Does the Informal Sector Escape the VAT?*

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Abstract

Value Added Tax (VAT) systems around the world commonly use a size threshold below which firms are exempted from registration, thus creating an informal sector. This paper investigates theoretically and empirically the pass-through of VAT to the prices of these informal firms. Tax pass-through to informal prices can happen through two channels: through the supply chain, as informal firms are not credited taxes paid on their inputs; and at the final consumption stage, where informal firms might be competing with larger firms that face VAT. While we find no empirical evidence of the first channel, we show that prices faced by consumers of informal firms increase upon increases in the tax rate faced by their formal counterparts. We argue this is due to two potentially counteracting mechanisms: on one hand, higher tax rates induce some formal firms into informality, shifting out informal sector supply; on the other, they might induce some consumers to switch to informal varieties, shifting out informal sector demand. The net effect on informal sector prices depends on the relative size of these two effects. Our results have important implications for the progressivity of VAT, the efficiency of VAT systems, and the relevant trade-offs in setting an optimal exemption threshold.

Keywords
Value added taxes; Tax pass-through; Informality.

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H22; H25; H26; O17.

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1 Introduction

Many firms in developing countries are unregistered with the tax authorities and do not remit tax. In a Value Added Tax (VAT), "informality" is almost always part of the design as small firms are exempted to reduce administrative and compliance costs. This paper studies whether consumers in these informal markets nevertheless bear some of the economic burden of the VAT by examining its effect on the price of goods sold by unregistered, informal firms. The extent to which the VAT rate in the formal sector is passed-through to the informal sector has implications for both the efficiency and equity of the VAT, and could vary depending on the location of the exemption threshold. We provide a framework to examine factors that could affect pass-through that would vary by the size of the exemption threshold, and empirically investigate these factors in the context of a VAT in India.

Our focus is on the informal sector created by the size-based exemption to VAT registration as opposed to evasion either in the form of illicit non-registration or underreporting of revenue by registered firms. As this threshold is an explicit policy choice that potentially segregates firms within industries and commodity markets, it is an important margin of informality with unique size-related dynamics. The choice of exemption threshold varies widely across countries without a well-understood policy rationale. Keen and Mintz (2004) provided some theoretical considerations for choosing the optimal threshold, but we still have little empirical guidance on the relevant policy trade-offs.

We provide a theoretical framework that takes into consideration consumers' preferences over formal and informal varieties of goods and firms' choice to locate in the informal or formal sector based on the VAT rate and exemption threshold. In this general setting, the extent to which prices in the informal sector are affected by the VAT rate (i.e. the "pass-through" to the informal sector) depends on the elasticity of demand and supply, as well as the cross-price elasticity between the formal and informal varieties. As these are all quantities that can vary with the types of goods that are on the margin between the formal and informal sector, the pass-through is likely to depend on the size of the VAT exemption threshold.

We therefore empirically estimate pass-through using VAT rate changes in India between 2004 and 2015. Using a panel of establishment-level annual price data over the same period we estimate how prices of formal and informal firms respond differently to tax changes on the formal variety of the same commodity. We find that prices change similarly in both the formal and informal sector, suggesting that informal sector consumption does not escape the VAT. Comparing pass-through to the informal sector before and after a 50 percent increase in the VAT exemption threshold shows little difference, suggesting that at least within this large region, the location of the exemption threshold does not seem to change pass-through much.

The way the VAT can affect prices in the informal sector depends on both supply-chain effects and consumer-market effects, thanks to the way a VAT interacts with different stages

of the production process. While informal firms do not remit VAT on their output, they also do not get to claim credits on their inputs. If an informal firm were to buy its inputs from a VAT-registered firm, it would face a VAT liability that its formal counterpart would not. We find no evidence of these supply-chain effects, consistent with previous literature that has found strong segregation in production chains between registered and unregistered firms (DePaula and Scheinkman (2010); Liu, Lockwood, Almunia and Tam (2019); Gerard, Naritomi, Seibold and Zulian (2019); Gadenne, Nandi and Rathelot (2019)).

Our empirical analysis finds much stronger effects when it comes to sale to final consumers at which stage a VAT is effectively identical to a sales tax. There are two ways in which a VAT can interact with the informal sector in consumer markets. First, on the supply side, a higher VAT rate might drive some formal firms into informality. This could have the effect of shrinking supply in the formal sector while enlarging it in the informal sector. On the demand side, instead, higher taxes on formal varieties might lead some consumers to switch to informal varieties of the same good. Depending on which of these two effects prevails, the net effect on informal sector prices might be positive, negative, or null. We find consistent evidence that informal sector prices rise upon increases in the VAT rate faced by formal firms producing the same good. In our baseline specification, informal-sector prices grow by more than two thirds of the rise in formal-sector prices upon an increase in the VAT rate.

Studying the pass-through of consumption taxes on informal prices, as well as the pass-through of taxes upstream to the final stage, is challenging because of the type of data required. The data must contain information on both formal and informal firms, details on commodity produced, and unit prices. Administrative tax data usually does not contain information on unregistered firms, by definition. Even data that does have some information on informal firms usually does not contain detailed product information or prices. We combine survey data on manufacturing firms in India, for whom we are able to construct average unit prices and observe detailed commodity codes, with input-output tables and the tax schedule. These data allow us to study both supply-side and final-consumption effects directly, as tax rates on different goods can change independently: the Indian CenVAT system, which we exploit for our empirics, had several categories of goods with different rates, and we are able to observe both changes in the rate of an entire category and changes in categorization that give a specific good a new tax rate. This allows us to observe variation in the tax rate on each individual product sold by the firm, as well as in the average tax rate faced on its inputs.

Our theoretical framework informs the literature on which modeling features economists should be concerned with when thinking about a general model of VAT incidence, especially when it comes to equity considerations. In our model increasing a tax on the registered variety of a good will increase demand for the unregistered variety of that good, which will affect both the price consumers face for each variety and which firms decide to register in equilibrium. This stands in contrast to previous literature studying production chains. On one hand, models such as those in DePaula and Scheinkman (2010) are sophisticated in the way they deal with

the invoice-credit differences between formal and informal firms, but assume there is a single homogeneous good supplied by both formal and informal firms at the consumption stage. This means that the rate of pass-through to the informal sector is identical to that in the formal sector. On the other hand, models like the one in Liu et al. (2019) have monopolistically competitive firms producing differentiated goods. The CES structure of utility used in these models, combined with the assumption of monopolistic competition, yields constant mark-ups over marginal cost. While this can be a useful simplifying tool when studying production chains, it effectively assumes away the possibility of any pass-through in the informal sector.

While our data cannot speak directly to how segregated production chains are, we show that the sales-weighted production share of the informal sector can vary quite a bit across products, with many commodities clustering in the 0-50% range. This means that there is substantial potential for interaction between formal and informal firms in a wide variety of markets, justifying concerns for how interactions with the formal sector might affect informal-sector prices.

The location of the exemption threshold may affect pass-through in a number of ways. For example, a very low exemption threshold like is common in European countries means that exempted firms are mostly service-providing sole proprietorships and largely operating part-time. Conversely, developing countries like India tend to set much higher exemption threshold, and informal firms might have 10 employees or more. While this is consistent with administrative and compliance costs being higher in developing countries, it is unclear whether the location of the threshold might affect considerations about pass-through, by changing the types of firms that are operating below it. A change in threshold might imply more product heterogeneity, thus making switching by consumers more difficult, or it might make switching between formal and informal sectors harder. Any of these considerations may alter the way in which VAT is passed-through to informal sector prices, which in turn would have implications for efficiency and equity considerations both in the choice of registration threshold and of the VAT rate.

Thanks to a reform that occurred about half-way through our sample period, increasing the threshold by 50%, we can study whether informal-sector VAT pass-through changes upon a sizable movement in the exemption threshold. Interestingly, in a preliminary analysis we find no significant differences in pass-through, in either sector, before and after the reform. This could mean that firms that used to be formal start behaving like informal firms once they are below the threshold.

We perform a number of robustness checks, both validating our main results and further investigating the effect of taxes on informal sector prices. These robustness checks support our main identifying assumption that tax changes are orthogonal to underlying market conditions. Further, we repeat our pass-through analysis distinguishing between changes in the standard rate, applying to many goods and services, and product re-categorizations that lead to rate changes in a single commodity or a small group of commodities. The results of this exercise

are suggestive that the difference in pass-through measured in our main specification might be driven by the fact that the least productive formal firms are driven into informality by changes in the standard VAT rate.

The rest of the paper is organized as follows: Section 3 describes our theoretical framework showing the pass-through of a VAT to the informal sector depends on the substitutability of formal and informal varieties; Section 4 describes our setting of the CenVAT in India; Section 5 describes the data and our sample; Section 6 lays out our empirical methodology; and we present and discuss our results in Sections 7 and 8. Section 9 concludes.

2 Related Literature

Keen and Mintz (2004) consider the tradeoffs in choosing a VAT exemption threshold. In their framework, the planner trades off tax revenue with administrative and compliance costs and the distortions induced by a differential treatment of firms above and below the threshold. However, their analysis assumes that prices are fixed. Relaxing this assumption might be important for two reasons.

First, changes in relative prices of formal and informal varieties could play an important role in the efficiency of the tax system. Depending on the change in relative prices, firm behavior might be more or less distorted by the differential treatment above and below the threshold. Understanding how informal prices react to changes in VAT is therefore essential, and we provide theoretical and empirical guidance in this regard. Furthermore, our empirical framework allows us to directly estimate the degree to which firms move above and below the threshold as they face changes in the tax rate.

Second, assuming away effects on informal sector prices will miss some relevant equity considerations. Since informal firms tend to be smaller and sell to poorer consumers (Jenkins, Jenkins and Kuo (2006); Bachas, Gadenne and Jensen (2020); Gupta (2019)), analyzing pass-through can tell us the extent to which the existence of informal firms creates progressivity in the VAT. We investigate how prices in the informal sector are affected by a change in the VAT on formal firms, a crucial step in advancing our understanding of how VAT incidence is distributed across different income groups.

Our paper is also related to the literature on how the benefits of evasion or avoidance are distributed in the economy. Nygård, Slemrod and Thoresen (2019) study how consumers and producers across the income distribution benefit from evasion, which includes underreporting of income by registered firms and is not necessarily size-dependent. Asatryan and Gomtsyan (2020) study how the cost of a reduction in evasion following a specific enforcement action on selected commodities is shared among consumers and producers. While we discuss the impact evasion might have on our estimates in section 8.2, this paper focuses on the legal categorization of firms between registered and unregistered in the VAT system, considering

their interactions in a broad set of commodity markets. Pass-through in our context depends on how firms in different commodity markets are able to sort themselves into or out of the mandatory registration threshold. The interaction between the formal and informal firms can vary depending on context - for example, the types of industries that are informal in developed countries where the threshold is low tends to be small sole proprietorships in the service industry. This is not the case in countries where the exemption threshold is relatively higher and can include a broader set of commodities.

3 Theoretical Framework

Consider two varieties of a single commodity that we shall label X_r and X_u, where the former is the registered variety and the latter is the unregistered variety, and have corresponding prices p_r and p_u, which are taken as given by all agents in the model. Underlying this modeling framework is the technological assumption that firms will inherently produce a slightly different version of the good upon registration. The idea is to capture the fact that formality is tied to a number of business practices, such as book-keeping or the way in which merchandise is made available to customers, that matters for consumer's preferences. Consider, for example, the experience of buying the same shirt at an air-conditioned, large department store as opposed to purchasing one at a sidewalk stall.

3.1 Demand and Supply

There is a single consumer with exogenously given income. This consumer decides how much of each variety of the good to consume as part of a utility-maximizing process, resulting in demands for the registered and unregistered variety, respectively, $X_r^d(p_r, p_u)$ and $X_u^d(p_r, p_u)$. Prices denote prices paid by the consumer, so we assume without loss of generality that the tax is remitted by producers. Further, we assume away the possibility that income effects dominate, so that the own-price elasticity for each variety is strictly negative.

On the production side, there is a unit mass of firms indexed by their productivity ω, distributed continuously according to the C.D.F. $F(\omega)$, with corresponding P.D.F. $f(\omega)$. Since we are not interested in the entry/exit dynamics for the purposes of this particular paper, we will be assuming that all firms in the market have a high enough productivity to be operating at the prices and taxes considered.

For now, we ignore voluntary registration. Firms are registered if and only if they produce above the exemption threshold, $\bar{x}$. If firms register, they produce the registered variety and if not, they produce the unregistered variety. All firms face the same cost function up to their productivity, $c(x; \omega, t)$, which is increasing, strictly convex, and twice continuously differentiable in x, but registered firms can deduct input costs and so their cost function is always evaluated at $t = 0$. Cost, as well as marginal cost $c'(x; \omega, t)$, is also assumed to be

decreasing in ω and increasing in t.

A firm picks how much to produce, x in order to solve:

$$\max_x \upsilon[(p_r - \tau)x - c(x;\omega,0)] + (1-\upsilon)[p_u x - c(x;\omega,t)], \tag{1}$$

where $\upsilon \equiv \mathbb{1}\{x > \bar{x}\}$is an indicator for registration status. Since registration is tied to size, and more productive firms will want to be bigger, this implies that only the more productive firms will want to register. Let $\underline{\omega}$ and $\bar{\omega}$ be defined so that:

$$(c')^{-1}(p_u;\underline{\omega},t) = \bar{x} \tag{2}$$

$$(c')^{-1}(p_r - \tau;\bar{\omega},0) = \bar{x}. \tag{3}$$

For the purposes of discussion, we only consider parameter values $(\bar{x}, t, \tau)$ such that equilibrium prices always yield $\underline{\omega} \leq \bar{\omega}$. It follows that only firms with $\omega > \bar{\omega}$ will produce the registered good, according to $(c')^{-1}(p_r - \tau;\omega,0)$, and only firms with $\omega \leq \bar{\omega}$ will produce the unregistered good, with firms with $\omega < \underline{\omega}$ producing according to $(c')^{-1}(p_u;\omega,t)$, and firms with $\omega \in [\underline{\omega},\bar{\omega}]$ "bunching" at the threshold $\bar{x}$.

3.2 Equilibrium and Tax Pass-Through

Let $\mathbf{p} = [p_r, p_u]^T$ denote the vector of prices, $\bar{\tau} = [\tau, 0]^T$ denote taxes on each variety, and $\mathbf{D}(\mathbf{p}) = \left[X_r^d(\mathbf{p}), X_u^d(\mathbf{p})\right]^T$ denote aggregate demand. Correspondingly, we use $\mathbf{S}(\mathbf{p})$ to denote aggregate supply,

$$\mathbf{S}(\mathbf{p} - \bar{\tau}) = \begin{bmatrix} \int_{\bar{\omega}}^{\infty} (c')^{-1}(p_r - \tau;\omega,0) f(\omega) d\omega \\ \int_{-\infty}^{\underline{\omega}} (c')^{-1}(p_u;\omega,t) f(\omega) d\omega + \bar{x}(F(\bar{\omega}) - F(\underline{\omega})) \end{bmatrix}.$$

In equilibrium, supply equals demand for each variety. Since we are assuming that taxes are remitted by producers, equilibrium price vector $\mathbf{p}^* = [p_r^*, p_u^*]^T$ will satisfy:

$$\mathbf{S}(\mathbf{p}^* - \bar{\tau}) = \mathbf{D}(\mathbf{p}^*). \tag{4}$$

Studying pass-through requires us to understand how these equilibrium prices change upon changes of the tax rate on the formal variety. Taking derivative of equation 4 with respect to τ and rearranging terms, we obtain:

$$\begin{bmatrix} \frac{\partial p_r^*}{\partial \tau} \\ \frac{\partial p_u^*}{\partial \tau} \end{bmatrix} = \left[\mathbf{S}' - \mathbf{D}'\right]^{-1} \mathbf{S}' \mathbf{e_1}, \tag{5}$$

where $\mathbf{S}'$ and $\mathbf{D}'$ indicate respectively the Jacobian matrices of supply and demand and $\mathbf{e_1}$ simply denotes the two-dimensional standard unit vector, $[1,0]^T$.

Equation 5 shows that pass-through to the informal sector will not necessarily be zero, and will depend on the relative elasticities of supply and demand, as well as the cross-price elasticities of demand, similarly as in Benedek, De Mooij, Keen and Wingender (2015), who consider a two-sector general equilibrium model of tax pass-through. However, it differs in a crucial way from Benedek et al. (2015), as we not only allow for demand for one good to react to price changes in the other good, but also consider non-zero cross-price elasticities *of supply*. This can be easily seen in the Jacobian of aggregate supply, as production that enters the formal market when p_r increases (that is, $-\bar{x}f(\bar{\omega})\frac{\partial\bar{\omega}}{\partial p_r}$) disappears from the informal market (the lower-left entry in S′).

These considerations affect equilibrium prices and pass-through in non-trivial ways. For example, they imply that a tax on the formal sector *lowers* prices in the informal sector in the absence of cross-price elasticities, as shown in the following proposition.

Proposition 1. *If cross-price elasticities are zero, that is* $\frac{\partial X_r^d}{\partial p_u} = \frac{\partial X_u^d}{\partial p_r} = 0$, *then* $\frac{\partial p_r^*}{\partial \tau} > 0$ *and* $\frac{\partial p_u^*}{\partial \tau} < 0$.

Proof. See Appendix A. □

The intuition for proposition 1 is straight-forward. In the absence of cross-price elasticities of demand, pass-through in the formal sector is akin to classic partial equilibrium pass-through; further, an increase in the tax rate will push some firms out of the formal market and into the informal one. Since these marginal firms are more productive than the firms that start out in the informal market, this will have the effect of driving down the price in the informal market.

On its own merits, proposition 1 shows that taxes in the formal sector will affect prices in the informal sector. Furthermore, it implies that positive pass-through at the final consumption stage – as our empirical analysis will reveal is the case – implies that there must be non-zero cross-price elasticities of demand.

4 Institutional Context

We examine pass-through to the informal sector in the context of a value added tax on manufacturing in India, called the CenVAT. This was a centrally administered tax with few place-based exemptions and so the tax rates applied uniformly to commodities all over the country. As with most VAT, exports were zero-rated. We exclude exporters and a few small states where certain regions had tax exemptions from our analysis. Goods were broadly classified into standard, reduced and exempt tax categories, in addition to which some commodities were subject to special rates. There were changes in the standard, reduced and special CenVAT rates over the period of analysis, which we use to estimate differential pass-through in the formal and informal sector and are summarized in Table 1.

The rationale for these tax rate changes fall into a few categories, (1) to reduce the tax burden on lower-income consumers, (2) to harmonize tax rates (3) to stimulate certain industries/ sectors that have positive externalities, such as energy-efficient technology, and (4) general fiscal stimulus/ stimulus for a certain sector. Most of the tax changes fall into the first two categories. The concern of policy endogeneity mainly arises from tax changes undertaken for the last reason. This is a concern if the reason for the fiscal stimulus is a negative economic shock as we may conflate mean reversion with pass-through. We classify tax changes according to their stated policy rationale, and exclude changes that are potentially endogenous. We can do this because changes in the CenVAT rate and their justifications are announced each year in the budget speech by the Finance Minister[1].

Small firms could be exempt from the VAT if their revenue was below ₹10 mn until 2008 or below ₹15 mn thereafter. We define informal firms as those who are eligible for, and take this CenVAT exemption.[2]

5 Data

Our main data source is the Annual Survey of Industries (ASI), which is a statutory survey of manufacturing establishments with at least 10 workers in India. It is the universe of manufacturing establishments with at least 100 workers and an approximately 20 percent random sample of establishments with between 10 and 100 workers. We use this data from 2004-2014 and are able to follow establishments that appear in the survey over this period. Establishments report detailed production information including their sales classified by 8-digit commodity codes, quantity of item sold according to standardized units within each commodity code, and other inputs and details of the production process. We calculate a unit price for each firm-commodity sale from the gross revenue and quantity sold reported[3].

This data source excludes even smaller, informal manufacturing establishments with less than 10 workers. Therefore, our results are best interpreted as pertaining to segregation and pass-through of taxes among establishments that are more similar in size to VAT-registered establishments. However, we find little difference in pass-through based on size among informal firms in our data, suggesting that pass-through to even smaller informal firms might be similar as well.

In some cases, the quantity sold is imputed by the statistical agency based on their estimated unit price. These cases are identified by zero variance in the unit price recorded by the statistical agency (separate from our estimated unit price), account for about 5 percent of observations and are excluded from the analysis. Another source of mismeasurement in the price variable

[1] All speeches are available here: https://www.indiabudget.gov.in/bspeech.php

[2] The two thresholds correspond to about 200,000 USD and 300,000 USD at December 2008 exchange rates.

[3] Sometimes firms will enter separate entries for the same product code in the survey that have different unit prices. We treat these as two different price observations for the same commodity.

arises because of units mismeasurement. For example, quantity might be recorded in kilolitres instead of liters even though the commodity code specifies a uniform unit to be used. We follow Kothari (2014) to identify these cases and treat them as separate commodities in the analysis.

We combine this production data with annual changes in CenVAT rate applicable to each commodity category over the same time period. These tax changes are classified as (1) changes to the standard rate, (2) changes to the reduced rate, (3) reclassification of a good to a different rate category, or (4) all other types of changes. Tax changes of type (1) and (2) affect multiple goods at the same time, which could potentially bias our estimate of pass-through. The number of commodities affected by each type of tax change in each year is given in Table 9. We estimate pass-through using these different types of changes separately. We also classify tax changes according to their stated rationale, as given in the annual Union budget speeches where they are announced by the Finance Minister. The vast majority of tax changes are aimed at promoting certain desirable industries, reducing the tax burden on essential commodities, or harmonizing rates between similar commodities, and not because of expectations of future growth or decline in specific sectors or in the economy as a whole.

We define the informal sector in two ways. First we define firms that are below the CenVAT exemption threshold (Rs. 10 mn until 2008 and Rs. 15 mn afterwards) and eligible to remain unregistered as informal. Second, recognizing that firms that remain informal could still voluntarily register, we define firms that report any tax payments as registered. The size-based definition of formality matches most empirical descriptions of informal firms.

The drawback of the second definition is that firms may fail to report tax payments. Only 60 percent of firms above the exemption threshold producing taxable commodities report any tax payments suggesting that there is some underreporting. However, there is a sharp increase in the probability of tax payments being reported once firms cross the exemption threshold (See Figure 1). We present results using both definitions of informality. To the extent that firms who voluntarily register fail to report tax payments (not revenue), we are overestimating the degree of pass-through to the informal sector. However, there is no strategic reason to underreport tax payments. We plan to perform sensitivity analyses of our estimates according to the degree of underestimating registration.

In addition to estimating the pass-through of the tax rate on the output, we also estimate the pass-through of the tax rate on inputs, which is often different. We calculate the average input tax rate that a firm faces as a weighted average of the tax rates applicable on all its inputs according to its intensity of use. We measure the share of each input in total input costs either at the earliest year that a firm is observed or as an average across all years that a firm is observed. The tax rates applicable on each of these inputs are then weighted by its share in total input costs. Changes in the average input tax rate over time are therefore driven entirely by changes in the tax rates. One caveat here is that for multi-product firms we do not observe their input use for each commodity separately. We apply the same average input tax rate for

all commodities produced by a given firm.

Finally, we classify commodities as "B2C" or "B2B" depending on the share of the product sold to final consumers given by Input Output tables. We match commodities with their Input-Output table counterpart using the product code. Because the Input-Output data is at a higher level of aggregation, there is no exact match and the range of final consumption is between 0 and 98 percent. We therefore classify all commodities where at least 70 % of the output goes to final consumption as "B2C" commodities. Our results are qualitatively similar when we vary the final consumption share cutoff for defining "B2C" commdities.

Summary statistics by commodity-years and firm-years are given in Table 2.

6 Empirical Methodology

We empirically estimate the pass-through of a VAT to unregistered producers using exogenous variation in the VAT rate on each commodity. Let p_i denote the consumer price of commodity i and q_i denote the net-of-tax price that producers receive, $q_i = p_i(1 - \tau_i)$ where τ_i is the VAT rate on commodity i. Pass-through is defined as the change in the pre-tax price due to a one percentage point change in the tax rate ($\frac{\partial \log(q_i)}{\partial \tau}$). We can write this as:

$$\begin{aligned} \log(p_i) &= \log(q_i) - \log(1 - \tau_i) \\ &\approx \log(q_i) + \tau_i \\ \frac{\partial \log(p_i)}{\partial \tau_i} &= \frac{\partial \log(q_i)}{\partial \tau_i} + 1 \end{aligned} \tag{6}$$

where the second step follows from a Taylor approximation around $\tau_i = 0$.

In our data, we can more reliably measure the consumer price p_i. Full pass-through in the formal sector would mean that $\frac{\partial \log(q_i)}{\partial \tau} = 0$, which implies that $\frac{\partial \log(p_i)}{\partial \tau} = 1$. Zero pass-through would mean that $\frac{\partial \log(q_i)}{\partial \tau} = -1$ and therefore, $\frac{\partial \log(p_i)}{\partial \tau} = 0$. We estimate whether a change in τ_i induces a proportional change in prices in the informal sector at the same time.

We estimate the pass-through using the following specification:

$$\log(p_{ift}) = \eta \tau_{it} + \beta \tau_{it} \times (1 - \upsilon_{ft}) + \gamma_i + \delta_t + \zeta_f + \epsilon_{ift}, \tag{7}$$

where τ_{it} is the statutory tax rate on commodity i sold by firm f at time t, p_{it} is the tax inclusive unit price, and $(1 - \upsilon_{ft})$ is a dummy for whether the firm is unregistered (proxied by whether they are above the registration threshold or voluntarily registered). We also include firm and time fixed effects, γ_i and δ_t. η captures the average pass-through of the final goods VAT rate to gross-of-tax prices in the formal sector and β captures the difference in pass-through in the informal sector. If the formal and informal sector goods are perfect substitutes, we would expect $\beta = 0$. On the other hand, if taxes are only passed through to the formal sector goods,

we would expect $\beta = -\eta$.

Our key estimation assumption is that the tax changes are exogenous to demand and supply shocks that might affect prices, i.e. we require that there is no policy endogeneity such that taxes on a particular good are raised when that industry is growing. We classify tax changes according to their rationale given in annual budget speeches where they are announced each year and find that the vast majority aim to increase progressivity by lowering the rate on essential commodities, promote certain industries or harmonize tax rates on similar goods. We exclude any potentially endogenous tax changes. We can test the assumption that price changes do not drive tax changes by estimating the following specification:

$$\log(p_{ifh}) = \eta^h \tau_{it} + \eta_1 \tau_{i,t-1} + \eta_2 \tau_{i,t-2} + \eta_3 \tau_{i,t-3} + \gamma_i + \delta_t + \epsilon_{ift} \tag{8}$$

for each time period $h \in [t-3, t+1]$. We control for lagged tax rates because these are likely to be correlated with the rate at time t. We require that $\eta^h = 0$ for all $h \in [t-3, t-1]$, meaning that the current tax rate does not predict past price levels.

Precise estimation of pass-through in the formal or informal sector requires a further assumption that cross-price elasticities with other commodities are zero (see Benedek et al. (2015) and Agrawal and Hoyt (2019)) because we omit prices of other related goods from the specification. However, the parameter we are most interested in is the difference in pass-through between the two sectors. To estimate this parameter, we require a weaker assumption that the cross-price elasticities are not different between the formal and informal varieties.

Specification 7 only captures the pass-through of taxes on output at the final stage. However, unregistered retailers may pass-through any additional input costs due to foregone input tax credits at the upstream stage. Tax rates on upstream goods may be different from the rates applied to the final good. Furthermore, the degree to which firms' output relies on taxed upstream inputs might vary across goods. We therefore augment our basic specification to estimate the pass-through of taxes on the upstream stage as follows:

$$\log(p_{ift}) = \eta \tau_{it} + \beta \tau_{it} \times (1 - v_{ft}) + \beta_2 \bar{\tau}_{ft} + \beta_3 \bar{\tau}_{ft} * (1 - v_{ft}) + \gamma_i + \delta_t + \zeta_f + \epsilon_{ift}, \tag{9}$$

where $\bar{\tau}_{ft}$ is the average tax rate that firm f faces on its inputs. This is computed using the statutory tax on each input j and weighting this rate by the expenditure share of firm f on input j, s_{fj}, resulting in the following definition: $\bar{\tau}_{ft} \equiv \sum_j \tau_{jt} s_{fj}$. We can measure these expenditure shares at a fixed point in time or take the average shares over the entire time period to construct a time-invariant measure of input shares. This is important to ensure that the average tax rate measured is unaffected by changes in the firm's choice of inputs induced by a tax change.

7 Results

Among commodities produced by relatively small firms (annual revenue less than ₹60 mn), we do not see segregation of production between formal and informal firms. Figures 2 and 3 show histograms of commodities according to the share of that commodity produced by firms below the exemption threshold among a sample of firms whose annual revenue is less than 4 times the exemption threshold (i.e. less than ₹60 mn). The density in these figures is weighted by the value of production and by the number of firms producing a given commodity, respectively. Only a very small mass of commodities, in revenue and participation-adjusted terms, are produced exclusively by formal or informal firms. Our identifying variation comes from the commodities produced by both formal and informal firms. Even though both types of firms participate in the production of the same commodity code, the products may be differentiated in a way that is not captured by these classifications. The empirical analysis that follows investigates the extent of differentiation within the same commodity code by how prices react to tax changes.

On average, across all commodities we do not find evidence of tax pass-through to the informal sector. Table 3 shows the results of Specification 7. Column (2) is our preferred specification using firm fixed effects. We see that the coefficient on the interaction term, *VAT Rate X Below Threshold* or β in equation (7), is -0.01 and statistically indistinguishable from η (coefficient on VAT rate), which is the pass-through to formal firms. This is similar in magnitude to the result in Column (1) without fixed effects but including a dummy for registration, which suggests that the result is not driven by selection of firms that appear multiple times in the data. The p-value on the F-test that $\eta + \beta = 0$ is 0.78 in Column (2), which suggests that we cannot rule out zero pass-through to the informal sector.

However, when we look at final goods, where we expect the VAT to affect prices in the formal sector, there is also some pass-through to the informal sector. Column (3) restricts the sample to goods where over 75 percent of the output is sold to the final consumer. For this subset, we see that a one percentage point increase in the VAT rate results in a 2.5 percent increase in the tax-inclusive price of the good in the formal sector. Pass-through to the informal sector is lower by 0.8 percentage points. These retail-oriented commodities and firms are the relevant subset where pass-through to consumers is expected and would matter for progressivity. VAT on intermediate goods (i.e. B2B sales) should have no impact on prices in transactions between formal firms because taxes remitted by the seller are claimed as input tax credits by the buyer. In other words, there is no tax wedge.

As we expect, for intermediate goods there is no pass-through in the formal sector and informal sector prices fall when the VAT rate increases possibly because they have to compensate for the loss of input tax credits or because of a change in the composition of firms that remain informal. This is also consistent with the results of proposition 1, if we believe

that in intermediate stages of production there is so much segregation between formal and informal chains[4] that the cross-price elasticities between formal and informal varieties are virtually zero. Panel B shows very similar results when we exclude very large firms with over Rs. 60m in turnover that are less comparable to small firms below the exemption threshold.In the remainder of the analysis, we focus on firms in this sub-sample.

These results are not driven by policy endogeneity in tax changes. Figure 4 shows coefficients from Specification 8 estimating the correlation between VAT rate at time t and prices at time $h \in [t-3, t+1]$. We see that the VAT rate at time t only affects prices at time t and is uncorrelated with previous prices. Regression results are reported in Table 7. Because we rely on a sample of firms observed over multiple years to estimate dynamic effects in lagged years, the sample size falls considerably when our dependent variables is not price at time t. To ensure that the lack of correlation between prices and VAT rate is not due to lack of power, we re-estimate Specification 8 with $Log(Price)_t$ as the dependent variable in the same sample included in the regressions in columns 4 and 6 where the dependent variable is a 1 year lag and lead, respectively. Even in this sample, we estimate a positive and statistically significant pass-through of the VAT rate at time t.

Table 4 shows the same Specifications for the second definition of informal - firms that report no tax payments and are below the exemption threshold. Results are qualitatively similar, suggesting that the previous results are not simply driven by size differences between firms above and below the threshold. Column (3) shows that pass through is lower in the informal sector by 0.5 percentage points even when we define informal firms as those whose revenue is less than the exemption threshold and do not report any tax payments.

Taxes may affect pass-through to the formal sector in two ways - first, informal firms may change their output price in response to tax changes and second, informal firms may change their registration status in response to tax changes and the firms that remain unregistered have systematically higher or lower prices. The pass-through results we saw in Tables 3 and 4 may reflect a change in the composition of firms that remain informal. Table 6 shows that an increase in the VAT rate increases the probability that a firm is either below the exemption threshold or unregistered. This effect is stronger for firms in the final goods stage (Columns 2 and 5).

Turning to pass-through of taxes at the upstream stage, we find modest differences in pass-through in the formal and informal sector among firms that are more heavily reliant on intermediate inputs in production and products whose inputs are more likely to be sold by registered firms. Tables 10 and 11 show the results of Specification 9 for two different measures of the average input tax rate - weighted by the input shares in the earliest year a first is observed and weighted by the average input shares across all years observed, respectively. We find pass-through to the formal sector to be small and statistically insignificant. But

[4]Such segregation is the one of the main predictions of the theoretical work in DePaula and Scheinkman (2010), and is consistent with the findings of Liu et al. (2019).

a one percentage point increase in the average input tax rate leads to between 0.6 and 0.9 percentage point lower pass-through in the informal sector, driven by the intermediate input goods (Column 4), which is surprising. We would expect that higher input tax rates raise the cost of production for unregistered firms, which should in turn raise output prices.

Pass-through to the informal sector can vary across different types of commodities. Our main specification estimates average pass-through across all commodities, where implicitly commodities with more firms involved in production (and therefore have more price observations) receive greater weight. To understand how important pass-through to the informal sector might be for a typical consumption basket for the poor, we might wish to more heavily weight commodities that form a higher share of their consumption expenditure. We present pass-through estimates for major consumption categories in Table 12. In some categories, we are limited by the available data. Nevertheless, within food and beverages, we find similar results to the main specification where we find that the difference in pass-through between the formal and informal sector is small and statistically insignificant (0.006). Among apparel and household durables, we do find a negative coefficient on the interaction between VAT rate and the informal sector dummy.

8 Heterogeneity and Robustness

8.1 Threshold Heterogeneity

As we mention in section 4, in 2008 there was a change in the exemption threshold, which went from ₹10 mn to ₹15 mn. We exploit this change to study whether there were significant pass-through differences depending on the location of the threshold. We use a specification similar to 7 to test whether there are differences in pass-through. More specifically, we estimate the following model:

$$\begin{aligned}\log(p_{ift}) = \alpha_1\tau_{it} + \alpha_2\tau_{it} \times (1 - v_{ft}) + \alpha_3\tau_{it} \times \text{High Threshold}_t \\ + \alpha_4\tau_{it} \times (1 - v_{ft}) \times \text{High Threshold}_t + \xi_i + \mu_t + \nu_f + u_{ift}.\end{aligned} \tag{10}$$

We can then test the null $\alpha_3 = 0$, under which pass-through in the formal sector is the same regardless of the position of the threshold, and the null $\alpha_3 = -\alpha_4$, under which pass-through in the informal sector is the same regardless of the position of the threshold. Results are displayed in table 14. As we can see, we find no evidence that pass-through to formal- or informal-sector prices changes upon the change in threshold. Indeed, our estimates of pass-through are remarkably similar to our baseline specification.

8.2 Evasion

Although our establishment data comes from a national survey conducted by a body independent of the tax authority, we might still be concerned that firms' responses reflect the incentives to evade on taxes. Under the CenVAT, firms are incentivized to under-report revenue and over-report taxable inputs. We measure prices by dividing reported revenue by reported quantity. One way in which this key outcome might be affected by evasion, therefore, is if firms underreport their revenue without adjusting the reported quantity. In this case, evasion would result in systematically lower prices. Our estimates of pass-through in the formal sector would be biased downwards if formal firms underreported revenue by more after a tax increase[5].

If evasion in the formal and informal sector respond differently to tax rate changes, that could affect our estimates of the difference in pass-through between the two sectors. Again, this is only true if evasion occurs to revenue under-reporting while leaving quantities relatively unchanged. It is plausible that formal and informal firms react differently since unregistered firms do not file tax returns or report revenue to the tax authority. If evasion causes reported unit prices to fall after a tax increase, and it does so only in the formal sector, we would expect to see a smaller difference in pass-through between the formal and informal sector. On the other hand, a tax rate increase could drive more firms into the informal sector, especially close to the exemption threshold, pushing unit prices down in the informal sector as well. This would bias pass-through in the informal sector downwards as well. As a robustness check, we estimate our main specification excluding firms in the bunching region just above and below the exemption threshold (i.e. firms with between ₹9.5mn and 10.5mn in revenue before 2008, and between ₹14.5mn and 15.5mn thereafter). Table **??**, column 2 shows very similar results for final consumption goods. Pass-through in the informal sector is slightly smaller by about 0.9 percentage points.

8.3 Overshifting

Our pass-through estimates rely on the assumption that the tax rate changes are exogenous to price changes driven by supply and demand. We verify that past prices are not correlated with future tax rates. Table 7 reports the results of equation (7) augmented with lags of the tax rate. Each of columns (2)-(7) have a different lag or lead of the unit price as the dependent variable. We see that the contemporaneous tax rate is only correlated with current price and not the three preceding lags of price (columns 2 - 4). The pass-through coefficient in column 5, where the dependent variable is price at time t is slightly smaller than the pass-through without the lagged controls (0.027 instead of 0.032) and statistically significant at the 5 percent level. In contrast, the magnitude of the correlation between the current tax rate and past prices is much smaller, between 0.001 - 0.005 and statistically insignificant. The sample size

[5]Whether underreporting increases with the tax rate is theoretically ambiguous. If the penalty is a function of the tax rate, as is the case in our context, then underreporting may not increase with the tax rate (Yitzhaki (1974)).

for specifications with lagged price as the dependent variable is much smaller since not all firms are observed every year. However, in column 7 where we restrict the sample to firms that are also observed in columns 4 and 6, we still find that current tax rates are correlated with current prices, though the pass-through estimate is much larger in magnitude (0.045).

Another concern is that the difference we observe between pass-through among formal and informal firms is simply the difference in pass-through among larger and smaller firms. That is, it is not the registration status that matters but the size. To address this, we conduct two placebo tests. We construct two placebo groups of "informal firms", one that consists of firms above the exemption threshold (revenue between ₹15 mn and ₹60 mn) and the other that consists of the larger firms below the exemption threshold (revenue between ₹10 mn and ₹15 mn). In column (1) of Table 8, we estimate specification (7) on a sample of firms above the exemption threshold. There is no differential pass-through to medium-sized firms that are still above the exemption threshold. Similarly, in column (2) where the sample is restricted to only firms below the exemption threshold, there is no differential pass-through among the larger informal firms.

Our main specification uses all changes in tax rates indiscriminately. This means that some of our variation in tax rates comes from changes in the standard rate, or the basic rate that applies to many commodities, and to which the tax rate on many other commodities is tied. This means that our main estimates in table 6 might suffer from omitted variable bias since we do not control for the prices of related goods, which might be concurrently impacted by the same tax rate change. In order to address this concern, we differentiate changes in the standard rate from changes in the tax rate due to reclassification of goods or changes in the rates of goods that do not follow the standard rate. In all specifications, we include commodities where the tax rates never change to allow us to pin down time, firm and product fixed effects. Results for firms selling a large share of their goods to final consumers are reported in table 9.

The pass-through rate in the formal sector estimated from these different types of tax changes is similar, about 0.03-0.04, aside from changes in the reduced rate category (columns 3 and 4), which is a much smaller set of tax changes and suggests that these estimates might be biased by omitting prices of related goods. The estimated pass-through coefficient from changes in the standard rate is of a similar magnitude as our main estimate, however, is not statistically significant at the 10 percent level. This is in line with what Benedek, De Mooij, Keen and Wingender (2019) find using European VAT changes.

We can see in column (6) that the pass-through rate for formal firms estimated using reclassifications is larger than when we pool all the tax changes as in our main specification. We find that a 1 percentage point increase in the tax rate for a commodity leads to a 9.3% increase in that commodity's price in the formal market. However, the new estimate for β is small and positive, suggesting that pass-through is not very different in the informal sector - we cannot rule out that pass-through in the two sectors are the same. Of course, the types of commodities that are subject to reclassifications could be different from commodities that

are always subject to the standard rate. It is a smaller subset of goods and the pass-through estimated on this subject may not generalize to all commodities.

We find that for final-consumer sales, prices increase with tax rates *both* in the formal and informal sectors. Indeed, we find that across several specifications prices in both sectors react more than one-for-one to changes in the tax rate. As widely studied in the literature on commodity taxation there can be several explanations for this phenomenon, known as over-shifting, all of which lay outside of our current theoretical model.

One possible explanation is that the assumption that there are no general-equilibrium effects is violated, and we are observing effects akin to those described by Agrawal and Hoyt (2019). This seems less likely given that over-shifting persists regardless of whether we consider several tax rates changing at once, as in our main results, or tax rate changes on individual goods.

A second possible explanation which has received much attention historically is that over-shifting is driven by imperfect competition (see, for instance, the discussion in Fullerton and Metcalf (2002)). This also seems unlikely given the context surrounding our empirical estimates, but we plan to further investigate this by investigating whether there are significant changes to companies' accounting profit margins after a change in tax rates.

A third possible explanation for over-shifting is compositional. In our current model we assume that the only product heterogeneity comes from the registered/unregistered decision. Naturally, one might instead expect that each firm produces goods of different qualities, and that quality correlates with productivity in such a way that means informal firms also tend to sell low-quality products. In such a world, even in the absence of any tax pass-through on prices, we would see higher *average* price for formal firms if the firms that became informal are also those selling the lowest-quality goods. If instead pass-through is positive, it is easy to see how these two effects combined might result in observed over-shifting.

Finally, estimated overshifting might be driven by non-exogenous variation in tax rates. If the fiscal authority increased taxes in booming markets and decreased them in markets facing weak demand, that would bias upward our pass-through estimates. We take a narrative approach to address this concern, and categorize all rate changes that happened in our sample period, isolating the ones that, according to the speeches of the current Indian Minister of Finance, where linked to expected performance in those markets. Preliminary results, where we exclude only two large changes in the standard rate that were explicitly linked to the Great Recession, show that this is not a big concern for our estimates. As we can see in table **??**, our pass-through estimates change very little relative to our main specification, and if anything suggest an even higher pass-through.

9 Conclusion

This paper sets out to study the pass through of VAT on firms in the informal sector. This might be an important avenue to understand the progressivity of real-life VAT systems, as recent literature has shown that smaller, unregistered firms tend to produce lower-quality goods and attract poorer customers. These unregistered firms still find themselves interacting with formal firms, both when they buy some of their inputs, and when they compete to sell their output goods. This motivates us to study pass through of VAT on the informal sector through two channels.

First, we look at how unregistered firms are affected by the VAT imposed on the good they produce, relative to registered firms. We find that on average, unregistered firms do not see their prices change with changes in VAT. This result changes once we restrict the sample to firms that conduct most of their business with final consumers, rather than with other firms. We find that at the final goods stage, there is tax pass-through in the formal sector as we expect, and that pass-through in the informal sector is lower but that even informal sector prices respond to the tax rate change.

Our results on final-consumption firms are robust to a number of robustness checks. We do not observe significant differences in passthrough when splitting our sample along size thresholds different than those mandated by tax law. Pass-through is also indistinguishable between the formal and informal sector when we restrict attention to only tax changes due to reclassifications. Results remain similar as in our main specification if we exclude potentially endogenous tax changes, if we exclude firms around the registration threshold, or when we vary our definition of final-consumption firms.

Second, we study how prices in the informal sector are affected by tax rates on inputs. A first look at these results seems to suggest negative pass through of upstream taxes on the prices of final goods in the informal sector but no pass-through in the formal sector. Our finding of no pass-through of upstream taxes in the formal sector is consistent with theory. However, negative pass-through in the informal sector is surprising and most likely driven by selection and evasion.

10 Figures

Figure 1: Probability of any tax payments by revenue

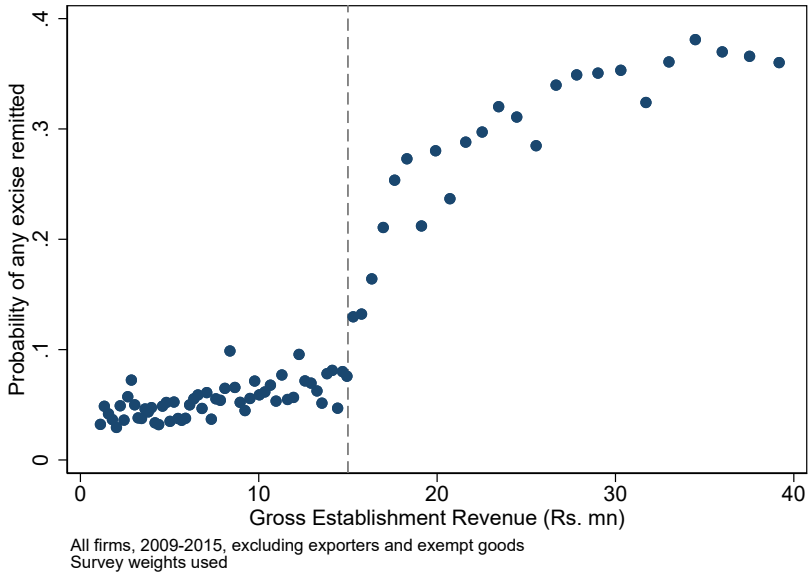
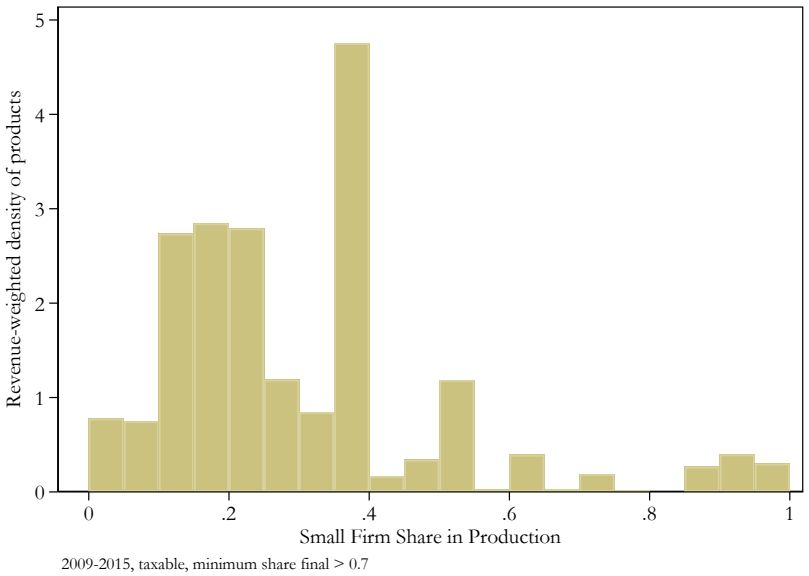
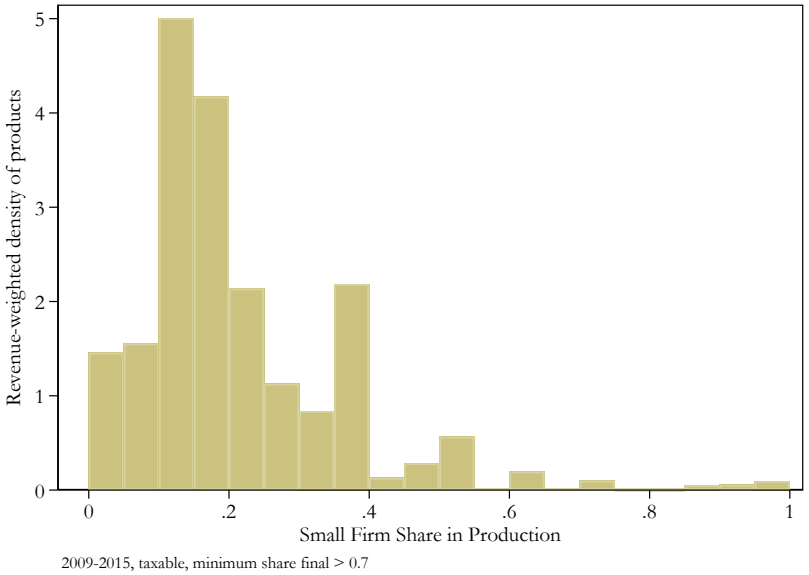


Figure 2: Share of commodity produced by informal firms, weighted by number of firms



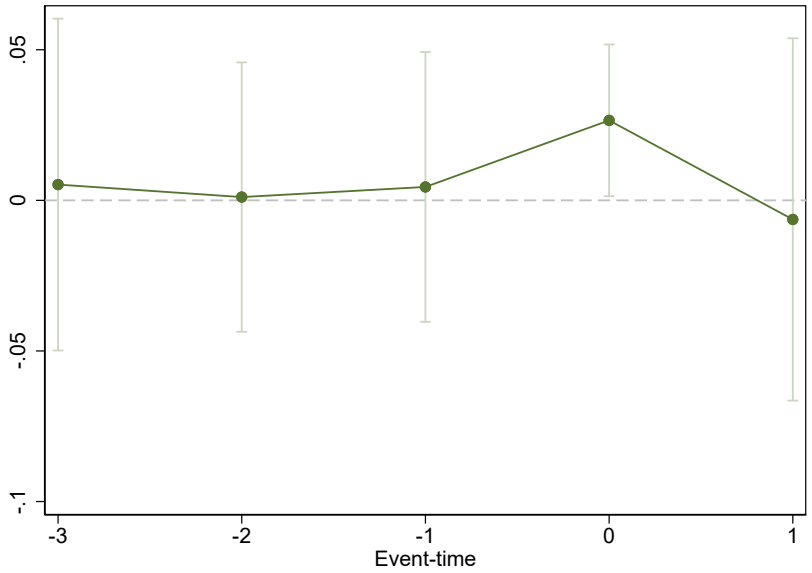
Notes: Figure shows histogram of the share of each commodity that is produced by "small firms", i.e. firms whose total revenue is less than the exemption threshold. A value of 0 indicates that all of the production for that commodity is done by firms with annual revenue greater than the exemption threshold. The shares are calculated among a sample restricted to firms with less than ₹60 mn in annual turnover to analyze production segregation among firms with revenue close to the exemption threshold of ₹15 mn, and for commodities where at least 70 percent of sales are to final consumers. Each commodity observation is weighted by the number of firms producing that commodity.

Figure 3: Share of commodity produced by informal firms, weighted by revenue



Notes: Figure shows histogram of the share of each commodity that is produced by "small firms", i.e. firms whose total revenue is less than the exemption threshold. A value of 0 indicates that all of the production for that commodity is done by firms with annual revenue greater than the exemption threshold. The shares are calculated among a sample restricted to firms with less than ₹60 mn in annual turnover to analyze production segregation among firms with revenue close to the exemption threshold of ₹15 mn, and for commodities where at least 70 percent of sales are to final consumers. Each commodity observation is weighted by its total value of production.

Figure 4: Price Impact Dynamics of Tax Changes



Notes: Figure shows the impact of tax changes in year t on price changes in years relative to year t. Taxes only affect prices in the year of the tax change and not in years before or after.

11 Tables

Table 1: Tax Rate Changes by Year and Type

	Standard	Reduced	Reclassification	Other	Num. Products
2004	0	0	0	0	4,070
2005	2,960	284	0	0	4,070
2006	2,960	284	0	0	4,070
2007	2,762	180	437	16	4,070
2008	2,326	317	797	90	4,070
2009	2,047	134	891	389	4,070
2010	2,163	99	1,042	232	4,070
2011	2,955	246	78	243	4,070
2012	2,909	202	167	173	4,070
2013	2,727	194	347	302	4,070
2014	2,717	380	291	240	4,070
2015	2,323	475	578	21	4,070
2016	2,265	499	551	145	4,070
2017	2,741	489	12	17	4,070
2018	2,738	489	82	8	4,070

Notes: This table shows the number of tax rate changes by type of change in each year. *Standard* refers to goods subject to change in the general CenVAT rate, *Reduced* refers to goods taxed at a concessionary rate, *Reclassifications* refer to when goods switch between standard, reduced or exempt categories, *Other* tax changes include changes in tax rates to goods with special rates.

Table 2: Summary Statistics

	Mean	Std. Dev.	Min.	Max.	Obs.
Panel A: Commodity-Wise					
Price, Rs. thousand	154.08	6,496.63	0.00	898,502.94	19,519
VAT rate	12.17	4.68	0.00	65.00	16,783
Average Input VAT rate, earliest year	6.05	5.70	0.00	103.00	19,446
Average Input VAT rate, all years	9.19	5.18	0.00	68.67	19,446
Unregistered	0.50	0.39	0.00	1.00	19,519
Below Threshold	0.55	0.38	0.00	1.00	19,519
Standard Rate Category	0.82	0.38	0.00	1.00	19,519
Share B2C	0.40	0.23	0.00	0.98	19,473
Total Revenue, Rs. mn	310.45	961.30	0.00	30,812.68	19,519
Number of Firms	29.79	99.92	1.00	3,741.76	19,519
Panel B: Firm-Wise					
Unregistered	0.59	0.49	0.00	1.00	98,524
Below Threshold	0.64	0.48	0.00	1.00	98,524
Employees	33.38	117.40	0.00	29,569.00	98,440
Total Firm Revenue, Rs. mn	14.66	14.50	0.00	60.00	98,524
Number of Commodities Produced	4.26	3.54	1.00	55.71	98,524

Notes: This table shows summary statistics for our main analysis sample, which is restricted to non-exporter firms with less than Rs. 60 mn in annual revenue, in states without any CenVAT exemptions, and with imputed prices removed. Panel A shows commodity X year summary statistics. Each observation is a commodity-year. "Average Input VAT rate, earliest year" is the weighted average tax rate on inputs where the weights are based on the input shares of a firm in the earliest year it is observed. "Average Input VAT rate, all years" weights input tax rates by the average share of each input in all years that a firm is observed. Panel B shows firm-wise summary statistics where each observation is a firm-year.

Table 3: VAT Pass-Through by Compulsory Registration Cutoff

Panel A: All Firms

	All Sales		High B2C Sales	Low B2C Sales
	(1)	(2)	(3)	(4)
VAT Rate	0.011	0.008	0.025***	−0.024
	(0.008)	(0.008)	(0.008)	(0.022)
VAT Rate × Below Threshold	−0.009	−0.010***	−0.008***	−0.013***
	(0.007)	(0.003)	(0.003)	(0.004)
Below Threshold	−0.265***			
	(0.077)			
Observations	338,738	301,167	101,880	195,961
Product Clusters	3,602	3,568	1,855	3,341
p-val $\beta = -\eta$	0.883	0.781	0.012	0.114

Panel B: Less than 60m turnover

	All Sales		High B2C Sales	Low B2C Sales
	(1)	(2)	(3)	(4)
VAT Rate	0.008	0.005	0.024***	−0.036
	(0.009)	(0.011)	(0.008)	(0.031)
VAT Rate × Below Threshold	−0.006	−0.009***	−0.008**	−0.011***
	(0.004)	(0.003)	(0.004)	(0.004)
Below Threshold	−0.163***			
	(0.050)			
Observations	167,069	135,026	37,298	95,368
Product Clusters	3,135	3,037	1,276	2,743
p-val $\beta = -\eta$	0.829	0.765	0.013	0.134

Notes: Below Threshold is an indicator variable for whether a firm's revenue is below the registration threshold. Each regression in columns 2-4 controls for firm fixed, year and product fixed effects. Sample excludes states exempt from CenVAT and exempt commodities. "High share of B2C sales" in column 3 restricts products to those where over 70 percent of the sales are to final consumers. Standard errors, reported in parentheses, are robust to heteroskedasticity and clustering by product code. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: VAT Pass-Through by Registration Status

	All Sales		High B2C Sales	Low B2C Sales
	(1)	(2)	(3)	(4)
VAT Rate	0.005	0.003	0.021***	−0.036
	(0.009)	(0.010)	(0.007)	(0.031)
VAT Rate × Unregistered	−0.002	−0.009***	−0.005***	−0.012***
	(0.003)	(0.003)	(0.002)	(0.004)
Unregistered	−0.182***			
	(0.046)			
Observations	167,069	135,026	37,298	95,368
Product Clusters	3,135	3,037	1,276	2,743
p-val $\beta = -\eta$	0.799	0.589	0.022	0.125

Notes: Unregistered is an indicator variable for whether a firm's revenue is below the registration threshold and the firm does not report any tax payments. Each regression in columns 2-4 controls for firm fixed, year and product fixed effects. Sample excludes states exempt from CenVAT and exempt commodities. "High share of B2C sales" in column 3 restricts products to those where over 70 percent of the sales are to final consumers. Standard errors, reported in parentheses, are robust to heteroskedasticity and clustering by product code. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Pass-through of VAT at upstream stage, weighted by input shares average across all years

	All Sales		High B2C Sales	Low B2C Sales
	(1)	(2)	(3)	(4)
VAT Rate	0.012	0.010	0.031***	−0.027
	(0.008)	(0.008)	(0.011)	(0.026)
VAT Rate X Below Threshold	−0.007	−0.009**	−0.010***	−0.012**
	(0.006)	(0.004)	(0.004)	(0.006)
Avg. VAT on Inputs	−0.002	−0.003	−0.009*	0.001
	(0.003)	(0.003)	(0.005)	(0.004)
Input VAT X Below Threshold	−0.001	−0.000	0.004	0.001
	(0.004)	(0.004)	(0.003)	(0.008)
Below Threshold	−0.236***			
	(0.070)			
Observations	207,791	186,494	60,740	123,064
Product Clusters	3,312	3,245	1,530	2,957
p-val $\beta = -\eta$	0.606	0.958	0.016	0.160

Notes: Below Threshold is an indicator variable for whether a firm's revenue is below the registration threshold. Each regression in columns 2-4 controls for firm, year and product fixed effects. Sample excludes states exempt from CenVAT and exempt commodities. "High share of B2C sales" in column 3 restricts products to those where over 70 percent of the sales are to final consumers. Standard errors, reported in parentheses, are robust to heteroskedasticity and clustering by product code. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Impact of CenVAT rate on informality

	Below Threshold			Unregistered		
	(1)	(2)	(3)	(4)	(5)	(6)
VAT Rate	0.002**	0.001**	0.001	0.002**	0.001*	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	107,012	28,915	76,024	107,012	28,915	76,024
Product Clusters	2,828	1,147	2,493	2,828	1,147	2,493

Notes: Below Threshold is an indicator variable for whether a firm's revenue is below the registration threshold. *Unregistered* is an indicator variable for whether a firm's revenue is below the registration threshold and the firm does not report any tax payments. All regressions include firm fixed, year and product fixed effects. Sample excludes states exempt from CenVAT and exempt commodities. "High share of B2C sales" in columns 2 and 5 restrict products to those where over 70 percent of the sales are to final consumers. Standard errors, reported in parentheses, are robust to heteroskedasticity and clustering by product code. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Pass-through Dynamics

	Log(Price)	Log(Price)_{t-3}	Log(Price)_{t-2}	Log(Price)_{t-1}	Log(Price)_{t}	Log(Price)_{t+1}	Log(Price)_{t}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VAT Rate	0.032**	0.005	0.001	0.004	0.027**	−0.006	0.045*
	(0.013)	(0.028)	(0.023)	(0.023)	(0.013)	(0.031)	(0.027)
VAT_{t-1}		−0.001	0.010	0.022**	0.005	0.051**	0.018*
		(0.010)	(0.008)	(0.011)	(0.010)	(0.021)	(0.010)
VAT_{t-2}		0.001	−0.001	0.022**	0.017	−0.067*	0.035**
		(0.008)	(0.006)	(0.011)	(0.016)	(0.038)	(0.017)
VAT_{t-3}		0.029*	0.015*	0.010	−0.005	0.054***	−0.049
		(0.018)	(0.008)	(0.015)	(0.019)	(0.019)	(0.039)
Observations	45,422	6,271	7,632	10,906	37,462	10,199	10,770
Product Clusters	1,362	338	404	536	1,247	546	530

Notes: Sample is restricted to commodities with a high share of B2C sales. Column (1) includes firm fixed effects while all other columns only contain year and commodity fixed effects. Current tax rate is correlated with only current price and not previous years' prices, suggesting that it is unlikely to be driven by policy endogeneity. The available sample size is different when looking at lagged values of prices because firms may not be observed every year and so column (7) has the contemporaneous price as the dependent variable like in column (5) but restricts the sample to observations that are also included in columns (4) and (6). Standard errors, reported in parentheses, are robust to heteroskedasticity and clustering by product code. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Placebo Informal Groups

	Only Formal Firms	Only Informal Firms
	(1)	(2)
VAT Rate	0.032**	0.017**
	(0.013)	(0.008)
VAT Rate X Med Firm	−0.005	
	(0.004)	
VAT Rate X Large Informal		0.005
		(0.003)
Observations	44,573	13,824
Product Clusters	1,351	804
p-val $\beta = -\eta$	0.026	0.028

Notes: Sample is restricted to commodities with a high share of B2C sales. Column (1) restricts the sample to firms above the exemption threshold. Column (2) restricts the sample to only firms below the exemption threshold. The placebo group in column (1) are firms with over Rs. 15 mn in sales but less than Rs. 60 mn. In Column (2) the group is restrict to those with less than Rs.15 mn but above Rs. 10 mn. Standard errors, reported in parentheses, are robust to heteroskedasticity and clustering by product code. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 9: Pass-Through by Type of Rate Change Among High B2C Firms

	Standard		Reduced		Reclassifcation		Reclassifcation/Other	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VAT Rate	0.032	0.040	0.180***	0.215***	0.102***	0.093***	0.072***	0.059***
	(0.023)	(0.028)	(0.058)	(0.076)	(0.035)	(0.034)	(0.017)	(0.016)
VAT Rate X Below Threshold		−0.014***		0.045*		0.010		−0.002
		(0.005)		(0.026)		(0.013)		(0.003)
Observations	27,082	35,123	10,594	12,956	11,862	14,596	15,502	20,780
Product Clusters	1,070	1,214	200	232	433	508	513	591
p-val $\beta = -\eta$		0.317		0.006		0.008		0.001

Notes: Sample is restricted to commodities with a high share of B2C sales. Columns (1) and (2) estimate pass-through of changes to the standard CenVAT rate. The sample is restricted to commodities that are classified as taxed at the standard rate or that next experienced a tax change during the sample period, mainly exempt goods. Each pair of remaining columns similarly restricts the sample to commodities that either never experience a rate change or are classified within the reduced rate category, reclassified between major rate categories, or experienced some other type of change, respectively. Standard errors, reported in parentheses, are robust to heteroskedasticity and clustering by product code. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 10: Pass-through of VAT at upstream stage, weighted by input shares in first year observed

	All Sales		High B2C Sales	Low B2C Sales
	(1)	(2)	(3)	(4)
Avg. VAT on Inputs	−0.000	0.001	−0.004	0.006
	(0.002)	(0.003)	(0.004)	(0.004)
Input VAT × Below Threshold	−0.001	−0.006	−0.006	−0.002
	(0.003)	(0.004)	(0.004)	(0.006)
Below Threshold	−0.306***			
	(0.024)			
Observations	236,887	215,348	70,777	141,561
Product Clusters	4,214	4,122	1,894	3,709
p-val $\beta = -\eta$	0.715	0.260	0.050	0.548

Notes: Below Threshold is an indicator variable for whether a firm's revenue is below the registration threshold. Each regression in columns 2-4 controls for firm fixed, year and product fixed effects. Sample excludes states exempt from CenVAT and exempt commodities. "High share of B2C sales" in column 3 restricts products to those where over 70 percent of the sales are to final consumers. Standard errors, reported in parentheses, are robust to heteroskedasticity and clustering by product code. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 11: Pass-through of VAT at upstream stage, weighted by input shares average across all years

	All Sales		High B2C Sales	Low B2C Sales
	(1)	(2)	(3)	(4)
Avg. VAT on Inputs	0.001	0.002	0.001	0.004
	(0.002)	(0.003)	(0.003)	(0.004)
Input VAT × Below Threshold	−0.005	−0.009**	−0.004	−0.009*
	(0.004)	(0.004)	(0.004)	(0.005)
Below Threshold	−0.262***			
	(0.036)			
Observations	236,887	215,348	70,777	141,561
Product Clusters	4,214	4,122	1,894	3,709
p-val $\beta = -\eta$	0.258	0.131	0.504	0.463

Notes: Below Threshold is an indicator variable for whether a firm's revenue is below the registration threshold. Each regression in columns 2-4 controls for firm fixed, year and product fixed effects. Sample excludes states exempt from CenVAT and exempt commodities. "High share of B2C sales" in column 3 restricts products to those where over 70 percent of the sales are to final consumers. Standard errors, reported in parentheses, are robust to heteroskedasticity and clustering by product code. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 12: VAT Pass-through in Major Consumption Categories

	Food and Beverages	Apparel	HH durables
	(1)	(2)	(3)
VAT Rate	0.067*	−0.016	0.066
	(0.040)	(0.023)	(0.147)
VAT Rate X Below Threshold	0.006	−0.013	−0.032
	(0.016)	(0.009)	(0.028)
Observations	7,565	2,591	395
Product Clusters	113	102	30
p-val $\beta = -\eta$	0.093	0.271	0.819

Notes: Below Threshold is an indicator variable for whether a firm's revenue is below the registration threshold. Regressions include firm, year, and product fixed effects. Sample is restricted to products with high share of B2C sales, where over 70 percent of sales are to final consumers. Standard errors, reported in parentheses, are robust to heteroskedasticity and clustering by product code. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 13: VAT Pass-through Excluding Endogenous Tax Changes

	All Sales		High B2C Sales	Low B2C Sales
	(1)	(2)	(3)	(4)
VAT Rate	0.013	0.004	0.026**	−0.038
	(0.010)	(0.011)	(0.010)	(0.033)
VAT Rate X Below Threshold	−0.007*	−0.008**	−0.006*	−0.009*
	(0.004)	(0.003)	(0.004)	(0.005)
Below Threshold	−0.093**			
	(0.046)			
Endogenous	0.547*			
	(0.309)			
VAT Rate X Endog.	−0.045	−0.006	0.021	−0.022
	(0.034)	(0.014)	(0.023)	(0.015)
VAT X Endog. X Below Thresh.	−0.010	−0.003	−0.011	−0.002
	(0.006)	(0.008)	(0.009)	(0.009)
Observations	122,491	104,148	28,067	74,030
Product Clusters	2,924	2,814	1,133	2,474
p-val $\beta = -\eta$	0.562	0.748	0.038	0.161

Notes: Below Threshold is an indicator variable for whether a firm's revenue is below the registration threshold. *Endog.* is an indicator for whether a rate change is potentially motivated by expectations about future output. Each regression in columns 2-4 controls for firm fixed, year and product fixed effects. Sample excludes states exempt from CenVAT and exempt commodities. "High share of B2C sales" in column 3 restricts products to those where over 70 percent of the sales are to final consumers. Standard errors, reported in parentheses, are robust to heteroskedasticity and clustering by product code. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 14: Differential VAT Pass-through for Different Threshold Levels

Panel A: Informality proxied by position relative to threshold

	All Sales		High B2C Sales	Low B2C Sales
	(1)	(2)	(3)	(4)
VAT Rate	0.005	−0.002	0.024*	−0.029
	(0.013)	(0.014)	(0.014)	(0.033)
VAT Rate X High Threshold	0.011	0.010	0.003	0.006
	(0.009)	(0.008)	(0.009)	(0.022)
VAT Rate X Below Threshold	−0.008	−0.010**	−0.008*	−0.011**
	(0.006)	(0.004)	(0.004)	(0.005)
VAT Rate X High Threshold X Below Threshold	−0.000	−0.000	−0.000	−0.003
	(0.005)	(0.004)	(0.005)	(0.007)
Below Threshold	−0.232***			
	(0.070)			
High Threshold	0.271*			
	(0.156)			
Observations	210,642	189,212	61,669	124,800
Product Clusters	3,319	3,252	1,540	2,962
p-val $\alpha_3 = -\alpha_4$				
ftest$_h ighlow_i nformal$	0.161	0.189	0.674	0.919

Panel B: Informality proxied by position relative to threshold and tax remittance

	All Sales		High B2C Sales	Low B2C Sales
	(1)	(2)	(3)	(4)
VAT Rate	0.005	−0.003	0.022*	−0.028
	(0.013)	(0.014)	(0.013)	(0.033)
VAT Rate X High Threshold	0.009	0.008	0.001	0.003
	(0.008)	(0.008)	(0.007)	(0.023)
VAT Rate X Unregistered	−0.009*	−0.012***	−0.008**	−0.013***
	(0.005)	(0.004)	(0.004)	(0.005)
VAT Rate X High Threshold X Unregistered	0.006	0.006	0.004	0.004
	(0.004)	(0.004)	(0.004)	(0.005)
Unregistered	−0.267***			
	(0.056)			
High Threshold	0.267*			
	(0.152)			
Observations	210,642	189,212	61,669	124,800
Product Clusters	3,319	3,252	1,540	2,962
p-val $\alpha_3 = -\alpha_4$	0.057	0.075	0.386	0.759

Notes: Below Threshold is an indicator variable for whether a firm's revenue is below the registration threshold. *Unregistered* is an indicator variable for whether a firm's revenue is below the registration threshold and the firm does not report any tax payments. *High Threshold* is an indicator variable for whether the observation appeared after 2008, when the threshold was moved from ₹10 mn to ₹15 mn. Each regression in columns 2-4 controls for firm fixed, year and product fixed effects. Sample excludes states exempt from CenVAT and exempt commodities. "High share of B2C sales" in column 3 restricts products to those where over 70 percent of the sales are to final consumers. Standard errors, reported in parentheses, are robust to heteroskedasticity and clustering by product code. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 15: Log Aggregate Quantity by VAT Rate and Registration Cutoff

	All Sales	High B2C Sales	Low B2C Sales
	(1)	(2)	(3)
VAT Rate	−0.001	−0.031**	0.012
	(0.008)	(0.012)	(0.010)
VAT Rate X Below Threshold	−0.000	0.004	−0.017**
	(0.006)	(0.009)	(0.007)
Below Threshold	−3.499***	−3.977***	−3.160***
	(0.075)	(0.115)	(0.093)
Observations	50,673	9,548	40,445
Product Clusters	4,081	1,264	3,673
p-val $\beta = -\eta$	0.916	0.077	0.653

Notes: Below Threshold is an indicator variable for whether a firm's revenue is below the registration threshold. Each regression controls for product fixed effects and year fixed effects. Sample excludes states exempt from CenVAT and exempt commodities. "High share of B2C sales" in column 2 restricts products to those where over 70 percent of the sales are to final consumers. Standard errors, reported in parentheses, are robust to heteroskedasticity and clustering by product. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 16: Log Aggregate Quantity by VAT Rate and Registration Status

	All Sales	High B2C Sales	Low B2C Sales
	(1)	(2)	(3)
VAT Rate	0.006	−0.024**	0.017
	(0.008)	(0.012)	(0.011)
VAT Rate X Small Firm	−0.006	−0.008	−0.021***
	(0.006)	(0.009)	(0.008)
Unregistered	−3.509***	−3.955***	−3.195***
	(0.077)	(0.116)	(0.095)
Observations	50,159	9,436	40,026
Product Clusters	4,079	1,254	3,670
p-val $\beta = -\eta$	0.930	0.037	0.728

Notes: Unregistered is an indicator variable for whether a firm's revenue is below the registration threshold and the firm does not report any tax payments. Each regression controls for product fixed effects and year fixed effects. Sample excludes states exempt from CenVAT and exempt commodities. "High share of B2C sales" in column 2 restricts products to those where over 70 percent of the sales are to final consumers. Standard errors, reported in parentheses, are robust to heteroskedasticity and clustering by product. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

A Theoretical Appendix

Proof of proposition 1. Plug zero cross-price derivatives into $\mathbf{D}'$ in equation 5. Consider the determinant of $[\mathbf{S}' - \mathbf{D}']$:

$$|\mathbf{S}' - \mathbf{D}'| = \left(\int_{\bar{\omega}}^{\infty} \left((c')^{-1}\right)'(p_r^*; \omega, 0) f(\omega) d\omega - \bar{x} f(\bar{\omega}) \frac{\partial \bar{\omega}}{\partial p_r} - \frac{\partial X_r^d}{\partial p_r} \right) \times \left(\int_{\underline{\omega}}^{\omega} \left((c')^{-1}\right)'(p_u^*; \omega, t) f(\omega) d\omega - \frac{\partial X_u^d}{\partial p_u} \right).$$

This determinant is unambiguously positive since every term in each parenthesis is positive: $\left((c')^{-1}\right)'(p_r^*; \omega, 0)$ and $\left((c')^{-1}\right)'(p_u^*; \omega, t)$ are positive because we are assuming all firms in the distribution considered have a high enough productivity that they will want to produce some positive amount; $f(\omega)$ must be non-negative and strictly positive for some relevant range since it is a P.D.F.; $-\frac{\partial X_r^d}{\partial p_r}$ and $-\frac{\partial X_u^d}{\partial p_u}$ are positive since we are assuming that own-price elasticities are strictly negative; and $\frac{\partial \bar{\omega}}{\partial p_r}$ must be negative since, differentiating both sides of equation 3 with respect to p_r, we can see that

$$\frac{\partial \bar{\omega}}{\partial p_r} = -\frac{\left((c')^{-1}\right)'(p_r - \tau; \bar{\omega}, 0)}{\frac{\partial (c')^{-1}}{\partial \omega}(p_r - \tau; \bar{\omega}, 0)},$$

where the numerator of the fraction is positive due to the strict convexity of the cost function and the Inverse Function Theorem, and the denominator is positive since marginal cost is decreasing in ω.

Since the determinant above is positive, the sign of $\frac{\partial p_r^*}{\partial \tau}$ is determined by the sign of:

$$(S'_{22} - \mathbf{D}'_{22})\mathbf{S}'_{11} = \left(\int_{\underline{\omega}}^{\omega} \left((c')^{-1}\right)'(p_u^*; \omega, t) f(\omega) d\omega - \frac{\partial X_u^d}{\partial p_u} \right) \times \left(\int_{\bar{\omega}}^{\infty} \left((c')^{-1}\right)'(p_r^*; \omega, 0) f(\omega) d\omega - \bar{x} f(\bar{\omega}) \frac{\partial \bar{\omega}}{\partial p_r} \right),$$

which again must be positive since every term in each parenthesis is positive. Similarly, the sign of $\frac{\partial p_u^*}{\partial \tau}$ is determined by the sign of:

$$(S'_{11} - \mathbf{D}'_{11})\mathbf{S}'_{21} = \left(\int_{\bar{\omega}}^{\infty} \left((c')^{-1}\right)'(p_r^*; \omega, 0) f(\omega) d\omega - \bar{x} f(\bar{\omega}) \frac{\partial \bar{\omega}}{\partial p_r} - \frac{\partial X_u^d}{\partial p_u} \right) \times \left(\bar{x} f(\bar{\omega}) \frac{\partial \bar{\omega}}{\partial p_r} \right),$$

which instead must be negative since every term in the first parenthesis is positive, while the term in the second parenthesis is negative. □

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