There is however no impact of the treatment on firm machinery, either in industries with a relatively low dependence on external finance, or amongst firms which have a lower likelihood of being financially constrained (Panel B). For the latter group of firms, while the coefficient on the interaction term is positive for all but 1 specification, it is significantly smaller in magnitude, relative to those in Panel A, and also imprecisely estimated.

The results in Table 6 mirror those in Table 5. The top panel shows that exposure to the treatment has a positive impact on firm TFP but only for firms which have a higher likelihood of being financially constrained, and are in industries with a relatively higher dependence on external finance. Thus, for young firms in industries with a relatively higher dependence on external finance (Table 6, Panel A, column (1)), exposure to the treatment increases firm TFP by 10 percent.

The results in Tables 5 and 6 confirm that the positive impact of the VAT on firm machinery is driven by firms which are financially constrained. Moreover, the increase in firm machinery amongst financially constrained firms in response to a reduction in the cost of capital due to the ITC provision of the VAT also results in an increase in productivity for these firms. In this regard, our results underline the positive spillovers emanating through a reduction in distortionary taxation affecting the cost of capital.

6 Robustness

Section 5 showed that our empirical results are stable to the inclusion of 2-digit industry year fixed effects, state-specific time trends and a host of time-varying state and firm-level covariates. Additionally, Figures 1 and 4 verify the absence of pre-trends in the outcome of interest while Tables A.2 and A.3 showed that the timing of VAT adoption was unrelated to measures of firm performance, as well as state expenditures, revenues and deficits. In this regard, as a final check to the robustness of our results, we conduct a placebo test by randomly assigning states alternate years of VAT adoption and re-estimating specification (2) with this set of placebo treatment years instead of the true treatment years. If the results in Section 5 are 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 significant.

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.

7 Conclusion

This paper empirically identifies the impact of a reduction in tax distortions on capital goods on the stock of plant and machinery for financially constrained firms. We use a natural experiment in India involving the replacement of the retail sales tax with the VAT which introduced an input tax credit (ITC) and permitted firms to offset their final VAT liability with VAT payments made during the purchase of inputs. This eliminated the collection of sales taxes at multiple points in the production chain and served as an investment tax credit for capital goods, including plant and machinery, and the paper tests the impact of this investment tax credit on firm machinery for financially constrained firms.

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 states' adoption of the VAT. The increase in firm machinery however was restricted only to firms with a high likelihood of being financially constrained, based on observable characteristics, and operating in industries dependent on external sources for finance, suggesting that financially constrained firms alone responded to the treatment. We also show that the treatment increased firms' revenue TFP and this too was driven by firms with a higher likelihood of being financially constrained and operating in industries with a high dependence on external finance. The results in this regard underline the positive spillovers emanating from the VAT structure on firm performance.

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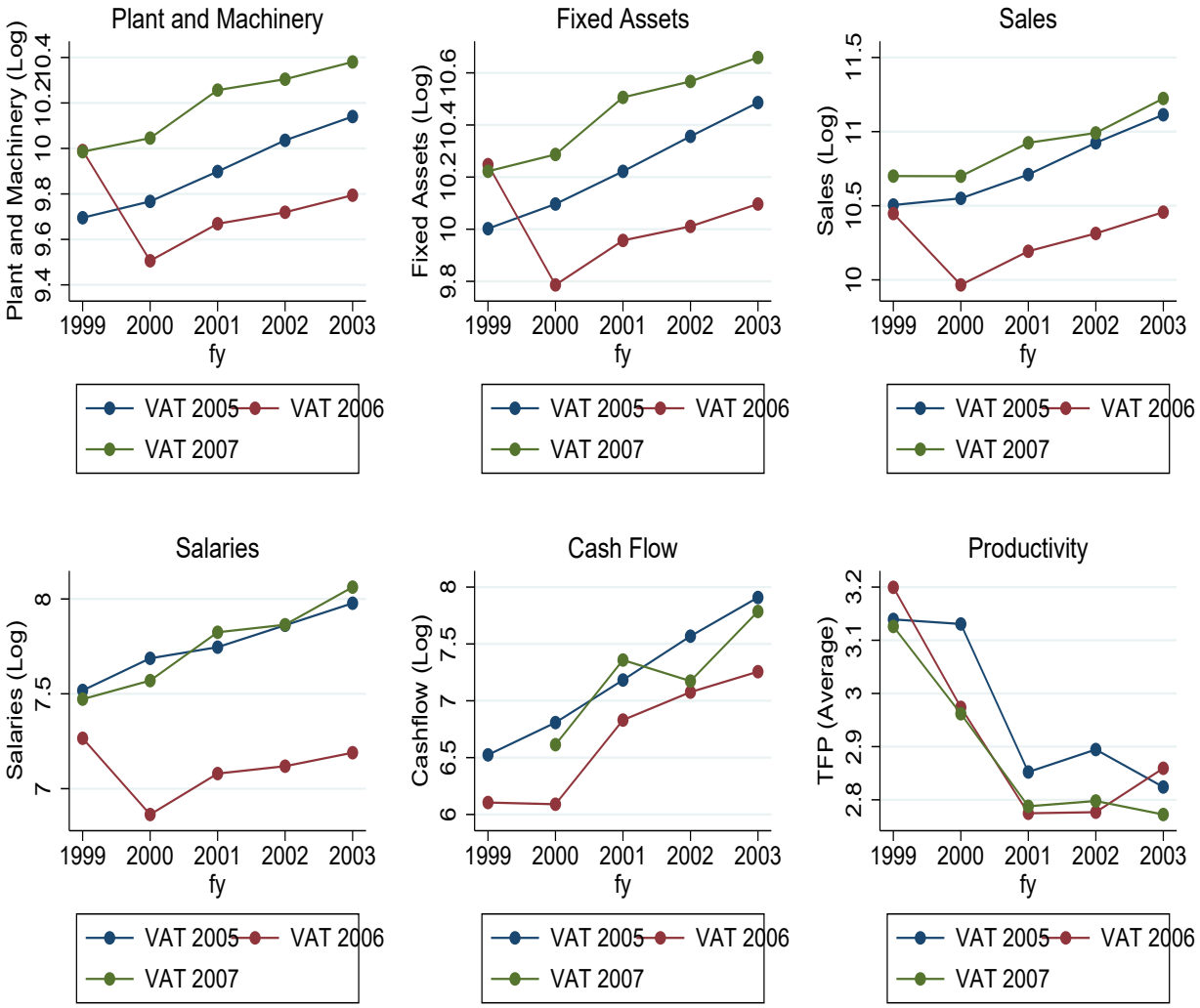
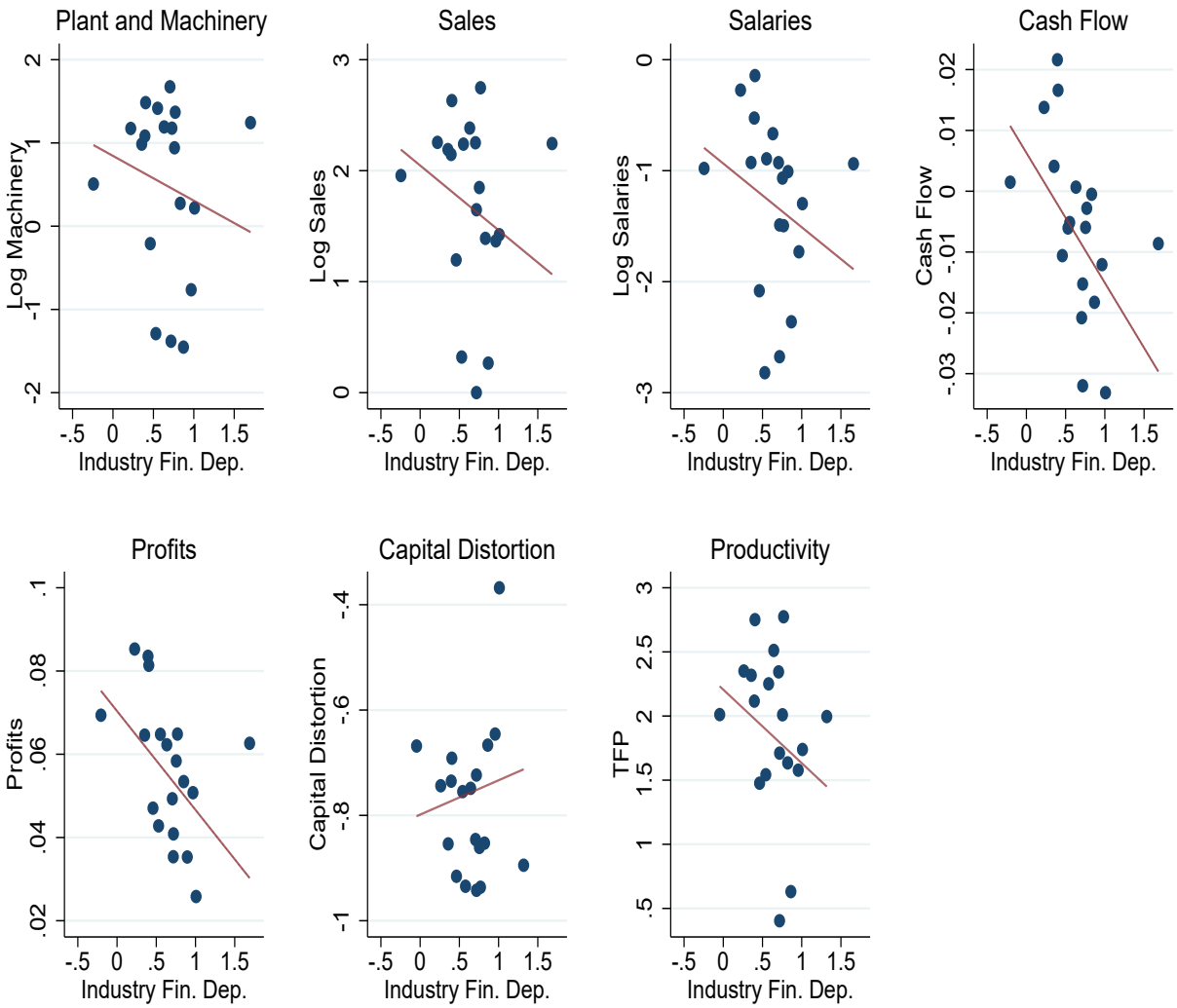
9 Figures

Figure 1: Pre-Trends in Outcome Variables and Firm Characteristics Across States



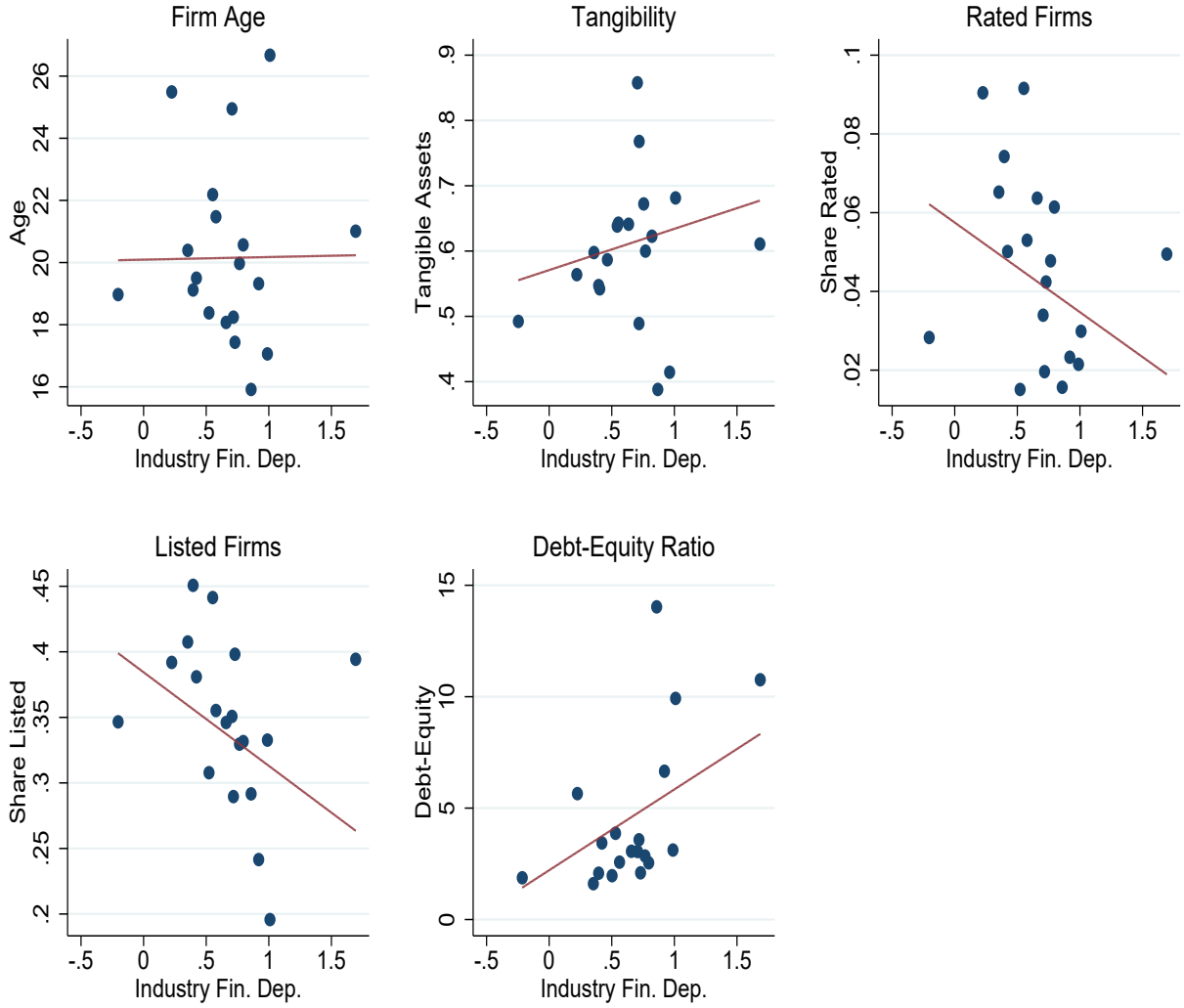
Notes: This figure compares pre-trends in our major outcome variables and firm characteristics across groups of states based on their year of VAT adoption. VAT 2005 refers to states which adopted the VAT in 2004 or 2005; VAT 2006 refers to states which adopted the VAT in 2006; VAT 2007 refers to states which adopted the VAT in 2007 or 2008. Each point on the pictures represents the mean value of the variable of interest across states.

Figure 2: Industries-Level Dependence on External Finance and Firm Performance



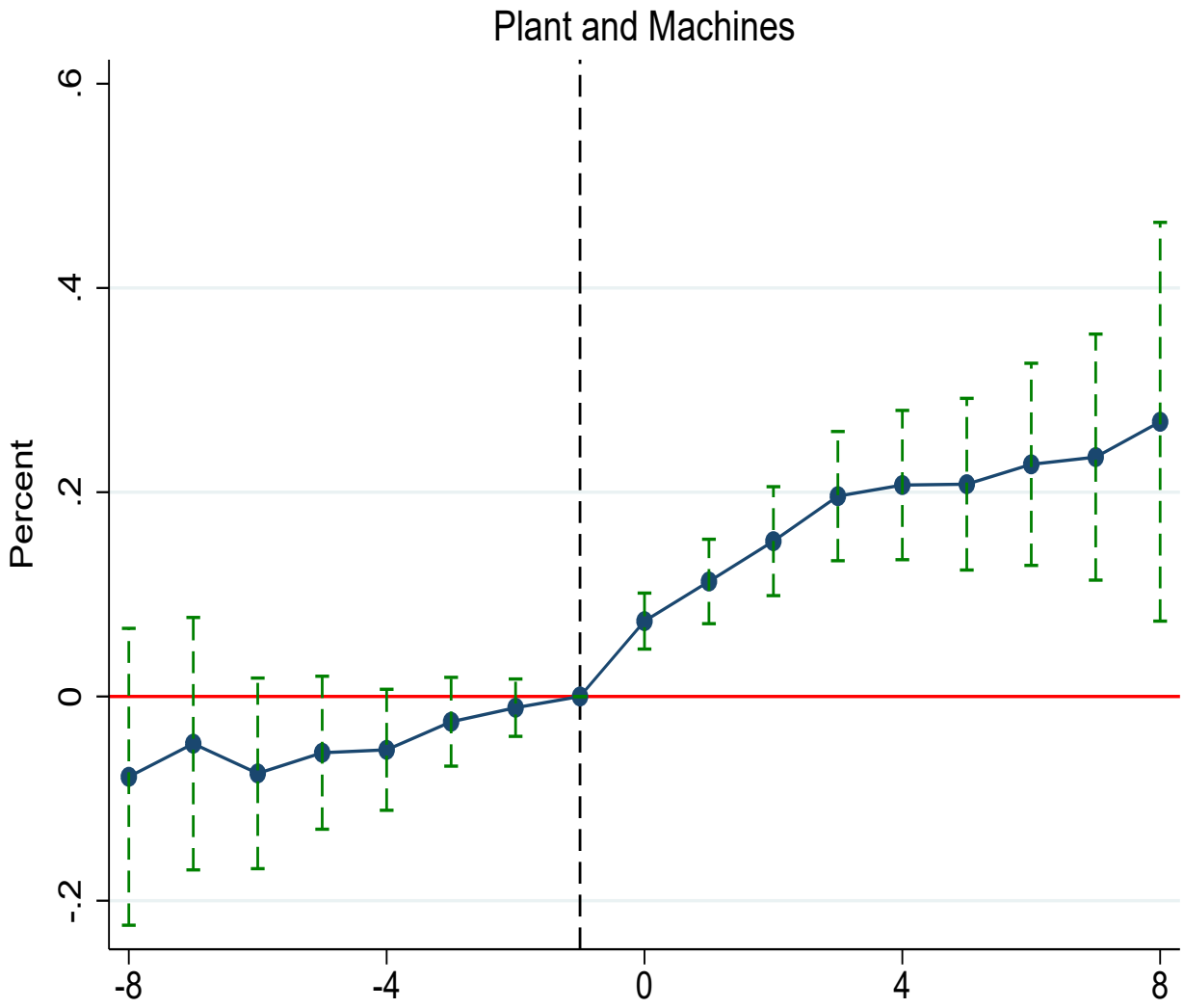
Notes: This figure depicts the correlation between industries' dependence on external finance and select firm characteristics. The x-axis is a continuous measure of industries' dependence on external finance, measured as suggested by Rajan and Zingales (1998). The x-axis is divided into 20 bins based on the continuous measure of industries' dependence on external finance. In each picture, the blue cirlces represent the unconditional mean of the firm characteristic of interest in each bin of industries' dependence on external finance.

Figure 3: Industry-Level Dependence on External Finance and Firms' Likelihood of Being Financially Constrained



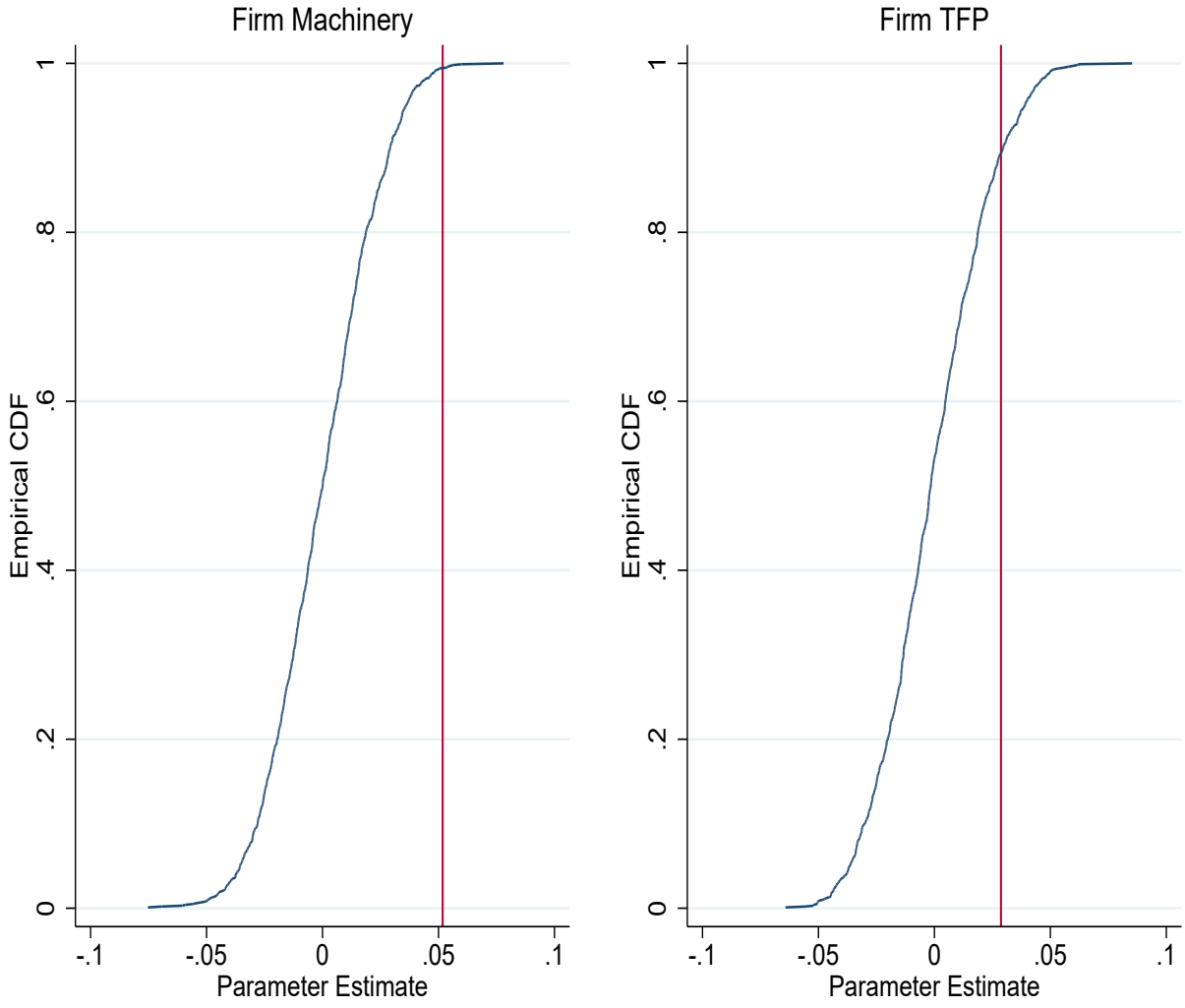
Notes: This figure depicts the correlation between industries' dependence on external finance and firm-level indicators of financial constraints. The x-axis is a continuous measure of industries' dependence on external finance, measured as suggested by Rajan and Zingales (1998). The x-axis is divided into 20 bins based on the continuous measure of industries' dependence on external finance. In each picture, the blue cirlces represent the unconditional mean of the firm-level indicator of financial constraints in each bin of industries' dependence on external finance.

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
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
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
Share of Tangible Assets	0.58	0.49	0.01	2.83	76447
Debt Equity Ratio	5.60	191.97	0	32357	83894
Share of Firms Publicly Listed	0.31	0.46	0	1	100646
Share of Firms With Credit Rating	0.11	0.32	0	1	100646

Table 2: VAT Adoption and Unit Prices for Manufacturing Commodities

	(1) Unit Price	(2) Unit Price	(3) Unit Price	(4) Unit Price
VAT	-.044	-.061**	-.069**	-.064*
	(.031)	(.030)	(.031)	(.036)
Observations	378789	378789	378789	378789
R^2	.79	.79	.79	.81
Dep Var Mean	244539.58	244539.58	244539.58	244539.58

This table presents results from regressions of commodity prices on VAT adoption by states. The unit of observation is commodity-establishment-year. The dependent variable in each specification is the logged unit price of manufacturing commodities (measured in 2012 Rupees). The independent variable in each specification is a dummy equaling 1 if the state in which the manufacturing establishment is located has adopted the VAT. All specifications include year, establishment and commodity fixed effects. Column (2) introduces state-specific time trends; column (3) controls for firm age, square of firm age and state-level covariates; column (4) weighs the regression by the sampling weights provided by the Annual Survey of Industries. Standard errors are clustered at the commodity level

Table 3: VAT and Firm Plant and Machinery

	(1) Plant Machines	(2) Plant Machines	(3) Plant Machines	(4) Plant Machines	(5) Plant Machines
VAT	.057***	.052***	.046***	-.012	-.030
	(.018)	(.018)	(.016)	(.027)	(.028)
VAT*Fin.Dep.				.090***	
				(.034)	
VAT*High Fin. Dep.					.121***
					(.036)
Observations	85305	85290	84587	84438	84438
R^2	.91	.92	.92	.92	.92
Dep Var Mean	20.29	20.29	20.29	20.29	20.29
Year FE	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y
Industry-Year FE	N	Y	Y	Y	Y
State-Time Trend	N	Y	Y	Y	Y
Covariates	N	N	Y	Y	Y

This table presents results from specifications testing the impact of VAT adoption by states on firms' plant and machinery. The unit of observation is the firm. The outcome of interest in each specification is logged firm plant and machinery, measured in 2012 millions of USD. All specifications include firm fixed effects. Columns (2) -(5) include state-specific time-trends and 2-digit industry-year fixed effects. Columns (3)-(5) controls for a quadratic in firm age, a flexible linear state fiscal deficit, state non-tax revenue, state social sector spending, commercial bank-branch density, and state levels of literacy and urbanization. The independent variable of interest is a dummy equaling 1 if a state has adopted the VAT in the concerning year. Column (5) tests the differential effect of VAT adoption by states on firms across industries' dependence on external finance. Industry dependence on external finance is measured akin to Rajan and Zingales (1998).

Table 4: VAT and Firm Cash Flow, Profitability, TFP and Capital Distortion

	(1) Cash Flow	(2) Profits Pre-Tax	(3) TFP	(4) Cap. Dist.
VAT	-.001	.004	-.023	.014
	(.004)	(.003)	(.022)	(.014)
VAT*High Fin. Dep.	.002	.000	.071**	-.066***
	(.004)	(.003)	(.029)	(.015)
Observations	88404	92915	74943	74943
R^2	.33	.40	.93	.68
Dep Var Mean	.00	.06	45.76	-.76

This table presents results from specifications testing the impact of VAT adoption by states on firms' cash flow, profitability and productivity. The unit of observation is the firm. The outcome of interest in column (1) is cash flow as a share of assets; in column (2), profits before interests and taxes as a share of assets; in column (3), firm TFP; and in . column (4), distortion in firm capital relative to its marginal product for capital. Firm cash flow is calculated as the firm's income less expenses. Firm TFP and capital distortion are calculated akin to Hsieh and Klenow (2009). All specifications include firm fixed effects, state-specific time trends and 2-digit industry-year fixed effects, along with a quadratic in firm age, a flexible linear trend in salaries and return on assets and state level The independent variable of interest is a dummy equaling 1 if a state has adopted the VAT in the concerning year. Column (5) tests the differential effect state social sector spending, commercial bank-branch density, and state levels of literacy and urbanization. VAT is a dummy equaling 1 if a state has adopted the VAT in the concerning year. All columns test for the differential effect of VAT adoption by states on firms across industries' dependence on external finance. Industry dependence on external finance is measured akin to Rajan and Zingales (1998).

Table 5: VAT Adoption and Firm Machinery - Differential Effects Across Industries' Dependence on External Finance

			Panel A: Financially Constrained		
	(1) Young Firm	(2) Low Tangibility	(3) Unlisted Firm	(4) Unrated Firm	(5) High Debt-Equity
VAT	-.047	.009	-.010	-.016	-.021
	(.046)	(.035)	(.033)	(.029)	(.034)
VAT*High Fin.Dep.	.176***	.126***	.131***	.115***	.148***
	(.058)	(.043)	(.040)	(.037)	(.046)
Observations	36382	56829	55936	73445	51984
R^2	.90	.92	.92	.92	.92
Dep Var Mean	13.63	14.07	10.30	11.82	24.11
			Panel B: Financially Unconstrained		
	(1) Old Firm	(2) High Tangibility	(3) Listed Firm	(4) Rated Firm	(5) Low Debt-Equity
VAT	-.035	-.056	-.035	.033	-.043
	(.033)	(.040)	(.049)	(.074)	(.046)
VAT*High Fin.Dep.	.066	.067	.021	-.055	.078
	(.045)	(.059)	(.073)	(.120)	(.056)
Observations	48056	27609	28502	10993	32454
R^2	.94	.91	.94	.97	.92
Dep Var Mean	25.42	33.14	40.12	76.60	14.16

This table presents results from specifications testing the impact of VAT adoption by states on firm machinery, across industries' dependence on external finance. The unit of observation is the firm. The outcome of interest in all specifications is logged firm plant and machinery, measured in 2012 millions of USD. The column headers informs the firm characteristic by which the sample is restricted. All specifications include firm fixed effects, state-specific time trends and 2-digit industry-year fixed effects, along with a quadratic in firm age, a flexible linear trend in salaries and return on assets and state level time-varying controls for growth in state domestic product, state capital expenditures, state tax revenue state fiscal deficit, state non-tax revenue, state social sector spending, commercial bank-branch density, and state levels of literacy and urbanization.

Table 6: VAT Adoption and Firm Machinery - Differential Effects Across Industries' Dependence on External Finance

			Panel A: Financially Constrained		
	(1) Young Firm	(2) Low Tangibility	(3) Unlisted Firm	(4) Unrated Firm	(5) High Debt-Equity
VAT	-.003	-.009	-.028	-.012	-.017
	(.036)	(.026)	(.027)	(.023)	(.028)
VAT*High Fin.Dep.	.104**	.084**	.098***	.067**	.081**
	(.046)	(.033)	(.033)	(.030)	(.036)
Observations	31801	51384	49747	64735	47737
R^2	.91	.93	.92	.92	.92
Dep Var Mean	28.80	39.36	28.06	28.51	49.51
			Panel B: Financially Unconstrained		
	(1) Old Firm	(2) High Tangibility	(3) Listed Firm	(4) Rated Firm	(5) Low Debt-Equity
VAT	-.047*	-.039	-.001	.061	-.039
	(.028)	(.039)	(.040)	(.060)	(.036)
VAT*High Fin.Dep.	.035	.023	-.023	-.094	.064
	(.037)	(.054)	(.058)	(.086)	(.047)
Observations	43142	23559	25196	10208	27206
R^2	.94	.92	.94	.97	.93
Dep Var Mean	58.48	59.77	81.10	154.92	39.17

This table presents results from specifications testing the impact of VAT adoption by states on firm TFP, across industries' dependence on external finance. The unit of observation is the firm. The outcome of interest in all specifications is firm TFP, calculated akin to Hsieh and Klenow (2009). The column headers informs the firm characteristic by which the sample is restricted. All specifications include firm fixed effects, state-specific time trends and 2-digit industry-year fixed effects, along with a quadratic in firm age, a flexible linear trend in salaries and return on assets and state level time-varying controls for growth in state domestic product, state capital expenditures, state tax revenue state fiscal deficit, state non-tax revenue, state social sector spending, commercial bank-branch density, and state levels of literacy and urbanization.

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	$\tau(y$-$x)$
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 - Alternative Dependent Variables

	(1) Machinery Sh. of Assets	(2) GFA	(3) Power Fuels	(4) Sales	(5) Salaries	(6) Expenses
VAT	.018	-.072***	-.035	-.037	-.021	-.010
	(.023)	(.027)	(.028)	(.034)	(.025)	(.036)
VAT*High Fin. Dep.	.030	.162***	.091**	.081*	.094***	.068
	(.030)	(.035)	(.037)	(.042)	(.032)	(.046)
Observations	84419	90756	71785	82989	84588	92661
R^2	.88	.91	.91	.88	.91	.87
Dep Var Mean	.39	6.24	2.57	56.70	2.58	50.70

This table presents results from specifications testing the impact of VAT adoption by states on alternate measures of firm machinery, capital and overall performance. The unit of observation is the firm. The outcome of interest in column (1) is firm machinery as a share of assets; in column (2), gross fixed assets; in column (3), firm consumption of power and fuels; in column (4), firm sales; in column (5), firm salaries; and in column (6), firm expenses. All outcome variables are logged. All specifications include firm fixed effects, state-specific time trends and 2-digit industry-year fixed effects, along with a quadratic in firm age, a flexible linear trend in salaries and return on assets and state level time-varying controls for growth in state domestic product, state capital expenditures, state tax revenue state fiscal deficit, The independent variable of interest is a dummy equaling 1 if a state has adopted the VAT in the concerning year. Column (5) tests the differential effect equaling 1 if a state has adopted the VAT in the concerning year. All columns test for the differential effect of VAT adoption by states on firms across industries' dependence on external finance. Industry dependence on external finance is measured akin to Rajan and Zingales (1998).