Taxation and Supplier Networks: Evidence from India*

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Abstract

Do tax systems affect the efficiency of supplier networks in developing countries? This paper considers the implications of tax policy for supply chain efficiency using administrative tax data on the universe of firms paying taxes in West Bengal, India, between 2010 and 2015; this data includes information on nearly 5 million annual transactions between suppliers and buyers. We first document substantial market segmentation between firms paying Value-Added-Taxes (VAT) and non-VAT-paying firms, even after observable heterogeneity is controlled for. We then develop a theoretical framework to understand how firms’ production, sourcing and tax status decisions interact and are affected by tax policy. The model predicts equilibrium (partial) market segmentation because of both supply-chain distortions (taxes affect how much firms trade with each other) and strategic complementarities in firms’ tax choices. Finally we test the model’s predictions using a reform which increases the VAT rate on some commodities. We find evidence of a causal impact of the tax system on the structure of supplier networks, and of complementarities in firms’ tax choices within these networks.

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1 Introduction

Do tax systems affect the efficiency of supply chains? Most tax systems allow economic agents to select into different tax status and potentially alter the incentives they have to exchange with each other. This is particularly true of the Value-Added-Tax (VAT), a form of taxation that is used today by over 140 countries and is one of the largest source of revenues in developing countries (Bird and Rowlands, 2007; Gordon and Li, 2009). VAT is levied on firms’ sales minus their input purchases but only purchases from VAT-paying suppliers are tax-deductible. A VAT system thus treats transactions between firms differently depending on whether the two parties to the transaction pay VAT. This suggests that in markets where VAT- and non VAT-paying firms co-exist the tax system distorts supply chains, causing misallocation in input markets.

In this paper we start by documenting to what extent inter-firm supplier networks are segmented by tax status in a large developing economy. We use administrative data containing the universe of firms’ tax returns in West Bengal, India for the period 2010-2015. Two particularities of the context and the data enable us to characterize market segmentation. First, small firms in West Bengal can choose not to pay VAT but to opt instead for a turnover tax scheme under which they pay a linear tax on their sales. Firms that choose to do so (12% of the 180,000 tax-registered firms) are at a disadvantage in VAT supply chains: VAT-paying firms cannot deduct purchases from firms in the turnover scheme from their tax liability. Second, VAT-paying firms have to report annual transactions with other tax-registered firms to the tax authorities, so we have data on 4.8 million annual buyer-supplier pairs. This allows us to map supplier networks by matching sellers’ and buyers’ tax identifiers, and consider the extent to which VAT and non-VAT paying firms trade with each other. We find that VAT-paying firms are 30% more likely to trade with other VAT-paying firms than firms in the turnover scheme are. The correlation between firms’ tax status and how much they buy from or sell to VAT-paying firms is robust to controlling for firms’ location and product characteristics. This correlation also holds within firms: firms’ tax status changes are highly correlated with changes in how much they trade with VAT-paying firms.

Having established the existence of partial market segmentation seemingly driven by firms’ tax status choices, we study the effect of the tax system on supplier networks from both a theoretical and empirical perspective. Our first contribution is a multi-stage supply-chain model in which firms make sourcing, production and tax status (whether or not to pay VAT) decisions. This model is a bi-partite application of trade network models – and in
particular Tintelnot et al. (2017) – and allows us to determine how the tax system affects the supply chain. Our key theoretical result is that a VAT system will yield partial market segmentation between VAT and non-VAT firms, for two reasons. First, the VAT’s incentive structure leads to supply-chain distortions: all else equal a VAT-paying firm buys a higher share of its inputs from VAT-paying suppliers than a non-VAT-paying firm does. This mechanism implies some endogenous market segmentation by tax status, increasing in firms’ elasticity of substitution in production, even in a world where firms’ tax status are exogenously given. Endogenising firms’ tax status choices introduces a second mechanism, strategic complementarities in tax status decisions, which leads to further segmentation: firms are more likely to choose to pay VAT the more VAT-paying suppliers and clients they have.

Our second contribution lies in providing evidence on the causal effects of i) the tax system on supplier networks (supply chain distortions) and ii) supplier networks on firms’ tax decisions (complementarities). To identify causal effects, we consider a tax reform introduced in 2013-2014 which increased the VAT rate paid on some products but left other parameters of the tax system unchanged. We also take advantage of the information on each firm’s supplier network and within firm-variations over time. To deal with the reflection and correlated-effect problems associated with estimating network effects (Manski, 1993) we implement an instrumental-variable method in the spirit of Bramoulle et al. (2009) micro-founded by our theoretical work: we use changes in the VAT rates faced by the trading partners of a firm’s trading partners as an instrument for the tax status of that firm’s trading partners (see also Giorgi et al., 2010).

We find evidence of strategic complementarities in firms’ tax decisions. If all the suppliers of a firm switch to the VAT scheme, the effect on its probability to enter the VAT scheme is of the same magnitude as a reduction of its VAT tax rate by 1 percentage point. Firms also respond to the choices made by their clients. Our estimates imply that firms selling all their products to VAT-paying clients will not longer take their VAT tax rate into consideration when choosing whether or not to pay VAT, as predicted by our model. Looking at within supplier-buyer pairs variations in transactions over time we find that firms are more likely to trade (and when they trade, trade more), all else equal, when both the supplier and the client pay the VAT. The causal effect of firms’ VAT choice on transactions is stronger when the VAT rate faced by the supplier increases, in line with the model’s predictions. Our estimates imply a low value for the elasticity of substitution in production (less than 2.5) suggesting there is substantial stickiness in supplier-buyer relationships in our context, at least in the short run.
To the best of our knowledge this paper is the first to consider the efficiency cost of taxation at the level of supply chains, and to present evidence regarding the causal effect of taxes on supplier networks.\footnote{In an independently developed project Gerard et al. (2018) study a question similar to ours in the context of the state of São Paulo, Brazil.} Our results contribute to the literature on public finance that asks how the particular context of developing countries changes the equity-efficiency trade-offs associated with different taxes.\footnote{See e.g. Emran and Stiglitz (2005); Boadway and Sato (2009); Kleven et al. (2013); Best et al. (2015); Gerard and Gonzaga (2017); Bachas and Soto (2017); Cagé et al. (2017); Carrillo et al. (2017).} We show that the co-existence of VAT-paying and non VAT-paying firms (small firms in simplified tax schemes, but also firms in the informal sector), a pervasive feature of markets in developing economies, implies that the tax system distorts supply chains. Results also illustrate how the structure of supplier networks simultaneously affects the tax system through complementarities in tax status choice. This paper is more particularly related to the literature on the VAT which typically argues that the VAT’s build-in incentive structure, by generating a third party reported paper trail on transactions between firms, makes it well-suited to the developing country context of low tax compliance – some evidence on the impact of the VAT’s third party reporting features is found in Pomeranz (2015) and Naritomi (2016). Our paper suggests that this compliance advantage of the VAT must be weighted against the distortions it generates at the supply chain level. The idea that the VAT creates ‘informality chains’ – or links in tax status choices along the supply chain – was first formally introduced by de Paula and Scheinkman (2010). We develop this idea by incorporating tax decisions in a trade network model and provide causal evidence on the existence of such chains.\footnote{Evidence suggestive of complementarities in tax status choices is also found in Almunia et al. (2016) who show that higher input use increases the probability that UK firms choose to voluntarily register to the VAT.}

Our results also contribute to the growing literature on firm supplier networks, reviewed in Bernard and Moxnes (2017), and in particular recent papers that leverage new datasets on domestic firm to firm transactions to characterize supplier networks and the propagation of shocks within these networks. Bernard et al. (2015) and Carvalho et al. (2016) use a survey of Japanese firms and study, respectively, the impact of new rail infrastructure and that of earthquakes on supplier networks; Atalay et al. (2011) characterize US production networks using US survey data and Tintelnot et al. (2017) use administrative VAT data for Belgium to characterize gains from trade. We contribute to this literature in three ways, using administrative data for a large developing economy. First we consider theoretically and empirically how a particular policy – the tax system – affects supplier networks. Second, we show how these networks themselves affect firms’ decisions, by creating
complementarities in tax choices. Third, our results provide some evidence regarding the nature of buyer-supplier relationships and hence the determination of links within supplier networks; specifically our estimates of the supply chain distortions created by taxes suggest firms have a low willingness to substitute across suppliers. This is consistent with a large literature on firms in developing countries that studies the role of market frictions in the formation of buyer-supplier relationships, and finds that enforcement and information constraints loom large in this context (McMillan and Woodruff, 1999; Banerjee and Duflo, 2000; Allen, 2014; Macchiavello and Morjaria, 2015).

Finally this paper contributes to the large literature explaining firm-level productivity differentials between rich and developing countries by misallocation across firms (see Hopenhayn, 2014, for a review). In particular Banerjee et al. (2005) and Hsieh and Klenow (2009) discuss the role of, and provide evidence for, substantial misallocation of factors of production across firms in developing countries relative to rich countries (see also Brandt et al., 2013; Khwaja and Mian, 2005; Boehm and Oberfield, 2018). This literature often points to government regulations, and in particular tax systems, as potential drivers of this misallocation but to the best of our knowledge our paper is the first to provide causal evidence on the role of taxes in misallocation in input markets. Our evidence on market segmentation suggests that misallocation within supply chains may contribute to lower productivity levels in developing countries. Our results regarding the causal effect of tax changes show that this misallocation is in part the result of policy.

The paper is organized as follows. Section 2 describes our context of study and data and provides descriptive evidence on market segmentation. Section 3 develops a two production stages model of firm sourcing and tax status decisions and derives predictions regarding the impact of an increase in the VAT rate. Section 4 presents our empirical strategy to estimate the causal impact of the tax system on supply chains using a reform, and section 5 discusses results.

2 Context and data

2.1 Institutional background

Our context of study is West Bengal, a large state in the East of India with 90 million inhabitants and which accounts for 7% of the country’s GDP. The main source of revenues at the state level is the value-added-tax (VAT); the main VAT rates in 2010-2011 were 4%
(medium tax schedule) and 14\% (high tax schedule), with some goods taxed at 0 or 1\% (low tax schedule) - see the Appendix for a list of the goods included in each tax schedule. Firms’ VAT liabilities are defined by their total sales minus VAT paid on their inputs. All firms with a turnover greater than 5 million INR (70,000 USD) must register to pay taxes with the state tax authorities. Small firms, defined as firms with a turnover less than 5 million INR, can opt not to pay VAT but instead pay taxes under the ‘turnover scheme’ and only pay a 0.025\% tax on their total sales. Importantly for the purpose of this paper, firms in the VAT scheme cannot deduct taxes paid on their inputs purchased from firms in the turnover scheme from their tax liability.

In fiscal year 2013-2014 the two main VAT rates increased by one percentage point: from 4 to 5\% for commodities in the medium tax schedule and from 14 to 15\% for commodities in the high tax schedule, with no change for the low tax schedule. This corresponds to a 25\% increase in the tax rate for the medium tax schedule and a 7\% increase for the high tax schedule. There was no change in the types of commodities included in each schedule or in the tax rate paid by firms in the turnover scheme. We will return to this reform when estimating the causal effect of the VAT on firms’ sourcing decisions and their supply chains.

2.2 Data and descriptive statistics

Firm-level data  We use administrative data on firm-level tax returns and registration information from the Directorate for Commercial Taxes of the state of West Bengal, India, for the fiscal years 2010-2011 to 2015-2016. This dataset contains the annual tax returns of the 180,000 firms paying taxes to the state over the period, whether in the VAT or the turnover scheme. Firms paying taxes under the VAT scheme (hereafter VAT firms) report their total sales, total input purchases, and VAT paid on these inputs, the latter gives rise to an ‘input tax credit’ which is deducted from the total taxes due on sales. Firms paying taxes under the turnover scheme (hereafter turnover firms) report their total sales and total input purchases, but the latter isn’t used to compute their tax liabilities. The main variables we use from the tax returns are firms’ gross total sales and the firm’s tax status: whether it is paying taxes in the VAT or turnover scheme. We also use information on the total output taxes (taxes paid on sales prior to the deductions due to the input tax credit) paid by VAT firms to compute firms’ effective VAT rate. In addition to the variables used to compute their tax liabilities firm must report the main three commodities they sell and how much they sell of each, we use information on the main commodity sold to allocate firms to one of 170 commodity categories and a (potential) VAT tax schedule. Registration information
gives us firms’ location at the postcode level and age. Restricting our sample to firms for which we have information on location and commodities sold our sample contains 806,932 observations at the firm-year level.

**Data on supplier-buyer matches** Firms in the VAT scheme must also report to the tax authorities all transactions with other registered firms of more than 50,000 INR annually, regardless of whether the trading partner is in the VAT or the turnover scheme, as well as the tax id of their trading partners. Compiling this information gives us a transaction dataset with 4.8 million annual buyer-supplier pairs. Firms in the turnover scheme do not report transactions to the tax authorities, so we do not observe trade between turnover firms. Merging this transaction data with the firm data allows us to compute for each firm the share of its sales that it sells to VAT clients and the share of its inputs that is buys from VAT suppliers.

**Descriptive statistics** Table 1 presents the key characteristics of firms in our data in fiscal year 2010-2011. The first column includes all firms in the turnover scheme (13% of the sample), the second all firms in the VAT scheme but with a turnover under 5 million INR and therefore eligible to choose the turnover scheme (54%) and the last all remaining VAT firms (33%). We see that, whilst the data contains some very large firms, most have a turnover of less than 5 million. Less than one-third are in Kolkata, though this share increases amongst larger firms. The share of sales bought by VAT clients is very low (1%) for turnover firms, and much lower than that of VAT firms. The share of inputs coming from VAT suppliers is similarly lower for turnover firms than for VAT firms, and this even amongst firms of similar sizes. The difference between the share of VAT sales and the share of VAT inputs suggests that firms in the turnover scheme tend to be located downstream in supply chains, at least in supply chains that also include VAT firms. The last three lines of Table 1 show that the lower shares of VAT sales and inputs for turnover firms can be explained both by the fact that they are less likely to trade with VAT firms, and by the fact that they have less trading partners, conditional on having at least one, than VAT firms.

Table 1 provides evidence of partial market segmentation between VAT and turnover firms: VAT firms are more likely to sell to or buy from VAT firms than turnover firms. This could be due to different characteristics of VAT and turnover firms, unrelated to their tax status, that lead them not to trade with each other - different locations for example. Table 2 assesses whether this is the case by considering the correlation between a firm’s own
tax status and the share of its sales (inputs) that goes to (comes from) VAT firms on the sample of firms eligible to the turnover scheme. We find that part of the correlation with the share of VAT sales can be explained by VAT and turnover firms selling different goods (column 3) and being in different locations (column 4) but the correlation remains large and statistically significant when controlling for these firm characteristics. The last column of the table shows that the correlation remains positive within-firms over time: the timing of changes in firms’ tax status is correlated with changes in their shares of VAT sales and VAT inputs.

The types of products sold by firms in 2010-2011 are presented in Table 3. Over one-fourth of tax-registered firms in West Bengal sell machines or construction materials, other commonly sold categories are electronic and electronic goods, food, chemical products, textiles and metal products. The share of VAT firms among firms eligible to choose the turnover scheme (column 3) is highest for commodities typically sold to other firms (machines, metal product and mining) and lowest for good categories more commonly sold to households (household goods, textiles and food). This is in line with the idea that firms selling to non-VAT clients are less likely to choose to be in the VAT scheme.

3 Model

We draw the structure of the model from Tintelnot et al. (2017). We extend it by introducing taxes and allowing firms to choose their tax status but simplify the network by making it bipartite: they are two layers of firm in the economy, upstream and downstream. Upstream firms sell to downstream firms and the final consumer, downstream firms buy from upstream firms and sell to the final consumer.

3.1 Set-up

3.1.1 Final consumer

The final consumer \( F \) is endowed with income \( E \) and has CES preferences:

\[
U = \left( \frac{\sum_i (\beta_i q_{iF})^{\sigma-1}}{\sigma} \right)^{\frac{\sigma}{\sigma-1}}.
\]
where \( q_{iF} \) is the quantity of good \( i \) consumed by the final consumer. Maximising her utility we obtain a demand for good \( i \):

\[
q_{iF} = \left( \frac{\beta_i}{p_{iF}} \right)^\sigma P_F^{\sigma-1} E
\]

(1)

where \( P_F = \left( \sum_i \beta_i^\sigma p_{iF}^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \) is the consumer price index and we have used \( E = \sum_i q_{iF} p_{iF} \).

The price elasticity of final demand for good \( i \) is simply given by \(-\sigma\). Writing total demand in value \( x_{iF} = p_{iF} q_{iF} \):

\[
x_{iF} = \beta_i^\sigma \left( \frac{P_F}{p_{iF}} \right)^{\sigma-1} E
\]

3.1.2 Downstream firms

Downstream firms, indexed by \( k \), produce using labour and goods from upstream firms \( j \) and sell only to the final consumer. Their production function is:

\[
q_{kF} = \phi_k \left( \sum_j \alpha_{jk} q_{jk}^{\rho-1} + \alpha_{j\ell} q_{\ell k}^{\rho-1} \right)^{\frac{\rho}{\rho-1}}
\]

where \( q_{jk} \) are the inputs of good \( j \) purchased by firm \( k \) and \( \rho \) is the elasticity of substitution in production. Writing \( p_{jk} \) the price paid by \( k \) for good \( j \), we can write demand for good \( j \) as

\[
q_{jk} = \frac{q_{kF}}{\phi_k} \left( \frac{\alpha_{jk} p_k}{p_{jk}} \right)^\rho
\]

(2)

and the cost function as

\[
c_k = \frac{P_k}{\phi_k} \text{ with } P_k = \left( \sum_j \alpha_{jk}^\rho p_{jk}^{1-\rho} + \alpha_{j\ell}^\rho w^{1-\rho} \right)^{\frac{1}{1-\rho}}
\]

where \( P_k \) is an index of firm \( k \)’s input prices. Total demand for good \( j \) in value – \( j \)’s sales to \( k \) – can be written as \( x_{jk} = p_{jk} q_{jk} \) is:

\[
x_{jk} = \frac{q_k}{\phi_k} \left( \alpha_{jk} p_k \right)^\rho \frac{p_{jk}^{1-\rho}}{}
\]
The share of firm $k$’s costs that it spends on good $j$ is:

$$s_{jk} = \alpha_{jk}^{\rho} \left( \frac{P_k}{P_{jk}} \right)^{\rho-1} \quad (3)$$

### 3.1.3 Upstream firms

Upstream firms, indexed by $j$, produce using only labour and sell to downstream firms $k$ and final consumers. Their production function is

$$q_j = \phi_j \alpha_{\ell j}^{\frac{\rho}{\rho-1}} q_{\ell j}$$

Their cost function is

$$c_j = \frac{P_j}{\phi_j} \text{ with } P_j = \frac{\alpha_{\ell j}^{\rho}}{w}$$

### 3.2 Prices and taxes

Our assumptions imply that firms sell to consumers at a constant markup $\mu = \frac{\sigma}{\sigma-1}$ and to other firms at constant markup $\nu = \frac{\rho}{\rho-1}$. We denote as $v_i$ the tax status of firm $i$. If $v_i = 1$ firm $i$ is in the VAT scheme, it pays a tax $t_i$ on its sales and deducts the VAT paid on its input purchases from its tax liabilities. If $v_i = 0$ firm $i$ is in the turnover scheme, it pays a tax $\tau$ on its sales. Defining the tax wedges $\gamma_{iF} = 1 - \tau - v_i(t_i - \tau)$ and $\gamma_{jk} = (1 - \tau - v_j(t_j - \tau) + v_j v_k t_j)$ we can write the prices to final consumers and to intermediate firms as:

$$p_{iF} = \frac{P_i \mu}{\phi_i \gamma_{iF}} \forall i = j, k \quad (4)$$

$$p_{jk} = \frac{P_j \nu}{\phi_j \gamma_{jk}} \quad (5)$$

with

$$P_k = w \left( \alpha_{\ell k}^{\rho} + v^{1-\rho} \sum_j (\alpha_{\ell j} \alpha_{jk})^\rho \phi_j^{\rho-1} \gamma_{jk}^{\rho-1} \right)^{\frac{1}{1-\rho}} \quad (6)$$

**Proposition 1.** The tax system causes supply chain distortions: downstream firms will, all else equal, buy more from VAT suppliers when they themselves are VAT. To see this consider the impact of a change in downstream firm $k$’s tax status on the share of its purchases bought from a VAT upstream firm $j$: 

9
\[
\frac{\partial \log(s_{jk})}{\partial v_k} = (\rho - 1) \frac{t}{1 - t} (1 - s_{Vk})
\]  
(7)

where \(s_{Vk}\) is the share of firm \(k\)'s purchases bought from VAT suppliers.\(^4\)

Proof: taking the derivative of \(s_{jk}\) in expression (3) with respect to the tax status of the downstream firm yields expression (7).

This proposition states that there will be partial market segmentation between VAT and non-VAT firms even in a world in which firms’ tax status are exogenous, because of supply chain distortions. We see that when a downstream firm goes from being in the turnover scheme to being in the VAT scheme it starts buying more from VAT suppliers.\(^5\) Firms pay a tax on purchases from VAT suppliers only if they themselves are not in the VAT scheme; downstream firms thus lower the cost of their inputs purchased from VAT firms when they themselves are VAT. The effect of downstream firm \(k\)'s tax status on its purchases from any VAT supplier \(j\) is decreasing in \(s_{Vk}\), the share of its total purchases bought from VAT suppliers. Intuitively, the more the firm buys from VAT suppliers the more its input price index \(P_k\) decreases when it becomes VAT; at the limit a firm buying all its purchases from VAT suppliers \((s_{Vk} = 1)\) with the same VAT rate will not change its input mix when it becomes VAT because the price of all its inputs will decrease equally.

### 3.3 Tax status choice

We now consider the determinants of firms’ tax status choice, assuming each firm takes other firms’ tax status as given. The profits firms make from final sales are:

\[
\pi_{iF} = (\mu - 1) \mu^{-\sigma} \left(\frac{\phi_i}{P_i}\right)^{\sigma - 1} (\beta_i \gamma_{iF})^{\sigma} P_{F}^{\sigma - 1} E
\]

The profits (upstream) firms make from intermediate sales are:

\[
\pi_{jI} = (\nu - 1) \nu^{-\rho} \mu^{-\sigma} \rho^{-1} E \left(\frac{\phi_j}{P_j}\right)^{\rho - 1} \sum_k (\alpha_{jk} \gamma_{jk})^{\mu} (\beta_k \gamma_{kF})^{\sigma} \phi_k^{\sigma - 1} P_k^{\rho - \sigma}
\]

\(^4\)This assumes for simplicity that there is only one VAT rate, \(t_j = t, \forall j\).

\(^5\)We present this case of a downstream firm changing tax status because it is empirically meaningful: we observe many downstream firms changing tax status. There are few cases of upstream firms choosing to be in the turnover scheme but the mirror results holds for a change in the tax status of an upstream firm: an upstream firm going from the turnover to the VAT scheme will sell more to clients in the VAT scheme.
Downstream firms maximize $\pi_k = \pi_{kF}$, upstream firms maximize $\pi_j = \pi_{jF} + \pi_{ji}$. They choose their tax status by comparing their (maximized) profits under the VAT and the turnover scheme. We obtain the following proposition.

**Proposition 2.** We can write firm $i$’s propensity to be in the VAT scheme $v_i$ as:

$$v_i = f \left( t_i, t_i \sum_k v_k \tilde{\lambda}_{ik}, \sum_j t_j v_j \tilde{s}_{ji} \right)$$  

where $\tilde{\lambda}_{ik}$ is the share of firm $i$’s sales bought by downstream firm $k$ in the first best world with no taxes and similarly $\tilde{s}_{ji}$ is the first-best share of firm $i$’s purchases it buys from upstream firm $i$. The variable $v_i$ is decreasing in the first term, the firm’s own VAT rate, and increasing in the second term which is the firm’s VAT rate multiplied by its share of VAT sales. It is also increasing in the third term, the average VAT rate paid by its potential suppliers, weighted by purchase shares.

Proof: see Appendix.

This proposition states that there are strategic complementarities in firms’ tax decisions within supply chains. To see this note that the second term of expression (8) is increasing when the firm has more (potential) VAT suppliers and the third term increasing when it has more (potential) VAT clients. The terms $\tilde{\lambda}_{ik}$ and $\tilde{s}_{ji}$ represent the first best structure of the supplier network - the network that would occur in the absence of taxes - and are a function of the distribution of firms’ technologies. The more a firm buys from, and sells to, VAT firms, the more likely it is to itself choose to be VAT. Intuitively firms with many potential VAT suppliers will face a lower input price index if they choose to be in the VAT scheme rather than in the turnover scheme; similarly firms with many potential VAT clients will face more demand for their products if they choose to be in the VAT scheme. Note that expression (8) also states that the firms’ own VAT rate will have a negative effect on its propensity to be in the VAT scheme, for intuitive reasons, but this effect is decreasing with the share of its sales going to VAT clients. At the limit the tax status choice of a firm selling only to VAT clients will not be affected by a change in its VAT rate because this tax rate is in practice not paid on any of its sales.

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6In our empirical section below we allow for these terms to be a function of firms’ product type - which determine their input requirements - and their location.
3.4 Equilibrium

An equilibrium is characterized by the tax status of both upstream and downstream firms \{v_j, v_k\} and the price faced by downstream firms \(P_k\), as a function of policy parameters \(\tau\), \{\(t_g\)\}, the technological parameters \(\alpha, \beta, \phi, \sigma, \rho\), the endowment \(E\) and the wage \(w\).

Inequation (11) defines each downstream firm’s tax status \(v_k\), given the vector of tax status of upstream firms \(\{v_j\}\) and the parameters. Inequation (12) defines each upstream firm’s tax status \(v_j\), given the vector of tax status of downstream firms \(\{v_j\}\), the parameters and \(P_k\). Equation (6) defines \(P_k\) as a function of firms’ tax status \(\{v_j, v_k\}\) and parameters.

Once the firms’ tax status \(\{v_j, v_k\}\) and downstream firms’ \(P_k\) are known, we can recover all prices using equations (4) and (5), quantities sold to the final consumer using (1) and then quantities exchanged by firms using (2).

The system formed by (6), (12) and (11) is likely to lead to multiple equilibria. The part formed by the inequations (12) and (11) can be framed as a static discrete game between firms.

Overall the model predicts that there will be partial market segmentation between VAT and non-VAT firms in equilibrium, because of two mechanisms. The first, detailed in proposition 1, holds even when firms’ tax status are exogenous: because VAT inputs are cheaper for VAT clients than for non-VAT clients the tax system distorts firms’ choice of input mix and leads to more transactions, all else equal, between firms with the same tax status than between firms with different tax status. The second, detailed in proposition 2, states that firms’ tax status decision is a function of those of their potential trading partners: firms with many potential VAT trading partners are more likely to choose to be VAT, re-enforcing market segmentation. The following sections provide evidence regarding both mechanisms.

4 Empirical strategy

This details our strategy for providing evidence regarding the model’s two propositions. We start with complementarities in tax status choice. Our model predicts that a change in a firm’s trading partners’ tax status will change its propensity to choose to be in the VAT scheme. We then discuss supply chain distortions. Here the prediction is that transactions between two firms will increase when they both have the same tax status.
4.1 Complementarities in tax choices

Our model states that a firm’s tax status decision in year $t$, written $V_{it} = 1$ if the firm is in the VAT scheme and 0 otherwise, can be specified in the following way:

$$V_{it} = \beta_1 t_{it} + \beta_2 t_{it} \sum_k \tilde{\lambda}_{ik} V_{kt} + \beta_3 \sum_j t_{jt} \tilde{s}_{ji} V_{jt} + \gamma_i + \gamma_t + \epsilon_{it} \quad (9)$$

where $\gamma_i$ and $\gamma_t$ are respectively firm and year fixed effects and standard errors are clustered at the firm level. This specification makes clear that our object of interest - complementarities in tax status choice - is a form of network effect similar to social effects estimated in the networks literature (see for example Giorgi et al., 2010). Several challenges arise when attempting to identify such network effects. First, the existence of a link between two agents (in our case a supplier-buyer relationship) is often endogenous to these agents’ decisions of interest. Our model makes clear that in our case the structure of the network is endogenous to firms’ tax status decision (see proposition 1). It also offers a solution to this challenge: the relevant network in the specification for firms’ tax status choice is not the realized network but the first best network characterized by the $\tilde{\lambda}$ and $\tilde{s}$. Our preferred estimation method of (9) will predict the first best network using information on firms’ products and location, for now we use the average value of transactions between firms over time to proxy for $\tilde{\lambda}$ and $\tilde{s}$. Whilst far from ideal this method, combined with firm fixed effects, ensure that our network measure is time invariant within firm and therefore that changes in the network, or different firm positions within the network, cannot be driving our estimates.

Second, network effects naturally give rise to a reflection problem, compounded by the possibility of unobserved correlated effects across firms driving tax choices (Manski, 1993). To deal with both problems we follow the methodology introduced by Bramoulle et al. (2009) and use characteristics of a firm’s trading partners’ trading partners to instrument for its trading partners tax status $V_{kt}$ and $V_{jt}$. The choice of characteristics used as instrument is driven by our model, that predicts that a key determinant of firms’ tax status is their VAT tax rate. We therefore use changes in trading partners’ trading partners tax rate to instrument for the tax status of both suppliers and clients. This strategy identifies the causal effects of interest under the assumption that the tax rate of their trading partners’ trading partners does not affect firms through channels other than their trading partners’ tax choices; this assumption holds if we exclude from our instrument firms that trade both with a firm and with this firms’ trading partners.
Identification of the causal effects $\beta_1$, $\beta_2$ and $\beta_3$ is therefore obtained using variations over time in the tax rates paid by firm $i$, by firm $i$’s trading partners, and by the trading partners of firm $i$’s trading partners. Our research design thus relies on the 2013-2014 tax reform which increases the VAT rate paid by firms in the medium tax schedule by 25% and that paid by firms in the high tax schedule by 7%, leaving other tax rates unchanged. Figure 1 plots the median effective VAT rate that we observe being paid on sales in the data (the ratio of VAT paid on sales to total sales) for firms in the three different tax schedules. We see that the VAT rate was indeed unchanged throughout the period for firms in the low tax schedule (4% of firms) but increased in 2014 for firms in the high tax schedule (21% of firms) and firms in the medium tax schedule (74% of firms).\footnote{We categorize products taxed at 0\% and products taxed at 1\% as being in the low tax schedule. We use the main product sold by a firm to allocate it to a tax schedule but many firms sell several products which can belong to different schedules. This, and the use of un-modelled tax exemptions by some firms, explains why the effective VAT rate paid by firms is not always exactly equal to the schedule rate.}

### 4.2 Supply chain distortions

To estimate the causal impact of a change in a firms’ tax status on its sourcing decisions we estimate the following specification at the level of the transaction between supplier $j$ and client $k$ in year $t$:

$$\log(s_{jkt}) = \beta V_{kt} + \gamma_{jk} + \gamma_{tj} + \epsilon_{jkt} \quad (10)$$

where $s_{jkt}$ is the share of the transaction between client $k$ and supplier $j$ in $k$’s total input purchases, $\gamma_{jk}$ is a supplier-client pair fixed effect and $\gamma_{tj}$ is a supplier-year fixed effect, and standard errors are clustered at the level of the product sold by the client. We restrict our sample to all supplier-client pairs which trade at some point in our period and for which i) the client is eligible to choose between the VAT and the turnover scheme, and ii) the supplier is never eligible to be in the turnover scheme, to avoid capturing the effect of complementarities in tax status choice (the supplier changing tax status because its client has).

Identification of the causal effect of interest comes from within-pair variations over time, more precisely from changes in transactions between two firms when the client changes tax status. To avoid capturing the effect of changes in suppliers’ behavior that could lead them to both acquire more clients and influence these clients into joining the VAT scheme our preferred specification includes yearxsupplier fixed effects. This means that we identify $\beta$...
by comparing the relative changes over time in transactions between a VAT supplier and its clients that change and do not change tax status. We impute a value equal to the minimum reporting threshold (50,000 INR, or 700 USD) to transactions between firms that do not trade in a year.

Note that specification (10) provides us with an estimate of a key structural parameter of our model, the elasticity of substitution in production. Our model states that, as long as \( s_{V_k} \) is small, \( \beta \approx (\rho - 1) \frac{t_j}{1-t_j} \). This implies that the effect of a change in the client’s tax status on transactions should increase with the tax rate paid by the supplier.

5 Results

We start by presenting firm-level evidence regarding the causal effect of a change in the tax choices of a firm’s trading partners on its own tax choice, i.e., complementarities in tax choices. We then move on to transaction-level evidence on supply chain distortions.

5.1 Complementarities in tax choices

Table 4 presents results obtained by running specification (8) which models a firm’s choice of whether to be in the VAT scheme as a function of its own tax rate (first row), its tax rate multiplied by the share of its sales going to VAT clients (second row) and the weighted average tax rate paid by its VAT suppliers (third row). The first two columns present OLS results, in the last two columns we instrument for the tax status of the firm’s trading partners using the tax rates of their trading partners, we use suppliers’ suppliers’ and clients’ clients’ tax rates in column 3, and all trading partners in column 4. We always exclude trading partners’ trading partners that sell or buy directly to the firm whose tax choice is in the dependent variable from our instruments.

We see that the tax rate the firm faces when in the VAT scheme has a clear negative impact on the firm’s decision to be in the VAT scheme: a 1% increase in the tax rate leads to a fall in the probability of being in the VAT scheme of roughly 3 percentage points, from a baseline of 82%. An increase in the share of the firm’s sales going to VAT clients increase the probability that the firm chooses the VAT scheme, as predicted, and so does an increase in the share of its inputs coming from VAT suppliers. Instrumenting for clients’ and suppliers’ tax status hardly affects the results. This may be because most of the effect of the two variables comes from changes in tax rates over time, not changes in suppliers’ or clients’
tax status. In this scenario the upward bias due to the reflection and correlated effects problems isn’t a major concern.

Turning to the magnitude of the effects of trading partners’ tax status and tax rates, we note that the sum of the coefficients for the firm’s tax rate and its tax rate times the share of its sales going to VAT clients cannot be distinguished from 0. This is in line with the intuition in the model as it implies that a firm selling only to VAT clients (for which these two variables are the same) will not be affected by a change in its VAT rate, simply because no VAT is paid on its sales. The magnitude of the effect of the average weighted tax rate of VAT suppliers on the firm’s tax status choice is equivalent to one-tenth of that of its own tax rate: increasing the VAT rate paid by a firm’s suppliers has the same impact on its tax status choice as decreasing its own VAT rate by 0.1 percentage points. Another way to think about the magnitude implied by the estimates is to consider what happens if all firms’ suppliers went from being in the simplified tax scheme to paying VAT. This would increase the probability that the firm chooses to be in the VAT scheme by the same amount as decreasing its VAT rate by 1 percentage point.

5.2 Supply chain distortions

Table 5 presents results obtained by running specification (7) on the sample of all buyer-supplier pairs in which the supplier is never eligible, and the client always eligible, to choose the simplified tax scheme. In the first three columns we restrict the sample to all buyer-supplier pairs in which the supplier is in the medium tax schedule, so that the tax paid on the transaction if the client is in the simplified tax scheme is 4 or 5%, in the last three columns the supplier is in the high tax schedule so the potential tax paid is roughly three times higher, at 14 or 15%.

All specifications include year and pair fixed effects so identification only comes from within-pair changes over time. In addition we allow for industry-level shocks for both suppliers and clients by adding fixed effects for years interacted with the product sold by the client and that sold by the supplier in columns 2 and 4. Columns 3 and 6 present results obtained using our preferred specification which includes year fixed effects interacted with supplier fixed effects, so that identification comes from comparing, for the same supplier, within-pair changes over time in pairs in which its client changes tax status and in pairs in which its client doesn’t.

We see that firms trade more when the client joins the VAT scheme, as predicted by the model. The magnitude of the effect is lower (and no longer statistically significant for pairs
in which effect is predicted to be low) when we introduce supplier times year fixed effects, suggesting changes in suppliers’ behavior may indeed indeed bias estimates upwards. The relative magnitude of the effects over the two samples is also in line with the model’s predictions, which state that the effect increases with the tax rate paid on the transaction: the effect is 3-5 times higher for pairs for which the high VAT rate is (potentially) paid than for pairs for which the medium VAT rate applies. The value of the elasticity of substitution in production $\rho$ that these results imply is therefore remarkably stable across samples, between 1.8 and 2.3. This range is low compared to values typically found in the literature - Broda et al. (2017) for example find a value of 3.7 for India. This suggests that our context is characterized by substantial market frictions which lead to stickiness in firm to firm relationships, at least in the short run.

6 Conclusion

This paper considers how tax systems affect the efficiency of supply chains. We use administrative tax data on the universe of firms paying taxes in West Bengal, India, for the period 2010-2015. We observe both firms paying Valued-Added-Taxes and firms paying taxes under a simpler turnover tax scheme. Data on the 4.8 million annual transactions between tax-registered firms allows us to map supplier networks and consider the extent to which VAT- and non VAT-paying firms trade with each other.

We first document substantial market segmentation between these two types of firms, the correlation between firms’ tax status (VAT or non-VAT) and how much they trade with other VAT-paying firms is robust to controlling for firm observable characteristics and also holds within firms. We then develop a theoretical framework to understand how firms’ production, sourcing and tax status decision interact and are affected by tax policy. We include in the model the key characteristic of VAT systems: firms cannot deduct from their VAT liability their input purchases from non VAT-paying firms. The model predicts equilibrium partial market segmentation because of both supply-chain distortions (taxes affect how much firms trade with each other) and complementarities in tax status decisions (firms are more likely to choose to pay VAT if their trading partners do).

We test the model’s predictions using a 2013 reform which increases the VAT rate on some commodities but leaves other aspects of the tax system unchanged. Using firm-level evidence and information about firms’ supplier networks we find clear evidence of strategic complementarities in firms’ tax decisions. A change in the tax choices of firms’ trading
partners has a causal impact on firms’ own tax choices, in line with the model’s predictions: firms with more VAT-paying potential trading partners are more likely to choose to pay VAT. Looking at transaction level data we find that firms are more likely to trade (and when they trade, trade more), all else equal, when both the supplier and the client pay VAT. These results suggest the tax system distorts firms’ sourcing decisions, leading to misallocations in input markets.

These findings have potential wide-ranging implications for the efficiency cost of the tax system when VAT- and non VAT-paying firms coexist and potentially trade with each other. Our data only enables us to measure market segmentation between tax registered firms but our results likely extend to segmentation between VAT-paying and informal firms whose role in the supply chain is similar to that of the non VAT-paying registered firms we observe. In future work we will quantify how much our two theoretical mechanisms (supply chain distortions and complementarities) explain total misallocation in input markets, study what our results imply for the optimal form of firm taxation in developing countries, and quantify the key trade-offs of policy reforms.
References


This graph plots for each year the median effective VAT rate paid on sales for VAT firms in the three tax schedules. The effective VAT rate on sales is obtained for each firm by dividing the VAT it paid on its sales by its total sales. We allocate each firm to a tax schedule using the main product they sell.
Table 1: Descriptive statistics on firms in 2010-2011

<table>
<thead>
<tr>
<th></th>
<th>Turnover scheme</th>
<th>VAT scheme (small)</th>
<th>VAT scheme (large)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnover</td>
<td>1656</td>
<td>1525</td>
<td>109,361</td>
</tr>
<tr>
<td></td>
<td>(1346)</td>
<td>(1348)</td>
<td>(1,120,874)</td>
</tr>
<tr>
<td>In Kolkata</td>
<td>0.18</td>
<td>0.29</td>
<td>0.41</td>
</tr>
<tr>
<td>Share VAT sales</td>
<td>0.01</td>
<td>0.25</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(0.38)</td>
<td>(0.38)</td>
</tr>
<tr>
<td>Share VAT inputs</td>
<td>0.36</td>
<td>0.52</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>(0.46)</td>
<td>(0.47)</td>
<td>(0.38)</td>
</tr>
<tr>
<td>Has a VAT trading partners</td>
<td>0.59</td>
<td>0.75</td>
<td>0.97</td>
</tr>
<tr>
<td>Nb VAT clients (&gt; 0)</td>
<td>1.20</td>
<td>2.77</td>
<td>15.65</td>
</tr>
<tr>
<td></td>
<td>(0.75)</td>
<td>(2.47)</td>
<td>(31.50)</td>
</tr>
<tr>
<td>Nb VAT suppliers (&gt; 0)</td>
<td>2.33</td>
<td>3.27</td>
<td>12.12</td>
</tr>
<tr>
<td></td>
<td>(1.83)</td>
<td>(3.14)</td>
<td>(18.79)</td>
</tr>
<tr>
<td>Observations</td>
<td>14,601</td>
<td>69,889</td>
<td>43,835</td>
</tr>
</tbody>
</table>

Column 1 includes all firms in the turnover scheme, column 2 all firms in the VAT scheme with a turnover under 5 million INR, column 3 all firms in the VAT scheme with a turnover over 5 million INR. The variable “share VAT sales” is the ratio of total sales to VAT firms reported in the transaction data to total sales reported by the firm in the firm data, the variable “share VAT inputs” is the ration of total purchases from VAT firms in the transaction data to total purchases reported by the firm in the firm data. Period: fiscal year 2010-2011. Turnover is in 1000 INR.
Table 2: Correlation between a firm’s tax status and its use of VAT trading partners

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome: In VAT scheme</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share VAT sales</td>
<td>0.255***</td>
<td>0.256***</td>
<td>0.209***</td>
<td>0.174***</td>
<td>0.007***</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td>(0.027)</td>
<td>(0.026)</td>
<td>(0.020)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Share VAT inputs</td>
<td>0.046***</td>
<td>0.046***</td>
<td>0.059***</td>
<td>0.055***</td>
<td>0.035***</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.016)</td>
<td>(0.009)</td>
<td>(0.010)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Year FE</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Good FE</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Location FE</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Firm FE</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>495,385</td>
<td>495,385</td>
<td>495,385</td>
<td>495,385</td>
<td>495,385</td>
</tr>
</tbody>
</table>

The dependent variable is an indicator equal to 1 if firm \( i \) is in the VAT scheme in year \( t \), 0 if it is in the turnover scheme. Each column presents estimates from a regression of this indicator variable on the share of firm \( i \)’s sales that are sold to VAT clients and the share of firm \( i \)’s inputs purchased from VAT suppliers in year \( t \), as well as year fixed effects (columns 2 to 5), commodity fixed effects (columns 3 and 4), location fixed effects (column 4) and/or firm fixed effects (column 5). The sample includes all firms with a turnover of less than 7 million INR over the fiscal years 2010-2011 to 2015-2016.
### Table 3: Products sold and firm tax status in 2010-2011

<table>
<thead>
<tr>
<th>Commodity type</th>
<th>Turnover</th>
<th>% Large firms</th>
<th>Amongst small, % VAT</th>
<th>Nb firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machines &amp; equipment</td>
<td>28,285</td>
<td>32.05</td>
<td>91.32</td>
<td>19510</td>
</tr>
<tr>
<td>(422,356)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction materials</td>
<td>12,137</td>
<td>24.69</td>
<td>79.19</td>
<td>16911</td>
</tr>
<tr>
<td>(153,641)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical &amp; electronic goods</td>
<td>33,474</td>
<td>33.62</td>
<td>81.21</td>
<td>15560</td>
</tr>
<tr>
<td>(833,588)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food, drink &amp; tobacco</td>
<td>40,277</td>
<td>40.82</td>
<td>73.61</td>
<td>14828</td>
</tr>
<tr>
<td>(531,480)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical products</td>
<td>41,336</td>
<td>37.05</td>
<td>76.09</td>
<td>11107</td>
</tr>
<tr>
<td>(977,889)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Textiles</td>
<td>24,235</td>
<td>31.61</td>
<td>72.03</td>
<td>10969</td>
</tr>
<tr>
<td>(170,384)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal products</td>
<td>109,361</td>
<td>54.46</td>
<td>94.07</td>
<td>10739</td>
</tr>
<tr>
<td>(781,319)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood &amp; paper</td>
<td>20,826</td>
<td>29.00</td>
<td>90.6</td>
<td>9417</td>
</tr>
<tr>
<td>(140,983)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other commodities</td>
<td>60,963</td>
<td>27.57</td>
<td>88.78</td>
<td>8479</td>
</tr>
<tr>
<td>(1,097,142)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber &amp; plastic</td>
<td>44,919</td>
<td>34.48</td>
<td>87.42</td>
<td>4672</td>
</tr>
<tr>
<td>(1,095,713)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household goods</td>
<td>9,656</td>
<td>17.86</td>
<td>77.06</td>
<td>3444</td>
</tr>
<tr>
<td>(90,727)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mining &amp; energy</td>
<td>72,134</td>
<td>52.29</td>
<td>89.95</td>
<td>2689</td>
</tr>
<tr>
<td>(1,042,568)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>38,376</td>
<td>34.17</td>
<td>82.72</td>
<td>128325</td>
</tr>
<tr>
<td>(657,094)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This table presents descriptive statistics by type of main product sold by firms, where we have classified over 170 different product types into 13 large product categories. The first column presents the share of firms with a turnover of over 5 million INR, the second column the share of VAT firms amongst firms with a turnover of less than 5 million INR and the third column the total number of firms in that category in 2010-2011. Categories are ranked from the one with the largest number of firms (Machines & equipment) to the one with the lowest number of firms (Mining & energy) in 2010-2011.
Table 4: Complementarities in tax choices

<table>
<thead>
<tr>
<th>Outcome: In VAT Scheme</th>
<th>OLS</th>
<th>OLS</th>
<th>2SLS</th>
<th>2SLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax rate</td>
<td>−0.022**</td>
<td>−0.036**</td>
<td>−0.035**</td>
<td>−0.031**</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.018)</td>
<td>(0.017)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Tax rate × VAT clients</td>
<td>0.022**</td>
<td>0.020**</td>
<td>0.019**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.010)</td>
<td>(0.009)</td>
<td></td>
</tr>
<tr>
<td>Average tax rate VAT suppliers</td>
<td>0.002***</td>
<td>0.0004</td>
<td>0.002***</td>
<td>0.002***</td>
</tr>
<tr>
<td></td>
<td>(0.0005)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instrument</th>
<th>$S^2, \Lambda^2$</th>
<th>$S^2, \Lambda^2, \Sigma, \Lambda S$</th>
</tr>
</thead>
<tbody>
<tr>
<td>F stat (clients)</td>
<td>40.5</td>
<td>15.9</td>
</tr>
<tr>
<td>F stat (suppliers)</td>
<td>1202.4</td>
<td>2063.6</td>
</tr>
<tr>
<td>Observations</td>
<td>491,924</td>
<td>491,924</td>
</tr>
</tbody>
</table>

Standard errors clustered at the product level in parentheses. The sample includes all firms with a turnover of less than 7 million INR. The set of instruments used in column 3 is i) suppliers’ suppliers’ tax rate in column 3 ($S^2$), used as instrument for suppliers’ tax status, ii) clients’ clients’ tax rates ($\Lambda^2$), used as instrument for clients’ tax status. In column 4 all trading partners’ trading partners’ tax rates are used as instruments for trading partners’ tax status. ‘F stat (clients)’ refers to the first stage F statistic for the variable ‘Tax rate x VAT clients’ and ‘F stat (suppliers)’ to the first stage F statistic for the variable ‘Average tax rate VAT suppliers’. All specifications include firm and year fixed effects. Significance levels: ‘p<0.1; ‘**p<0.05; ‘***p<0.01’.
### Table 5: Supply chain distortions

<table>
<thead>
<tr>
<th>Supplier tax rate $t_j$</th>
<th>Medium tax</th>
<th>High tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client in VAT</td>
<td>0.060***</td>
<td>0.062***</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
<td>(0.024)</td>
</tr>
<tr>
<td>Pdct sup*Year FE</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Pdct client*Year FE</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Id sup*Year FE</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Observations</td>
<td>2,558,837</td>
<td>2,558,837</td>
</tr>
</tbody>
</table>

$\rho \approx 1 + \beta (1 - t_j) / t_j$

2.25  2.29  1.78  2.19  2.22  2.02

The sample includes pairs that trade during our period in which the supplier is never eligible and the client is always eligible to the turnover scheme. All specifications include year and pair fixed effects. Standard errors are clustered at the level of the product sold by the client. Significance levels: *p<0.1; **p<0.05; ***p<0.01
Appendix

A Proof of proposition 2

A downstream firm $k$ will choose the VAT scheme iff:

$$\frac{\alpha_j \rho \ell_j \nu_j \rho - 1 + \sum_j (\alpha_j \alpha_j) \rho \phi_j \rho - 1 [v_j + (1 - v_j)(1 - \tau)^{\rho - 1}]}{\alpha_j \rho \ell_j \nu_j \rho - 1 + \sum_j (\alpha_j \alpha_j) \rho \phi_j \rho - 1 [v_j(1 - t_j)^{\rho - 1} + (1 - v_j)(1 - \tau)^{\rho - 1}]} > \left( \frac{1 - \tau}{1 - t_k} \right)^{\mu(\rho - 1)}$$

Using first-order approximations that are valid when tax rates are small compared to one, we find that a downstream firm $k$ will choose to pay taxes under the VAT scheme when:

$$\sum_j v_j t_j s_{jk} > \mu (t_k - \tau)$$

where $s_{jk}$ denotes the share of $k$’s costs to goes to input $j$ when tax rates are close to zero, $s_{jk} = \alpha_j \rho p_{jk}^{\rho - 1} p_{jk}^{1 - \rho}$, with $p_{jk} = \frac{\gamma_j}{\phi_j}$ and $\bar{p}_k = \left( \sum_j \alpha_j \rho p_{jk}^{1 - \rho} + \alpha_k \rho w^{1 - \rho} \right)^{\frac{1}{\rho - 1}}$. This expression indicates that $k$ is more likely to choose the VAT scheme when a higher share of its inputs comes from VAT suppliers (high $\sum_j v_j s_{jk}$) and when the weighted average VAT rate paid by its suppliers is higher (high $t_j$), less likely when its own VAT rate is high and final consumers have low price elasticity (high $\mu$): the latter is because the cost of being in the VAT scheme is lower demand by final consumers, this cost is higher when the mark-up on sales to final firms is higher.

For upstream firms, the total profits $\pi_j$ is the sum $\pi_{jF} + \pi_{jI}$. Finding the tax status for $j$ that maximises $\pi_j$ is equivalent to finding the tax status that maximises:

$$\gamma_{jF}^\sigma + \sum_k b_{jk} \gamma_{jk}^\rho$$

with $b_{jk} = \frac{\nu - 1}{\mu - 1} v^{-\rho} \left( \frac{\phi_j}{\nu} \right)^{\rho - \sigma} \alpha_j \beta_k \gamma_{jk}^\rho \phi_k^{\sigma - 1} p_{jk}^{\rho - \sigma} \beta_j^{-\sigma}$. The weights $b_{jk}$ represent how important for firm $j$’s profits firm $k$ is, compared to the final consumer. If $b_{jk}$ are high, firm $j$ care more about its corporate buyers than about the final customer. $b_{jk}$ is larger when $\alpha_j$, $\beta_k$, $\phi_k$ are large and when $\beta_j$ is small.

The trade-off for upstream firms is that being VAT increases the output price they charge to the final customers and turnover firms but reduces the price they charge to VAT clients.
They will choose VAT status iff:

\[(1 - t_j)\sigma + \sum_k \beta_{jk}(v_k + (1 - v_k)(1 - t_j)\rho) > (1 - \tau)\sigma + \rho \sum_k \beta_{jk} (1 - \tau)\rho \sum_k \beta_{jk} \]

Assuming tax rates are small compared to one, we can take a first-order approximation of this expression. A condition for a firm to choose the VAT status is then:

\[\rho \tau \sum_k \beta_{jk} > \sigma(t_j - \tau) + \rho(t_j \sum_k \beta_{jk} (1 - v_k))\]

The left-hand side represents what firm \(j\) wins when switching to the VAT status: its corporate buyers will not pay the turnover tax anymore. The right-hand side represents what it loses: the final customer will pay the VAT rather than the turnover tax and the corporate buyers that are taxed at the turnover scheme will pay the VAT. From this expression it is clear that: (i) a higher \(\sigma\), which increases the sensitivity of firm \(j\) to the final consumer makes it less likely to adopt the VAT scheme, (ii) a higher \(\rho\), which increases the sensitivity of firm \(j\) to its corporate consumers makes it more likely to adopt the VAT scheme, (iii) having more important corporate customers that are VAT, makes it more likely to adopt the VAT scheme.