Merging to Dodge Taxes?
Unexpected Consequences of VAT adoption in India

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Abstract

This paper investigates whether tax evasion creates incentives among firms to reorganize their production under Value Added Tax (VAT). The VAT is the world's most popular consumption tax and is considered revenue efficient since cross-reporting of firm-to-firm transactions facilitates self-enforcement. However, the ability to evade tax on consumer transactions creates incentives for the last two firms in the production chain to integrate vertically. In this paper, I test this hypothesis by using a quasi-experiment in India where the sales tax was replaced with VAT in a staggered manner between 2003 and 2008, changing tax evasion opportunities along the production chain. A differences-in-differences analysis reveals that after the reform, treated firms sourced more "upstream" products and had a greater vertical mergers, indicating greater vertical integration under VAT. In addition, the effect is largest for firms that are closest to final demand indicating that tax-evasion is one of the channels. Overall, the results suggest that VAT is no longer production efficient in settings of low compliance.

Keywords: Tax evasion; Vertical integration; Upstreamness; Value added taxes

JEL Codes: H20, H30, D22, D23

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Recent empirical work in public economics has investigated tax instruments in their ability to raise substantial tax revenues in developing countries where tax enforcement is less than adequate (Pomeranz (2015); Best et al. (2015)). Less studied is the effect of tax instruments on the *real* decisions of the firms that are crucial players in the collection and remittance of taxes. An important question that emerges is: Do firms respond to the tax evasion incentives created by tax instruments? Or in the context of this paper, do firms reorganize their production to dodge taxes? An optimal tax does not maintain production efficiency when firms reorganize to evade taxes (Kopczuk and Slemrod (2006)).

Under Value Added tax (VAT)— the world's most popular consumption tax— tax evasion opportunities vary significantly along the production chain. A VAT remitting firm pays tax on the net value added and is required to provide invoices of its purchases to claim input tax credit. This generates a paper trail for firm-to-firm transactions and allows a stricter enforcement of the tax. Consequently, VAT has been successful in reducing evasion and increasing tax revenues. Several countries have switched to VAT in recent past as illustrated in Figure 1, except for the United States where there is a debate if the country should move to VAT. However, the research has shown that the self-enforcement mechanism under VAT unravels at the last (retail) stage where there is no cross-reporting by consumers. Slemrod (2007) refers to this enforcement problem at the last stage as *Achilles heel* of administering value added tax.[1] In this paper, I show that the ability to evade at the last stage also has consequences for the organization of firms along the production chain.

The absence of cross-reporting by consumers under VAT implies that in contrast to an unintegrated second last firm that sells to a downstream firm, an integrated retail firm that sells to consumers can evade taxes on its sales. This ability to evade tax at the last stage creates an incentive for the second last firm in the production chain to integrate with the last firm (Kopczuk and Slemrod (2006)), which allows the integrated firm to make larger sales to consumers that are not subject to cross-reporting. A testable prediction is that we expect greater vertical integration in firms closer to the last stage than firms father up the chain when tax enforcement is imperfect under VAT. [2]

In this paper, I use a unique quasi-experiment in India where the state-level retail sales tax (RST) was replaced by VAT in a staggered manner across states. Replacement of RST with VAT provides exogeneous shock to tax evasion opportunities along the chain. This is because in RST, all firms except the last firm do not face any tax liability and therefore have no tax evasion incentive, whereas under VAT, all firms remit tax. Furthermore, the ability to evade tax lends advantage

[1] Many governments around the world aim to strengthen this part of VAT by offering incentives to consumers to ask for receipts. Naritomi (2013) shows in context of Brazil that an anti tax evasion program which provided monetary rewards for consumers to ensure that firms report final sales transactions, increased reported firms' revenues by at least 22 percent over four years.

[2] Another channel through which firms might dodge taxes is by selling directly to consumers instead of integrating with the downstream firm — unfortunately, testing this is beyond the scope of this paper. We can think of results in this paper as a lower bound to the actual treatment effect.

to being the last firm in the chain. I use a staggered differences-in-differences research design to show that the state VAT adoption significantly increased vertical integration in firms. More over, evidence suggests the effect is largest for firms closer to the retail stage suggesting that tax evasion is a plausible mechanism.

To measure vertical integration, I construct a measure of product upstreamness using plant-level input-output data (Annual Survey of Industries). Specifically, I draw from the trade literature (Acemoglu et al. (2010); Antras et al. (2012); Antrás and Chor (2013); Fally (2011); Alfaro et al. (2016)), a measure of product upstreamness. A product that is used more as an input to other products and/or in production of more upstream products is assigned higher value of upstreamness. I use the input-output data to construct an upstream index for each product in the sample.

To test the effect on vertical integration, I use the fact that a more vertically integrated firm sources inputs which are more upstream, and the vertical distance between its inputs and outputs is higher. Therefore, an increase in vertical integration leads to an increase in upstreamness of firm inputs (and consequently, an increase in the vertical distance between its inputs and outputs). I also provide a more direct evidence of vertical integration by estimating the effect of VAT adoption on vertical and horizontal mergers of firms in this period.

The identifying assumption is that the time trends in vertical integration in states that adopted VAT earlier do not differ significantly from states that adopted later, in the absence of VAT adoption. Additionally, the two-way fixed effect specification estimates the average treatment effect when the following hold: homogenous treatment effects (de Chaisemartin and D'Haultfoeuille (2019)), and time-invariant treatment effects. (Goodman-Bacon (2018)) [3] Even though it was agreed in 2002 that all states would introduce VAT with effect from April 2003, states adopted VAT with varied lags. Political and administrative reasons contributed to the state-specific delay in implementation. Some reasons included forthcoming state elections and disagreement between ruling federal and state governments on VAT implementation. Despite obeserved parallel trends in the pre-treatment period, we can not rule heterogeneity or time-varying treatment effects. [4] To alleviate such concerns, I complement the staggered differences-in-differences strategy with within-state variation in the treatment intensity. The firm-specific variation in treatment intensity arises from the fact that firms that produced VAT-exempt goods prior to VAT adoption are less intensely treated than the firms which produced goods subject to VAT. This specification relies on the assumption of common trends between firms producing VAT goods and firms producing

[3]Several authors including Goodman-Bacon (2018); Athey and Imbens (2018); and de Chaisemartin and D'Haultfoeuille (2019) have recently pointed out that in the presence of heterogeneous and time-varying treatment effects, a staggered differences-in-differences design yields a weighted average of treatment effects across all groups and periods, where some weights could be neagtive.

[4]In fact, the event study of the state VAT adoption on vertical integration shows strong dynamic effects. Moreover, unregistered manufacturing share is a predictor of adoption delay though it is not obvious if unregistered manufacturing share is a determinant of vertical integration trends.

VAT-exempt goods.

The results indicate that the VAT adoption increased vertical integration in firms, as reflected by average upstreamness of firm inputs. Average upstreamness of inputs increased by 0.35 production steps after the state VAT adoption in firms that produced VAT goods, compared to firms that produced VAT exempt goods prior to the reform. The evidence on mergers and acquisitions provides support to the hypothesis. While the number of log horizontal mergers remain unchanged during this period, the state-level log vertical mergers increased by 2% after VAT adoption. Because firms have incentives to integrate under sales tax due to double taxation on inputs, the estimates in my paper can be interpreted as a *lower-bound* of the actual treatment effect of the VAT adoption.

Next I explore the channels that explain the finding. In particular, I test if tax evasion causes firms to vertically integrate under VAT. A testable empirical implication for the presence of this channel is that a substantial part of the effect is driven by firms closer to the final demand. Figure 13 illustrates exactly this. The figure plots the treatment effect as a function of distance to the final demand at the baseline. Firms which are at 0 distance to the final demand in the sample exhibit the largest increase in the input upstreamness, consistent with the tax evasion hypothesis.

However, there are other potential channels that could explain increase in vertical integration in the middle of the chain. As we see in Figure 13, firms which belong to second to tenth ventile also experience a small and significant increase in input upstreamness after VAT adoption. An alternative mechanism is that VAT imposes tax burden and creates incentives to integrate in the middle of the chain. This arises from the fact that firms are required to make monthly/quarterly tax payments on purchased inputs. When inputs are purchased before the realization of sales and tax refunds are slow or non-existent, VAT can put significant tax burden on credit-constrained firms. The second alternative mechanism relates to compliance costs. Filing costs increase or decrease under VAT depending on the size of firm and its position in the value chain. If filing costs increase, larger firms benefit from economies of scale under VAT. The third alternative mechanism relates to the possibility that a lower tax rate under VAT increased net-of-tax price received by firms. Research has shows that a higher output price increases vertical integration in firms (Alfaro et al. (2016)).

The empirical results however, do not lend support to the liquidity constraints, the compliance costs, and the tax rate decrease hypothesis. In particular, the effect size of VAT adoption does not depend on the magnitude of financial constraints faced by the firm, as measured by its industry level cash flow sensitivity estimate (Almeida et al., 2004). This is at odds with the prediction of the liquidity constraint hypothesis which states that effects are larger for firms with higher liquidity constraints. Finally, in contrast to the compliance costs hypothesis prediction which states that the effect is larger for smaller firms, I find that the estimated treatment effect is not correlated with the firm size in any meaningful way, where the firm size is measured by the number of its employees. Finally, even though the VAT adoption lowered consumption tax rate by 0.06 percentage points,

I find that the vertical integration effect does not differ by whether the tax rate on a firm's major output increased or decreased as a consequence of the tax reform.

One concern with my estimates is that they capture only *reporting* response of firms and exclude *real* responses. This has been pointed out in recent work in public economics that uses the tax returns data where it is hard to separate actual response from misreporting. However, because I use firms survey data, it is less likely that the firms misreport input and output mix. This dataset is collected by Ministry of Statistics to measure industrial statistics and is separate from tax returns. The identity of the firms is confidential and not accessible to tax authorities. Therefore, we can expect that all measured reponses in this paper are *real* responses and not purely *reporting* response.

Taken together, the results point to tax evasion as one of the channels that leads to greater vertical integration in firms after VAT adoption. Being at the retail end provides strategic advantage because it allows firms to under-report sales and reduce tax liability. In contrast, an integrated firm in the middle of the production chain is subject to cross-reporting on both its inputs and outputs and therefore has no incentive to integrate to evade.

The findings in my paper have important implications for tax policy design in developing countries. First, the results show that firms adjust their production processes in response to evasion, which is a new result in the literature. This implies that the lower revenue collection in low compliance settings is possibly a combination of both actual tax evasion and firm production responses. Second, integration for evasion imposes revenue-production efficiency trade-off for the tax-authority. Using VAT adoption as an instrument for vertical integration, I show that, on average, an integrated firm has higher profits per worker but remits lower taxes, compared to a less integrated firm.[5] This introduces a trade-off between tax enforcement and firm profits.

The revenue-production efficiency has implications for the optimal tax literature. A canonical result in the optimal tax theory is that an optimal tax must maintain production efficiency (Diamond and Mirrlees (1971)). With perfect enforcement, VAT maintains production efficiency. However, in the presence of integration responses to evasion, a privately optimal firm is larger than a socially optimal firm. Therefore, the revenue-maximizing tax rate under VAT that disregards firms' incentives to integrate raises lower revenues than the one which takes them into account. Therefore, the optimal tax deviates from production efficiency as has been previously argued by some authors (Emran and Stiglitz (2005); Kopczuk and Slemrod (2006); Gordon and Li (2009)). Characterization of the optimal tax in the presence of integration for evasion is a potentially interesting avenue for future research.

The first contribution of this paper lies in the field of public finance. A burgeoning literature in public finance argues that the tax system in addition to the tax rates such as the institutional

[5]Integration significantly increases a firm's value-added defined as the difference between gross sale value and material costs.

setting, plays a key role in determining the tax capacity (Slemrod and Yitzhaki (2002); Gordon and Li (2009)). Recent empirical evidence has demonstrated the revenue implications of tax evasion. Ability to evade taxes implies cross-reporting of transactions (Pomeranz (2015)); withholding (Brockmeyer and Hernandez (2018)); and the choice of tax instrument (Best et al. (2015) play a key role in determining revenues. My paper shows that tax evasion not only affects revenues but also the real operations of firms. Additionally, a growing literature has demonstrated the real effects of tax structure specific to VAT. For instance, Gadenne et al. (2019) show that size-based exemptions under VAT distort supply chains where exempt firms are more likely to transact with other similarly exempt firms. Likewise, Carloni et al. (2019) use VAT changes in the European Union to show that consumer prices respond more to increases than to decreases under VAT. Additionally, recent work has explored the consequences of tax-enforcement variation along the supply chain to informality (De Paula and Scheinkman (2010)) and to the tax incidence (Kopczuk et al. (2016)).

Furthermore, the second contribution of my paper lies in organizational economics. Beginning with Coase (1937) economists have proposed several factors that determine boundary of a firm.[6] Empirical evidence suggests that market competition (Aghion et al. (2006)); tariffs/output price (Alfaro et al. (2016)); corporate tax avoidance (Auerbach and Reishus (1987)) affect firm boundary. More recently, Oberfield and Boehm (2019) use the same manufacturing data and a vertical distance measure to show that weak enforcement of contracts incentivizes firms to integrate vertically. My paper shows that tax considerations and tax evasion, in particular, have consequences for a firm boundary as well. Finally, my paper provides a simple methodological approach to estimating the effects on vertical integration using an upstream measure, useful to study effect of value-added taxes along the supply chain without access to confidential tax returns data.

The paper is organized as follows. Section 1 discusses the tax reform in India. Section 2 presents a simple framework that illustrates the role of tax evasion in creating incentives for vertical integration. Section 3 describes the data and the construction of the upstream index. Section 4 performs the empirical estimation. Section 5 explores the mechanisms that could explain vertical integration effects. Section 6 discusses the implications of the results to firms and the government. Section 7 concludes.

1 The VAT Tax Reform, 2004-09

Prior to 2017, each state in India imposed and collected its own sales tax. Sales tax contributed to almost two-thirds of state's own revenues and a third of domestic trade taxes in the country. This system of sales tax was reformed between 2003 and 2009, the characteristics of which are discussed below.

[6]For instance, on page 7, Coase (1937) notes that, "If we consider the operation of a sales tax, it is clear that it is tax on market transactions and not on the same transactions organized within the firm...to the extent that firms already exist, such a measure as a sales tax would merely tend to make them larger than they would otherwise be."

Pre-reform period: Prior to the implementation of VAT, all states implemented single point sales tax system which was highly complex with many rates, plethora of explanations, many rates in some group of items, extensive use of statutory forms, high and unrealistic quota of assessment, loss of revenue on value additions, and "tax rate war" between states (Finance (2005)). The single point of taxation though fixed, varied by states. Though the subsequent dealer could deduct the sales tax if it was paid by the previous dealer earlier in the chain, these rules varied by states, leading to substantial cascading and double taxation.

Tax reform process: At the conference of the State Finance Ministers on January 23, 2002, it was agreed that all the 28 states would implement VAT with effect from April 1, 2003. Additionally, it was decided that all states would be fully compensated for any revenue loss in first year, 75% of the loss in second year, and 50% in third year to dispel any concerns regarding the revenue loss. Nevertheless, only one state, Haryana implemented VAT at that date. Figure 2 illustrates the timeline of state VAT adoption. 60% of the states adopted VAT by 2006. The adoption was complete by 2009. Figure 3 shows that the majority of smaller states adopted earlier while larger states adopted in different years later on.

This delay in implementation was mainly due to political and administrative reasons. Nationwide adoption of VAT was federal government's initiative and required cooperation of all states. The opposition party in the center ruled some states and it was particularly in those states that cooperation was difficult to achieve. This period also coincided with elections in some states. For instance, the Chairman of the Empowered Committee of State Finance Ministers on VAT noted, "The Delhi Government is apparently citing elections to its State Assembly in November for not implementing VAT immediately. And since Delhi is not implementing VAT now, the neighbouring States are also hesitating.". The federal government negotiated with each state individually. The media reported substantial apprehension among traders during this time with respect to the adoption of VAT. [7]

Features of the new tax reform: Under the new system, [8] the tax units (or firms registered to pay VAT) remited taxes according to a tax credit or invoice method in which firms could deduct tax paid on inputs from the tax paid on output to determine the final tax liability. The input tax credit was given to manufacturers and traders for the purchase of inputs/supplies from within the state, and meant for sale of final output either within or outside the state, and irrespective of when the output would be utilized/sold. However, the tax paid on inputs purchased from other states were not eligible for the tax credit. [9] If the tax credit exceeded the monthly tax liability, the

[7] For instance, one of the dailies reported on 2nd February 2005:
"So will VAT come into effect on schedule or will it be another 'April Fool' joke? This is the apprehension among many businessmen across the country."

[8] See Finance (2005) for complete details of the tax reform. Also note that in July 2017, the state-wide VAT system was replaced with the nationwide Goods and Services Tax (GST).

[9] All the inter-state sales were subject to a Central Sales tax (CST). The CST revenue acrrued to the state in which the sale originated. CST being origin based tax was inconsistent with VAT which was a destination based tax, hence

excess credit was carried over to the end of next financial year. Any excess unadjusted input tax credit at the end of second year was eligible for a refund.

Unlike the pre-VAT period, capital goods used as inputs (with the exemption of goods on the "negative" list) were eligible for input tax credit that could be adjusted over a maximum of 36 equal monthly installments. Exports and sales made to Special Economic Zones were zero-rated and tax paid on them was subject to a full refund in three months. The dealers were required to file returns either monthly or quarterly depending on their turnover. In addition, small dealers with gross annual turnover below a certain threshold were exempt from VAT registration. Once the annual turnover crossed the threshold, the dealers were required to register and pay VAT going forward. This threshold varied fby states and changed over time within states. All registered dealers were by law required to issue serially numbered tax invoice, cash memo or bill forsales.

The tax reform reduced the multiplicity of tax rates. Even though the state specific variation in tax-rates remained, all states broadly had two VAT rates of 4% and 12.5% that covered about 550 goods and served as the floor tax rates. The 4% VAT rate comprised of largest number of goods (about 270), common for all the states, and consisting of basic necessities such as medicines and drugs, agricultural and industrial inputs and capital goods. The remaining commodities fell under the general VAT rate of 12.5%. There was a special VAT rate of 1% for gold and silver ornaments. Additionally, each state exempted about 46 commodities from taxation. This included natural and unprocessed products in unorganized sector, items legally barred from taxation and items with social implications. The states were flexible to chose 10 of these commodities of local social importance (from a list of goods common to all states) without any inter-state implication. The rest of the tax-exempted commodities remained common to all states.

Replacement of Retail Sales tax with Value-added tax: As long as the tax reform did not vary other aspects such as tax rates systematically along the production chain, the replacement of VAT with RST provides exogeneous variation in incentives for firms to integrate at the final stage. To see this clearly, consider Figure 5 that illustrates how production chain is affected when firms integrate to evade tax after the replacement of RST with VAT. Panel (a) shows revenue collected under RST where entire tax is remitted by the last firm in the production chain, F3. In contrast to RST, under VAT in panel (b), all firms remit tax equal to tax rate times their net value added. Total revenues collected in both tax systems is equal when the tax rates are equal and there is no evasion. Panel (d) illustrates how the second last firm F3 gains by integrating with the last firm F4 to evade tax in VAT system. The integrated firm F3 under-reports sales to consumer which lowers effective tax remitted by F3 to the tax authorities.

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was slowly phased out. At the time of implementation of VAT, CST stood at 4% which was reduced to 3% in 2007, and then to 2% in 2008. See http://dor.gov.in/centralintro for further details.

2 A Simple Framework

I present a simple framework to illustrate how the presence of evasion increases vertical integration under VAT. Consider a simple production chain where the total value V is created in the production chain by two separate firms F_1 (wholesaler) and F_2 (retailer), and each contribute V_1 and V_2 such that $V_1 + V_2 = V$. Integration incurs fixed costs F. I first illustrate the role of evasion in creating incentives to integrate when there are no efficiency gains from integration. That is, for now I assume vertical integration preserves the total value added in the chain. The two firms integrate when:

$$(1 - t_r)(V_1 + V_2) - (1 - t_r)V_1 - (1 - t_w)V_2 > F \implies (t_w - t_r)V_1 > F \tag{1}$$

t_r and t_w denote the tax rate the retailers and wholesalers face on their value-added. When the tax rate faced by wholesalers and retailers does not differ significantly, that is, $t_r = t_w$, the left hand side reduces to zero. In other words, in the case when the tax reform did not alter the tax rates on wholesalers compared to the retailers significantly, there are no incentives for the two firms to vertically integrate. Now suppose that $t_r = t_w$ but the evasion opportunities differ along the chain. In particular, $t_w = t_r$ but $t_r^e < t_w$, and t_r^e represents the tax rate remitted by an evading firm. The statutory tax rates faced by the wholesalers and the retailers are equal but the ability to evade implies a retail firm effectively pays a lower tax rate. Clearly now the left hand side is positive and the tax reform would move some firms to integrate, conditional on being large enough. Given an F, larger wholesalers are more likely to integrate.

Additionally when integration brings in efficiency gains, the incentives to integrate for tax evasion are even larger. This can be imagined as an increase in V. For instance, performing several production steps within one firm could save contractual or relationship costs and improve efficiency (Coase (1937); Oberfield and Boehm (2019)). In such a case, V increases and firms profits net-of-integration costs increase.

Clearly, lower revenues are collected when firms integrate to evade. With no integration and no evasion, revenues equal $t_r V_1 + t_r^e V_2$. With vertical integration and evasion, the revenues fall to $t_r^e V_1 + t_r^e V_2$ because $t_r^e < t_r$. Vertical integration implies a larger share of sales is subject to evasion opportunities. Kopczuk and Slemrod (2006) discuss how the vertical integration response increases the costs of enforcement in VAT. From the society's point of view, this imposes an externality and lower revenue is collected in the presence of imperfect compliance. An optimal VAT must take into account this trade-off between production and revenue efficiency. A socially optimal tax under VAT would then allow level of integration less than a privately optimal tax. In other words, production inefficiency is part of optimal tax in VAT with imperfect compliance.

3 Data and Measurement of Vertical Integration

This section discusses the approach this paper takes to measure vertical integration in firms and the dataset used to estimate the effects of VAT adoption.

3.1 Data

The main dataset that I use comes from the Annual Survey of Industries (ASI) , which is conducted by the Ministry of Planning and Statistics (MOSPI) every year. The ASI is a repeated cross section survey representative of formal establishments, (stratified at the state by 4 digit industry level) The cross section is designed as follows: large establishments with 200 or more workers till 2003-2004, and firms with 100 or more workers are surveyed each year after 2004 (with about 10% non-reporting each year). Smaller establishments are surveyed with a probability which depends on the state and industry block, with a minimum sampling probability of 15%. MOSPI has recently allowed researchers to track establishments who were sampled multiple times. I have access to ASI "panel" for years 1999 to 2010.

I bprrow the cleaning code and methodolgy from Allcott et al. (2016). I remove establishments with invalid identification code and which are reported closed/non-responsive in a given year. This leaves around 37,000 establishments in a year. The survey covers period from April of a year to March of the next year which coincides with the fiscal calendar in India. This works to my advantage because the tax reforms in India are largely implemented at the start of the fiscal year, that is, April of a year. The unit of analysis in the sample is an establishment which is a subset of the firm, a unit smaller than the firm. There is no information on parent firm for multi-unit firms. However, approximately 95% of firms are single unit and file a single return. This implies that the terms establishment and firm can be used interchangeably. I interpret the findings in this paper as responses of a firm.

The survey requires firm owners to provide information on the status and the number of units, labor cost and employment, fixed assets, quantity and type of inputs employed, type, and quantity of ten major outputs produced. The inputs and outputs are classified at the 5 digit industry level according to Annual Survey of Industries Commodity Classification (ASICC) code. For outputs, information provided includes quantity, gross sale value, ex-factory value, sales tax, and excise tax paid.

There are a few advantages of using the ASI dataset. First, it contains extensive information on firms' inputs and output decisions which allows me to identify firm position in the value chain based on its inputs and outputs. Second, because the survey maintains confidentiality of firms, information reported by firm owners is not accessible to the tax authorities, there is no incentive for firm owners to misreport information in the survey for tax purposes. Third, the survey is nationally representative, which allows me to assume input-output linkages observed in the survey

as representative of the nation-wide linkages.

Table 1 describes the key firm variables in the ASI data. An average firm employs approximately 139 workers, produces 3 outputs, and uses 11 inputs. There are a few oddities in the data, for instance, some firms report upto 98 inputs, many firms report 0 output and 0 workers. These could reflect reporting errors.

The summary statistics reveal that an average firm in the sample uses inputs with an upstream index of 4. This implies that the average inputs used by a firm are approximately 4 production steps away from the final consumption in the input-output network generated in the sample. Because the data does not provide any information on the firm position characteristics, it is not possible to determine whether an observed firm is a manufacturer, wholesaler or a retailer. Nevertheless, rows 2 and 3 of Table 1 report the probability that a randomly selected firm in the sample uses inputs with upstreamness less than the median. The median upstream value in the complete product space is 2 (see Figure 8). Approximately 10% of the firms in the sample use downstream inputs, which is consistent with the fact that the survey covers mostly manufacturing firms that are more likely to be upstream.

Figure A-1 plots the distribution of the number of firms by 1-digit industry classification (NIC). A large share of the firms belong to mining, quarrying, and basic manufacturing industries. The latter includes manufacture of metals, paper products, and electronics, fabricated metals. Unfortunately, wholesale trade and retail industries are poorly represented in this data. Neverthless, the manufacturing firms data is informative because many firms in the sample produce goods such as TV, radio, motor vehicles, which are important from final consumption point of view.

Additionally, I supplement the above data with information on state-wise VAT adoption date, state-product tax rates, and a list of state-specific tax-exempt goods from state tax laws and reports. The dataset on tax rates is useful to alleviate the concenr that vertical integration effect partially reflects response to higher net-of-tax prices in the VAT regime. This is because the tax reform effectively lowered the average commodity tax rate (Figure 9). Tax rates were collected for each product in the sample for 17 states for both sales tax and VAT regime. A research assistant manually read the state tax laws and assigned relevant tax rates to each product in each state in the two tax regimes. The final sample excludes the north-eastern states, and Jammu and Kashmir because of their under-represention in the ASI data.

Finally, I supplement with PROWESS dataset (2001-2010) which contains information on publicly-listed and some private firms. It is compiled using information sourced through annual and/or quarterly financial statements of approximately 27,000 active business entities. Though not nationally representative, PROWESS data includes non-manufacturing, financial and retail firms as well. More importantly, it contains information on mergers and acquisitions carried out by firms in the sample during this period. This dataset is useful to provide more direct evidence of the effect of VAT on vertical integration.

3.2 Measurement of Vertical Integration

It is generally difficult to directly identify vertically integrated firms in terms of ownership and commodity flows. Previous authors (Acemoglu et al. (2010); Fan and Lang (2000); and Alfaro et al. (2016)) have used indirect measures that use national input-output Tables. These measures, however, are fairly broad and identify only a subset of integrated firms. I improve on these methodologies by proceeding in two steps: i) I classify goods according to their position in production chain according to a measure of upstreamness; and ii) I determine implications of greater vertical integration on upstream measure of inputs and outputs and test them in the data.

The idea is that a more vertically integrated firm uses inputs which are relatively more upstream, or higher up in the production chain. Recent work in trade has classified goods by their position or its "upstreameness" in the production chain (Fally (2011); Antras et al. (2012)). A product that is mainly used as an input for production of other goods is given a higher score of upstreamness than a product that is sold directly to the consumers. In addition, a product used by firms that are more upstream themselves is more likely to be upstream.

As an illustration, consider a production chain comprised of three firms in Figure 6. F1 supplies to F2, which supplies inputs to retail firm F3, which in turn sells the final output to the consumer. Given the network of firms, products P2 and P3 are more upstream than P1 because they are used in the production of P1. Now suppose that the last two firms integrate by merging and firm F2 disappears as a result.[10] The integrated firm uses P2 as inputs. If we fix the upstreamness of the products at the pre-integration levels (as in the top figure), then the average inputs upstreamness is higher in the integrated network than the unintegrated network. In addition, if there are no other accompanying changes in production processes in the integated firm, outputs on average are more downstream in the network with integrated firm.

Another intuitive measure of vertical integration is the vertical distance between firms' inputs and outputs. Vertical distance refers to the number of steps in production process that are performed *within* the firm. A more integrated firm performs more steps within the firm which implies that greater vertical integration is associated with larger firm's vertical distance. An interpretation is that when outputs become more downstream and inputs become more upstream, vertical distance of a firm increases. Figure 7 plots average vertical distance of firms in the sample in the pre-reform period 2000. A firm had a vertical distance of approximately 1 in 2001. This implies that an average firm in the pre-reform period performed one prodution step in-house.[11] The testable hypothesis is:

Hypothesis: *The replacement of sales tax with VAT increases incentives for a firm closer to the final demand to produce in-house instead of buying it from outside. This is reflected in an increase in its input*

[10] Or they make a contract instead of going through actual merger.

[11] Recently, Oberfield and Boehm (2019) use a slightly similar measure of vertical distance and the same data to show that weak contract enforcement distorts production organization in India.

upstreamness and a decrease in its output upstreamness. Consequently, vertical distance between its inputs and outputs increases.

The next task is to accurately measure products' upstreamnes. For this purpose, I draw a measure from the trade literature (Fally (2011)).

3.2.1 Measurement of Upstreamness

This section provides details on the construction of Fally's upstreamness index using input-output table. Fally (2011) proposes a measure based on the notion that firms selling a disproportionate share of their output to relatively upstream firms should be relatively upstream themselves. Similarly, a product that is largely used in the production of more upstream products is more upstream.

$$U_{2i} = 1 + \sum_{j=1}^{N} \frac{a_{ij} Y_j}{Y_i} U_{2j}$$

where a_{ij} refers to the quantity of good i used in the production of good j, Y_j denotes the total quantity of good j produced in the economy.

Formally the above can be written as:

$$U_2 = [I - \Delta]^{-1}\mathbf{1}$$

where Δ is the matrix with $a_{ij}Y_j/Y_i$ in entry (i, j) and $\mathbf{1}$ is a column-vector of ones.

Δ matrix is productXindustry "Use matrix" provided as part of Input-Output (IO) tables for a country. (i, j)th element of this matrix denotes the amount of product i used in the production of product j. India's Input-Output tables at the 3-digit industry level exist for the year 2003-04. Product classification in the Annual Survey of Industries (ASI) data is finer at the 5 digit level. Additionally, there is no clear concordance between IO tables and industry codes in the ASI data. Therefore, I construct the Use matrix from the ASI data for the year 1999-2000, which allows to use trading network of firms four years before the reform. I next discuss the construction of U_2 from the ASI data.

3.2.2 Construct the Use Matrix from 1999-2000 survey data

For each firm, define the industry to which a firm belongs according to the major product. The major product is one which has maximum ex-factory value (MOPSI 2013) where: [12]

$$ExFactoryValue = PerUnitSaleValue \times QuantityManufactured$$

[12] I remove 'unclassified' inputs/outputs of the firm.

For each industry in the data, I calculate the amount of each input used and the total output produced. This is obtained by collapsing firm level input-output data to productXindustry level using ASI sampling weights. Use of weights allows me to obtain nationally representative Use Matrix. Each element of this matrix is $a_{ij}Y_j$, that is the amount of good i used in the production of good j. From the Use Matrix, calculate the total absorption of a product across all industries (Y_i). Absorption Y_i refers to the total use of the product i within the network economy. This includes all the manufacturing firms within the sample. Y_i provides the denominator for each row in Δ. Once Δ is obtained, U_2 can be calculated using the formula:

$$U_2 = [I - \Delta]^{-1}\mathbf{1}$$

An issue that arises is that the $[I - \Delta]^{-1}$ matrix is not invertible. This happens because of the presence of some goods that are not used across industries but are only used within the industry to which they belong. To solve this problem, I use pseudo inverse. As a robustness check, I also perform Tikhonov Regularization to the matrix. [13] This procedure assigns upstream measure to each product observed in year 2000, which leads to 3,210 such products.

3.2.3 *Making sense of the Upstream measure*

Figure 8 shows the distribution of products' upstream indices. The mean product upstreamness is 3.23 and the median is 2.06. Most of the products take upstream values between -5 and 10. Some products have negative upstream values, with the lowest value corresponding to -13. These negative values arise because some rows in the $[I - \Delta]$ matrix are zero-valued for cells except the diagonal. For instance, the knitted garments are largely absorbed within the knitted-garments industry. This is the limitation of the data which does not contain the complete input-output network. In particular, final consumption and other wholesale and retail activities are missing from this data. In the absence of the full network data and a detailed industry/product classification, the upstreamness of such products is going to be less precisely estimated. To alleviate some of the concern, I perform a robustness check where I drop products that take negative values from the analysis and the results go through.[14]

Table A-8 lists products with the lowest (negative) and highest upstream values. Eyeballing suggests that the negative upstream indices correspond to consumer oriented products and high-

[13] I also use Tikhonov Regularization as a robustness check: For a given h, this method approximates A^{-1} with C_h such that:

$$\lim_{h \to 0} C_h A = I$$

Appropriate C_h is determined such that the norm of $(A\hat{x} - y)$ is the smallest. This when A is rank deficient or ill-conditioned gives:

$$C_h = (A'A + h^2 I)^{-1} A'$$

I implement this for $h = 10^{-3}$ Section 4.4 reports robustness to alternative methods of matrix inversion.

[14] Results using specification 2 are reported in Table A-7.

est indices correspond to basic products such as coir fibre; energy products such as LPG; and water for industrial use. Table A-2 shows how products indices are distributed for four main industries of India. For instance, raw cotton has a higher upstream index than bleached and processed cotton. Knitted cloth is much downstream. Similarly, iron ore is quite upstream with a value of 4.85. Iron sheets and plates are downstream with value of 2.74. Overall, U_2 seems to capture the position in the production chain fairly well.

4 Empirical Strategy and Results

Having proposed a measure of vertical integration, this section uses the staggered adoption of VAT to estimate the effect of state VAT adoption on vertical integration in firms. The firms which produced VAT-exempt are less intensely treated by the reform and serve as a control group in the main specification.

4.1 Main specification: VAT and non-VAT good Producers

The identification of the treatment effect requires that vertical integration evolves similarly in early adopters of VAT and later adopters of VAT. The parallel-trends assumption would not hold if, for instance, the delay in implementation was correlated with the state-specific time varying characteristics. For instance, Table A-1 tests for presence of correlation between state-specifc delay in implementation and state growth variables in the pre-reform period. The data comes from NITI Ayog's GDP reports. We see that while the state's delay is not correlated with its GDP growth rate, manufacturing growth rate, or agricultural growth rate, there is a significant correlation with unregistered manufacturing growth rate. This is concerning if we think that trends in unregistered manufacturing could affect vertical integration in the registered manufacturing sector. Additionally, a specification that uses the only the timing variation in state VAT adoption must also satisfy homegeneity and time-invariant treatment effect for the estimate to have a causal intepretation (de Chaisemartin and D'Haultfoeuille (2019), Goodman-Bacon (2018)). Therefore, this section reports results for Specification 4, which employs variation in treatment intensity within state: producers of non-tax exempt goods and tax-exempt goods, in addition to the variation in VAT adoption.

As discussed in Section 1, a feature of the VAT reform was that each state proposed a list of goods that were to be exempt from VAT within that state. Some products include agricultural implements, common items such as salt, vegetables, books and periodicals, and feed for animals and poultry. Relative politcial importance often explained why a product was exempt from VAT in one state and not in another. Some of these products were tax exempt in the sales tax regime as well. The firms that produced tax-exempt goods in pre-reform period act as a control group because for manufacturers of these goods, both input and output tax liability is unchanged with

the tax-reform. The producers of VAT-exempt were not eligibile for input-tax credit because their output is not subject to VAT. Moreover, these firms were not required to collect tax and file VAT tax return. Therefore, we expect the tax-burden and the compliance costs to be unaffected by the VAT reform for these firms.[15]

I identify the list of products that were tax-exempt under the VAT law and hand-code their names to the products in the ASI data. I identified 172 such VAT-exempt products. Such products were produced by roughly 1010 out of 29920 firms in the 2002 sample. I assign such VAT-exempt firms to control group and estimate the following specification:

$$y_{ist} = \beta_0 + \gamma_t + \gamma_s + \beta_1 adopt_{st} + \beta_2 NonTaxExempt_i^{2002} + \beta_3 NonTaxExempt_i^{2002} \times adopt_{st} + \epsilon_{ist} \quad (2)$$

A firm is non-tax-exempt if it *did not* produce a VAT-exempt product in 2002 (the year right before first state adopted VAT.) The identifying assumption here is that in the absence of the VAT, vertical integration for VAT good producers would evolve over time in ways similar to the vertical integration in firms that produced VAT exempt good. All regressions are weighted by the inverse of sampling weights provided in the dataset to account for heterogeneity because of endogenous sampling (Solon et al. (2013)). For a greater precision, I focus on the period 2003-2010 when VAT had begun to be implemented. In other variants, I add industry, firm fixed effects and state-specific linear time trends. I cluster the standard errors at the state level to account for possible serial correlation (Bertrand et al. (2004)).

Table 2 reports the estimated coefficient of interaction of a non-tax exempt firm in 2002 and the adoption dummy, β_3. I find that the coefficient is significant in all specifications. The effect is largest in the specification that includes only state and year fixed effects (0.584) compared to the regression with firm fixed effects (0.35). The treatment effect in (1) comprises of both within-firm effect and a compositional change in sample due to firm exits; whereas (6) includes only within-firm effect. Additionally, the magnitude and significance of coefficient is unaffected by the inclusion of industry-fixed effects. To explore the dynamic effects of the VAT adoption, I also plot the coefficients from the event study version of specification 2 that includes firm fixed effects. The full specification is as follows:

[15]Note that this does not account for any general equilibrium changes that might result from the reform. For instance, these firms might see their profits decline if the average demand for their product decreases due to high price levels in general, resulting from other firms integrating along the chain. This could in turn lead to more integration within the control firms. Therefore, we expect the estimated effect in this specification to be a lower bound of the actual treatment effect.

$$y_{ist} = \beta_0 + \gamma_t + \gamma_i + NonTaxExempt_i^{2002} + \sum_{-3}^{3} \beta_t \text{Years since Adoption}_t \times NonTaxExempt_i^{2002} + \epsilon_{ist} \tag{3}$$

The dummy for a year before the state VAT adoption is omitted.[16] Figure 10 presents the results. The bars indicate confidence interval at 10% significance level. We see that while there are no significant pre-trends, firm input upstreamness increases significantly the first VAT year is adopted. The effect largely remains similar in the next three years.

Table 3 presents results with average upstreamness of firm outputs as the outcome variable. The coefficient of Non Tax Exempt X$Adopt$ is insignificant in all specifications. Moreover, the coefficient is of the opposite sign (positive) in the first four columns that do not include firm fixed effects. Columns (5) and (6) present results with firm fixed effects. Here we see that the coefficient is of the expected negative sign though largely insignificant. Figure 11 presents event study version of this specification. We see that there is a slight insignificant drop in output upstreamness in the first two years after VAT adoption. One reason why the output effect is insignificant is that vertical integration changed the composition of outputs. For example, efficiency gains due to integration might allow integrated firms to produce more upstream outputs. To see if there is any composition change Table A-4 presents the results for second moments of output upstreamness. Column (1) presents effect on upstreamness rank of firm outputs, that is, the difference between the most upstream and the least upstream output. The coefficient is positive but insignificant. Columns (2) and (3) test for changes in the mean and median absolute deviation. Both coefficients are insignificant. Columns (4) and (5) show some indication that a firm's most downstream output is more downstream after the reform, however, it is insignificant even at the 10% significance level. The results here do not provide strong evidence in favor of the observable changes in firm output composition as measured by the second moments of output upstreamness.

4.2 Alternative Specifications

Using Staggered state VAT adoption

We can also use the staggered nature of state VAT adoption directly in a differences-in-differences framework to estimate the effects of VAT. This serves as a useful robustness check despite the obvious concerns. Specifically, I estimate the following specification:

$$y_{ist} = \beta_0 + \beta_1 Adopt_{st} + \gamma_s + \gamma_t + \epsilon_{ist} \tag{4}$$

[16] Note that the variable $NonTaxExempt_i^{2002}$ is not perfectly collinear with the firm fixed effects. This is because several firms are not observed in 2002 and therefore can not be categorized in either the treated or the control group.

$Adopt_{st}$ takes value 1 if VAT was adopted in state s in year t, 0 otherwise. γ_s and γ_t denote state and year fixed effects, respectively. y_{ist} is average upstreamness index for firm i's inputs (or outputs) in state s and time t. The main identifying assumptions are that the actual date of implementation of VAT in a state is orthogonal to any endogenous trends in the outcome variable, the treatment effects are homogenous; and the treatment effects do not vary over time. When these assumptions hold true, β_1 identifies the average treatment effect of replacement of sales tax with VAT on the firms' inputs upstreamness.

Table 4 reports the estimated $Adopt$ coefficient when the outcome variable is the average inputs upstreamness for several specifications. The sample is restricted to 2003-2010. (1) is the least restrictive specification and controls for only time and state fixed effects. The coefficient is 0.2 and significant at 1 percent. This suggests that firms procurred inputs that are 0.2 production steps more upstream after VAT adoption. The significance remains strong when I add state specific linear trends but coefficient reduces to 0.176 (2). The coefficient remains unchanged when I add industry fixed effects, implying that most of the effect comes from within industry. However, the addition of firm fixed-effect reduces coefficient size and renders it insignificant at the 10% confidence level. This is concerning as it suggests that after controlling for compositional changes due to firm entry and exits, the state VAT adoption did not have significant effect on vertical integration on the firms that remained in the sample. A possibilty is that the effect using state-VAT adoption is underpowered. The staggered VAT adoption relies only on the variation in the timing of the VAT adoption. In the case when the treatment effects vary over time, this leads to smaller estimates when the initial adopters for whom the treatment effect is increasing with time, serve as a control for the late adopters.[17]

State level evidence

We can aggregate the firm wise input-output data to the state-level and perform an event analysis of VAT adoption on aggregate upstreamness of inputs and outputs. This allows us to estimate state-wise aggregate changes. Panel a of Figure 12 presents the event analysis of effect on average state upstream measure of inputs and outputs. We see that while the inputs became more upstream after the state-VAT adoption, there is no change in the upstream measure of outputs, similar to the findings using the main specification. Panel b shows that vertical distance between firms outputs and inputs increased. Figure 4 illustrates the event study with the state own revenues as the outcome variable. This allows to test if the states' own tax collections increased following the state VAT adoption. I obtain the state-level yearly figures from NITI Ayog 2003-2010. The figure illustrates no significant effect on state log revenues following the VAT reform.

[17]This leads to "negative weights" (Goodman-Bacon (2018)) and the interpretation of the estimate is not necessarily causal.

4.2.1 *Heterogeneous Effects of the Reform*

A key dimension of heterogeneity is the industry to which a firm belongs. Figure A-5 plots the estimated treatment effects by one-digit industry classification (NIC 2004). We see that the point estimates are largest for the firms in the "Business activity" industry (NIC 7). This industry includes firms engaged in the real estate, research and development, and other business activities. The effect is also large for the firms belonging to the manufacture of consumer related products (NIC 1) such as textiles, food products and beverages, tobocco products, footwear and leather products; and firms related to mining. The effect on firms engaged in wholesale trade and transport is barely significant at 5%, which can partially be explained by their small sample size (see Figure A-1). The results in this subsection add to the evidence that the effect is dominated in firms engaging in consumer related products and services. Finally, Figure A-4 presents the yearly distribution of the number of firms in the ASI data as a function of the distance to final demand. The distance to final demand is measured by the average upstreamness of a firm's outputs in 2003. We see that from 2004 to 2009, there is a general decline in the number of firms sampled in the data. More over, this decline is much larger for firms closer to consumer suggesting plausible consolidation in the production towards the end of the production chain.

4.3 Effect on Mergers and Acquisitions

An obvious concern in the above analysis is that the input upstreamness does not accurately measure a firm's position in the chain. That is, buying more upstream inputs does not directly imply greater vertical integration, especially when integration requires transfer of ownership. Therefore, in this section, I use the mergers and acquisitions data from PROWESS provided by CMIE to estimate the effect on state merger activity after the VAT adoption. When integration occurs through acquisition of suppliers, we should expect larger vertical mergers and acquisitions after the VAT reform.

I obtain the M&A module from CMIE. A firm in the sample is represented by a unique CMIE company code. This does not change even when a firm is acquired. An observation in this module is a merger/acquisition event. The information includes the date of the announcement, firm code of the "target" and "acquirer" firm, and their respective main products at the time of the merger/acquisition. For example, the data description states, "In 1997, Grasim Industries sold its 53.3 per cent stake in Shree Digvijay Cement Co. to Cimpor, a Portuguese cement company. Since Cimpor acquired the stake in Shree Digvijay, it will be termed as the acquirer for this deal. Shree Digvijay will be the target company".[18]

To determine whether a given merger or acquisition is vertical or horizontal, I assign the target

[18]Fortunately for this paper, the M&A information is available only for the years 2000-10 which spans the the tax-reform period.

and the acquirer firm to a respective sector in India's national Input-Output table 2003. CMIE defines main product as that product or service from which the firm derives more than half of its revenue.[19] I use IO matrix to construct upstream indices for sector using the same methodology as outlined in Section 3.2. I then assign an upstreamness measure to both the target and the acquirer. Finally, I code a merger or an acquisition between two firms as vertical if the difference between the upstream index of the acquirer and target firms is not equal to 0, otherwise it is coded as a horizontal merger. There are 7,687 vertical and 3,313 horizontal mergers and acquisitions during this time. I aggregate the mergers to the state-year level.

Figure 17 indicates that vertical mergers and acquisitions increased significantly after the reform. The figure plots the estimated coefficients from a regression of logarithm of the number of mergers/acquisitions in a state on state, year fixed effects and a dummy indicating years since the VAT adoption. All regressions are weighed by the number of companies in the state. In contrast, the horizontal merger activity is unchanged during this time. [20] The yearly mergers/acquisitions are higher by around 5% after the VAT adoption. A point to note is that the merger activity reflected in this sample comes from larger firms. These include firms that publicly announced a merger/acquisition. To the extent that a number of mergers go unannounced, the estimate in this section is a lower bound of the actual effect on mergers and acquisitions.

4.4 Robustness Checks

In this section, I perform several robustness checks. First, a concern is that a firm's classification to an industry on the basis of its major product may not be an adequate description of firm's economic activity. This assumption was used in the construction of the input-output table from the firm-input-output data. The incorrect classification of a downstream product as upstream can potentially lead to underestimation especially when the effect is heterogenous with respect to the firm's position in the production chain. Similarly, incorrect classification in the reverse direction could lead to overestimation. To alleviate these concerns, I estimate specification similar to 4 but restrict to a sample of single output firms. Table A-3 illustrates that though the total sample size reduces by half, the effect is halved and is significant. Second, I perform a falsification check where I move the treatment back to several periods before the reform. Figure A-3 presents the estimated treatment effects for various perturbations. Assuringly, I find that the estimated treatment effects are insignificant for several periods before the reform. Third, I test if it is the case that the results are largely driven by one state. In particular, I perform "leave-one-out" regressions where I estimate specification 2 by iteratively dropping a state. Figure A-2 illustrates the distribution of the estimated treatment effects. The treatment effect is close to the full sample value and is signifi-

[19] The sectors in the IO table are at 3-digit and are therefore broader than 5-digit level product classification in ASI data.

[20] Because a lot of state-year observations have zero number of mergers/acquisitions, I add one to the outcome variable.

cant in all specifications. Finally, as Figure 8 illustrates, upstream index has long tails which is a potential concern because the mean is susceptible to outliers. For this reason, I estimate the same specification but winsorize the distribution by 5% in either direction. Table A-5 reports the results for the winsorized sample. The coefficient size reduces by half in the winsorized compared with the unwinsorized sample in Table 4, regardless the effect is significant at 1%.

5 Exploring Mechanisms

Having established that VAT adoption led to greater vertical integration among firms in India, in this section, I explore potential five channels that could explain the effect. I show that the empirical evidence suggests integration for evasion is the most plausible explanation.

5.1 Tax evasion at the Retail Stage

As illustrated in Figure 5, the cross-reporting of transactions made by firms makes evasion an unlikely prospect for upstream firms. The last firm, however is not subject to the same level of cross-reporting which allows it to under-report sales and reduce tax liability. Consequently, the second last firm has an incentive to integrate with the last firm, F4. Integrated F3 reports sales of 40 against 50 and pays effective tax rate lower than the statutory tax rate.

A testable implication is that if tax evasion is a channel, a large share of the effect is concentrated in firms located closest to the retail stage. To identify retail firms, I use the fact that firms that produce more downstream products are closer to consumers. A firm's position in the production chain is described by the average upstream measure of its outputs at the beginning of the reform period. In particular, I estimate the following specification:

$$v_{ist} = \beta_0 + \beta_1 adopt_{st} + \beta_2 NonTaxExempt_i^{2003} + \sum_0^n \beta_3^k \mathbb{1}(distance == k) \times NonTaxExempt_i^{2003} \times adopt_{st} + \sum_0^n \beta_4^k \mathbb{1}(distance == k) + \gamma_s + \gamma_t + \epsilon_{ist} \tag{5}$$

I create n quantiles and assign a firm to one of these quantiles on the basis of the average output upstreamness in 2003. Firms with more upstream outputs in 2003 are less likely to be closer to final demand. Additionally, I include a dummy variable that takes value 1 for firms that have the lowest upstream measure, indicating the most retail firms in the sample. A large share of these firms produce knitted cotton garments, shirts, and dresses.

In Figure 13, I plot the estimated coefficients β_3^k against quantiles k where $n = 20$ with 95% confidence interval. It is interesting to note that the effect is largest for firms closest to the con-

sumers where the coefficient is around 2.5. The coefficients are smaller in magnitude but stable at 0.5 for firms in quantiles 1 to 15. The estimated coefficients are insignificant for firms in quantiles above 15. This is consistent with the hypothesis that the firms closest to the consumers are the most to gain from the tax evasion point of view. This is reflected in larger estimated coefficients for such firms.

5.2 Liquidity Constraints under VAT

Another channel by which firms integrate under VAT is that the VAT adoption worsens their credit position. This is because the VAT on the firms' input purchases generates sudden tax liability for them. When the refunds are slow, VAT exacerbates the firm's credit position. This is more relevant for small-sized firms and firms that making seasonal sales. A liquidity-constrained firm can then avoid immediate payment on its inputs by integrating with the supplier, because use of inputs produced in-house do not trigger tax liability. Consequently, if the liquidity constraints imposed by VAT is a mediating channel, VAT increases vertical integration among firms.

To test the *liquidity constraints* hypothesis, I perform the same steps as above. I measure how liquidity constrained a firm is by its industry's cash flow sensitivity (Almeida et al., 2004). The idea is that a firm's propensity to save cash captures its financial (or liquidity) constraints. I construct the industry-level cash flow sensitivity estimate from the firm input-output data in the following ways: I first restrict the firm data (ASI) to the pre-reform period 2004. I aggregate the firm-level opening and closing stock of cash to its 3-digit NIC industry level. I then determine the industry-level correlation between the yearly cash growth and opening cash stock, by regressing industry-year cash growth on the full interaction of industry-opening cash stock and industry fixed effects. The coefficients of the interaction in this specification are the cash flow sensitivity estimate (CFSE) for an industry. Finally, I classify a firm as more liquidity constrained if it belonged to an industry with a higher CFSE in 2004.

I plot the estimated effect of VAT on vertical integration interacted with the measure of liquidity in Figure 14. If *liquidity constraints* hypothesis is correct then we expect larger effects for firms that are more liquity-constrained. In contrast, I find that the effect of VAT on vertical integration is relatively stable across firms with varying degrees of liquidity constraints. This suggests lack of evidence in favor of *liquidity constraints* as a key channel leading to greater vertical integration among firms.

5.3 Higher Compliance Costs under VAT

In contrast to the sales tax remitted by only the retail firms, all firms in the production chain are required to file and remit taxes under VAT. This can potentially impose significant compliance burden on firms, in the form of significant accounting and book-keeping costs. These compli-

ance costs have generally been studied as fixed costs in the public finance literature (Slemrod and Gillitzer 2014). If higher compliance costs is a channel, the compliance burden imposed by VAT is greater for smaller firms. A way in which small firms reduce their burden is by integrating and increasing their size.

To test the *compliance costs* hypothesis, I plot the estimated effect of VAT on vertical integration interacted with the firm size quantile in Figure 15. I measure the firm size by the number of its employees in 2003 (i.e. pre-reform period). If the *compliance costs* hypothesis is correct, we expect larger effects for smaller firms. In contrast, I find that the effect of VAT on vertical integration is relatively stable across the distribution of firm size. This points to lack of evidence in favor of *compliance costs* as a a key channel leading to greater vertical integration among firms.

Finally, Table A-9 tests for correlation in the three measures used to test the mechanisms. Assuringly, the table highlights weak correlation among the measures which suggests that the measures act independently on the outcome.

5.4 Lower tax rates in VAT regime

An unignorable feature of the tax reform was a reduction in the product tax rates. This is a concern because previous literature has shown that firms are more likely to integrate when the output prices are higher (Alfaro et al. (2016)). A consequence of lower tax rate is higher net-of tax output price for the firms. The left panel of Figure 9 plots the distribution of tax rate changes at the 5-digit industry level across 17 states. A point in the sample is a product-year. We see that the net effect of the reform was a decline in tax rate by about 0.06 percentage points. The right panel illustrates the average state tax rate change for late-adopters versus early-adopters. There is a weak correlation in late adopters and the decline in the average tax rate. This is worrisome because it suggests that a part of the vertical integration response could be driven by firm responses to changes in net-of-tax output prices.

To alleviate this concern, I estimate the heterogeneity of the VAT effect by the sign of the product tax rate change. In principle, if the firms are responding to lower tax rates under VAT by vertically integrating, we expect larger effects for firms that face a tax rate-decrease, compared with firms that face a tax rate-increase. A firm is identified as facing an output tax rate decrease if the tax rate on its major output in 2003 declined as part of the reform.

Table 5 presents the results. The first column reports the main results using the specification 2—total effect of the VAT adoption on vertical integration as measured by the average input upstreamness. Notice the sample size is much smaller, 88,886 as opposed to 243,566 in the main table 2. This is because this sample is restricted to firms that i) are observed in 2003, and ii) belong to states with available tax rate information. The latter restricts the data to 17 states. The regression includes firm and year fixed effects. This means that the result in this column are comparable to Column (5) of Table 2. Assuringly, we find that the point estimate is unchanged despite a smaller

sample size. Interestingly, column(2) shows that we can not reject significant difference in the treatment effect by whether the firm witnessed an increase or a decrease in output tax rate. This increases confidence in the result that tax evasion is perhaps the main channel that leads to greater vertical integration under VAT.

5.5 Higher Tax Rate on Upstream Firms

Even if higher output tax rates did not lead to vertical integration among firms, it is still possible that the changes in the statutory tax rates were not neutral along the product position in the value chain. This can lead to greater vertical integration, independent of tax evasion. For instance, it is possible that the reform increased the tax rate on more upstream goods even if it decreased the tax rate overall. This is important because as discussed in Section 2, a tax system that leads to a higher tax rate on products that are more upstream can lead to greater vertical integration even when firms are not evading. Such a tax system penalizes production that is performed out-house on the market. By bringing the production in-house, firms save on higher tax rate subject to transaction on the market and pay the lower tax downstream tax rate.

I plot the changes in statutory tax rates against the product position in the value chain. I continue to measure a product's position by the upstream measure. Figure 16 shows the relationship. We see that the tax rates decrease was much larger for upstream products than the downstream products. This suggests that if anything, the reform *lowered* the tax rates on upstream products, which suggests that it is less likely that firms integrated to avoid higher tax on upstream products.

6 Discussion

The previous subsection showed that tax-evasion is a plausible channel by which the replacement of sales-tax with VAT leads to greater vertical integration. However, it leaves the following question unanswered: How does vertical integration affects firms and revenues largely? This is pertinent from the optimal tax policy point of view. Therefore, this section uses the changes in vertical integration brought by the tax-reform to estimate effect on firm outcomes. The state-VAT adoption dummy and a dummy that indicates if the firm produced VAT exempt good serve as instruments. I estimate the following specification on a host of firm outcomes:

$$y_{ist} = \alpha_0 + \alpha_1 VI_{ist} + \alpha_2 Stat\hat{R}ate_{ist} + \alpha_3 FirmPosition_{ist} + \gamma_i + \gamma_t + e_{ist} \tag{6}$$

where VI_{ist} represents the extent of vertical integration of firm i in year t. I proxy this variable with the average upstreamness of inputs of firm i in year t. This implies that for two firms at a similar distance from the final demand, the firm using more upstream inputs is considered more vertically integrated. Firm position as measured by its distance from the final demand and

statutory tax rate on outputs faced by the firm serve as included instruments. Because the actual statutory tax rate faced by a firm depends its output mix, which is endogenous to the tax change, I instead calculate the "predicted" tax rate defined as follows:

$$\hat{StatRate}_{ist} = \frac{\sum_{k\in(1,K)} Y_{ik}^{2003} Rate_t}{\sum_{k\in(1,K)} Y_{ik}^{2003}}$$

where $k \in (1, K)$ represents the K outputs of the firm, Y_{ik} represents the tax-exclusive value of output k produced by firm i. $\hat{StatRate}_{ist}$ calculates the effective tax rate faced by the firm. This is an average of tax liability across multiple outputs of a firm, weighed by the pre-reform value of corresponding output (Gruber and Saez (2002)). Weighing is useful because the effective tax burden faced by a multi-product firm depends on both the statutory tax rate and its share in the total output. A relatively low-tax output that forms a greater share of firm's total output imposes a much larger tax burden on the firm than a very high tax output that forms a neglibible share.

Clearly vertical integration is determined by a host of factors such as firm productivity, expectations, credit position, not all of which can be accounted for. Therefore, I instrument the VI_{ist} variable with the VAT tax reform: In particular, the regression in Specification 2 forms the first stage, with the addition of the variables $\hat{StatRate}_{ist}$ and $FirmPosition_{ist}$.

$$\begin{aligned} VI_{ist} = \beta_0 + \beta_1 adopt_{st} + \beta_2 NonTaxExempt_i^{2003} + \beta_3 NonTaxExempt_i^{2003} \times adopt_{st} \\ + \beta_4 \hat{StatRate}_{ist} + \beta_5 FirmPosition_{ist} + \gamma_i + \gamma_t + \epsilon_{ist} \end{aligned} \tag{7}$$

Addition of the statutory tax rate variable controls for any direct effects of changes in the tax rates on firm outcomes, independent of changes in vertical integration. Because the statutory tax rate variable is available for only 19 states, we run into few cluster problem (Cameron and Miller (2015)). The estimates reported here are not clustered.

The key assumptions required to estimate the effect of greater vertical integration on firm outcomes are as follows. First, the instrument is exogenous to the firm outcomes. This can not be completely tested. However, the observed parallel trends before the VAT adoption do not suggest any observable correlation between trends in vertical integration and state VAT adoption. Second, the instrument satisfies exclusion restriction. This suggests that the only effect of the reform on firm outcomes is through vertical integration. Given the nature of the tax-reform that changed effective product tax rates and reduced double taxation by allowing input tax credit, this is a rather strong assumption. I address these two concerns in the following way. I control for changes in the statutory tax rates brought about by the reform. Firm distance controls for any direct effects of the VAT adoption that are correlated with a firm's position in the production chain. This includes effects of input tax credit that vary along the production chain. [21]

[21] A simple way to think about it is that there are two additional mediating channels through which the reform affects firm outcomes. Controlling for these channels blocks the direct path from the instrument to the firm outcomes.

The previous sections showed that the VAT reform significantly increased vertical integration among firms. Fourth, because the treatment variable—change in the input upstreamness— is of variable intensity, we require the monotonicity assumption. This assumption requires that the instrument increases the treatment at all values of treatment. When the monotonocity is satisfied, an IV estimator calculates the weighted average of unit causal response at each value of the treatment variable. For non-negative values of the treatment variable, one possible test is to compare the CDF of the treatment variable when the instrument is turned on (firm produces VAT product) versus when it is turned off (firm produces VAT exempt product). If the monotonicity assumption is satisfied, the CDF with the instrument turned on first order stochastically dominates the CDF when the instrument is turned off (Angrist and Pischke (2009), page 182).

Figure 18 illustrates the monotonicity test. The x-axis plots the CDF of the changes in firm level input upstreamness before and after the VAT adoption. The dashed line represents the CDF if the firm produced a tax-exempt output before the reform (instrument off) and the solid line represents the CDF if the firm produced VAT good before the reform (instrument on). Figure 18 shows that more than half of the changes are positive which can be interpreted as a consequence of the VAT reform which increased average firm upstreamness. More over, along the non-negative values where the CDF test is valid, the CDF of the changes for firms that produced a VAT product lies below the CDF of changes for firms which produced VAT exempt product in 2003. Finally, Table A-10 reports the results of Kolmorgorov-Smirnov test of the equality of distribution. The hypothesis of distribution equality is strongly rejected.

Table 6 reports the 2SLS estimates of effect of increased integration on a host of firm outcomes. The Kleibergen-Paap F-stat varies across specifications because of missing outcome values [22]. The relative value of the F-stat at about 7.8 is concerning. With weak instruments, IV estimates are biased toward the OLS estimates which are generally inconsistent. The Stock-Yogo critical values for 25% and 20% bias in the IV estimate is 7.25 and 8.75 respectively. While we reject a 25% bias, we can not reject 20% maximal bias in the IV. Because in the case of weak instruments, IV is biased towards the OLS, I report the OLS estimates and correponding standard errors in the third to last row of Table 6.

The two-stage least square estimates indicate that a unit increase in vertical integration, as measured by the firm average input upstreamness, significantly increases firm's value added, where value added is measured as the difference in gross sales and material costs (Column 1). Note that if any fixed costs were incurred in the process of integration, those are not reflected in the value-added measure. The effect on ouput per worker is barely significant (Column 2). An integrated firm is larger, as measured by log sales or the log number of workers (Columns 6 and 7). There is no significant effect on either the workers' wages (Column 4) or the net-of-tax output price

[22]Restricting to firms that report all the outcome variables reduces the sample size by almost 6000 observations. Estimates are underpowered and the F-Stat drops further to 6.5. These issues suggest that the estimates in this section should be interpreted with caution and are more suggestive in nature.

(Column 8). However, integration hurts government revenues. Column 10 reports the "unpaid tax," which calculates the difference in the tax rate a firm should remit based on statutory tax rate on its outputs and the tax rate it actually remits, as reported in the ASI "sales tax" paid column.[23] The difference between these two quantities does not necessarily indicate evasion. Actual reported tax paid could be lower than the statutory tax when the firm is subject to exemptions or when it did not report in the survey data. It could also be lower if the firm adjusted its production to produce low tax outputs or shift production towards the untaxed good (tax avoidance). Either way, we see that a one unit increase in vertical integration increases the unpaid tax rate by about 1.14 percentage points (Column 8). Finally, vertical integration significantly increases profit per worker, where profit is defined as the difference in before-tax value added and wages paid. It does not include any fixed or capital costs incurred in the process of vertical integration.

To conclude, this section illustrates that tax-policy induced changes in vertical integration has policy implications. Integration leads to larger firms as measured by value added, firm gross sales or the number of workers. However, this comes at a cost to the government. The average tax rate remitted by an integrated firm is lower. This implies that the cost of enforcing a value-added tax increases when firms integrate for evasion. Consequently, an optimal tax under VAT in settings with weak enforcement must incorporate the tradeoff between production efficiency (high before-tax profits per worker) and revenues (more evasion leads to lower revenues).

7 Conclusions

Value added tax is one of the most popular consumption taxes in developing countries. It is hailed for its ability to generate greater revenues through minimal tax evasion and production efficiency. This paper presents evidence that VAT may not be production-efficient since it leads to re-organization of production chains. The ability of firms to evade tax at the retail stage creates incentives for last two firms in the production chain to integrate vertically. To test this hypothesis, I use a quasi-experiment featuring staggered adoption of VAT by states in India between 2003 and 2008 and plant level input-output data. To measure vertical integration, I create an index of upstreamness of a product where the products located higher in the production chain are assigned higher values. Greater vertical integration implies larger upstreamness of inputs. Using a differences-in-differences strategy, I find that the tax reform increased average upstreamness of firm inputs. Effects are larger for firms situated closer to the final demand suggesting that tax evasion is a plausible channel. Empirical evidence does not lend support to the alternative hypotheses such as higher liquidity constraints or compliance costs imposed by the VAT adoption. The findings in this paper suggest that firm responses to evasion reduce government revenues.

[23] A firm reports absolute sales tax remitted in addition to the net sales value for each product. I calculate the 'actual tax rate' paid as the total tax remitted divided by the net of tax output value. For a significant fraction of the firms, this quantity is 0.

Consequently, an optimal tax under VAT in settings with weak enforcement must incorporate the tradeoff between production efficiency (high before-tax profits per worker) and revenues (more evasion leads to lower revenues).

References

Acemoglu, D., Griffith, R., Aghion, P., and Zilibotti, F. (2010). Vertical integration and technology: Theory and evidence. *Journal of the European Economic Association*, 8(5):989–1033.

Aghion, P., Griffith, R., and Howitt, P. (2006). Vertical integration and competition. *The American Economic Review*, 96(2):97–102.

Alfaro, L., Conconi, P., Fadinger, H., and Newman, A. F. (2016). Do prices determine vertical integration? *The Review of Economic Studies*, 83(3):855.

Allcott, H., Collard-Wexler, A., and O'Connell, S. D. (2016). How do electricity shortages affect industry? evidence from india. *American Economic Review*, 106(3):587–624.

Almeida, H., Campello, M., and Weisbach, M. (2004). The cash flow sensitivity of cash. *Journal of Finance*, 59(4):1777–1804.

Angrist, J. D. and Pischke, J.-S. (2009). *Mostly Harmless Econometrics, An Empiricist's Companion*.

Antrás, P. and Chor, D. (2013). Organizing the global value chain. *Econometrica*, 81(6):2127–2204.

Antras, P., Chor, D., Fally, T., and Hillberry, R. (2012). Measuring the upstreamness of production and trade flows. *American Economic Review*, 102(3):412–16.

Athey, S. and Imbens, G. W. (2018). Design-based Analysis in Difference-In-Differences Settings with Staggered Adoption. NBER Working Papers 24963, National Bureau of Economic Research, Inc.

Auerbach, A. and Reishus, D. (1987). The impact of taxation on mergers and acquisitions. *NBER*, (7):69–86.

Bertrand, M., Duflo, E., and Mullainathan, S. (2004). How much should we trust differences-in-differences estimates? *The Quarterly Journal of Economics*, pages 249–275.

Best, M. C., Brockmeyer, A., Kleven, H. J., Spinnewijn, J., and Waseem, M. (2015). Production versus revenue efficiency with limited tax capacity: theory and evidence from pakistan. *Journal of Political Economy*, 123(6):1311–1355.

Brockmeyer, A. and Hernandez, M. (2018). Taxation, information and withholding: Evidence from costa rica. *Mimeo*.

Cameron, A. C. and Miller, D. L. (2015). A Practitioner?s Guide to Cluster-Robust Inference. *Journal of Human Resources*, 50(2):317–372.

Carloni, D., Harju, J., and Kosonen, T. (2019). What goes up may not come down: Asymetric incidence of the value added taxes. *Mimeo*.

Coase, R. (1937). The nature of the firm. *Economica*.

de Chaisemartin, C. and D'Haultfoeuille, X. (2019). Two-way fixed effects estimators with heterogeneous treatment effects. Working Paper 25904, National Bureau of Economic Research.

De Paula, A. and Scheinkman, J. A. (2010). Value-added taxes, chain effects, and informality. *American Economic Journal: Macroeconomics*, 2(4):195–221.

Diamond, P. and Mirrlees, J. (1971). Optimal taxation and public production: I–production efficiency. *American Economic Review*, 61(1):8–27.

Emran, M. S. and Stiglitz, J. E. (2005). On selective indirect tax reform in developing countries. *Journal of public Economics*, 89(4):599–623.

Fally, T. (2011). On the fragmentation of production in the us. *University of Colorado mimeo*.

Fan, J. P. and Lang, L. H. (2000). The measurement of relatedness: An application to corporate diversification. *The Journal of Business*, 73(4):629–660.

Finance, M. o. (2005). A white paper on state-level value added tax. *The Empowered Committee of State Finance Ministers*.

Gadenne, L., Nandi, T., and Rathelot, R. (2019). Taxation and supplier networks: Evidence from india. 105(8).

Goodman-Bacon, A. (2018). Difference-in-differences with variation in treatment timing. Working Paper 25018, National Bureau of Economic Research.

Gordon, R. and Li, W. (2009). Tax structures in developing countries: Many puzzles and a possible explanation. *Journal of public Economics*, 93(7):855–866.

Gruber, J. and Saez, E. (2002). The elasticity of taxable income: evidence and implications. *Journal of Public Economics*, 84(1):1 – 32.

Kopczuk, W., Marion, J., Muehlegger, E., and Slemrod, J. (2016). Does tax-collection invariance hold? evasion and the pass-through of state diesel taxes. *American Economic Journal: Economic Policy*, 8(2):251–86.

Kopczuk, W. and Slemrod, J. (2006). Putting firms into optimal tax theory. *American Economic Review*, 96(2):130–134.

Naritomi, J. (2013). Consumers as tax auditors. *Unpub. paper, Harvard University*.

Oberfield, E. and Boehm, J. (2019). Misallocation in the market for inputs: Enforcement and the organization of production. *Econometrica*.

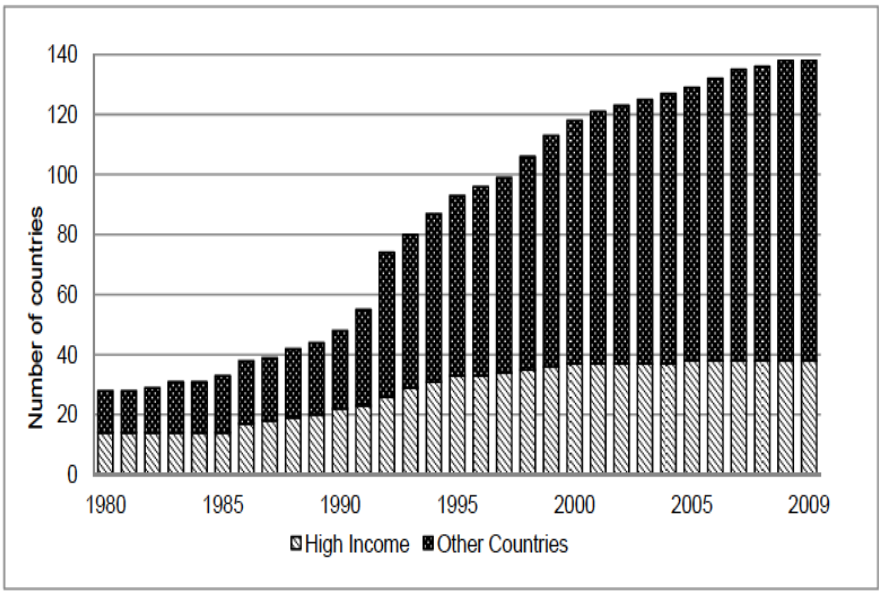
Pomeranz, D. (2015). No taxation without information: Deterrence and self-enforcement in the value added tax. *American Economic Review*, 105(8):2539–69.

Slemrod, J. (2007). Cheating Ourselves: The Economics of Tax Evasion. *Journal of Economic Perspectives*, 21(1):25–48.

Slemrod, J. and Yitzhaki, S. (2002). Tax avoidance, evasion, and administration. In Auerbach, A. J. and Feldstein, M., editors, *Handbook of Public Economics*, volume 3 of *Handbook of Public Economics*, chapter 22, pages 1423–1470. Elsevier.

Solon, G., Haider, S. J., and Wooldridge, J. (2013). What Are We Weighting For? NBER Working Papers 18859, National Bureau of Economic Research, Inc.

8 Tables and Figures



Source: IMF data.
Note: Figure shows the number of countries with a VAT at each date.

Figure 1: Country VAT Adoption: This figure shows the aggregate number of countries that adopted VAT since 1980.

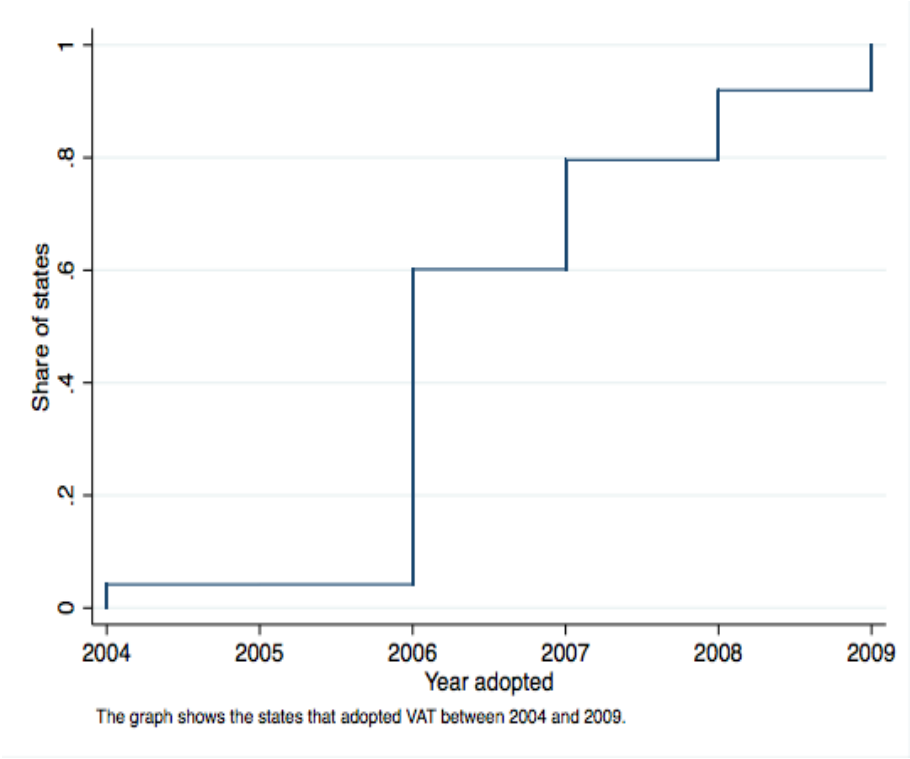


Figure 2: State VAT adoption in India: This figure illustrates the time distribution of state VAT adoption in India. The first state Haryana adopted VAT in 2003. The last state Uttar Pradesh adopted VAT in 2008. Data: State VAT laws.

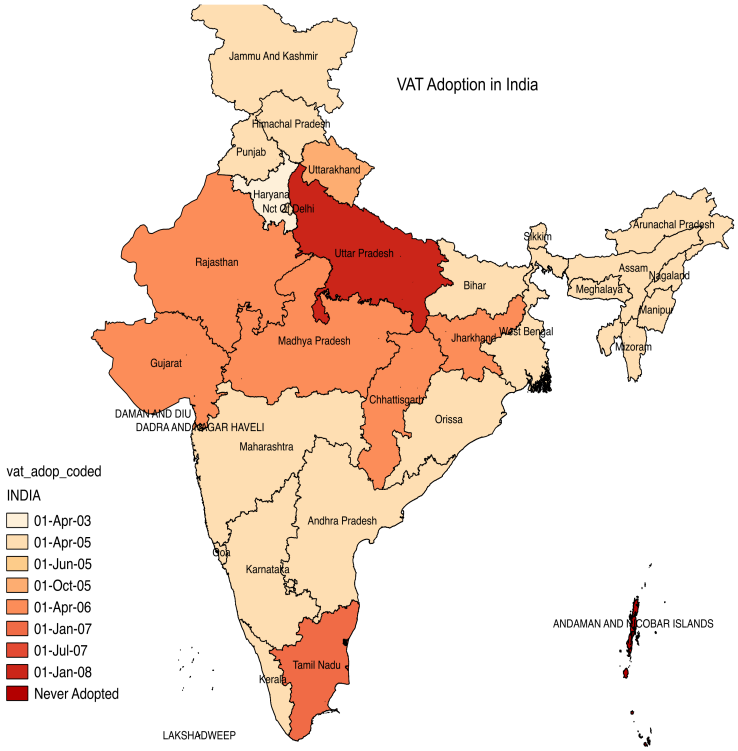


Figure 3: State VAT adoption in India: This figure illustrates the spatial distribution of state VAT adoption in India. The only state/territory that never adopted VAT is Andaman and Nicobar Islands. Data: State VAT Laws.

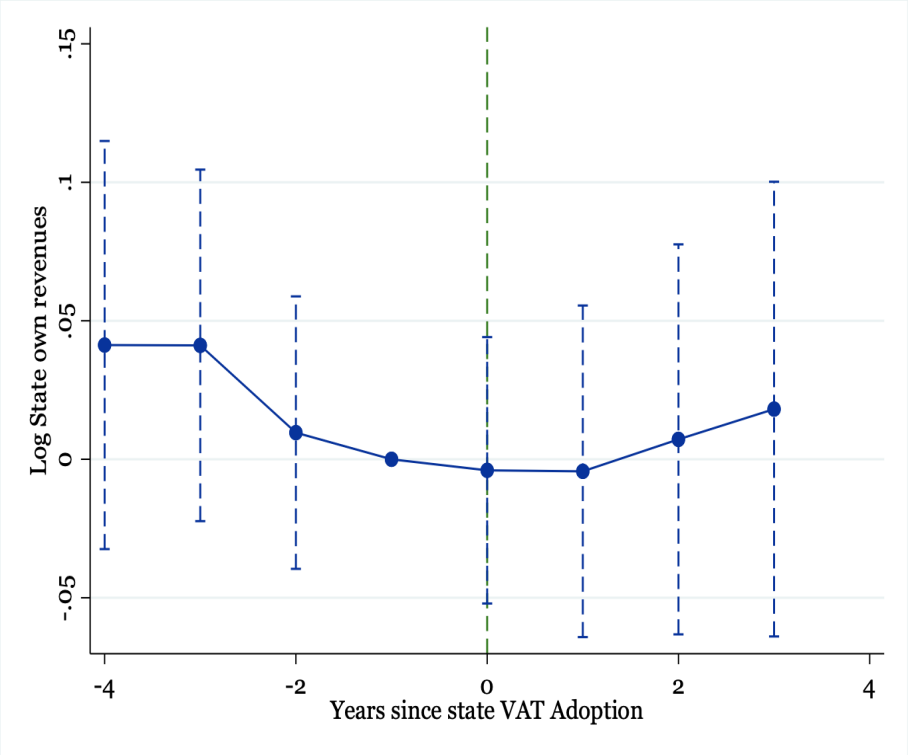


Figure 4: Effect of the VAT adoption on state revenues This graph presents an event study of log yearly state own revenues and years since since VAT adoption. The specification includes state and year fixed effects. Data: NITI Ayog. Sample restricted to 2003-2010. The bars indicate 10% robust confidence interval.

	Mean	Standard Deviation	Min	Max	N
Uptreamness (Inputs)	4.6039351	5.0402157	-13.386	449.45999	316269
$P(U < 2)$	.89354632	.30841789	0	1	316269
$P(U \geq 2)$	.10645368	.30841789	0	1	316269
Employee Days	55364.136	231786.26	0	16437410	313840
Mean Factory Value	2.120e+08	2.246e+09	0	4.645e+11	301388
Mean Gross Output	2.360e+08	2.437e+09	0	4.860e+11	301388
Per-unit Price	85014.268	4804127.8	-16.76	1.701e+09	301388
Capital	44890312	1.252e+09	-1.708e+11	2.827e+11	313514
Total Liabilities	1.351e+08	1.431e+09	-31129102	3.346e+11	307137
Total Assets	1.772e+08	1.921e+09	-28498084	4.075e+11	313526
Stock of Materials	37643652	4.683e+08	0	1.622e+11	302447
Stock of Finished Goods	31344468	2.370e+08	0	4.724e+10	246631
Materials	32079251	4.329e+08	0	1.465e+11	290249
Loans	1.091e+08	1.303e+09	0	2.086e+11	250926
Cash	8048781.9	2.260e+08	-1246668	6.404e+10	311366
Number of workers	139.19135	611.99213	0	45481	312961
Number of Inputs	11.588845	3.6616965	1	98	313947
Number of Outputs	3.1084546	1.9392734	0	12	313947

Table 1: Summary Statistics: This table presents summary statistics for key variables in the Annual Survery of Industries dataset 2001-10. This dataset is to estimate effect of the VAT adoption on firm input upstreamness. An observation in the sample is a firm-year. Firms larger than 100 employees are surveyed each year. Firms smaller than 100 employees are surveyed with a probability. Please refer to Section 3 for more details about the dataset.

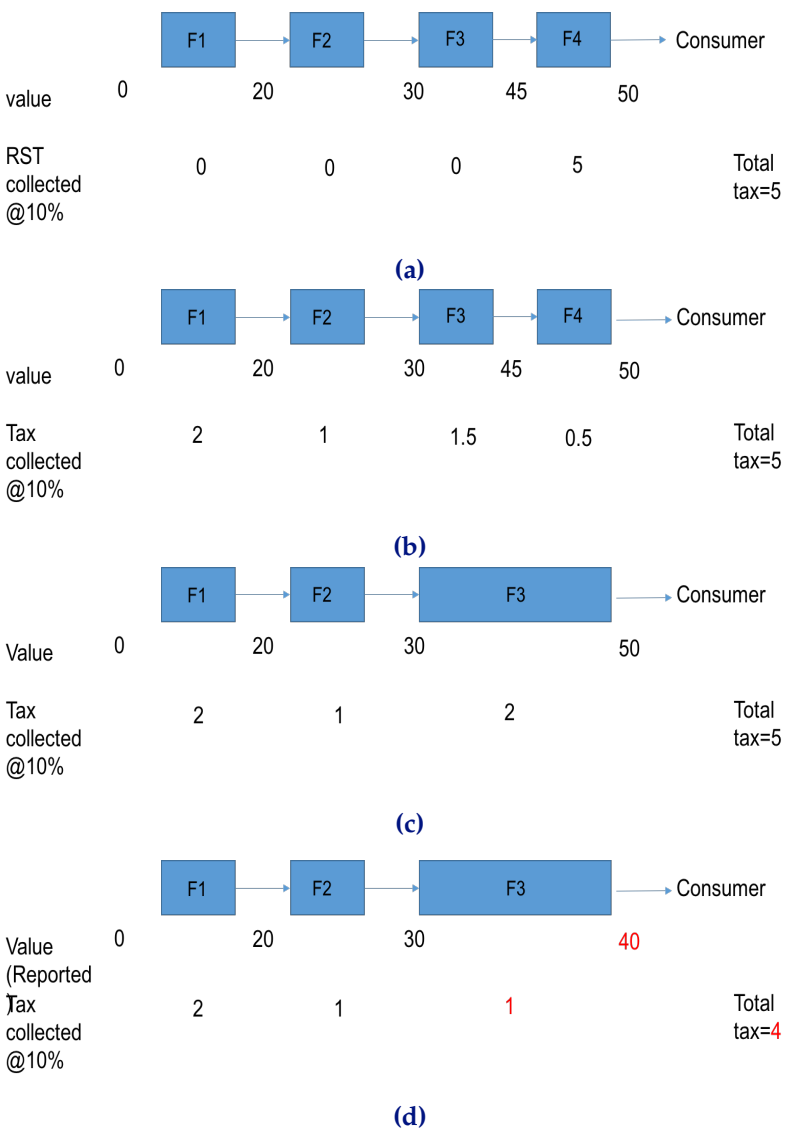


Figure 5: This figure illustrates change in tax instrument and the resulting change in firm organization. Panel (a) shows tax collection under RST. Only the last firm which sells directly to the consumer is responsible for remitting tax. In Panel (b), all firms remit tax as a fixed proportion of their value added. If the tax rate is same under RST and VAT, the total tax collected across the value chain either (a) or (b) is same. Panel (c) illustrates when second last firm, F3 integrates with the last firm, F4. The integrated firm, F3 gains by under-reporting sales to consumer which are not subject to cross-reporting, in contrast to transactions with other non-consumer firms. This lowers tax paid by F3.

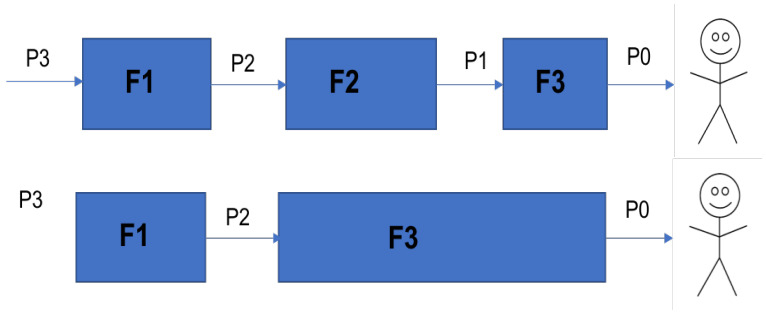


Figure 6: Vertical integration and product upstream measure: This figure illustrates the implications of vertical integration to the average product upstreamness in the production chain. The top panel illustrates when the last two firms in the chain F2 and F3 are disintegrated. An average firm in this chain uses less upstream inputs and produces more upstream outputs. In contrast, the bottom panel illustrates when the last two firms F2 and F3 integrate. An average firm in the production chain now uses more upstream inputs and produces more downstream outputs.

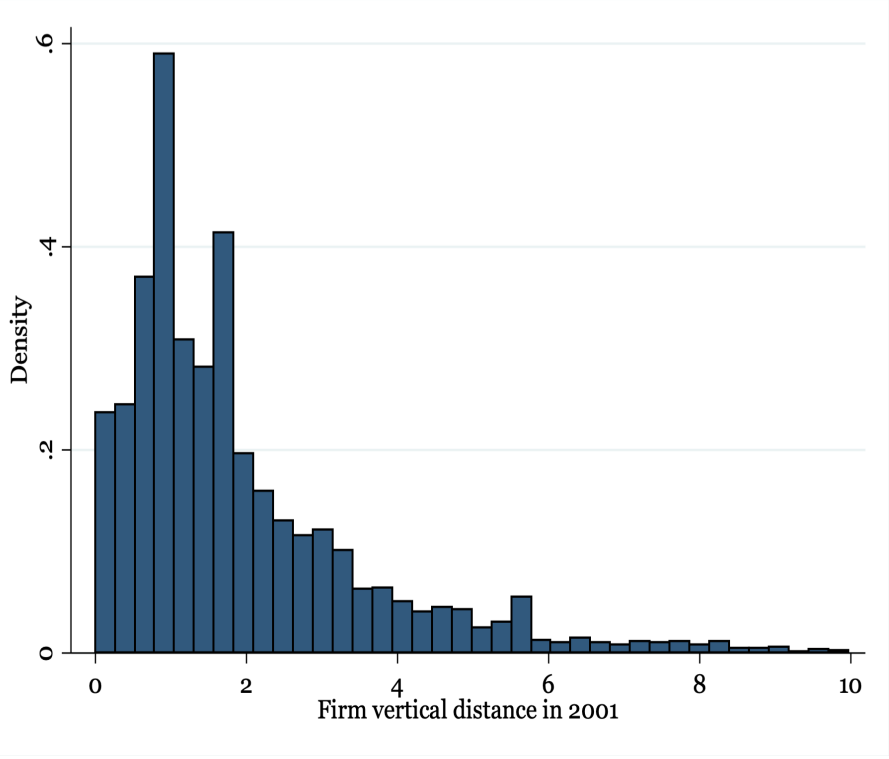


Figure 7: Vertical distance of firms: This figure plots the distribution of firms in the sample according to the vertical distance. Vertical distance is the difference between the average upstreamness of the output and input of a firm. A firm that sources inputs which are more upstream has higher vertical distance, compared to a firm with similar output but less upstream inputs. Data: Annual Survey of Industries, 2003-10.

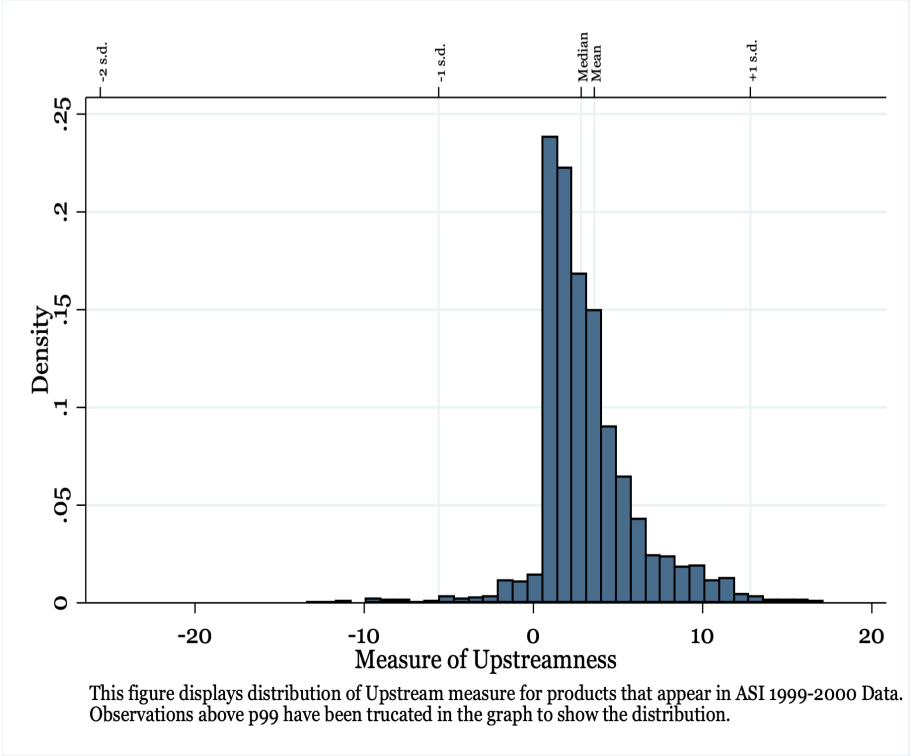


Figure 8: Distribution of U_2: This figure plots the distribution of products according to their upstream measure. The sample includes products observed in the Annual survey of Industries dataset in year 1999-00.

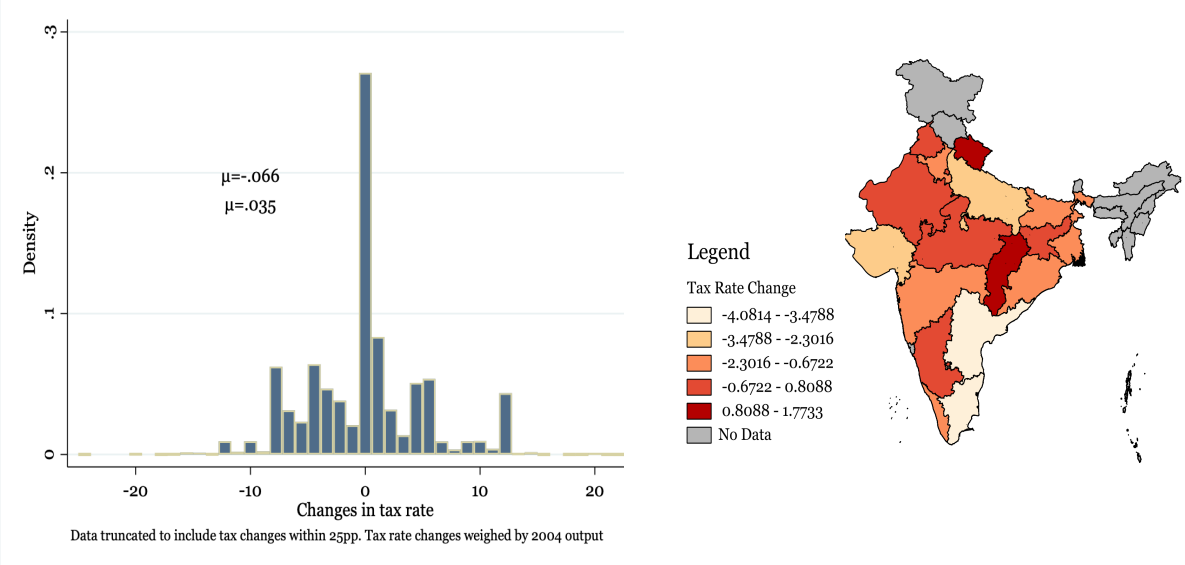


Figure 9: Tax rate change in VAT reform: The first panel presents the distribution of state-product tax rate changes, which were part of the reform. The right panel shows average product tax rate change across states. The tax rate change data is obtained by hand-coding of product tax rate for each state-product, before and after the VAT reform. The tax rate data exists for 17 out of 32 states in the Annual survey of Industries data.

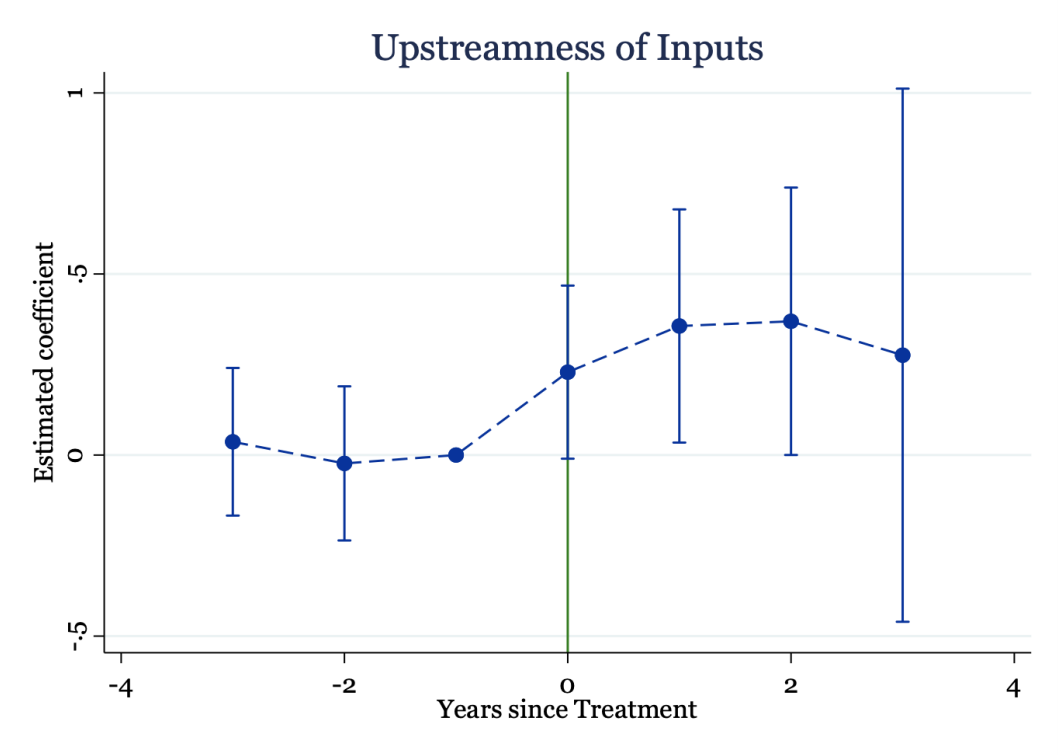


Figure 10: Effect of VAT adoption on vertical integration (Inputs): This figure presents event study coefficients of firm's average input upstreamness on the dummies for years since VAT adoption interacted with a dummy indicating whether the firm's main product in 2002 was non-VAT-exempt. Dummy for a year before the adoption is omitted. The regression also includes firm and year fixed effects. The bars indicate robust 10% confidence interval. Data: Annual Survey of Industries, 2003-10.

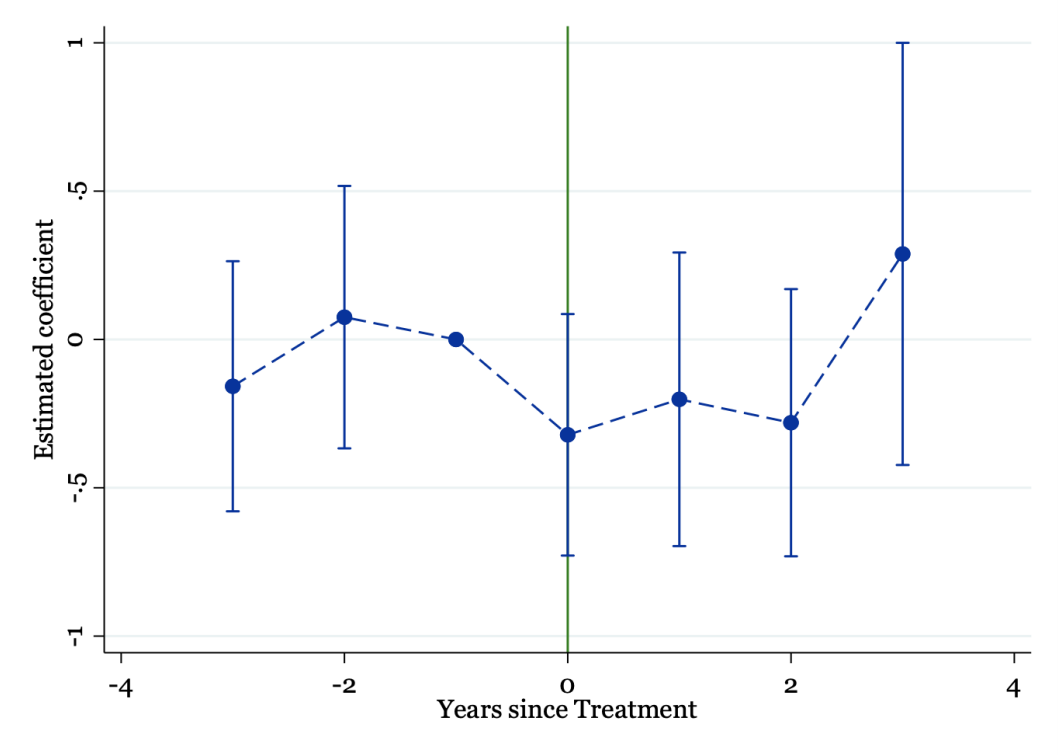
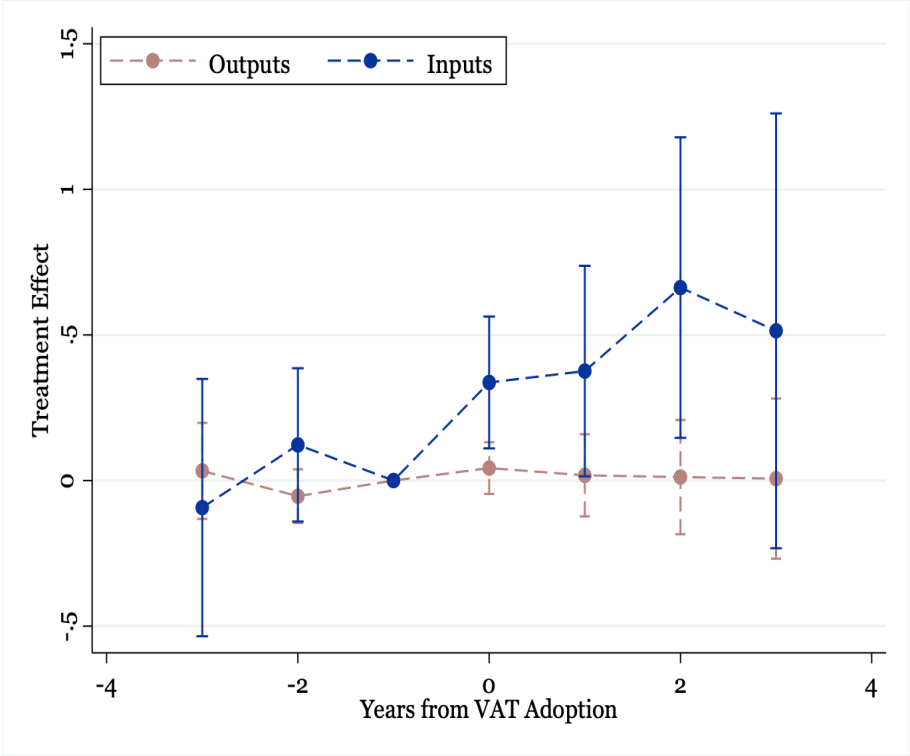
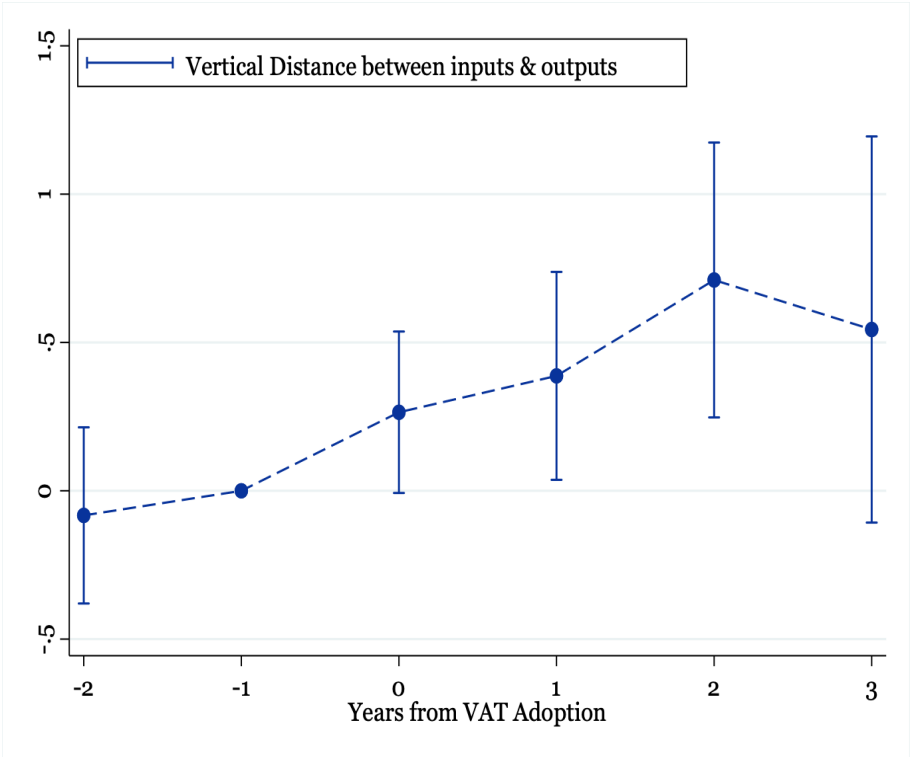


Figure 11: Effect of VAT adoption on vertical integration (Outputs): This figure presents event study coefficients of firm's average ouput upstreamness on the dummies for years since VAT adoption interacted with a dummy indicating whether the firm's main product in 2002 was non-VAT-exempt. Dummy for a year before the adoption is omitted. The regression also includes firm and year fixed effects. The bars indicate robust 10% confidence interval. Data: Annual Survey of Industries, 2003-10.



(a)



(b)

Figure 12: State-level effects: This figure plots the effect of the state VAT adoption on three outcomes: average upstreamness of firm outputs, inputs and vertical distance between firm output and input. Vertical difference is the difference between upstreamness of firm output and input. Observation is a state-year average. The bars indicate coefficients from regression of the outcome variable on dummies indicating years since treatment. Dummy for a year before VAT adoption is omitted. Regressions include state and year fixed effects. Robust confidence intervals are plotted at 5% significant level. Data: Annual Survey of Industries, 2003-10.

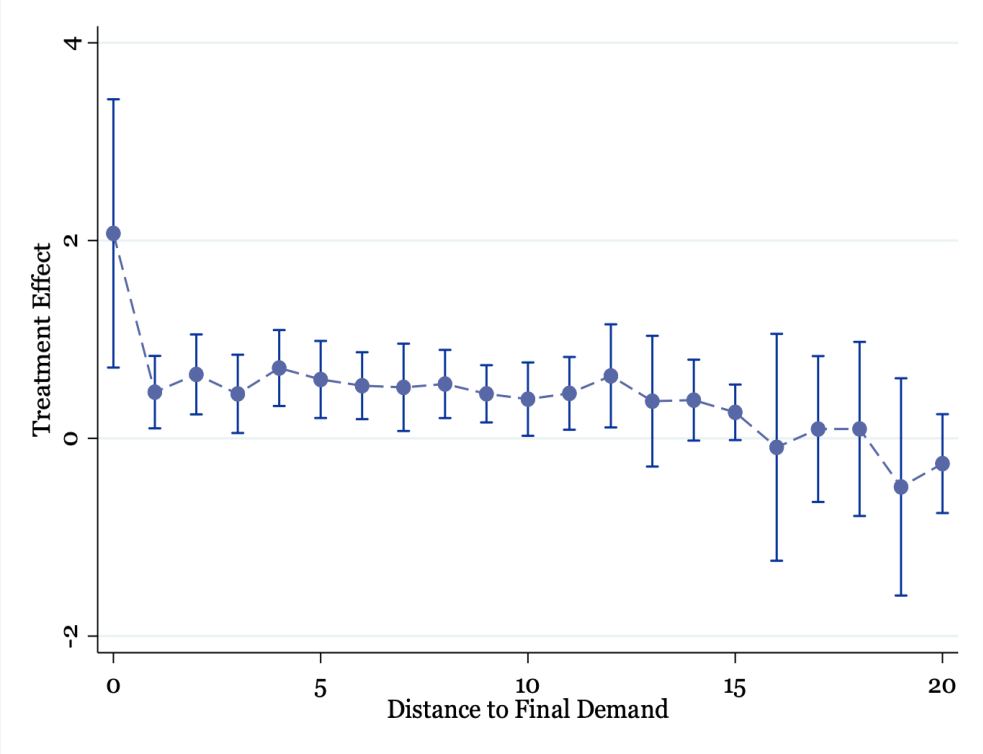


Figure 13: Mechanism 1: Tax evasion: This figure presents treatment effects as a function of distance from the final demand. Firm-year observations are ordered into 20 quantiles and a quantile for the lowest distance. Distance to final demand is determined by the average upstream measure of firm outputs in 2004. Data: Annual Survey of Industries, 2003-10.

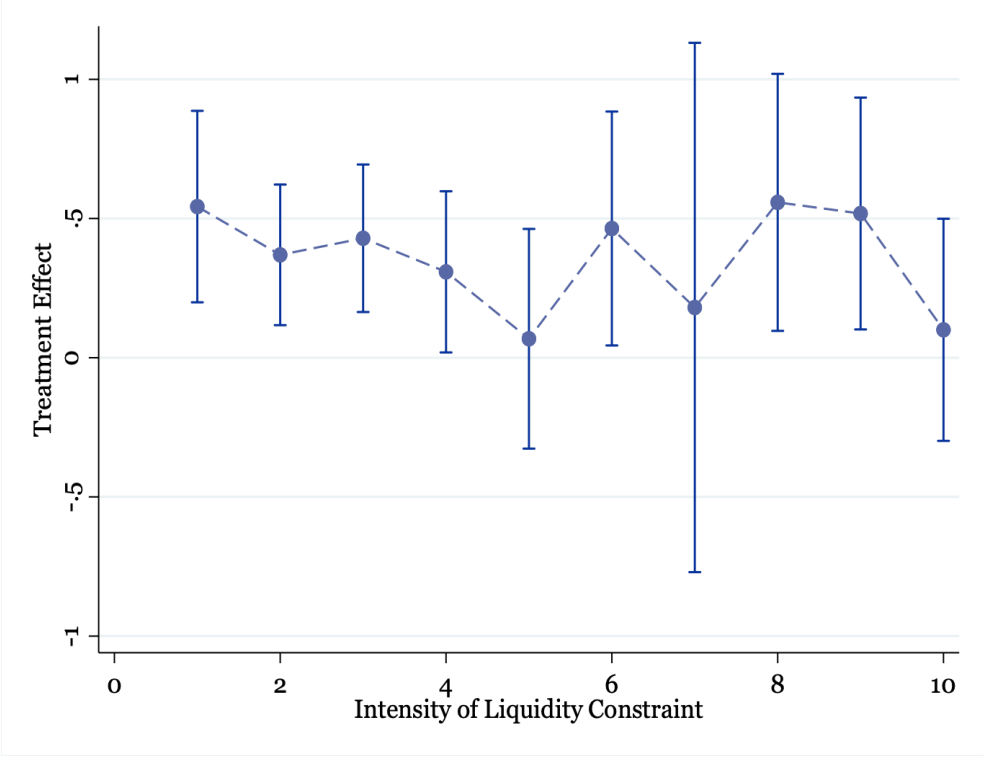


Figure 14: Mechanism 2: Liquidity constraint: This figure presents treatment effects as a function of liquidity constraints. Firm-year observations are ordered into 20 quantitles according to firm liquidity constraint measure. Liquidity constraint is measured by cash flow sensitivity estimate of 3-digit industry of the firm (Almeida et al. (2004)). Data: Annual Survey of Industries, 2003-10.

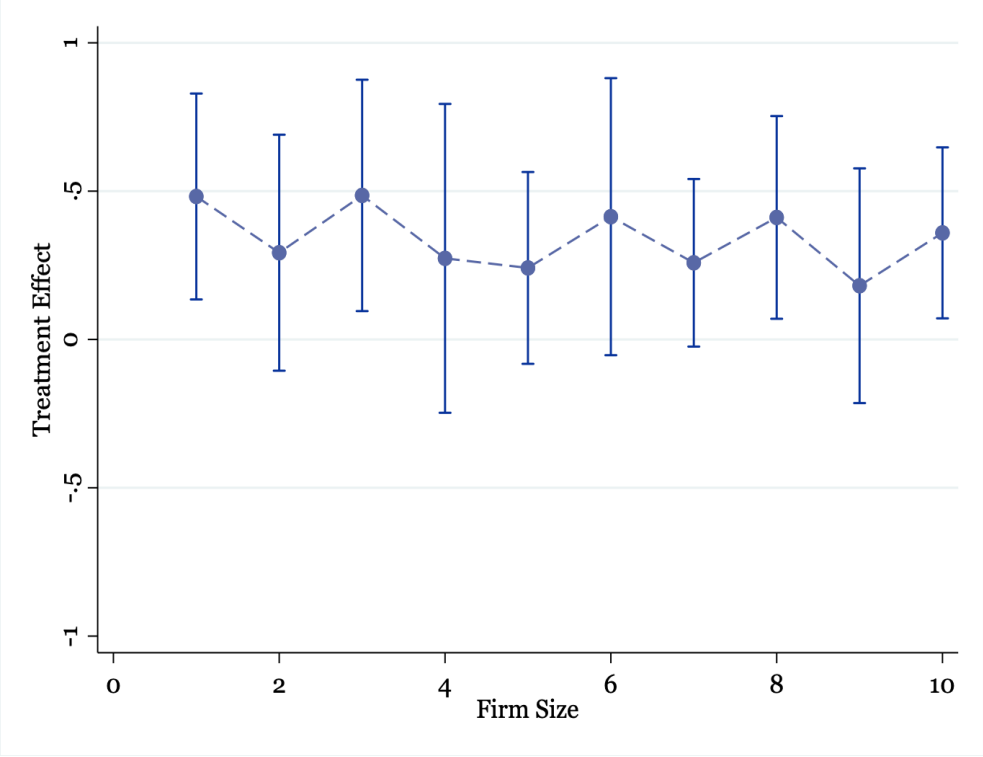


Figure 15: Mechanism 3: Compliance costs: This figure presents treatment effect as a fucntion of the firm size. Firm-year observations are ordered into 20 quantiles according to their size. Firm size serves as a measure of compliance costs faced by a firm under VAT. It is measured as the number of employees in the firm. Data: Annual Survey of Industries, 2003-10.

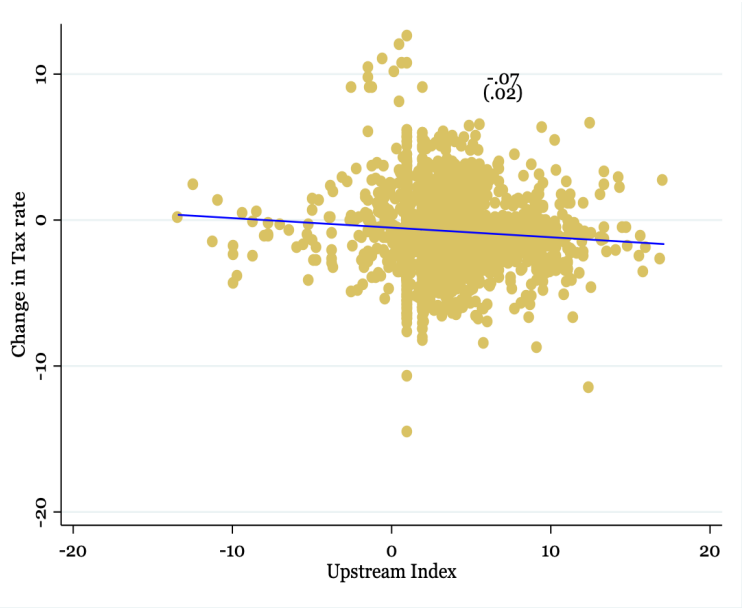


Figure 16: Mechanism 5: Higher tax rate on upstream firms: This figure tests if the higher tax rates on goods produced by the upstream firms created incentives for firms to integrate under the VAT reform. Higher tax rates on goods produced out-house rather than in-house create penalty for producing out-house. This would be the case if the VAT reform increased tax rates on upstream goods compared to downstream goods. Data: VAT and Sales Tax Laws 2001-2010.

	(1)	(2)	(3)	(4)	(5)	(6)
Non Tax Exempt$X$*Adopt*	0.584	0.572	0.489	0.482	0.376	0.356
	(0.170)***	(0.174)***	(0.206)**	(0.207)**	(0.162)**	(0.169)**
Non tax exempt	-0.189	-0.162	2.213	2.226	-0.192	-0.182
	(0.432)	(0.436)	(0.560)***	(0.558)***	(0.0827)**	(0.0862)**
Adopt	-0.370	-0.391	0.0477	0.0290	-0.295	-0.490
	(0.176)**	(0.188)**	(0.268)	(0.270)	(0.278)	(0.222)**
State specific linear trends	No	Yes	No	Yes	No	Yes
Ind FE	No	No	Yes	Yes	No	No
Firm FE	No	No	No	No	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	243566	243566	243566	243566	243566	243566
adj. R^2	0.073	0.074	0.172	0.172	0.848	0.849

Table 2: Results for Specification 2, Firm Inputs: This table reports the coefficients of regression 2 where the outcome variable is the average upstreamness of firm inputs. More specifically, I regress the average upstreamness of firm input mix on a dummy indicating if the main output produced by the firm in 2002 is subject to VAT. All regressions include state, year fixed effects and a dummy for the year of state VAT adoption. Standard errors clustered at the state level are reported in the parantheses. There are 32 states in the sample. Data: Annual Survey of Industries, 2003-10. *$p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

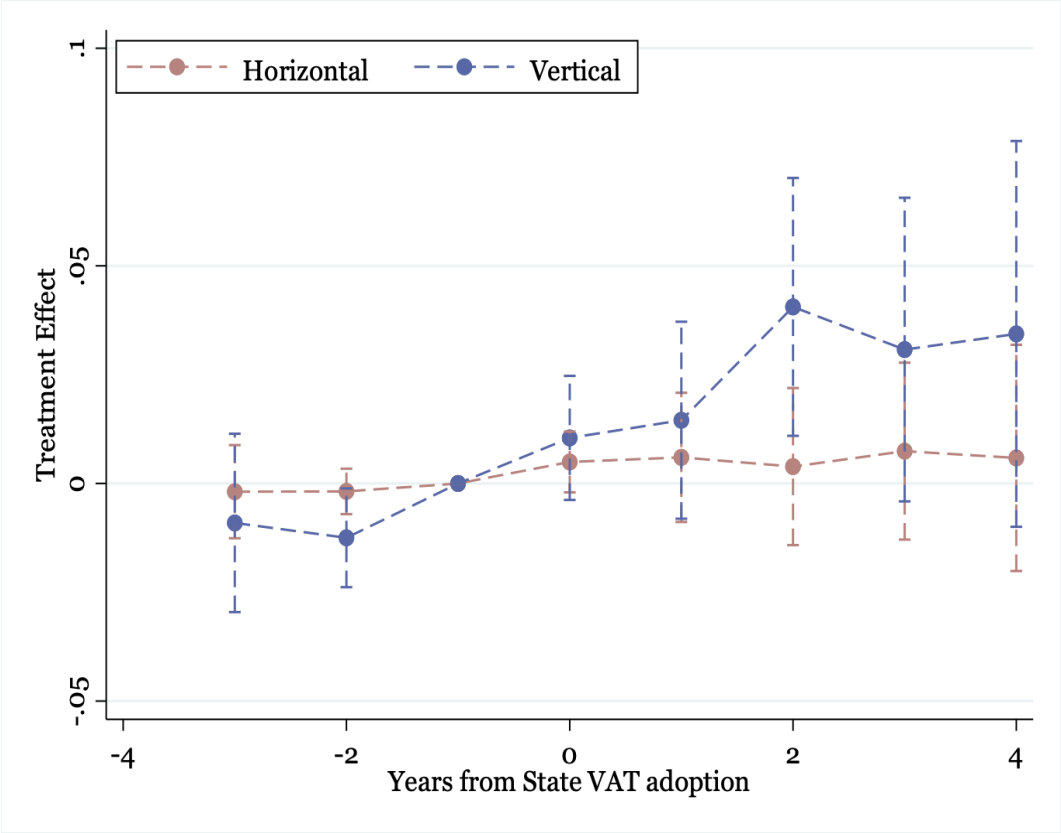


Figure 17: Mergers and acquisitions: This graph plots event-study coefficients of state-year number of log(mergers+1) on dummies indicating years since VAT adoption. The regression includes state, year fixed effects and is weighted by the number of companies in the state. Dummy for a year before adoption is omitted from regression. Confidence intervals are plotted at 5% significance level. Data: PROWESS 2001-2010.

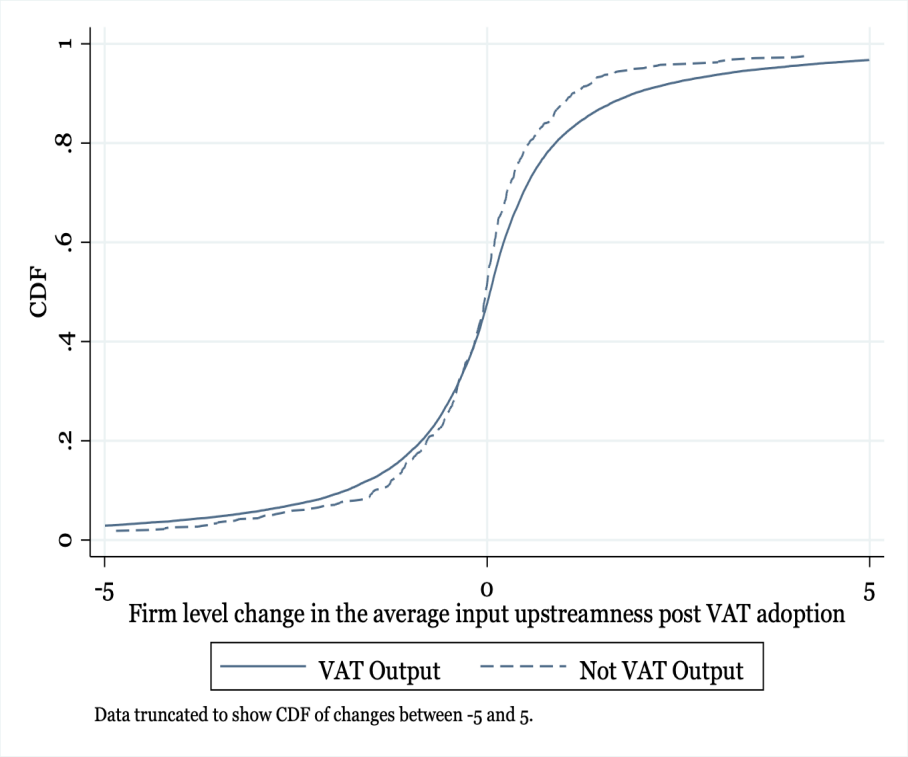


Figure 18: Test of Monotonicity assumption for 2SLS Estimation

	(1)	(2)	(3)	(4)	(5)	(6)
Non Tax Exempt$X Adopt$	0.212	0.227	0.0684	0.0816	-0.169	-0.164
	(0.148)	(0.150)	(0.154)	(0.153)	(0.166)	(0.164)
Non tax exempt	-0.773	-0.786	-0.101	-0.113	0.0866	0.0840
	(0.219)***	(0.221)***	(0.164)	(0.164)	(0.0848)	(0.0837)
Adopt	-0.0933	-0.0746	0.0189	0.0367	0.222	0.164
	(0.134)	(0.137)	(0.140)	(0.148)	(0.210)	(0.206)
State specific linear trends	No	Yes	No	Yes	No	Yes
Ind FE	No	No	Yes	Yes	No	No
Firm FE	No	No	No	No	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	212065	212065	212065	212065	212065	212065
adj. R^2	0.024	0.024	0.128	0.129	0.776	0.776

Table 3: Results for Specification 2, Firm Outputs: This table reports the coefficients of regression 2 where the outcome variable is average upstreamness of firm outputs. More specifically, I regress the average upstreamness of firm output mix on a dummy indicating if the main output produced by the firm in 2002 is subject to VAT. All regressions include state, year fixed effects and a dummy for the year of state VAT adoption. Standard errors clustered at the state level are reported in the parantheses. There are 32 states in the sample. Data: Annual Survey of Industries, 2003-10. *$p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	(1)	(2)	(3)	(4)	(5)
Adopt	0.209	0.176	0.228	0.179	0.0760
	(0.0660)***	(0.0616)***	(0.0728)***	(0.0603)***	(0.209)
State specific linear trends	No	Yes	No	Yes	No
Ind FE	No	No	Yes	Yes	No
Firm FE	No	No	No	No	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
N	243542	243542	243542	243542	243542
adj. R^2	0.073	0.074	0.171	0.172	0.848

Table 4: Results for Specification 4: This table reports the estimates from regression 4. Specifically, I estimate the effect of state level VAT adoption on the average upstreamness of inputs. Between 2003 and 2010, states adopted VAT in a staggered manner. All regressions include state and year fixed effects. Robust standard errors clustered at state level are reported in parentheses. Total Number of Clusters=32. Data: Annual Survey of Industries, 2003-10. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	(1)	(2)
Non Tax Exempt$X Adopt$	0.345**	0.375**
	(0.106)	(0.120)
Non tax exempt	-0.0617	-0.0626
	(0.0380)	(0.0378)
$Adopt$	-0.218	-0.219
	(0.161)	(0.161)
Non Tax Exempt$X Adopt X$(Tax change < 0)		-0.0827
		(0.130)
Constant	4.877***	4.877***
	(0.0612)	(0.0613)
N	88886	88886

Table 5: Differential effects by tax rate change: This table presents results for the main specification where the treatment is interacted with whether or not the firm also experiences a decline in tax on its outputs, as part of the tax reform. Standard errors clustered at the state level are reported in the parantheses. Data: Annual Survey of Industries, 2003-10. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	(1) Value added	(2) $Log(\frac{Y}{w})$	(3) $Log(\frac{Y}{K})$	(4) Log wage	(5) Log Price	(6) Log sales	(7) Log workers	(8) Tax unpaid	(9) Excise paid	(10) Profit per worker
VI	73627955.4	0.206	0.0922	0.0417	0.164	0.450	0.244	0.0143	-0.0102	1467862.9
	(2.07)**	(1.63)	(0.47)	(0.64)	(0.59)	(2.61)***	(2.20)**	(2.82)***	(-0.63)	(2.02)**
statrate	-15940223.3	0.245	0.0725	0.0693	0.352	0.367	0.131	1.016	-0.249	542884.5
	(-0.33)	(1.91)*	(0.41)	(1.12)	(1.09)	(1.96)**	(1.13)	(100.88)***	(-0.70)	(0.47)
Firm Position	-12234757.1	-0.0310	-0.0166	-0.00818	-0.00180	-0.0696	-0.0382	-0.00232	0.00148	-260402.7
	(-1.98)**	(-1.47)	(-0.54)	(-0.79)	(-0.04)	(-2.19)**	(-1.94)*	(-2.48)**	(0.60)	(-2.04)**
KP F-stat	7.822	7.834	6.891	7.827	5.966	7.840	7.815	7.840	7.840	7.815
Reduced Form	18742017.0	0.120	0.0783	0.0449	0.0762	0.269	0.160	0.0176	-0.00138	242737.4
t-stat	1.619	2.418	0.920	1.398	0.704	4.869	3.742	8.211	-0.352	1.285
OLS	-796863.2	-0.0106	-0.00566	-0.00937	0.0253	-0.0176	-0.00682	0.00000171	-0.000536	-23865.5
SE	406090.8	0.00266	0.00314	0.00141	0.00502	0.00315	0.00195	0.0000369	0.000570	11293.5
Observations	84529	84218	82617	84252	78117	84492	84255	84492	84492	84255

Table 6: IV estimates: This table presents instrumental variables estimate of the effect of vertical integration (VI) on firm outcomes. The instruments include year of state VAT adoption and the interaction with whether the firm produced VAT exempt product in 2004. *VI* is measured by the average upstreamness of firm inputs. *Value-added* and *profits per worker* are winsorized at 1%. Value added is defined as the difference between firm gross sales and material costs. *Log wage* denotes logarithm of average worker compensation in the firm. *Profit per worker* is defined as the difference between before-tax value added and wage costs divided by the number of workers. *Tax unpaid* is defined as the difference between statutory tax rate and actual tax rate remitted as reported in the ASI data. Data: Annual Survey of Industries, 2003-10. *t-statistics* are reported in parantheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Online Appendix

	(1) State GDP	(2) Manufacturing	(3) Unregistered MN	(4) Agr. GDP	(5) Tax revenues
DelayAdoption	0.0177	0.0171	0.0141	-0.0135	-0.0180
	(0.0219)	(0.0622)	(0.00551)**	(0.0328)	(0.0189)
Observations	160	160	160	160	156
Adjusted R^2	0.132	0.074	0.604	-0.024	0.054

Table A-1: Correlation between state-level delay in VAT adoption and outcomes: This table reports the coefficients of the first-difference regression of key state outcomes against a variable that takes value equal to the state-specific delay in VAT adoption. Sample restricted to pre-VAT adoption years. All regressions include state-specific fixes effects. Robust standard errors in parentheses. Data: Niti Ayog GDP reports *$p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	Product Name	Upstream Measure
Iron & Steel	Iron Ore	4.85
	Pig Iron	3.97
	Nuts, bolts, screw, washers	3.57
	Pipe & filings, cast iron	3.36
	Sheets & plates, iron/steel	2.74
Leather	Skin, sheep	3.75
	Skin, sheep & goat-chrome tanned	2.81
	leather, semi-tanned	2
	Belt, waist, leather	1
Cotton	Kapas (raw cotton)	3.36
	Yarn, bleached cotton	2.89
	Yarn, finished/processed	2.72
	Knitted fabrics, cloth cotton	2
Meat and meat products	Meat (all types)	68.98
	Meat fresh	64.50
	Meat cooked (not canned)	6.78

Table A-2: Product upstreamness: This table illustrates the distribution of product upstreamness within a value chain. Higher value of upstreamness indicates the product is located higher up in the chain. For more detail about how this measure is created, please refer to Section 3.2. Data: Annual Survey of Industries, 1999-00

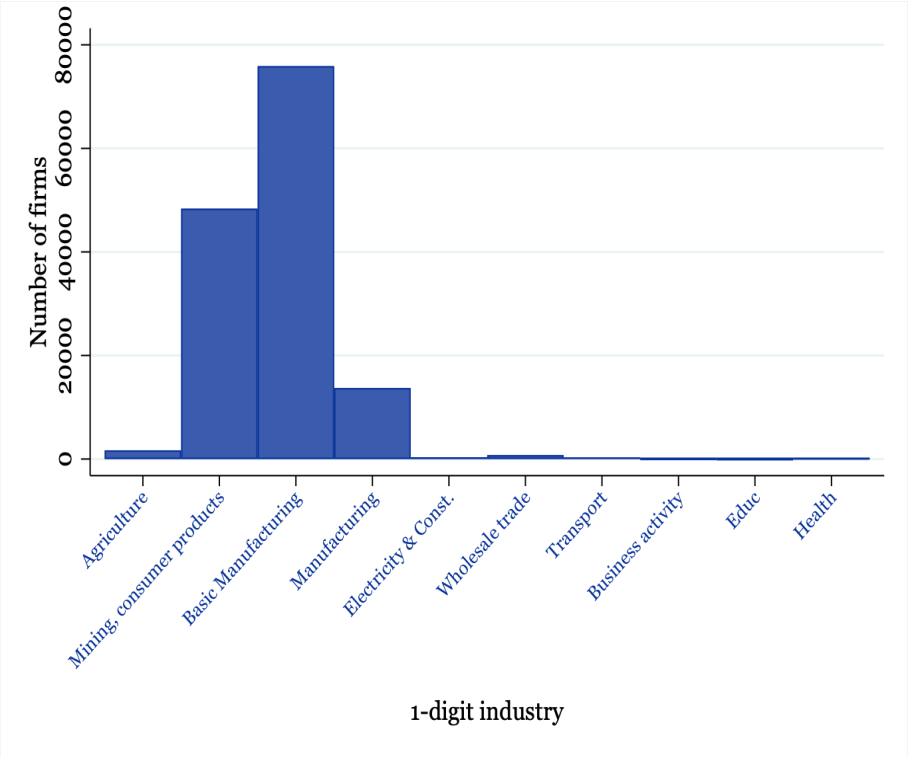


Figure A-1: Firm distribution by industry: This figure plots the distribution of firm-year observations in the Annual Survey of Industries data against the 1-digit ASICC code.

	(1)	(2)	(3)	(4)	(5)	(6)
Adopt	0.128	0.151	0.0972	0.114	0.0194	0.00699
	(0.0619)**	(0.0740)***	(0.0513)**	(0.0551)**	(0.0724)	(0.0928)
State specific linear trends	No	Yes	No	Yes	No	Yes
Ind FE	No	No	Yes	Yes	No	No
Firm FE	No	No	No	No	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
adj. R^2	0.014	0.015	0.048	0.049	0.849	0.849
N	126269	126269	126269	126269	126269	126269

Table A-3: Results for Specification 1: This table reports the estimated coefficients in regression 4. More specifically, I regress the average upstreamness of firm input mix on a dummy indicating years since state VAT adoption. All regressions include state, year fixed effects. Standard errors clustered at the state level are reported in the parantheses. There are 32 states in the sample. Data: Annual Survey of Industries, 2003-10. *$p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	(1) Rank	(2) Mean Abs Dev	(3) Median Abs Dev	(4) Min	(5) Max	(6) Median
Non Tax Exempt$XAdopt$	0.0588	-0.0305	0.0491	-0.203	-0.349	-0.0729
	(0.0624)	(0.140)	(0.158)	(0.152)	(0.356)	(0.161)
Non tax exempt	-0.0301	0.0156	-0.0251	0.104	0.178	0.0372
	(0.0319)	(0.0715)	(0.0810)	(0.0775)	(0.182)	(0.0823)
$Adopt$	-0.0405	0.177	0.0217	0.126	0.590	0.0797
	(0.0694)	(0.225)	(0.199)	(0.143)	(0.524)	(0.186)
Observations	212065	212065	212065	212065	212065	212065
Adjusted R^2	0.765	0.640	0.451	0.761	0.729	0.762

Table A-4: Results for Specification 2, Output Second moments This table presents results of effect of VAT adoption on second moments of firms output upstreamness. All regression use specification2 which controls for firm and year fixed effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	(1)	(2)	(3)	(4)	(5)	(6)
Adopt	0.0736	0.0648	0.0864	0.0701	0.0254	-0.0466
	(0.0216)***	(0.0188)***	(0.0274)***	(0.0230)***	(0.0759)	(0.0505)
State specific linear trends	No	Yes	No	Yes	No	Yes
Ind FE	No	No	Yes	Yes	No	No
Firm FE	No	No	No	No	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	244295	244295	244295	244295	244295	244295
adj. R^2	0.065	0.066	0.180	0.180	0.843	0.844

Robust standard errors clustered at state level in parentheses. Total Number of Clusters=32.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. 5 per cent winsorized at either end

Table A-5: DD estimates for average input: 2004-2010 (Winsorized) Data: Annual Survey of Industries, 2003-10.

	(1)	(2)	(3)	(4)	(5)	(6)
Adopt	0.214	0.182	0.234	0.186	0.0706	-0.142
	(0.0648)***	(0.0607)***	(0.0713)***	(0.0592)***	(0.209)	(0.120)
State specific linear trends	No	Yes	No	Yes	No	Yes
Ind FE	No	No	Yes	Yes	No	No
Firm FE	No	No	No	No	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	244295	244295	244295	244295	244295	244295
adj. R^2	0.074	0.074	0.173	0.174	0.844	0.845

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A-6: Estimation with upstream measure calculated using Pseudo-inverse. Data: Annual Survey of Industries, 2003-10.

	(1)	(2)	(3)	(4)	(5)	(6)
Non Tax Exempt$X Adopt$	0.506	0.492	0.355	0.344	0.386	0.366
	(0.170)***	(0.171)***	(0.212)	(0.211)	(0.161)**	(0.167)**
Non tax exempt	-0.0119	0.0192	0.921	0.952	-0.197	-0.187
	(0.436)	(0.437)	(0.558)	(0.562)	(0.0821)**	(0.0855)**
$Adopt$	-0.348	-0.367	-0.207	-0.249	-0.286	-0.484
	(0.169)**	(0.182)*	(0.220)	(0.214)	(0.271)	(0.217)**
State specific linear trends	No	Yes	No	Yes	No	Yes
Ind FE	No	No	Yes	Yes	No	No
Firm FE	No	No	No	No	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	236020	236020	236020	236020	236020	236020
adj. R^2	0.074	0.075	0.208	0.208	0.848	0.849

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A-7: Robustness check: dropping non-positive upstream values Data: Annual Survey of Industries, 2003-10.

Upstreamness	ASICC08 Code	Description
-13.386	63437	GARMENTS, KNITTED- COTTON
-12.386	63332	SUITINGS, COTTON
-11.21	74066	CUFFS AND LINKS BUTTONS
-10.887	91525	CASSETTE, PRE-RECORDED
-9.8874	78204	TAPE RECORDERS, AUDIO
-9.8874	78205	AUDIO TAPES
-9.8874	42127	CASSETTE COVER, PLASTIC
-9.6737	55312	PAPER, SAND
-9.3363	42425	MAGNETIC TAPE OF PLASTIC / PVC
-8.702	78214	CASSETTE COMPONENTS
Upstreamness	ASICC08 Code	Description
52.623	31607	CALCIUM NITRATE
53.184	11101	BUFFALO, LIVE
64.266	11611	MEAT, MEAL
64.507	11209	MEAT FRESH, N.E.C
68.988	11231	MEAT (ALL TYPES), CANNED
74.09	85244	PARTS OF SHIPS, BOATS ETC., N.E.C
80.343	11203	BUFFALO MEAT, FRESH/FROZEN
81.343	12141	PEAS, GREEN
85.052	12315	BASMATI RICE
449.46	36121	OIL, GINGERLY

Table A-8: Lowest and highest upstream products: This table presents the ten highest and lowest upstream products. Larger upstream values indicate products that are higher up in the value chain. For details about how this upstream measure is created using the firm data, please refer to Section 3.2. Data: Annual Survey of Industries, 1999-00.

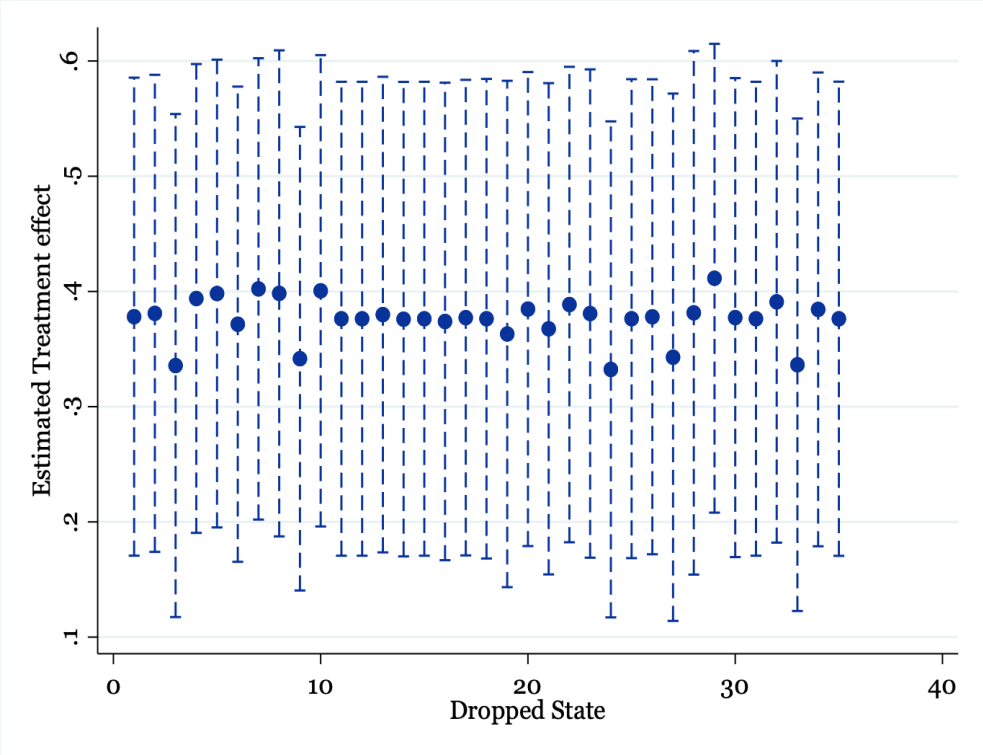


Figure A-2: Leave-one-out test: This figure presents results for robustness of the effect of VAT adoption on firm input upstreamness with respect to state. Each bar denotes the estimated effect using specification 2, with corresponding state dropped. Data: Annual Survey of Industries, 2003-10.

	Dist Final Demand	Liquidity	Firm size
Dist Final Demand	1.0000		
Liquidity	0.0866	1.0000	
Firm size	-0.0338	0.0050	1.0000

Table A-9: Correlation among measures: This table presents correlation among three key measures used to test the mechanisms in this paper. These include distance to the final demand, used to test the *evasion* mechanism; industry-level cash flow sensitivity measure used to test the *liquidity constraint* mechanism; and firm size measure used to test the *compliance costs* hypothesis.

Smaller group	D	P-value
TaxExempt = 0:	0.0873	0.000
TaxExempt = 1:	-0.0368	0.209
Combined K-S:	0.0873	0.000

Table A-10: Kolmogorov-Smirnov test: This table provides test of the hypothesis that the distribution of change in input upstreamness of firms that produced VAT goods before the reform first order stochastically dominates the corresponding distribution of firms that produced VAT exempt goods. Column 2 calculates the difference between the two groups and Column 3 reports the p-value for the hypothesis that group mentioned in row 1 is the smaller group.

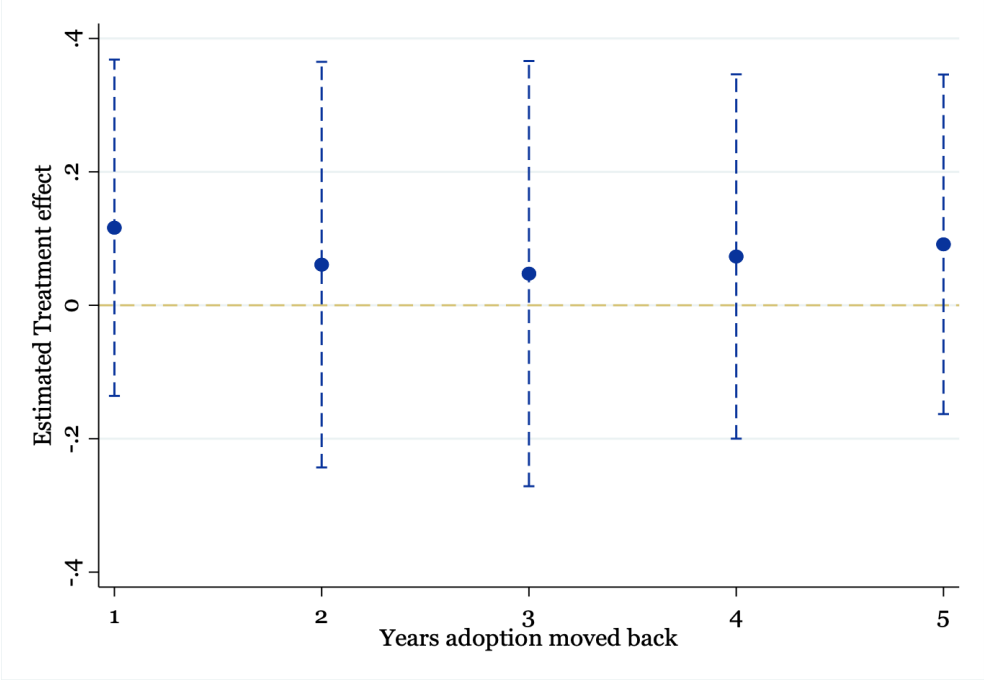


Figure A-3: Placebo test: This figure presents results of a placebo test where I keep the order of the state VAT adoption but move the year of adoption back. In particular, I estimate regression 4 move the adoption one to five years back. Data: Annual Survey of Industries, 2004-10.

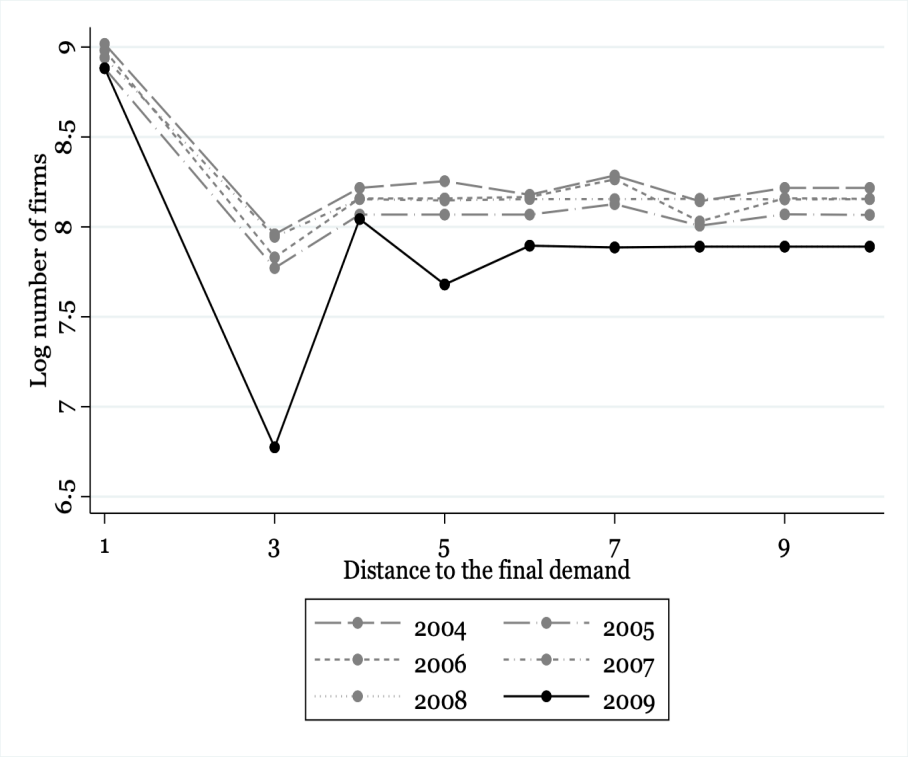


Figure A-4: Firms number by distance to final demand: This figure plots the total number of firms observed each in the ASI dataset as a function of distance to the final demand. The distance is calculated as the average upstreamness of firms' output. Data: Annual Survey of Industries, 2003-10.

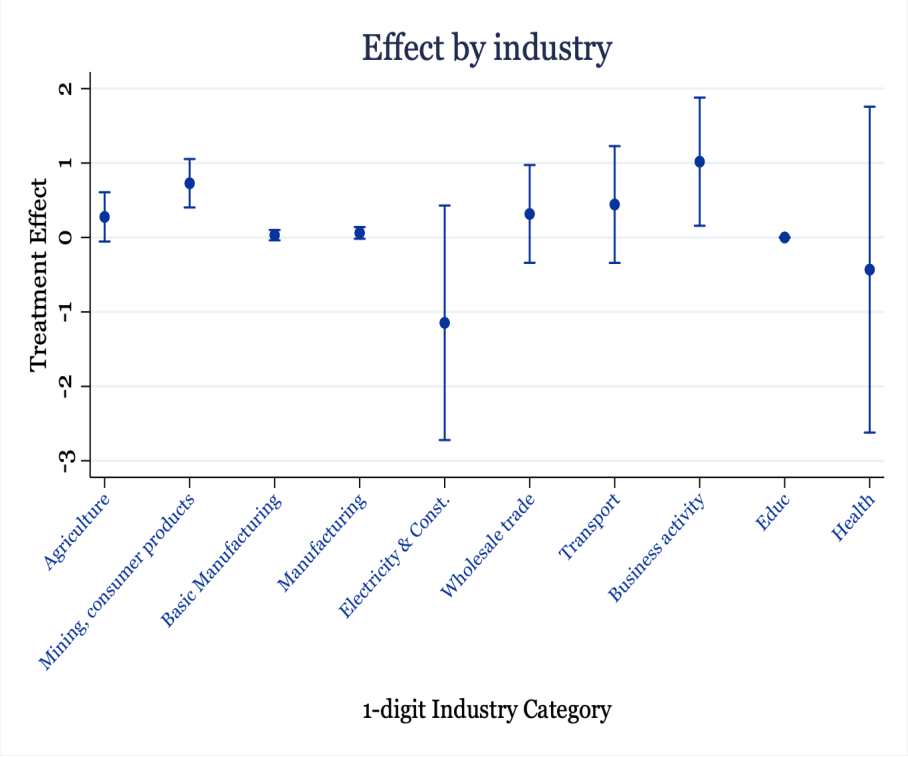


Figure A-5: Effect by industry: This figure reports the estimates of effect of VAT adoption on average upstreamness of the inputs, as a function of industry. Specifically, each estimate refers to the coefficient Non Tax Exempt$XAdopt$ in regression 2. Each bar restricts the confidence interval obtained by restricting the sample to firms in 1 digit ASICC industry as indicated on the x-axis. Data: Annual Survey of Industries, 2003-10.

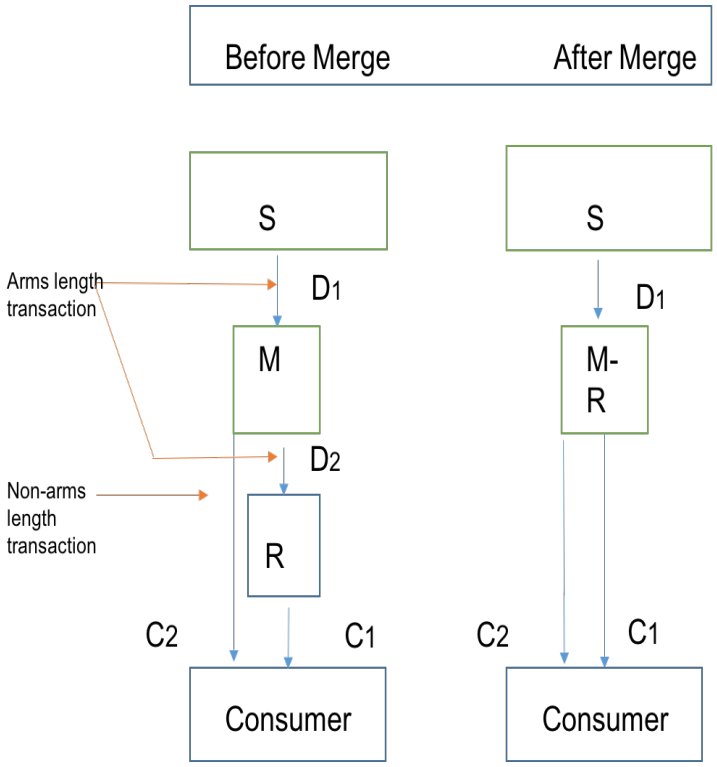


Figure A-6: Vertical integration under VAT: This figure illustrates the effect of vertical integration on the nature of transactions. Without integration (the left panel) greater number of transactions are 'arms length'. These include transactions between two firms such as S-M and M-R. In contrast, the transaction between R and C is non arms-length because it is not subject to cross reporting. With vertical integration (the right panel), fewer transactions are arms-length (such as between S and the integrated firm M-R). This leads to higher costs of enforcement under VAT and lower revenues collected.