Misallocation or Misreporting? Evidence from a Value Added Tax Notch in India

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Abstract

The exemption threshold for a value added tax (VAT) is a ubiquitous and salient size-based regulatory threshold for most firms in developing countries. This paper examines the effect of a VAT on manufacturing in India – the CenVAT – on the real and reported production behavior of firms, which reveals the response to incentives created by the VAT threshold. Using a novel dataset created by linking the five-digit product information to the applicable tariff codes, I identify establishments producing commodities subject to various CenVAT rates. I find that even in survey data where the firm's identity is not revealed to the tax authority and that cannot be used for audit purposes, firms' reported revenue is on average 6 to 20 percent lower than it would be in the absence of the CenVAT. I present a model to distinguish whether this observed reduction in revenue is due to real production changes or underreporting of true output, using information on the firm's input use. Based on the predictions of the model, I find that the observed production distortions can largely be attributed to real behavior.

1 Introduction

Most countries levy a value added tax (VAT) and most VAT systems feature a revenue based exemption threshold, making the VAT notch a widespread and important element of tax systems. The responsibility to remit the VAT to the government lies with firms. Recognizing that the costs associated with this responsibility (such as tax filing, record keeping etc.) may be very burdensome for small firms, and that the administrative costs to the tax authority for dealing with small firms may not be worth the additional revenue, most tax authorities give firms with revenue below a certain threshold the option to be exempt. However, this exemption also creates a discontinuous change in the firm's tax liability and compliance costs (a "notch"), which incentivizes some firms to reduce their reported output. This paper studies the extent to which this reduction in output reflects a reduction in real production as opposed to evasion, in the context of a VAT on manufacturing in India. Because the VAT often covers most goods and services in an economy, this exemption threshold is a particularly salient tax notch and can affect the economy-wide firm size distribution. In advanced and emerging economies alike, we observe at least some firms reducing their output to remain below the exemption threshold. In emerging economies, this VAT exemption threshold can be set at a much higher level in the revenue distribution of firms than in advanced economies and affect a large share of production and employment.

The anatomy of the behavioral response to the VAT notch matters for the appropriate policy response. As Slemrod and Kopczuk (2002) argue, the elasticity of taxable income (ETI) is not a structural parameter and is sensitive to the regulatory and enforcement environment. If a larger portion of the ETI is due to evasion responses than real responses, it can be more directly influenced by the enforcement policy itself. This is one reason it might be valuable to estimate the real production response to taxation of firms in developing countries, separately from evasion. Furthermore, to the extent that the cost of evasion reflects a transfer to another agent in the economy (eg. revenue from penalties in tax audits), it is the elasticity of the real tax base with respect to the tax rather than reported base that is a sufficient statistic for excess burden (Chetty (2009)). Although under some assumptions the distinction between evasion and real response does not affect welfare consequences of the tax (Saez, Slemrod and Giertz (2012); Feldstein (1999)), it can have different policy implications. It can imply, for instance, that more attention be paid to the *enforcement elasticity of the tax base* as described in Keen and Slemrod (2017), as an important parameter for optimal tax systems. Finally, we might have other welfare criteria, such as "fairness", where we might care about the level of evasion itself.

Existing research on firms' responses to tax incentives in developing countries use rich administrative data from tax returns and show that reported output is highly responsive to kinks and notches in the tax schedule (Best et al. (2015); Alejos (2018) etc.). In fact, some authors argue the estimated output elasticity with respect to the tax rate is too high to be a real production response. Given reasonable output elasticities, Best et al. (2015) estimate that evasion has to account for between 15 to 70 percent of the change in the corporate tax base in Pakistan in response to the profit tax rate. The estimated extent of evasion in Pakistan stands in stark contrast to Harju et al. (2018), who suggest that in an advanced economy like Sweden, firms bunch below the VAT registration threshold by reducing real rather than reported output. One contribution of this paper is to examine firm behavior in survey data, which captures firms outside of the tax net and information not reported to the tax authority.

A second contribution of the paper is to consider how tax incentives affect measurement of firm production in survey data even though information recorded in the survey has no direct implication for the firms' tax liability. Previous work by Hurst et al. (2014) showed that in the United States, the self employed underreport income relative to salaried workers even in survey data like the Panel Study of Income Dynamics (PSID), which has no bearing on their tax liability. The reason for this may be simply that households have no incentive to report truthfully and find it optimal to quote the same income figure that they have calculated in their tax returns. Similarly, firms may find it convenient or prudent to report the same figures that they report to the tax authority in other government surveys if they believe there is even a small chance of detection. This behavior has implications for the use and interpretation of such survey data in other contexts where it is widely employed, such as the estimation of aggregate productivity or even total value added in the economy. For example, international comparisons of firm productivity using establishment data such as Hsieh and Klenow (2009) may be overestimating productivity differences between developed and developing countries if there is greater evasion in developing countries. An example of how tax incentives may affect aggregate statistics is how Ireland's GDP in 2015 was estimated to have grown by 26 percent largely due to transfer pricing[1].

The context in which I examine firms' behavioral response to a VAT notch is a value added tax on manufacturing in India called the "CenVAT". I find that there is a much a greater density of firms with revenue just below the exemption threshold than we would expect, suggesting that firms reduce their reported revenue to remain below the threshold. Firms can be exempt from the CenVAT if their gross revenue is below the exemption threshold. Just as with most standard VAT systems, firms can, and some do, choose to voluntarily register for the CenVAT even if their revenue is below the exemption threshold. Firms who opt for the CenVAT exemption do not have to register with the tax authority, which further lowers their cost of tax compliance. This VAT exemption therefore creates a

[1] http://www.oecd.org/sdd/na/Irish-GDP-up-in-2015-OECD.pdf

kink in the tax liability and a notch in compliance costs at the threshold, which may incentivize firms whose potential output is above the threshold to report output below threshold, which would result in the observed excess mass of firms below the threshold. When the exemption threshold was raised in 2008 by 50 percent, the excess mass in the firm revenue distribution shifted to the new threshold, providing further evidence that firms' reported revenue is influenced by the threshold.

Multiple dimensions of heterogeneity matter for the analysis of firm behavior at the VAT notch. Two firms with the same potential revenue in the absence of the VAT notch may not choose the same revenue in the presence of the notch because CenVAT registration may not be equally desirable to both. Firms who are more likely to sell to other CenVAT-registered businesses are more likely to want to register for the CenVAT themselves, and might therefore have the same revenue in the presence of the CenVAT notch as in its absence. On the other hand, firms that sell mainly to final consumers value the CenVAT exemption and are more likely to bunch below the threshold in the presence of a VAT. This selection into bunching based on underlying structure of production presents a challenge in separating real and evasion response using reported inputs. Because identification of evasion relies on a discontinuous change in input-output cost ratios around the exemption threshold, it is important to ensure that this discontinous change is not due to selection of firms into bunching based on differences in underlying production structures.

For example, firms who rely on taxable inputs to production are more likely to voluntarily register for the CenVAT, and less likely to bunch below the exemption threshold. They will also therefore have relatively high taxable input cost to revenue ratios. Firms who rely less on these inputs are more likely to bunch and have lower taxable input cost to revenue ratios. Self-selection into either side of the exemption threshold by these two types of firms would result in lower than average input cost ratios to the left of the threshold and higher than average ratios to the right. I address this concern by comparing firms producing within the same 4-digit product category. Many firm characteristics that determine whether they value VAT exemption, such as share of demand from final consumers and reliance on taxable intermediate inputs in production, are determined by the commodity they produce.

To document and analyze the response to the VAT threshold, I use data from the the Annual Survey of Industries (ASI), which is an annual census of manufacturing establishments with over a 100 workers and a 20 percent random sample of the "organized" manufacturing sector with fewer workers. This data has been used in recent years to study various aspects of manufacturing productivity in India (Hsieh and Klenow (2009); Martin et al. (2017); Rotemberg (2017) etc.). In addition to revenue, firms also report detailed information on input use, including electricity consumed. These inputs provide a second source of information about firms' true revenue, given their input use. I estimate the counterfactual revenue of firms who report output near the exemption threshold, given their reported input use and the revenue implied by that level of input use given the behavior of similar firms reporting revenue away from the exemption threshold.

I build a novel dataset of tax rate changes from 2005 at a detailed 8-digit product code, which I link to the detailed production information of firms available in the ASI. As a survey intended to generate detailed production statistics about the manufacturing sector, it contains balance sheet information on establishments that are never reported to the tax authority such as fixed capital, working capital, loans, investment in plant and machinery, number of workers and man-hours worked broken down by type of worker, imports, exports and various other items. The data also cover some firms that are unregistered with any tax authority.

The analysis proceeds as follows: First, I use standard bunching estimation techniques as described in Kleven and Waseem (2013) to estimate the excess mass of firms due to the notch as well as the upper bound of the "manipulation region". Firms whose potential revenue is in the manipulation region are the firms who may reduce output to remain below the threshold. Next, examine the revenue to input cost ratio of firms near the bunching region. As I show in the conceptual framework, the pattern we would expect to see if the bunching were caused by real production changes is the opposite of what we would expect under misreporting. Because electricity is exempt from the CenVAT, and difficult to misreport for manufacturing firms who rely on electricity in their production process, I assume that firms in the manipulation region nevertheless report their electricity use truthfully.

Results show that reported output would have been higher by about 8 to 20 percent on average among taxable goods producers with reported revenue around the exemption threshold, in absence of this threshold. The total reported output of these firms represent about 1 percent of total output of all taxable goods manufacturers. These figures are an average across firms that do and do not value the VAT exemption, which means the response of firms who value the exemption is even larger. Public and private limited companies are more responsive than sole proprietorships and partnerships. The magnitude of the response is similar even when the threshold increases by 50 percent in nominal terms from Rs. 10 million (approx $150,000) to Rs. 15 million (approx $230,000).

In Section 2, I describe how this paper relates to various strands of literature, Section 3 provides details of the empirical context and firms' incentives in the CenVAT, Section 4 illustrates the theoretical framework linking firm's incentives, observed outcomes, and the assumptions required to identify evasion. Section 5 presents the empirical strategy to first estimate the extent of bunching at the threshold and then to separately estimate the extent of real response at the notch. Sections 6 and 7 describe the data and provides relevant descriptive statistics, Section 8.1 presents evidence on bunching at the tax notch, Section 8.2 shows the extent of evasion, Section 9 discusses some alternate explanations other than evasion that might result in patterns described in Section 8.2. Finally, Section 10 concludes.

2 Related Literature

This paper builds on the "traces of evasion" literature starting with Pissarides and Weber (1989) and summarized in Slemrod and Weber (2012). Evasion is difficult to measure directly except through audits. Instead, evasion is inferred from observed activity with the help of assumptions about the link between this activity and true income. For example, in their seminal work, Pissarides and Weber (1989) infer the extent of income underreporting among the self-employed by comparing the reported consumption to income ratio of the self-employed to employees with similar consumption profiles. Assuming that the self-employed and employees truthfully report their consumption, and that employees also truthfully report their income, the difference in the consumption to income ratio of self-employed individuals from that of employees tells us the extent of income underreporting.

Johnson et al. (1997) take a similar approach in aggregate data to estimate the extent of the informal sector that is not captured in official GDP estimates by using the total electricity consumption in various countries. Assuming the elasticity of GDP to electricity is approximately 1, deviation from this elasticity is an estimate of the underreported GDP because electricity consumption can be measured accurately and truthfully. In this paper, I apply the same intuition to compare the electricity use among firms just below the VAT exemption threshold to firms far away from the threshold.

Although I use data from a statutory survey of manufacturing establishments, which is never shared with the tax authority, the data may still reflect evasion. First, the data is presumably based on firms' records, which may be maintained with possibility of audits in mind. If firm owners and accountants believe there is even a small chance of detection based on discrepancies between what is reported to the tax authority and their records or survey responses, they may not report truthfully to the survey. For example, Amirapu and Gechter (2018) find that firms underreport the number of employees in the Economic Census, which is used to construct the sampling frame for the survey of manufacturers. Labor regulations set in at various worker thresholds, which incentivizes firms to underreport their workers even in the census data. An important difference here is that the worker information reported in the economic census is shared with regulatory bodies.

The paper also contributes to the literature on behavioral responses of firms at tax kinks and notches. Size-based regulation are a common feature of tax systems. These regulations introduce kinks or notches where either compliance costs, enforcement or tax liability change discontinuously across a revenue threshold. Firms' responses to these kinks inform us of the elasticity of their output with respect to these various cost margins. For example, Asatryan and Peichl (2017) estimate the elasticity of firms output with respect to a compliance cost notch. Harju, Matikka and Rauhanen (2018) study firms' responses to both a compliance cost notch and a tax liability notch and find that firms' output is much more responsive to compliance costs than tax liability. Finally, Almunia and Lopez-Rodriguez (2018) examine the response of Spanish firms to a revenue-based enforcement notch created by the "Large Taxpayers Unit". They find that firms reduce their output by 2 percent on average in response to the increase in enforcement at the threshold.

While this paper separates the real and reporting response, it does not estimate an elasticity of the tax base with respect to the tax rate. Lockwood (2018) stresses that under a notch, the elasticity of the tax base with respect to the tax rate is no longer a sufficient statistic for the marginal excess burden due to the tax. This is because a change in the tax rate under a notch can have a first order effect on tax revenue. Under a notch, firms who bunch reduce their tax liability on all their income and not just by the amount they reduced their income above the threshold. This results in a discontinuous change in their tax liability unlike in the case of a tax kink, and therefore a first-order effect on tax revenue. However, the share of the real output response is still informative about how much of the true elasticity of the tax base can be influenced by enforcement.

Finally, in order to relate firms' reported inputs to their true output, I use the "cost-shares" approach to production function estimation (Ackerberg et al. (2015)). More popular "proxy-based" methods of estimating production functions are neither appropriate nor necessary in this context. One of the key assumptions in the proxy-based approach – scalar unobservables - is that intermediate inputs depend only on observables like labor and capital input and a single unobservable, which is productivity. It is likely that this assumption fails in the VAT context as VAT-registered firms are incentivized to misreport intermediate inputs. There is also no need to identify all production elasticities because the estimate of evasion relies only on a specific subset of production elasticities, with respect to tax-exempt inputs. For these reasons, I use the first-order condition approach whereby I estimate the equilibrium Cobb-Douglas production elasticity using input cost shares – a widely used strategy (see Allcott et al. (2016); Rotemberg (2017); Hsieh and Klenow (2009) etc.)

3 Empirical Context

3.1 Small Scale Industry (SSI) Exemption under the CenVAT

Until July 2017[2], the central government of India imposed a value added tax on manufactured goods called the "CenVAT"[3] . The CenVAT was nominally a tax "on" manufacturing, which for the purpose of this tax was defined as any activity that resulted in the creation of a new and marketable product. This definition included repackaging, relabeling and branding of products but exempted wholesalers and retailers.

The CenVAT operated like a standard VAT up to the manufacturing stage in most respects except for two key differences. Like other VAT systems, firms remitted tax on their output and could receive input tax credits on any taxable inputs purchased from CenVAT-registered firms, creating the classic self-enforcing chain mechanism of a VAT and preventing cascading taxes. It offered an exemption for firms whose annual revenue was below an exemption threshold, which was Rs. 10 million (approx. $150,000) until 2007 or below Rs. 15 million (approx. $230,000) thereafter. Firms whose revenue was below the exemption threshold, and therefore were eligible for the exemption, could choose to voluntarily register for and remit the CenVAT, another standard feature of VAT systems. The differences from a standard VAT arise because of two particular rules regarding the revenue-based exemption for the CenVAT, which was called the "Small Scale Industry" (SSI) exemption[4].

Unlike other VAT systems, firms had two options once they crossed the exemption and registration threshold. They could either remit tax on their entire revenue and claim input tax credits (i.e. remit tax on their value added) or they could remit tax only on the revenue above the exemption threshold without claiming any input tax credits. In a standard VAT, firms would have to remit tax on their entire value added once they register. A second difference from the standard VAT is that firms could only opt for this SSI exemption if their revenue in the previous fiscal year was below Rs. 40 million (approx. $600,000). This second condition turns out to have little effect on firm behavior for reasons discussed in Appendix B. However, the option to remit tax on your turnover in

[2] In July 2017, India introduced the comprehensive "Goods and Services Tax" (GST), which subsumed this CenVAT along with many other taxes including the State Value Added Tax, Service Tax and others.

[3] This tax is also referred to as the "Central Excise Tax". The use of the term "excise" tax in its description is due to its origins as an excise tax on salt under British rule. Over time the tax base was expanded to cover nearly all manufacturing. A major reform in 1999 introduced the value added tax structure to the Central Excise Tax, when it was named the "CenVAT". Starting in 2001, firms could claim input tax credits on all taxed intermediate inputs and capital goods.

[4] Establishments designated as "SSI" received other preferential treatment such as the license to produce certain commodities or lower interest loans. But the criteria to qualify as an SSI firm for all other benefits was in terms of the original value of investment in plant and machinery, not their revenue. The revenue-based SSI classification only applied to the CenVAT exemption.

excess of the exemption threshold instead of the entire value-add creates a kink in the tax liability instead of a notch. Taxpayers still face a compliance cost notch at the exemption threshold because firms must register once they cross the threshold regardless of whether they choose to remit tax on turnover or on value-add.

Registration for the CenVAT is separate from any other registrations of the business. To register, firms have to fill out paperwork and obtain a taxpayer ID number specifically for the CenVAT, which they will then use to file either monthly or quarterly returns. Once a firm is registered and filing returns, they have to keep certain records and could be subject to audit according to the selection criteria of the tax authority such as risk of evasion and potential tax revenue. These additional requirements introduce a fixed compliance cost once a firm registers. It is possible to de-register if a firm's output remains below the exemption eligibility threshold.

3.2 Tax Liability Under the CenVAT

Consider a firm with pre-tax revenue of R_{it} and pre-tax cost of taxable intermediate inputs of $p^M M_{it}$, where p^M is the pre-tax unit price of intermediate inputs M_{it}. If the firm always registers for the CenVAT, regardless of whether they may be eligible for the SSI exemption, their tax liability is:

$$T(\tau, R_{it}, p^M M_{it}) = \tau R_{it}$$

where τ is the CenVAT rate. They remit tax on their revenue, R_{it} but receive input tax credits on their taxable inputs[5].

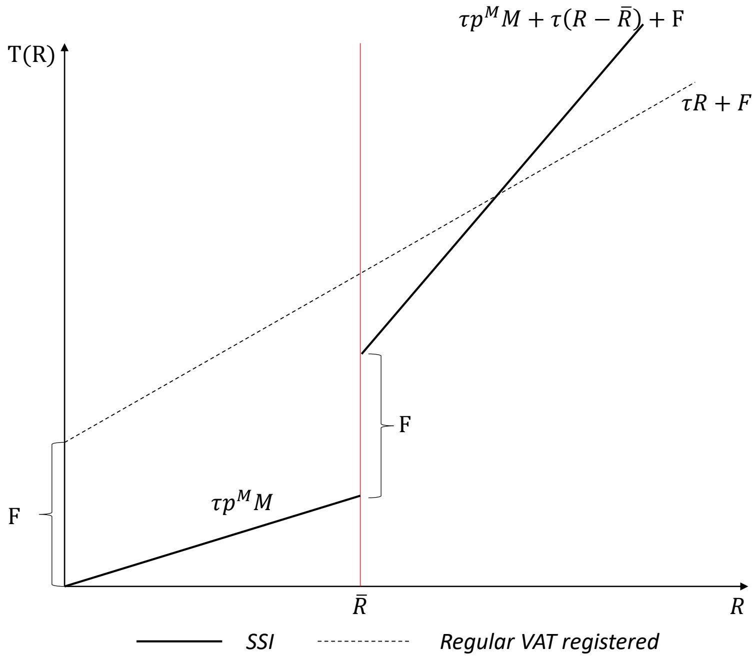
In addition, they incur compliance costs associated with CenVAT registration, which I treat as a fixed cost of compliance, F. The sum of their tax liability and compliance cost is:

$$T(\tau, R_{it}, p^M M_{it}) + F = \tau R_{it} + F \tag{1}$$

On the other hand, if a firm takes the SSI exemption when eligible, their tax liability and compliance costs are as follows:

[5] One might be expecting tax liability under a VAT to be written as the tax rate multiplied by the value added of firm, $\tau(R_{it} - p^M M_{it})$. However, here I have represented it as the tax on a registered firm's total revenue, so that it is clear to the reader that an unregistered firm still contributes to VAT revenue through their foregone input tax credits. Under this notation, the *difference* in tax liability for a registered and unregistered firm, is the tax on their value added, $\tau(R_{it} - p^M M_{it})$

Figure 1: Tax Liability and Compliance Cost under the CenVAT



$$T(\tau, R_{it}, p^M M_{it}, \bar{R}) = \begin{cases} \tau p^M M_{it} & \text{if } R_{it} < \bar{R} \\ \tau p^M M_{it} + \tau(R_{it} - \bar{R}) + F & \text{if } R_{it} > \bar{R} \end{cases} \quad (2)$$

They do not remit any tax on their output if their revenue is below the exemption threshold, $\bar{R}$ but must forgo their input tax credits. Once their revenue crosses the exemption threshold, they must remit tax on any revenue above the exemption threshold but still do not receive input tax credits and face a compliance cost notch equal to F at this threshold, which represents the costs associated with monthly filing, record keeping and higher probability of audit once a firm is registered. Tax officials need permission from a senior official to enter the premises of SSI firms but not of registered firms, which creates an additional enforcement notch at this threshold.

Figure 1 shows how the CenVAT rules create a kink in the tax liability and a notch in compliance costs at the exemption threshold, $\bar{R}$. The dashed line shows the sum of their tax liability $T(R_{it})$ and fixed compliance cost, F if they are always registered under the CenVAT. It is a linear function of their revenue with a slope of τ and an intercept of F. On the other hand, if they take the SSI exemption, their tax liability is described by the solid line. Until their revenue reaches $\bar{R}$, they do not have to register for the CenVAT and therefore do not incur the fixed compliance cost. Their tax liability is the forgone input tax credits, $\tau p^M M_{it}$, which increases with revenue as they require more inputs to generate greater revenue. Once they cross the exemption threshold, they incur the fixed compliance cost F and they must remit tax on revenue above threshold in addition to the forgone input tax credits. Their tax liability now increases more quickly with revenue, creating a tax kink and the fixed compliance cost creates the notch.

To summarize, firms faced a kink in tax liability at Rs. 15 million, a notch in tax liability at Rs. 40 million, and a notch in compliance costs at Rs. 15 million. This paper focuses on firm behavior at the Rs. 15 million exemption threshold, and treats it as a combination of a compliance cost notch and a tax kink[6].

Unlike the VAT threshold in many advanced economies, the exemption threshold for the CenVAT was relatively high. In 2004, nearly 50 percent of "organized" manufacturing firms were below the exemption threshold. Because the threshold is in nominal terms and not indexed to inflation, this share declined over time and in 2012 about 30 percent of organized manufacturing firms were below the exemption threshold. As we might expect, exempt firms have smaller output and therefore only represent between 1 to 3 percent of organized manufacturing output. They also represent a sizable proportion of total employment in organized manufacturing ranging from between 5 to 15 percent of total employment in the decade between 2005 and 2015. The substantial discrepancy between the output share and employment share is because these small firms are much less productive.

3.3 Voluntary Registration

Although tax liability is higher for a registered firm under the CenVAT, some firms' profits may also be higher if they register. As a result, in the CenVAT as with other VAT systems, some firms choose to voluntarily register. The voluntary registration decision depends primarily on the whether their potential buyers are registered CenVAT businesses, or if they are unregistered entities such as unregistered firms or final consumers, who cannot avail of input tax credits. A second determinant, conditional on firms being able to sell to both registered and unregistered firms, is their taxable input costs as a share of revenue.

From equations (1) and (2), we can see that holding all prices and quantities fixed, tax liability is higher under the CenVAT. However, in practice, firms can face a different

[6] This SSI exemption threshold of Rs.15 mn is still salient under the new tax regime that replaced the CenVAT - the Goods and Service Tax or GST. Firms whose revenue is below this threshold can opt for the "composition scheme" under the GST which means they are subject to a turnover tax instead of a VAT.

output price depending on whether they are registered, which means the increase in their revenue from registering can outweigh the increase in tax liability. Whether this is the case depends on share of the firm's sales to registered businesses compared to their share of sales to unregistered businesses or final consumers.

Consider an upstream firm A, deciding whether to register, whose can sell their output to two potential downstream entities whose inputs are G (produced by firm A) and L: (1) B, a CenVAT registered business and (2) C, an unregistered business or a final consumer. Profit for B and C is given by π_B and π_C as follows:

$$\pi_B = \begin{cases} R(G,L) - p^G G - wL - \tau R(G,L) & \text{if A registered} \\ R(G,L) - \tilde{p}^G G - wL - \tau R(G,L) & \text{if A not registered} \end{cases}$$

and,

$$\pi_C = \begin{cases} R(G,L) - p^G G - wL - \tau p^G G & \text{if A registered} \\ R(G,L) - \tilde{p}^G G - wL & \text{if A not registered} \end{cases}$$

π_B only depends on the pre-tax price of input G because the registered downstream firm B can avail of input tax credits, while π_C depends on the after-tax price of G. If the market for firm A's product is mainly composed of registered businesses, like B, then A can fully "pass-through" the CenVAT to the downstream firm[7], leaving firm A's revenue, net of tax on their output, unchanged if they register. Moreover, once A registers, they can claim input tax credits, which lowers their tax liability on inputs.

On the other hand, if the market for A's output is composed of final consumers or unregistered businesses, and pass-through is less than 1, their net-of-output tax revenue falls. In the extreme case where firms sell only to registered businesses, they would always voluntarily register and at the other extreme if they only sell to unregistered businesses and final consumers, they would never register. Conditional on firms selling to both types in some proportion, Liu, Lockwood and Almunia (2017) show that the registration decision depends on the share of their demand coming from final consumers or businesses, their reliance on taxable intermediate inputs in production, and competitiveness of the market matter for whether the firm values the exemption. The intuition is that the share of demand from final consumers determines the change in revenue net of output tax when firms register, while the intensity of taxable input use determines the decrease in tax liability on inputs. The higher the demand from final consumers, the lower benefit from registration and the higher the intensity of taxable input use, the higher the benefit from registration.

[7]Because B receives input tax credits, there is no tax wedge in the price paid by B and the price received by A, and the concept of an "after-tax" price is purely theoretical.

One concern that I address throughout the paper is that the observed difference in input cost shares of firms on either side of the exemption threshold arises because of the difference between the type of firms that value the exemption and therefore bunch below the threshold, and the type of firms that register voluntarily and do not bunch. I argue that the characteristics that determine whether firms will voluntarily register are determined by the product market in which the firm participates, but that the choice to bunch within a given product market depends on the firm's productivity.

In Liu et al. (2017)'s model, a firm's product is completely determined by their type. In this paper, there are characteristics of the commodity that a firm produces that are independent of the firm's own type. Specifically, the share of demand coming from final consumers, reliance on taxable intermediate inputs and competitiveness are independent of the firm's own type. Firms of various productivities can produce a given commodity. In the conceptual framework that I lay out in section 4, I analyze firm behavior within a commodity market taking the firm's choice of commodity and relevant characteristics of that commodity market as given.

3.4 Other features of the CenVAT

After 2001, the CenVAT had 3 to 4 applicable rate categories – the standard rate, reduced rate, exempt and special rate categories. The applicable VAT rate within these categories changed over time. Some manufactured commodities (largely food items, medicines and publishing) were exempt from the CenVAT, but only exports were zero-rated, which means exporters faced a zero rate on their revenue but could claim input tax credits. On the other hand, firms that produced exempt commodities faced a zero rate on their revenue but could not claim input tax credits.

4 Conceptual Framework

This section presents a stylized model to characterize the revenue distribution and revenue-to-input-cost-ratio distribution of firms. I consider these distributions both when firms do and do not evade.

Firms are price-takers in both input and output markets. Their tax liability is as described in equations (1) and (2), where they face a tax kink and compliance notch at exemption threshold $\bar{R}$. Firms could be producing one of many commodities, indexed by j. Their choice of commodity determines the price received for their output if they register, the price if they do not register, and their reliance on taxable intermediate inputs. Below I describe firms' decision-making holding their commodity group (and therefore the difference in price of output when registered or unregistered, and reliance on taxable inputs) as fixed.

Firms' choice variables are their input use, whether to voluntarily register for the CenVAT, and whether to register but take the SSI exemption allowing them to remit tax only on their turnover above the exemption threshold. Inputs are electricity (E_i), which is exempt from CenVAT, and other raw materials, which are subject to CenVAT (M_i).[8] Production is Cobb-Douglas $F(E_i, M_i) = E_i^{\alpha} M_i^{\beta}$. M_i and E_i are costlessly adjustable each period[9]. The price of output if registered is p_B^Y and the price if unregistered is p_C^Y.

4.1 No Evasion

First consider the firm's choice of inputs and the decision whether to take the SSI turnover tax option ignoring their decision to voluntarily register. The profit maximization problem can be broken down into three cases: (I) Input use to maximize profits conditional on revenue below exemption threshold, $\bar{R}$, (II) Input use to maximize profits conditional on revenue equal to exemption threshold and (III) Input use to maximize profits conditional on revenue above the exemption threshold, whereby the firm registers and remits tax only on turnover above the exemption threshold. The profit function in each of these three cases is described below:

1. Case I

$$\Pi^*_{R_i<\bar{R},\rho=0}(\omega_i) = \max_{E_i,M_i} \omega_i p_C^Y E_i^{\alpha} M_i^{\beta} - p^E E_i - (1+\tau) p^M M_i$$

2. Case II

$$\Pi^*_{R_i=\bar{R},\rho=0}(\omega_i) = \max_{E_i,M_i} \bar{R} - p^E E_i - (1+\tau) p^M M_i$$

3. Case III

$$\Pi^*_{R_i>\bar{R},\rho=0}(\omega_i) = \max_{E_i,M_i} \omega_i p_B^Y E_i^{\alpha} M_i^{\beta} - p^E E_i - (1+\tau) p^M M_i - \tau(R_i - \bar{R}) - F$$

[8] In reality, capital and labor are important inputs as well, but including them does not change the analysis. I therefore omit them for simplicity.

[9] Because exemption eligibility depends on revenue in the previous period, there may be a dynamic aspect to firms' decision making. However, as I describe in appendix B , this exemption eligibility threshold does not seem to influence firms' optimization and therefore I focus on the single period optimization of firms and drop the time subscript.

where ω_i is the firm's productivity. $\rho = 0$ if the firm takes the SSI exemption. In case III, firms who take the SSI exemption must still register once their revenue crosses the exemption threshold but they only remit tax on their output above the exemption threshold. They incur the fixed compliance cost, F, but can provide input tax credits to downstream firms and so receive the price p_B^Y. In cases I and II, firms receive the price p_C^Y on their output. In all three cases, firms cannot claim input tax credits and so the tax inclusive price of their taxable inputs is $(1+\tau)p^M$.

Given their realized productivity, ω_i, firms maximize over the three cases:

$$\max\{\Pi^*_{R_i<\bar{R},\rho=0}(\omega_i), \Pi^*_{R_i=\bar{R},\rho=0}(\omega_i), \Pi^*_{R_i>\bar{R},\rho=0}(\omega_i)\}$$

Solving these maximization problems for firms' optimal input use, the revenue distribution and corresponding revenue to electricity ratio in each of these cases is given by:

$$R_i^* = \begin{cases} \left[\omega_i p_C^Y \left(\frac{\alpha}{p^E}\right)^\alpha \left(\frac{\beta}{(1+\tau)p^M}\right)^\beta\right]^{\frac{1}{1-\alpha-\beta}} & \text{if } \omega_i < \omega^1 \\ \bar{R} & \text{if } \omega^1 < \omega_i < \omega^2 \\ \left[\omega_i (1-\tau) p_B^Y \left(\frac{\alpha}{p^E}\right)^\alpha \left(\frac{\beta}{(1+\tau)p^M}\right)^\beta\right]^{\frac{1}{1-\alpha-\beta}} & \text{if } \omega_i > \omega^2 \end{cases}$$

where ω^1 and ω^2 are defined by the following conditions: ω^1 is such that optimal revenue under the first case is equal to the exemption threshold. ω^2 is such that $\Pi^*_{R_i=\bar{R},\rho=0}(\omega^2) = \Pi^*_{R_i>\bar{R},\rho=0}(\omega^2)$.

Their revenue to electricity cost ratio is

$$\frac{R_i^*}{p^E E_i} = \begin{cases} \frac{1}{\alpha} & \text{if } \omega_i < \omega^1 \\ \left(\frac{\bar{R}}{p^E}\right)\left(\frac{p_C^Y \omega_i}{\bar{R}}\right)^{\frac{1}{\alpha+\beta}} \left(\frac{\beta}{\alpha}\frac{p^E}{(1+\tau)p^M}\right)^{\frac{\beta}{\alpha+\beta}} & \text{if } \omega^1 < \omega_i < \omega^2 \\ \frac{1}{\alpha(1-\tau)} & \text{if } \omega_i > \omega^2 \end{cases}$$

The average revenue to electricity ratio of firms producing at the exemption threshold is higher than that of firms producing either above or below the exemption threshold. As we will see, this is in contrast with what we would expect when we allow for misreporting.This is because more productive firms require less inputs to produce the threshold level of output.

Now consider firms who voluntarily register for the standard CenVAT. Their revenue and revenue to electricity cost ratio are as follows:

$$
\begin{aligned}
R_i^* &= \left[\omega_i(1-\tau)p_B^Y\left(\frac{\alpha}{p^E}\right)^{\alpha}\left(\frac{\beta}{p^M}\right)^{\beta}\right]^{\frac{1}{1-\alpha-\beta}} \\
\frac{R_i^*}{p^E E_i} &= \frac{1}{(1-\tau)\alpha}
\end{aligned}
$$

The observed relationship between revenue and revenue to electricity costs for all firms is a combination of the relationship for unregistered and registered firms.

A sufficient condition for firms to prefer the exemption is the following:

$$
\frac{p_C^Y}{(1+\tau)^{\beta}} \geq (1-\tau)p_B^Y \tag{3}
$$

In the absence of fixed compliance cost, equation (3) is also a necessary condition[10]. The quantity on the right hand side is the after-tax price received by a registered firm. For a firm to prefer the exemption, the price they receive if unregistered must be greater than the price received if registered, scaled by $(1+\tau)^{\beta}$, which captures the additional input costs to forgo input tax credits. The lower the firm's reliance on taxable inputs (β), the more likely they are to prefer the exemption.

4.2 With Evasion

Allowing for evasion, unregistered firms' optimization can be broken down into three cases, analogous to the cases without evasion:

1. True revenue is below the exemption threshold and the firm is unregistered:

$$
\Pi_{R_i<\bar{R},\rho=0} = \omega_i p_C^Y E_i^{\alpha} M_i^{\beta} - p^E E_i - (1+\tau)p^M M_i
$$

2. True revenue is above the threshold, but the firm is unregistered and reports revenue

[10] If equation (3) fails, voluntary registration is decreasing in productivity. Once we reach the productivity level at which firms would not voluntarily register, firms with productivity above that threshold would not voluntarily register either.

at the threshold:

$$\Pi_{R_i>\bar{R},\hat{R}_i=\bar{R},\rho=0} = \omega_i p_C^Y E_i^\alpha M_i^\beta - p^E E_i - (1+\tau)p^M M_i - c(R_i - \bar{R})$$

3. True revenue is above the threshold, the firm is registered and opts for the SSI exemption:

$$\Pi_{R_i>\bar{R},\hat{R}_i<R_i,\rho=0} = \omega_i p_B^Y E_i^\alpha M_i^\beta - p^E E_i - (1+\tau)p^M M_i - c(R_i - \hat{R}_i) - \tau(\hat{R}_i - \bar{R}) - F$$

where $\hat{R}_i$ is reported revenue, $c(R_i - \hat{R}_i)$ is the cost of misreporting and I make the widely used[11] assumption that the cost of misreporting depends on the *amount* of misreporting, $e_i = R_i - \hat{R}_i$, which gives optimal evasion as a function of the known CenVAT rate (see Appendix A).

Let $\tilde{\omega}^1$ and $\tilde{\omega}^2$ denote productivity thresholds at which firms switch from case 1 to 2 and from 2 to 3. Reported revenue distribution and revenue to electricity ratio can then be stated as:

$$\hat{R}_i^* = \begin{cases} \left[\omega_i p_C^Y \left(\frac{\alpha}{p^E}\right)^\alpha \left(\frac{\beta}{(1+\tau)p^M}\right)^\beta\right]^{\frac{1}{1-\alpha-\beta}} & \text{if } \omega_i < \tilde{\omega}^1 \\ \bar{R} & \text{if } \tilde{\omega}^1 < \omega_i < \tilde{\omega}^2 \\ \left[\omega_i (1-\tau) p_B^Y \left(\frac{\alpha}{p^E}\right)^\alpha \left(\frac{\beta}{p^M}\right)^\beta\right]^{\frac{1}{1-\alpha-\beta}} - c_e^{-1}(\tau) & \text{if } \omega_i > \tilde{\omega}^2 \end{cases}$$

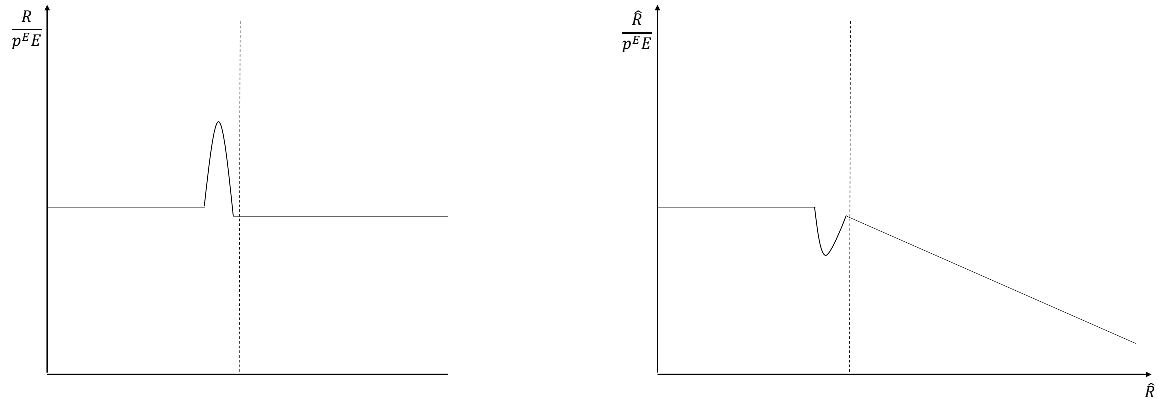
Reported revenue to electricity ratio:

$$\frac{\hat{R}_i^*}{p^E E_i} = \begin{cases} \frac{1}{\alpha} & \text{if } \omega_i < \tilde{\omega}^1 \\ \left(\frac{\bar{R}}{p^E}\right)\left[\left(\frac{\beta}{(1+\tau)p^M}\right)^\beta \left(\frac{\alpha}{p^E}\right)^{1-\beta} p_C^Y\right]^{\frac{1}{1-\alpha-\beta}} [(1 - c_e(R_i - \bar{R}))\omega_i]^{\frac{-1}{1-\alpha-\beta}} & \text{if } \tilde{\omega}^1 < \omega_i < \tilde{\omega}^2 \\ \frac{1}{\alpha(1-\tau)} - \frac{c_e^{-1}(\tau)}{p^E}\left[\left(\frac{\beta}{(1+\tau)p^M}\right)^\beta \left(\frac{\alpha}{p^E}\right)^{1-\beta} (1-\tau)p_B^Y\right]^{\frac{-1}{1-\alpha-\beta}} \omega_i^{\frac{-1}{1-\alpha-\beta}} & \text{if } \omega_i > \tilde{\omega}^2 \end{cases}$$

Proposition 1: Without evasion, revenue to input cost ratio at the exemption threshold is higher than the ratio below the bunching region.

Revenue to input cost ratio at the threshold is an average of the ratio for all bunching firms:

[11] see Amirapu and Gechter (2018); Best et al. (2015); Bachas and Soto (2018)



(a) Without Evasion

(b) With Evasion

Figure 2: Revenue to input cost ratio by Revenue

$$\left(\frac{\bar{R}}{p^E}\right)\left(\frac{p_C^Y}{\bar{R}}\right)^{\frac{1}{\alpha+\beta}}\left(\frac{\beta}{\alpha}\frac{p^E}{(1+\tau)p^M}\right)^{\frac{\beta}{\alpha+\beta}}\int_{\omega_1}^{\omega_2}\omega_i^{\frac{1}{\alpha+\beta}}f(\omega_i)d\omega_i > \frac{1}{\alpha}$$

The intuition behind this result is that more productive firms require less input to produce the threshold level of output. The firm with the lowest productivity at the bunching interval (ω^1) has revenue to input cost equal to α by definition since they are indifferent between bunching and producing at the exemption threshold.

Proposition 2: With evasion, revenue to input cost ratio at the exemption threshold is lower than below the bunching region.

With evasion, average ratio of reported revenue to electricity costs at the exemption threshold is:

$$\left(\frac{\bar{R}}{p^E}\right)\left[\left(\frac{\beta}{(1+\tau)p^M}\right)^{\beta}\left(\frac{\alpha}{p^E}\right)^{1-\beta}p_C^Y\right]^{\frac{1}{1-\alpha-\beta}}\int_{\omega_1}^{\omega_2}[(1-c_e(R_i-\bar{R}))\omega_i]^{\frac{-1}{1-\alpha-\beta}}f(\omega_i)d\omega_i$$

Unlike in the case without evasion, the above ratio is decreasing in productivity.

With and without evasion, we would observe bunching in the revenue distribution. However, without evasion, we would expect to a higher revenue to input cost ratio for the bunching firms, which is the opposite of what we would expect with evasion.

5 Empirical Strategy

5.1 Bunching Estimation

Following many previous examples in the literature (Saez (2010); Kleven and Waseem (2013); Almunia and Lopez-Rodriguez (2018)), I estimate the change in output of the marginal buncher and the average output response at the notch. For each of two periods (before and after 2008), I collapse the data into counts of firms within revenue bins of Rs. 200,000 (approx. \$3000). I estimate the counterfactual density by fitting a 4th degree polynomial to these counts, with dummies for the manipulation region as follows:

$$F_k = \sum_{i=0}^{4} \beta_i R_k^i + \sum_{k=r^{lb}}^{r^{ub}} \delta_k \mathbf{I}(R_k = k) + \epsilon_k$$

where β_i is the coefficient on each polynomial term and the coefficients, δ_k on dummies $\mathbf{I}(R_k = k)$, identify either the excess or missing mass within each revenue bin relative to the counterfactual density. F_k is the actual density of firms in each revenue bin, k. R_k is the midpoint of revenue in each bin.

I set the lower bound r^{lb} at the point where there is a break in the decreasing trend in density and iterate over different choices of the upper bound r^{ub} to find the upper bound such that the estimated excess mass to the left of the exemption threshold equals the missing mass to the right of the threshold as follows:

$$\sum_{k=r^{lb}}^{\bar{R}} \hat{\delta}_k = \sum_{k=\bar{R}}^{r^{ub}} \hat{\delta}_k$$

Average bunching response is estimated as:

$$b = \frac{\sum_{k=r^{lb}}^{\bar{R}} \hat{\delta}_k}{\frac{1}{2}(\hat{F}_{\bar{R}} + \hat{F}_{r^{ub}})}$$

which represents the average response across all firms, some of whom may not bunch. $\hat{F}_{\bar{R}}$ is the counterfactual density at the exemption threshold and $\hat{F}_{r^{ub}}$ us the counterfactual density at the estimated upper bound of the manipulation region.

We translate the bunching estimate into the percentage decrease in output it implies by multiplying the estimate by the bin size, which is Rs.200,000 and dividing by revenue at the exemption threshold, which was Rs. 10 mn before 2008 and Rs. 15 mn afterward.

6 Data

6.1 CenVAT rate data

The Central Board of Excise and Customs (CBEC), which administers the CenVAT publishes the CenVAT rates according to an 8-digit Indian Tariff Code (ITC) each year. Changes to the rates, if any, are usually announced in March of each year when the annual budget document for the central government of India is tabled in Parliament. However, there may be additional changes to rates or reclassifications, which are announced at other times in the year and published as "Notifications" from the CBEC. Using these various sources of information, I construct a novel dataset of of tax rates at the 8-digit ITC code from 2005 to present. Using a series of concordances, I link this tax rate information to detailed (5-digit) product information in an annual comprehensive survey of manufacturing establishments in India, the Annual Survey of Industries (ASI) [12].

6.2 Establishment-Level Production

I use annual data from the Annual Survey of Industries (ASI) between 2004 and 2015. This is a statutory survey administered by the Central Statistical Office (CSO) of the Government of India. It is a census of manufacturing establishments with at least a 100 workers and an approximately 15 percent random sample of manufacturing establishments with between 10 and 100 workers[13]. The ASI gathers balance sheet information about establishments including ownership structure, products manufactured, employees, fixed capital, and others. Some key variables from this data include annual establishment level revenue by 8-digit product code (gross and net of taxes and distribution costs),

[12]The first five digits of the ITC code correspond to the international harmonized system codes or HS codes. There exists a correspondence between the HS codes and another international product classification system – Central Product Classification (CPC) codes, which are then linked to the National Production Classification for Manufacturing Sector (NPCMS) codes used in the ASI from 2010 onward. The ASI provide a concordance between the NPCMS and the classification they use in earlier years, the Annual Survey of Industries Commodity Classification (ASICC-2009).

[13]There are some exceptions. All establishments in State X Industry cells with fewer than four establishments are included in the sample. The sampling probability is higher in a few states.

intermediate input costs, and electricity purchased and generated.

This data is not shared with the tax authority. Documents describing and evaluating the audit procedures of the Central Board of Excise and Customs (CBEC) never mention using data from the ASI as a source of third-party information (unlike other sources that are explicitly mentioned), suggesting they are unlikely to be used in an audit. However, the data are potentially entered by the establishment from their own records, which would be available to the tax authority in case of an audit. Therefore, the firm may exhibit the same pattern of underreporting in the survey as they do in their own records.

This dataset contains 442,533 unique firm-year observations, and 820,987 firm-product-year observations because there are firms that produce multiple products. Although revenue is reported separately for each product, inputs and other firm-level variables are not. I apportion employment and input costs to each product produced by the firm according to its share in the total revenue of the establishment. The data pertain to establishments and not firms, but I treat them interchangeably because most are single-establishment firms. I clean the data using the procedure described in Appendix C, and end up with a sample of approximately 215,395 establishment-years, which excludes any establishments that closed over three years before the survey, are owned wholly or partially by a government entity or cooperative, are in states with area-based CenVAT exemptions, or have ever exported commodities. I also exclude observations which are severe outliers following a process used by Allcott et al. (2016). Most of the reduction in sample size is because I exclude establishments in exempt states and exporters, which I exclude because exports are zero-rated regardless of the commodity.

7 Descriptive Statistics

Most of the analysis in the paper focuses on establishments producing goods taxable at the standard CenVAT rate, which covers the majority of output and employment in the organized manufacturing sector [14]. Because the ASI is focused on manufacturing, most commodities (about 55 percent of observations) in the ASI fall into the standard CenVAT rate category (See Table 1). A large minority of commodities are exempt (about 21

[14]The ASI data is often referred to as data on the "organized" manufacturing sector as the frame for the ASI comes from factories that are registered under the Factory Act 1948. Firms can be registered under the Factory Act but unregistered with the tax authority. Firms that are unregistered under the Factories Act may still be registered with the tax authority. The organized sector as defined by registration under the Factories Act accounts for less than 20 percent of total manufacturing employment in India. The remaining firms are in the "unorganized" sector, which is covered in a similar but separate survey only in the years 2005 and 2010. I also combine data from these surveys for some parts of the analysis.

Table 1: Distribution of Establishments by CenVAT rate

	Number of Observations	**Percent of Sample**
Standard	215135	54.5
Exempt	81668	20.7
Other CenVAT	61934	15.7
Other	36034	9.1
Exempt States	62168	8.9
Establishment-Years	37568	9.1
Exporter	151720	21.8
Establishment-Years	80230	19.5

Note: Unweighted counts, weighted proportion of sample. Annual data from 2004 - 2015. CenVAT rate categories are divided into "Standard", "Exempt", "Other CenVAT", and "Other". Goods falling into the "Other" category are petroleum, tobacco etc., which sometimes have specific rates and are ineligible for input tax credits. "Exempt States" are states where manufacturing in some regions or in the entire state are exempt from the CenVAT. Exports are zero-rated. Observations are Establishment X Product X Year, except for rows 6 and 8, which list Establishment X Year statistics.

percent of observations), and others are taxed at non-standard rates[15]. Overall output of taxable manufacturing commodities was about 86 percent of organized manufacturing output in 2005 and 84 percent of organized manufacturing output in 2012, and a similar proportion of employment in each year (82 percent in 2005 and 86 percent in 2012). I exclude petroleum from the analysis because petroleum producers do not receive input tax credits (and therefore the CenVAT is not a VAT for petroleum).

Each establishment can produce multiple products, which may not all belong in the same tax rate category. Multi-product establishments report revenue, distribution costs and taxes remitted on each final product separately but do not separately report inputs. In such cases I apportion inputs to each product in proportion to its share in the total value of establishment output for analysis at the establishment-product level. I classify an establishment as a producer of standard CenVAT rate goods if at least 75 percent of its production value is taxable at the standard CenVAT rate. Results are similar if I change the definition to at least 90 percent of the production value taxable at the standard CenVAT rate. Most establishments that produce a good taxable at the standard rate, produce only goods that are taxable at the standard CenVAT rate[cite].

[15] As appendix tables 2 and 3 show, exempt industries are agriculture, manufacture of food products, publishing, and some primary stage products in non-metallic, leather and apparel industries.

Table 2: Establishment Characteristics

	Sole Proprietorship	Partnership	Public or Pvt. Limited Co.
Median Revenue (Rs. Mn), 2005	3.865	8.934	39.738
Median Revenue (Rs. Mn), 2015	9.531	19.495	89.481
Avg. Share Output Taxable (%)	68	67	78
Share of ownership category below threshold (%)	72	52	21
Share below threshold in ownership category, 2005 (%)	39	44	16
Share below threshold in ownership category, 2015 (%)	52	34	14
Establishment-Years	61328	71533	109948

Note: Unweighted counts, weighted proportion of sample. Annual data from 2004 - 2015. Exemption threshold in 2005 was Rs. 10 mn, threshold in 2015 was Rs. 15mn.

Table 3: Input Costs as Share of Revenue

	Electricity	Labor	Exempt Intermediate Inputs	All Intermediate Inputs
Average Cost as Share of Revenue	.03	.086	.398	.624
s.d. Across Products	.046	.054	.337	.162
Average Cost as Share of Revenue	.027	.08	.359	.655
s.d. Across Products	.051	.047	.324	.152
Number of Products with >100 obs	321	324	98	320

Note: Unweighted counts, weighted proportion of sample. Annual data from 2004 - 2015. Exemption threshold in 2005 was Rs. 10 mn, threshold in 2015 was Rs. 15mn.

There are area-based exemptions in the CenVAT, which in some cases exempts production in entire states such Himachal Pradesh or in designated manufacturing areas in other states. I exclude establishments in the 10 states and union territories where there are such special exemptions, which forms 9 percent of the total sample. Like most VAT systems, exports are zero-rated in the CenVAT, which means that even commodities that are taxable at the standard rate can remit zero tax on exports but receive all input tax credits. Starting in 2009, the ASI reports the share of an establishment's output that is exported. I classify any establishment that has exported any of their output after 2009 as an "exporter" and exclude them from the analysis even in years prior to 2009. About 20 percent of establishment-years are "exporters" under this definition.

8 Results

8.1 Bunching at the VAT Notch

I find evidence of substantial bunching by firms at the exemption threshold. Figure 3 shows the distribution of firms by output for taxable goods producers between 2005 and 2007 when firms whose revenue was below Rs. 10 million could opt to be exempt from the CenVAT. The y-axis shows counts of firms within bins of half a million rupees (weighted by survey weights) marked by green circles on the graph. The solid black line shows the counter factual distribution of firms estimated by omitting the region between the two dashed vertical lines at Rs. 7 million and Rs. 13 million. Comparing the actual density as represented by the green circles and the counter-factual density in black, we clearly see an excess mass of firms just below the Rs. 10 million threshold.

Once the threshold shifts to Rs. 15 million in 2008, this excess mass shifts to just below the Rs. 15 million threshold as seen in Figure 4 , which shows the density of firms by output in 2009-2015. In this figure, I show the actual density (in green circles) and the counterfactual density as estimated after omitting the region between Rs. 12 million and Rs. 20 million (region between the dashed vertical lines). This shift in the region of excess mass corresponding to the shift in the threshold shows that the excess mass occurs in response to the VAT notch at the revenue threshold.

I translate the excess mass shown in these figures into estimates of bunching. Table 4 shows the bunching estimates for all establishments and for companies separately before and after the threshold change in 2008. All estimates are statistically significant at the 1 percent level. The bunching estimate is about 5 for all establishments prior to 2008, which translates to a reduction in output of about 10 percent on average across all firms

Figure 3: Bunching at the Exemption Threshold, 2004 to 2007

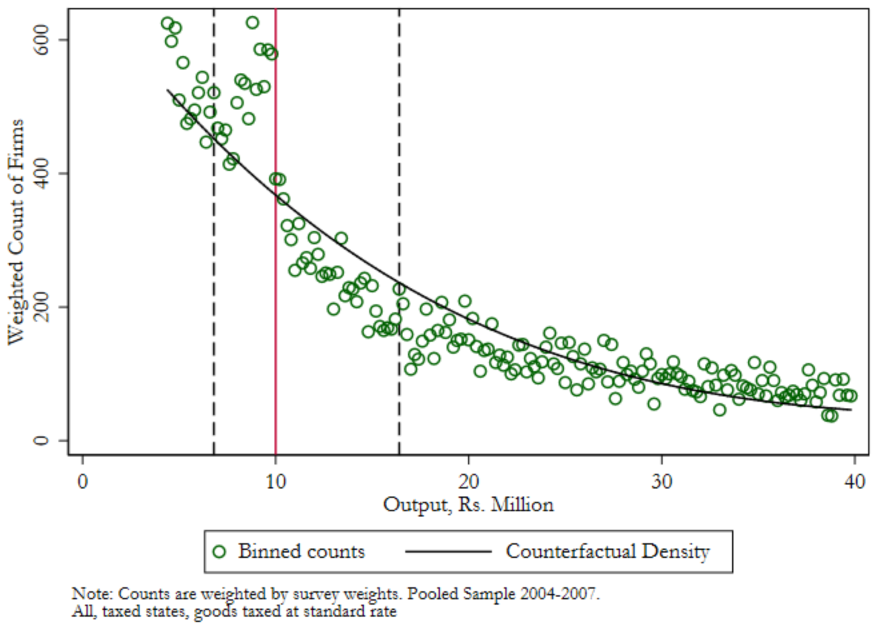


Figure 4: Bunching at the Exemption Threshold, 2010 to 2015

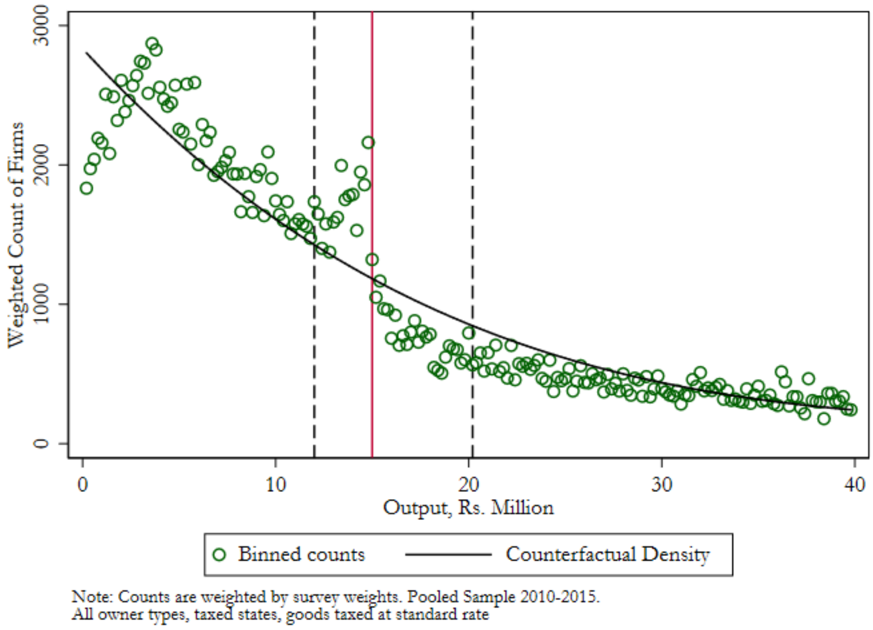


Table 4: Estimates of Excess Mass

	Pre-2008	Post-2008
All Firms	5.281	5.929
	(.766)	(.557)
Public and Private Limited Co.	10.135	10.409
	(1.722)	(1.033)

Note: Bootstrapped standard errors in parentheses. Proportion of excess mass at threshold for all types of establishments in the first row, which includes sole proprietorships, partnerships, and public and private limited companies. Second row shows bunching only among public and private limited companies. Because before 2010, sole proprietorships and partnerships faced another compliance cost notch at Rs. 4 million, the estimates in column 1, row 1, use only the distribution above Rs. 4 million to construct the counterfactual and estimate bunching.

producing goods taxable at the standard CenVAT rate. Average percent reduction in output is calculated by multiplying the excess bunching estimate with the bin size of Rs. 0.2 million to get the total reduction in output, and then dividing by the threshold level of Rs.10 mn before 2008 and Rs.15 mn after 2008 to get the percent change. Output reduction among all establishments at the new threshold after 2008 is similar – about 8.8 percent on average. Bunching is more pronounced among establishments owned by private or public limited companies before and after the threshold change. Output is reduced by about 20 percent on average among companies before the threshold change, and by 13 percent on average after the threshold changes.

This reduction in output might have been achieved either by reducing real output or by underreporting true output, even in survey data. Because firms most likely report what they record in their financial accounts to the survey, this data may reflect what they record in anticipation of audit by the tax authority. However, because they do not report some inputs to the tax authority, or cannot underreport some inputs like electricity, any real reduction in output should be reflected in changes in input use. In the next section, I estimate to what extent this recorded reduction in output is due to underreporting of output in survey data.

8.2 Real or Reporting Behavior at the VAT Notch

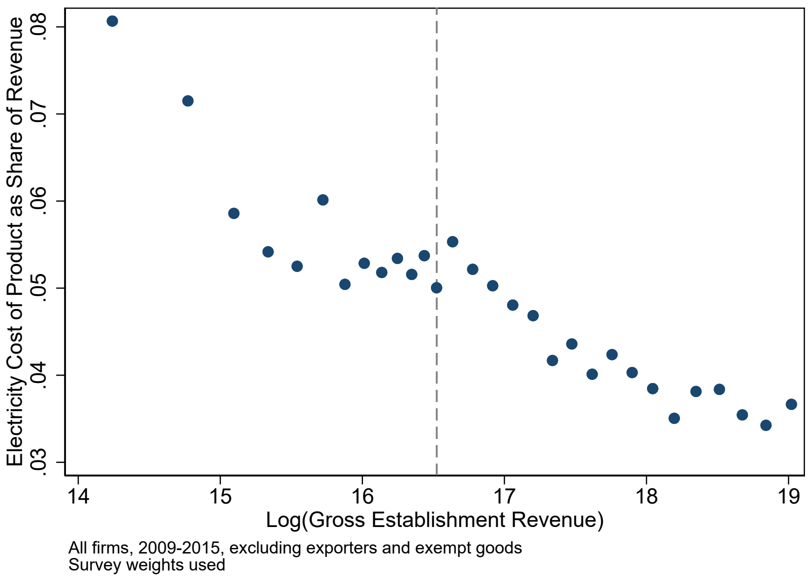
The previous section described the total reported output response to the VAT exemption threshold. In this section I use the information on firms' inputs along with the assumption that the production function for firms producing the same 4-digit product does not change at the exemption threshold, to assess whether the patterns we see are consistent with revenue underreporting or real pr

8.2.1 Electricity Share of Revenue At VAT Threshold

Figure 5 is a binned scatter-plot of the electricity cost share of revenue for each item produced with respect to the log revenue of the producing firm. Each dot represents a conditional mean of the electricity cost share within revenue bins, controlling for year fixed effects. The sample is restricted to all taxable goods producers between 2009 and 2015. The first thing to note is that there is general decline in the ratio of electricity costs to revenue but that there is an inflection in this trend around the exemption threshold.

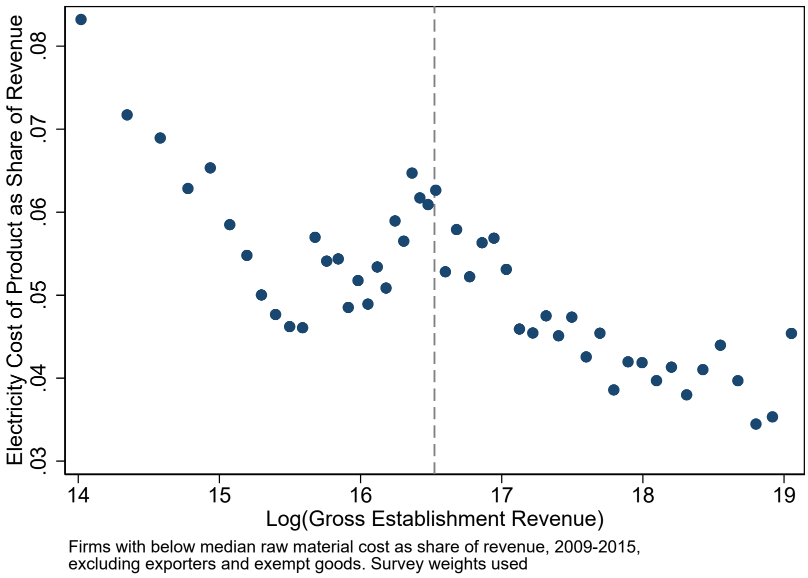
The VAT exemption threshold between 2009 and 2015 was at Rs. 15 million, indicated by the dashed vertical line. Around this threshold, there is a break in the general declining trend in the electricity cost share of revenue. We see that the cost share is below trend just below the exemption threshold.

Figure 5: Electricity Cost as Share of Revenue, 2009 to 2015



This dip in the electricity cost share trend below the threshold is more pronounced when we restrict the sample to firms who are more likely to value VAT exemption. Figure 6 shows a binned-scatter plot of electricity cost share of revenue to log reported revenue of taxable goods producers for whom raw material costs (other than electricity and fuel) are less than 70 percent of their total revenue. These firms are less likely to value input tax credits and therefore more likely to choose to be exempt from the CenVAT. The discontinuity in electricity cost share trend is even stronger among this sample.

Figure 6: Electricity Cost as Share of Revenue, 2009 to 2015, Low Raw Material Intensity



Labor costs also exhibit the same pattern even though it might be easier to underreport labor to be consistent with revenue underreporting. Figure 7 shows labor costs as a share of revenue of firms from 2009 to 2015. Again, costs as a share of revenue are generally declining in revenue but we see a dip in this trend just below the exemption threshold.

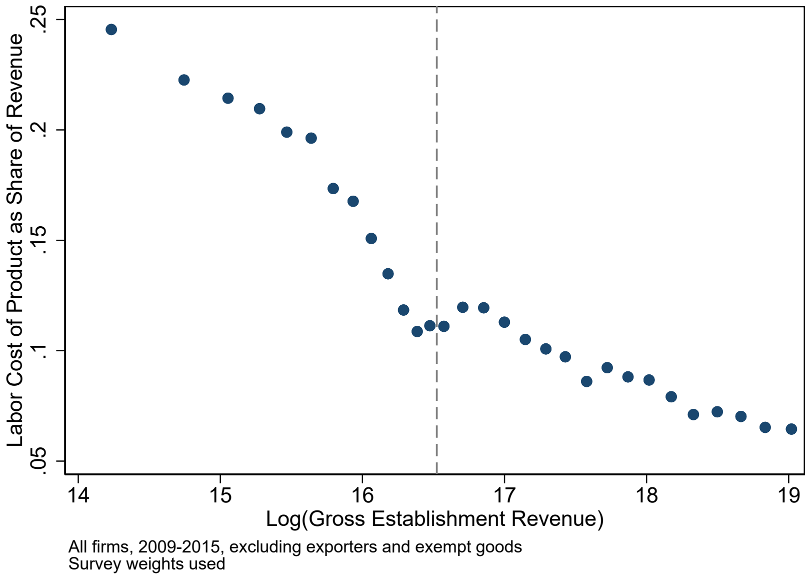
9 Alternative Explanations

9.1 Selection

Because some firms might choose to voluntarily register, we might suspect that the differences in input cost to revenue ratio around the exemption threshold might reflect the selection of some types of firms into voluntary registration. For example, if firms who are more efficient in their use of electricity (and therefore have lower electricity cost to revenue ratios) are also more likely to prefer the exemption, then we would see the same pattern of lower electricity cost shares below the threshold.

To test whether the observed break in the electricity share of revenue trend is due to selection, I compare the trend in firms' electricity share with respect to current revenue in the period before the threshold change to the trend in their current electricity shares.

Figure 7: Labor Cost as Share of Revenue, 2009 to 2015



10 Conclusion

The CenVAT exemption threshold creates a salient notch in tax liability and compliance costs for Indian manufacturing establishments. Firms that value the exemption, who are less likely to sell to CenVAT-registered businesses and are less reliant on taxable intermediate inputs in production, are more likely to lower their reported output and bunch below the exemption threshold. On average, firms' output is lower by 10 to 20 percent because of the CenVAT. This reduction in output might be due to the tax burden or due to the compliance cost associated with registration.

The pattern of input costs to revenue near the exemption threshold is more consistent with real behavior rather than underreporting at the exemption threshold.

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A Cost Share Assuming Cost of Misreporting Depends on Amount of Evasion

Rewrite equation (??) as:

$$\max_{E_i, M_i, \hat{R}_i} \Pi_i = R_i - p^M M_i - p^E E_i - \tau \hat{R}_i - c(R_i - \hat{R}_i)$$

which gives the first order condition with respect to $\hat{R}_i$ as:

$$c_e = \tau \tag{4}$$

Note that with this representation of the cost of misreporting, the increase in the marginal cost of misreporting due to an increase in true revenue is equal to the decrease in the marginal cost of misreporting due to an increase in reported revenue. That is, $-c_{\hat{R}} = c_R = c_e$, which is equal to τ by equation (4).

Therefore we can rewrite equation (??) as:

$$\alpha_E = \frac{p^E E_i}{(1-\tau)R_i} \tag{5}$$

We now have an expression for α_E in terms of known quantities aside from R_i because we only observe $\hat{R}_i$. However, once again by equation (4) we have that firms will always misreport by a constant amount. That is, in equilibrium, $R_i - \hat{R}_i = e^*$, where e^* is a constant. Let $\theta(R_i) \equiv \frac{R_i - \hat{R}_i}{R_i} = \frac{e^*}{R_i}$. Then $\lim_{R\to\infty} \theta(R_i) = 0$. By definition, $\hat{R}_i = (1-\theta)R_i$ and so for very large R_i, $\hat{R}_i \approx R_i$.

So,

$$\alpha_E \approx \frac{p^E E_i}{(1-\tau)\hat{R}_i}$$

for large firms.

B Analysis of the Exemption Eligibility Threshold in the CenVAT

In the main text, I discuss firms' response to the *CenVAT exemption threshold*, which is similar to the standard VAT exemption threshold. One of the key differences from a standard VAT is that not all firms are eligible to take this exemption even if their revenue is below the exemption threshold in that year. Exemption eligibility depends on whether their revenue in the previous year was below the *exemption eligibility threshold* of Rs. 40 mn (or Rs. 35 mn before 2008).

The exemption eligibility threshold creates a notch in firms' tax liability in the following year at the threshold in revenue this year. The size of this notch is firm and time-specific, and depends on a number of factors.

Consider the one-period profit maximization problem of a firm. Let $\Pi_{it|AR}$ denote the profit a firm that is CenVAT registered and $\Pi_{it|E}$ that takes the SSI exemption at time t and may or may not be CenVAT registered depending on their revenue in t. Firm's profit in period t if they are eligible to take the SSI exemption denoted by $\Pi_{it|C}$ is:

$$\Pi_{it|C} = \max\left\{\Pi_{it|AR}, \Pi_{it|E}\right\}$$

$\Pi_{it|C} \geq \Pi_{it|AR}$ by definition, highlighting that firms' profit if they can choose the exemption will be at least as high as their profit if they are ineligible for the exemption.

Now consider the firm's problem in period $t-1$:

$$\Pi_i = \max_{M_{it-1}, E_{it-1}, \hat{R}_{it-1}} \Pi_{it-1}(M_{it-1}, E_{it-1}, \hat{R}_{it-1}) + \beta\{\mathbf{I}(\hat{R}_{it-1} > \tilde{R})\Pi_{it|AR} + \mathbf{I}(\hat{R}_{it-1} < \tilde{R})\Pi_{it|C}\}$$

where Π_i is the present value of total profit in both periods, Π_{it-1} is the one-period profit at time $t-1$, which is a function of inputs (M_{it-1}, E_{it-1}) and reported revenue $\hat{R}_{it-1}$ at time $t-1$, and β is their discount factor. The above expression makes it clear that the notch depends β and the difference in firm's profit in period t with and without the exemption eligibility, $(\Pi_{it|C} - \Pi_{it|AR})$.

I find that the distribution of output among taxable goods producers around the threshold $\tilde{R}$ is smooth and similar to the distribution of exempt goods producers. This could be due to a number of factors: (1) the size of the notch is small for firms whose potential period

$t-1$ output is close to but greater than $\tilde{R}$, i.e. firms who might be induced to bunch at the threshold, (2) optimization error is large, (3) enforcement is higher for firms at this output level and so output elasticity with respect to tax is lower – the audit manual of the tax authority specifically targets firms who have been below this exemption eligibility threshold for a few years, (4) the discount factor is very high, or (5) what firms value most about the exemption is not the reduction in tax liability but the reduction in compliance cost.

Ultimately, firms do not seem to respond to the exemption eligibility notch, and it does not affect firms' behavior at the exemption threshold.

C Data Cleaning

There are approximately 442,533 unique firm-year observations, and 820,987 firm-product-year observations because there are firms that produce multiple products. Although revenue is reported separately for each product, inputs and other firm-level variables are not. I apportion employment and input costs to each product produced by the firm according to its share in the total revenue of the establishment. Although the data pertain to establishments and not firms, I treat them interchangeably because most of them are single-establishment firms. I exclude establishment-year observations where the establishment had been closed or not operating in the last three years, which reduced the sample to 441,394 establishment-years. I also exclude government owned or cooperative establishments, which further reduces the sample to 427,938 establishment-years. Excluding establishments wholly or partially owned by public entiries, I am left with 413,202 establishment-years. For most of the analysis I exclude establishments in states with area-based CenVAT exemptions either for the whole state or for large manufacturing hubs within the state. This reduces the sample to 321,635 observations. Similarly, I exclude establishments that have ever exported because exports are zero-rated regardless of the commodity produced. This leaves me with a final sample of 272,592 observations. Finally, I follow Allcott et al. (2016) to identify and exclude extreme outliers in terms of key production variables such as revenue, employment, electricity use, input use, and productivity, which leaves me with 215,395 establishment-year observations.