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Dynamics of Firm Growth around Tax Thresholds : Evidence from India*

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Abstract

Promoting growth of small firms is an important policy concern. However, size-based policies can incentivize firms to remain below a threshold. Using the context of an Indian revenue-based tax registration threshold that affected only manufacturing firms but not services firms, coupled with administrative tax data, we examine how firm *growth* responds to the threshold. We find that firms respond by slowing down growth in reported revenue from far below the threshold. Our difference-in-difference estimates suggest this slowdown to be around 14 percentage points or roughly 42% of average growth. A lack of corresponding change in reported costs, along with heterogeneity analysis suggests an evasion response rather than a real response by firms. We modify the standard Allingham-Sandmo model of evasion to calculate deadweight loss due to a threshold in a dynamic setting and find that the welfare cost of a threshold can be substantial in the long run.

Keywords: Bunching; Excise Tax; Firm Growth; Elasticity of Taxable Income
JEL Codes: H25; H26; D61; K34

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1 Introduction

Size-based policies are ubiquitous in policy design. Broadly, they either reduce the compliance burden or provide incentives to a group on the favorable side of a threshold. In case of firms, applicability of labor laws, eligibility of incentives and provisions of tax laws are often contingent on the size of the firm. An unintended consequence is that firms have an incentive to remain on the favorable side of the threshold which can result in a welfare loss. Therefore, understanding the magnitude of the firm's responses and underlying mechanisms are important considerations for policy design.

The current literature has viewed the impact of thresholds on firm behavior from a *static* perspective. Theoretically, the decision to bunch or not is typically modeled as a one-time decision (Saez 2010). Empirically, bunching methods used to estimate parameters such as elasticity of taxable income tend to rely on pooled data across years and examine the densities of taxpayers around the threshold (Kleven and Waseem 2013). However in many settings, the firm might respond *dynamically* across multiple periods, especially if bunching just below or above the threshold is not feasible. For instance, reporting revenue just below the threshold in the tax return for many periods might raise the probability of audit. In such cases, firms might modify not just the levels, but also the growth rates they report. There is scant empirical evidence for the impact of threshold-based policies on growth.

In this paper, we examine how Indian firms manipulate their reported growth in revenue in response to a revenue-based tax threshold. Using a difference-in-differences design that exploits the selective applicability of the Indian Central Excise Tax (or CenVAT) on firms, we find that firms slow down their growth rate as they approach the threshold in order to increase time spent below it. The slowdown occurs well below the threshold, lower than what traditional bunching approaches would suggest. This slowdown response offers an alternative explanation for why we often observe diffused bunching in many empirical applications, which is in contrast to the literature's emphasis on optimization frictions to justify diffused bunching. We find that firms cross the threshold eventually, resuming a faster growth path. We use our dynamic model of firm evasion to distinguish between short and long run welfare losses because of evasion which is not possible to do in static analysis.

Until 2017, all Indian manufacturing firms with an annual revenue of Rs. 15 million (approximately USD 180,000) or more had to register under the Central Excise regime or CenVAT[1]. Besides increasing their tax liability, registration also implied an increase in audit probability and compliance costs for the firms. Thus, there were potentially strong incentives for firms to remain below the threshold by either misreporting their revenue or decreasing

[1]This was an ad-valorem tax collected at the time when the goods leave the factory. Since 2001, firms could deduct expenses on raw materials and capital goods, which made it a value-added tax. Firms below the threshold had the option to register voluntarily. After 2017, CenVAT, along with many other taxes, has been subsumed under the Goods and Services Tax

real production. To curb misreporting, the tax department considered significant deviations in a firm's growth rate from it's historical trends as an important criteria for shortlisting a firm for audit. This information was publicly available and created incentives for firms to slow their growth near the threshold, as opposed to bunch just below the threshold by reporting nil growth for multiple years. Notably, services firms were exempt from paying CenVAT which allows us to use them as the comparison group. Traditional datasets used to study Indian firms, such as Annual Survey of Industries, do not have information on non-manufacturing firms and over-represent larger firms. Therefore, we rely on novel corporate income tax data which includes a panel of both manufacturing and services firms from 2009-16.

Our empirical strategy proceeds in two stages. First, we determine the region below the threshold where there is a significant slowdown by manufacturing firms by comparing their revenue-bin wise differences in growth rates with the services firms. We estimate this 'slowdown window' using a fixed-effects event study type regression and show that differences in reported growth are statistically insignificant except for a few bins below the threshold. Our specification includes bin fixed effects to account for the effect of previous year's revenue on growth. A variety of firm-level controls and sector fixed effects are also included to control for confounding factors that can potentially affect the firm's growth. The few papers that have examined growth slowdowns have typically taken arbitrary cut-off points below the threshold (see for instance Muthitacharoen et al. 2021). Our procedure for calculating the slowdown window is data-driven and therefore novel.

Second, to causally estimate the magnitude of the slowdown in growth after the firms enter the slowdown window, we use the difference-in-differences estimator proposed by Chaisemartin and D'Haultfœuille (2020) (the 'dCDH' estimator). This estimator is robust to heterogeneous treatment effects and the fact that firms can move in (which is the equivalent to being treated in our setting) and out of the slowdown window during the sample period.

We find that manufacturing firms begin the slowdown from Rs. 9 million of revenue, with the threshold located at Rs. 15 million [2]. A corresponding static bunching analysis would show a spike in density starting around roughly Rs. 13 million of revenue, much higher than our estimate. Moreover, there is no abnormal increase in growth rates once the firms cross the threshold, suggesting that the slowdown was a strategic response. Using the dCDH estimator, we estimate that the manufacturing firms report around 14 percentage point lower growth in revenue as compared to services firms, once they enter the slowdown window. Given that the average growth rate of manufacturing firms outside the slowdown window in our dataset was approximately 33 percent, the threshold induced slowdown is around 42% which is economically significant.

An important question from a welfare perspective is whether firms respond to the threshold by reducing their real business operations or do they misreport revenue on the tax form to

[2] In fact, firms start slowing down from even further below than Rs. 9 million but this slowdown is not sustained and significant. We therefore take a conservative estimate of Rs. 9 million in our analysis.

avoid CenVAT. Literature on firm responses to VAT thresholds has ambiguous findings (see for instance Liu et al. 2024; Velayudhan 2018). We show that there is no differential slowdown in the growth rate of reported costs as Indian manufacturing firms approach the CenVAT threshold. This suggests that firms misreport revenue rather than actually reducing their business activity which would have resulted in reduction of input costs. We then carry out a heterogeneity analysis to further investigate whether an evasion mechanism is consistent with the data. We look at several industry-level characteristics such as the share of business-to-business transactions, share of exports and sectoral volatility in growth rates and find sharper slowdown responses when firms have greater incentives to evade. We also look at firm-level characteristics such as the network size of private auditors hired by firms. We find that firms hiring private auditors with large network sizes tend to display sharper slowdowns, suggesting an information flow channel that makes evasion easier for taxpayers – a finding consistent with the literature (see for instance Chetty and Saez 2013).

Finally, we utilize our theoretical framework that generalizes the static Allingham and Sandmo (1972) framework to a multi-period setting in the presence of an audit threshold (see also Almunia and Lopez-Rodriguez 2018). This allows us to measure the deadweight loss due to the introduction of a threshold when reported growth matters for audit probability. We find that analogous to the static case as in Almunia and Lopez-Rodriguez (2018), only the firms' evasion response and the corresponding resource cost of evasion matters for welfare. We use back of the envelope estimates to show that, in our setting, the deadweight loss from a threshold can be substantial both in the short and long run.

Related Literature: Our paper contributes to several strands of literature. First, it contributes to the nascent literature which analyzes the impact on growth rather than levels in response to size-based policies (Harju et al. 2019; Muthitacharoen et al. 2021; Garbinti et al. 2023; Liu et al. 2024). An important gap in the identification strategy of the few papers that have analyzed growth variables is to have a credible comparison group. Usually, taxpayers who are very far from the threshold or those who voluntary registered are used as the comparison group. The decision to register voluntarily is endogenous and taxpayers that are far from the threshold may be different in unobservables. Our setting provides a policy-defined exogenous comparison group.

We also contribute to the growing literature on estimation of behavioral elasticities which tries to address the shortcoming of earlier empirical literature on estimating bunching elasticity at kinks (Saez 2010) and notches (Kleven and Waseem 2013). Our framework has the advantage of explaining diffused excess mass near the threshold as a strategic response rather than a consequence of some adjustment friction such as search cost and hour constraints (Chetty, Friedman, et al. 2011); inattention and inertia (Kleven and Waseem 2013; Chetty 2012); and more generalized class of frictions (Anagol et al. 2022). Since our estimation doesn't rely on imputing a counterfactual density, our analysis does not suffer from the concerns raised by Blomquist et al. (2021) and Bertanha et al. (2023) regarding assumptions needed for such imputations.

Finally, we contribute to the significant literature on evasion by firms in response to size-based policies (Almunia and Lopez-Rodriguez 2018; Best et al. 2015). Our empirical strategy allows us to disentangle whether the firm response is driven by a real change in production or by misreporting. This allows our theoretical model of dynamic evasion to extend the literature on welfare consequences of evasion (Feldstein 1999; Chetty 2009). We are therefore, able to extend the sufficient statistic approach to a dynamic setting.

2 Theoretical Framework

To guide our empirical investigation and measure the welfare impact of a change in audit intensity in a dynamic setting, we extend the model in Almunia and Lopez-Rodriguez (2018) by converting the firm's problem to a lifetime optimization problem rather than a single-period decision. We assume that perceived audit probability depends not just on the *level* of evasion in a period but also the *growth* in reported revenue. This is also a feature of our setting – India's tax department explicitly considers past trends in its audit decisions, and this is known to taxpayers (see Appendix A.1). We characterize the optimal reporting decision which shows that firms slow down their reported growth rates as they come near a policy threshold as they anticipate future implications of current reporting choices.

A representative firm earns true revenue y_t by using inputs worth x_t in period t. To keep focus on the firm's reporting decision, we assume that both true revenue and input costs are exogenous and constant in every period. All input costs are considered tax deductible. τ is the tax rate [3]. The firm chooses how much revenue to report to the tax authority in period t, denoted by $\bar{y}_t$. The evasion in period t is given by $u_t = y_t - \bar{y}_t$. $k(u_t)$ is the convex resource cost to the firm of evading u_t with $k'(.) > 0$ and $k''(.) > 0$. F is a fixed compliance cost incurred by the firm. [4] If the firm is audited, the firm pays taxes on evaded income scaled up by a penalty factor θ, that is, it pays $(1+\theta)\tau u_t$. δ_t is the perceived audit probability in period t.

The firm's expected profits in period t can be written as:

$$E(\pi_t) = \underbrace{(1-\tau)(y_t - x_t)}_{\text{True profits net of tax}} - \underbrace{k(u_t)}_{\text{Cost of evasion}} - \underbrace{F}_{\text{Compliance Cost}} + \underbrace{(1-\delta_t)\tau u_t}_{\text{Add back savings if not caught}} - \underbrace{\delta_t \theta \tau u_t}_{\text{Penalty if caught}} \tag{1}$$

[3]We model the tax as an Excise tax on manufacturing value added, which is the case in our policy setting

[4]Examples of resource cost of evasion include costs incurred in maintaining two sets of accounts – one for the tax authority and one for internal management for instance. It could also include non-pecuniary costs such as increase in risk for risk averse taxpayers. Such resource costs are likely to increase in a convex fashion when evasion increases. By contrast, the fixed compliance cost is assumed independent of evasion, for instance a fixed fee to purchase accounting software.

The firm chooses reported revenue($\bar{y}_t$) over its lifetime in order to solve:

$$\max_{\{\bar{y}_t\}_{t=0}^{t=\infty}} \sum_{t=0}^{\infty} \beta^t E(\pi_t), \tag{2}$$

where β^t is the discount factor.

We make the above problem dynamic by considering an audit probability that depends on both level and growth of under-reporting. In a static setting, such as Almunia and Lopez-Rodriguez (2018), audit probability is given by $\delta_t = \phi h(u_t)$, where ϕ is the audit intensity and $h(u_t)$ shows that audit probability increases with the level of evasion with $h'(.) > 0$ and $h''(.) > 0$. The presumption is that traces of evasion are easier to detect with increasing levels of evasion. We alter this formulation by assuming that $\delta_t = \phi h(u_t) + \phi g(\frac{\bar{y}_t - \bar{y}_{t-1}}{\bar{y}_{t-1}})$, such that $0 \leq \delta_t \leq 1 \ \forall t$.[5] The function $g(.)$ shows the negative relation between higher growth in reported income and lower audit probability, that is, $g'(.) < 0$.[6] Additionally, we consider $g''(.) > 0$ which implies that very low growth disproportionately increases perceived audit probability. The firm's choice of $\bar{y}_t$ affects both δ_t and δ_{t+1} and creates tradeoffs for it.

The firm's equilibrium choice of $\bar{y}_t$ is given by the following first-order condition:

$$k'(u_t) + \delta_t(1+\theta)\tau + \tau(1+\theta)\phi u_t \left(h'(u_t) - \frac{g'_t}{\bar{y}_{t-1}} \right) = \tau - \frac{\beta\tau(1+\theta)\phi u_{t+1}\bar{y}_{t+1}g'_{t+1}}{\bar{y}_t^2} \tag{3}$$

Equation 3 equates the marginal cost of evading an extra dollar with the marginal benefit from evading. Momentarily ignoring the terms with the g function, Equation 3 reduces to the static model as in Almunia and Lopez-Rodriguez (2018). The LHS shows that evading an extra dollar creates a resource cost for the firm captured by $k'(u_t)$, the expected cost of getting audited and paying tax on that dollar, as well as the marginal cost arising from the increased probability of detection on all infra-marginal dollars evaded. The RHS captures the marginal benefit of evasion which is the tax saved on the dollar evaded, τ.

When growth matters for perceived audit probability, the firm faces a tradeoff. Evading an extra dollar in period t lowers the reported growth in the current period t. This increases the probability of detection in period t, adding to marginal cost on the LHS (recall that $g'(.) < 0$). On the other hand, evading an extra dollar in period t, also mechanically means higher growth in period $t+1$, *ceteris paribus*. This reduces the probability of detection in $t+1$ and creates a marginal benefit to the firm on the RHS. If this marginal benefit from displaying strong growth next period outweighs the marginal cost arising from slower growth today, the firm responds by evading more today. The model thus incorporates an interaction between levels and growth

[5] For notational ease, let $g_t = g(\frac{\bar{y}_t - \bar{y}_{t-1}}{\bar{y}_{t-1}})$ and $g_{t+1} = g(\frac{\bar{y}_{t+1} - \bar{y}_t}{\bar{y}_t})$

[6] In our setting, the tax officials consider *deviations* from historical trends in reported income to decide whether to audit a firm(CBEC 2015). This would flag a firm that exhibits either a very high or low growth rate. Although exceptionally high growth may indicate evasion, for instance in the case of invoice mills, we abstract away from such instances. Our model assumes that only a lower growth causes a higher perceived audit risk.

of reported income. [7]

Growth Dynamics Near the Threshold: We model the effect of the threshold as an increase in audit intensity from ϕ to $\bar{\phi}$ once reported revenue exceeds the threshold. [8] Let t^* be the period until which the firm reports revenue below the threshold, crossing it in $t^* + 1$. With the threshold, the FOC can be written as:

$$k'(u_{t^*}) + \delta_{t^*}(1+\theta)\tau + \tau(1+\theta)\phi u_{t^*}\left(h'(u_{t^*}) - \frac{g'_{t^*}}{\bar{y}_{t^*-1}}\right) = \tau - \frac{\beta\tau(1+\theta)\bar{\phi}u_{t^*+1}\bar{y}_{t^*+1}g'_{t^*+1}}{\bar{y}^2_{t^*}} \quad (4)$$

Equation 4 is analogous to Equation 3 except that the LHS contains ϕ, whereas the RHS contains $\bar{\phi}$ since the firm is above the threshold in t^*+1. The increase in audit intensity implies that the firm will evade more in period t^* and slowdown its growth relative to a situation in which there is no threshold. To see this, note that in Equation 4, there is an extra marginal benefit on the RHS of evading more in period t^* (relative to there being no threshold), because the audit intensity in $t^* + 1$ is higher. Intuitively, the higher audit intensity in $t^* + 1$ means that reporting higher growth in that period translates into larger reduction in perceived audit probability. To achieve this higher growth in $t^* + 1$, the firm evades more in t^* which implies a fall in the growth rate in t^*.

Since $g(.)$ is assumed to be convex, a large reduction in growth rate will lead to a very sharp increase in audit probability. To avoid that, the firm will decrease growth rates in the periods before t^* too, which would appear as a gradual fall in growth below the threshold. We test this key prediction of the model in the empirical section.

After crossing the threshold, Equation 3 will again apply, but now with higher audit intensity $\bar{\phi}$ on both LHS and RHS . The change in the subsequent growth path, relative to facing lower audit intensity, is ambiguous and will depend on the relative magnitudes of the $h(.)$ and $g(.)$ functions. In Appendix A.2, we simulate the growth path of a firm in response to the threshold by assuming specific functional forms and parameters. Our simulations are consistent with the model – firms respond to the audit threshold by slowing down their growth below it. After crossing, firms increase the level of reported income which translates into a sharp increase in growth. Thereafter, the growth path is determined by the tradeoffs between levels of evasion in the current period and future growth.

[7] Note that our model assumes that low growth creates a higher audit risk only for the period in which growth was low. Firms that are audited in this dynamic framework pay penalty for evasion only in one period and not for previous periods. This is sufficient to generate the trade-offs in our model.

[8] In our policy setting, the effect of the threshold is, in fact, a combination of increase in audit intensity, compliance costs and marginal tax rate. We show empirically that the firm response is not driven by changes in the tax rate. Our heterogeneity analysis argues that audit intensity is a more plausible channel than compliance costs in driving behavior. We, therefore, model the threshold as an increase in audit intensity alone.

3 Context and Data

Until 2017, India levied CenVAT on all manufacturing firms which was collected by the Central government. Services firms were exempt. The tax originated as an ad-valorem Excise tax on manufacturing which gradually took on the character of a VAT, as credit was allowed for taxes paid on inputs used in production. Since 2003, small manufacturers with revenue up to Rs. 15 million could avail two options under the provisions of the newly introduced Small Scale Industry (SSI) exemption. Either, they could choose not to pay any CenVAT and also forgo tax credits from purchases of inputs. Otherwise, they could pay a concessional rate of 60% of their output tax liability and claim input tax credit.

Manufacturers that exceeded annual revenue of Rs. 15 million but lower than Rs. 40 million, had to pay normal CenVAT rates for revenue exceeding Rs. 15 million. Up to Rs. 15 million, these firms had the same two options as described above. When annual revenue exceeded Rs. 40 million, the SSI exemption was no longer available. For such firms, tax would be applicable at the normal rate from the first Rupee of revenue and input tax credit would be allowed. This meant that there was a discontinuous increase in tax liability (a 'notch') at Rs. 40 million as the average tax rate would jump for firms marginally above the threshold as they would not be eligible for the SSI exemption.

The policy design implied that for manufacturing firms with revenue below Rs. 15 million which exercised the first option of not paying any CenVAT, there was an increase in the marginal tax rate (a 'kink') at Rs. 15 million. In addition, there was a notch in compliance cost and audit intensity as they had to start filing monthly returns and face risk-based audits based on the information filed in CenVAT returns, once they crossed the threshold [9]. For firms that exercised the second option of paying taxes at a concessional rate, there was an increase in the marginal tax rate at Rs. 15 million, and plausibly no audit intensity or compliance cost notch as such firms would have to file monthly returns even before they crossed the threshold. In our analysis, we estimate the effect of change in policy regime at the threshold of Rs. 15 million on the growth of firm's reported revenue. Since we cannot identify firms that choose the second option below Rs. 15 million, and therefore do not face an audit notch, our estimates are likely to be downward biased as only the firms that did chose the first option are likely to slowdown before the notch.

Our data comprises of the universe of Indian corporate tax returns filed between financial years 2009-10 to 2016-17. While CenVAT was applicable on both corporate and non-corporate firms, our data is restricted to corporations. The advantage of using corporate tax data is that it allows us to observe revenue for firms who were below Rs. 15 million and not filing CenVAT returns because there was no threshold-based exemption from filing corporate income tax.

[9] Note that there is a non-zero audit probability below the threshold as firms had to file a declaration with the government to claim the SSI exemption.

[10] Firms report their overall activity in the tax return which allows us to classify them into manufacturing and services firms. We restrict our sample to active firms – those which file a tax return and report a non-zero revenue in every year from 2009 to 2016. Our main analysis uses firms with annual revenue between Rs. 3-27 million to study the impact of the threshold at Rs. 15 million. Around 29% of the firms in our sample are manufacturing, while the rest are services firms. For most of the variables, we winsorize the value above 99^{th} percentile to that level to remove the effects of the outliers.

As Table 1 shows the average revenue size of the manufacturing firms is slightly larger than the services firms. Despite this, the average value add for manufacturing is lower than services because of higher average deductible expenses. The growth rate of manufacturing firms is also 25% lower than services firms. We show that threshold-based policies can explain some of this slower growth.

Figure 1 shows a frequency plot of firms by revenue bin, separately for manufacturing and services firms around the threshold of Rs. 15 million. While significant bunching is visible for manufacturing firms below the threshold, there is almost no bunching for services firms since they were exempt from CenVAT. A standard bunching approach would use Figure 1 to estimate the enforcement elasticity of taxable income by equating 'excess mass' below the threshold to the 'missing mass' above the threshold for manufacturing firms. However, such an analysis would ignore the growth effects of the threshold as shown in Figure 2. We observe a divergence in average bin-level growth rates between manufacturing and services firms in the revenue bins far below the threshold which then disappears once the threshold is exceeded. The region in which growth slows down appears is wider than the region below the threshold in which bunching is visible. Our empirical strategy provides a method to estimate the region where the slowdown occurs and the magnitude of slowdown in that region.

4 Empirical Strategy

In order to determine the extent of firm slowdown in response to the threshold, we utilize a difference-in-differences strategy using the estimator by Chaisemartin and D'Haultfœuille (2020) . We ask two distinct but related questions. First, assuming there is a slowdown, what is the distance from the threshold, in terms of revenue, from where manufacturing firms begin to slow down as compared to service firms? To estimate this 'slowdown window', we carry out an event-study type regression. Second, by how much do manufacturing firms slow down after they enter this slowdown window? The first question requires a comparison of revenue-bin wise growth rates for manufacturing and services firms, whereas the second question requires a comparison 'before' and 'after' entering the slowdown window between manufacturing and services firms. We, therefore, require two distinct but related identification assumptions.

[10] We use the terms firms and corporations interchangeably in the paper

Determining the slowdown window

We estimate the following regression specification:

$$g^R_{ikt} = \alpha_0 + \sum_{j=3}^{j=27} \alpha_j + \beta_j d_i^{Manf} \times \mathbb{1}(\text{Revenue}_{it} \in [j, j+1)) + \delta_k + \gamma_t + \Gamma \mathbf{X}_{ikt} + \epsilon_{ikt} \tag{5}$$

Where g^R_{ikt} denotes the growth in revenue for firm i, in sector k, in year t; α_j denotes revenue bin fixed effects where bins are of width Rs. 1 million; d_i^{Manf} is a dummy for manufacturing firms; δ_k denotes sector-specific fixed effects; γ_t denotes year fixed effects; $\mathbf{X}$ denotes a vector of firm-specific controls[11]; and ϵ_{ikt} denotes the error term. The reference bin is taken as Rs. $16 - 17$ million. Errors are clustered at the sector-level.

Equation 5 compares the growth of manufacturing and services firms in each revenue bin of size Rs. 1 million between Rs. 3 million and Rs. 27 million, against the reference bin. We make the identifying assumption that the differences in growth rates between manufacturing and services firms in all revenue bins in our sample would be constant if it were not for the threshold. Therefore, we attribute any change in growth rate of manufacturing firms across revenue bins to the effect of the threshold, as the policy was only applicable to the manufacturing firms. Note that the assumption does not require that manufacturing and services firms display constant growth rates over time. A threat to the validity of our assumption would arise if there are significant differences in growth rates between manufacturing and services firms in revenue bins far below or far above the threshold. We verify whether this is indeed the case in our setting.

Notably, Equation 5 does not include firm fixed effects. This implies that the estimates of the coefficients β_j's can be potentially biased as they capture differences between different manufacturing and services firms in bin j with the reference bin, and not the same firms switching bins across years. However, including firm fixed effects would also be problematic. Since firms can enter and exit bins in different years, this is likely to introduce other biases because of differential timing. As argued by Goodman-Bacon (2021), with firm fixed and year fixed effects, the estimate of β_j's would include 'forbidden comparisons' between firms that have entered bin j in a particular year ('already treated') and firms that will enter bin j in later years ('not yet treated'). Furthermore, from a practical standpoint, for each bin j, there are likely to be very few firms that switch from a revenue bin j to the reference bin within a span of 8 years of our data. Since identification would only come from such firms, if we include firms fixed effects, we are likely to get under-powered estimates. For these reasons, we do not include firm fixed effects in Equation 5.

Admittedly, the problem of forbidden comparisons will remain in the Equation 5 which

[11] We use the following controls in the regression: firm age in the last financial year for which data is available, a dummy for whether the firm is privately held, a dummy for whether the firm is incorporated as a domestic company in India and fixed effects for the state in which the firm is incorporated.

omits firm fixed effects. To address this concern, we estimate the following alternate specification:

$$g^R_{ikt} = \alpha_0 + \beta_j d_i^{Manf} \times \mathbb{1}(\text{Revenue}_{it} \in [j, j+1)) + \delta_k + \gamma_t + \Gamma \mathbf{X}_{ikt} + \epsilon_{ikt} \tag{6}$$

where Equation 6 is separately estimated for each bin j of size Rs. 1 million by using firms reporting revenue in bin j as well as the reference bin . We address the issue of forbidden comparisons by removing all firms that switch between bin j and the reference bin during the study period.

Equations 5 and 6 give us estimates of the distance below the threshold from where manufacturing firms begin to slow down in response to the threshold. If the slowdown starts from bin j', then we call the revenue interval $[j', \rho)$ as the 'slowdown window', where ρ is the threshold [12].

Magnitude of Slowdown

To get an unbiased estimate of the average slowdown in growth of manufacturing firms after they enter the slowdown window, we use the difference-in-difference estimator suggested by Chaisemartin and D'Haultfœuille (2020). dCDH estimates a weighted average of the treatment effect of 'joiners' and 'leavers', where treatment is defined as being a manufacturing firm and reporting revenue within the slowdown window in a particular year. [13] In our context, joiners are firms who enter into the slowdown window at time t when they were outside the window at time $t-1$. Similarly leavers are firms who leave the slowdown window at time t, given that they were in the window at time $t-1$. The estimator uses firms untreated in $t-1$ and t as a counterfactual for firms who are joiners at t. Analogously, it uses firms treated in $t-1$ and t as a counterfactual for firms who are leavers at t to estimate the treatment effect. Since the estimator explicitly accounts for leavers, treatment status is allowed to turn off after receiving treatment which is not the case for most difference-in-difference estimators (see Roth et al. 2023).

[12] The specification in fact allows the slowdown window to extend beyond the threshold – such as $[j', j'')$ where $j'' > \rho$. If this is the case, we would presume that firms continue to display slow growth even after crossing the threshold.

[13] The estimator is given by DID_M where

$$DID_M = \sum_{t=2}^{T} \left(\frac{N_{1,0,t}}{N_S} DID_{+,t} + \frac{N_{0,1,t}}{N_S} DID_{-,t} \right)$$

$$DID_{+,t} = \sum_{g:D_{g,t}=1, D_{g,t-1}=0} \frac{N_{g,t}}{N_{1,0,t}} (Y_{g,t} - Y_{g,t-1}) - \sum_{g:D_{g,t}=D_{g,t-1}=0} \frac{N_{g,t}}{N_{0,0,t}} (Y_{g,t} - Y_{g,t-1})$$

$$DID_{-,t} = \sum_{g:D_{g,t}=D_{g,t-1}=1} \frac{N_{g,t}}{N_{1,1,t}} (Y_{g,t} - Y_{g,t-1}) - \sum_{g:D_{g,t}=0, D_{g,t-1}=1} \frac{N_{g,t}}{N_{0,1,t}} (Y_{g,t} - Y_{g,t-1})$$

Where g denotes groups; t denotes time period; Y denotes outcome; D denotes treatment status and N denotes number of observations. See Chaisemartin and D'Haultfœuille (2020) for more details.

The dCDH estimator relies on a common trends assumption. In our setting the assumption requires that between any two consecutive time periods, the absolute difference in growth rates would be the same for all firms if they received treatment [14]. Note that the assumption permits different firms to grow at different rates. It also allows the growth rates to change in a non-linear fashion over time. The assumption only requires that the variation in growth rates between any two consecutive time periods should be the same for all firms – if the growth rate of one firm changes between any two time periods i.e it *accelerates or decelerates*, then all firms must accelerate or decelerate by the same amount.[15]

While the identification assumption can never be fully tested, Chaisemartin and D'Haultfœuille (2020) provide a placebo test. This test compares the changes in growth rates between firms that switch their treatment status at time t (i.e are joiners or leavers) with other firms whose treatment status remains stable in the pre-periods, such as $t-2$, $t-3$ etc. If the identification assumption is violated, then the firms would report differential acceleration in the pre-periods. We test for this in the data. In Appendix A.3, we discuss how the standard Two Way Fixed Effects (TWFE) model can lead to biased estimates in our setting. We confirm that bias is likely in our context using the dCDH diagnostic test.

5 Results

Slowdown Window

Figure 3 shows the results from estimating equation 5 by plotting the D-i-D coefficient for revenue growth. We observe a sustained and statistically significant slowdown in growth, by the manufacturing firms as compared to services firms, within the revenue bins between Rs. 9 million to the threshold at Rs. 15 million. While a growth spurt is visible as the the bin changes from Rs. 14-15 million to above the threshold, there is no over-compensation in growth – manufacturing firms do not compensate by growing much faster. No slowdown is observed in bins far below the threshold or in any of the bins above the threshold relative to the reference bin. We,therefore, take the slowdown window as the revenue interval Rs. $[9, 15)$ million.

As discussed previously, to account for the bias from differential treatment timing, we drop firms that switch between a revenue bin j and the reference bin. The estimating equation is then given by Equation 6 and results are shown in Figure 4. There is no change in the pattern of slowdown and the slowdown window is same as before. We also show robustness to different reference bins. Figure 5 shows the results for both 'full regression' (equation 5)

[14] The analogous condition is required without treatment. Note that we define treatment as being a manufacturing firm and reporting revenue within the slowdown window in a particular year. Groups are taken as individual firms.

[15] While this is a separate identification assumption from the one made previously to measure the slowdown window, both will be met simultaneously in a special case. That case occurs when all firms grow at a potentially different but constant rate over time and when all firms within a sector grow at the same rate.

and 'no switchers' (equation 6). The results are qualitatively similar with a marked slowdown visible from Rs. 9 million onwards and no slowdown past the threshold. Table 2 reports the results of all event study regressions. Panel A of Table 7 reports the sensitivity of the slowdown window to different bin sizes and shows that the results remain qualitatively unchanged when considering alternative bin sizes of Rs. 0.75 million and Rs. 1.5 million.

As a placebo test, we consider the threshold at Rs. 40 million, instead of Rs. 15 million, and estimate equation 5 for bins between Rs. 27 million and Rs. 50 million, taking Rs. 41-42 million as the reference bin. Our choice of this placebo threshold is motivated by the notch in tax liability at Rs. 40 million. The average tax rate increases at Rs. 40 million as the SSI exemption no longer applies and tax has to be paid on the entire revenue. Slowing down of firms before this notch would thus test whether firms respond to a notch in tax liability. As shown in Figure 6, there is no slowdown below the tax notch. Figure 7 shows placebo tests with other misspecified thresholds. In each case, there is no slowdown below the misspecified threshold. [16]

Magnitude of Slowdown

To causally establish slowdown in growth after entering the slowdown window at the firm level, we use a difference-in-differences strategy.

Table 3 reports the TWFE and dCDH estimates. The TWFE estimate is negative and significant and shows that manufacturing firms slow down, on average, by 3.1 percentage points relative to the counterfactual of there being no threshold at Rs. 15 million. The dCDH estimate in Column 2 (our preferred estimate) shows a slow down of 13.7 percentage points for manufacturing firms after they enter the slowdown window. Given that the average growth rate of manufacturing firms outside the slowdown window in our sample is 33.3%, this suggests a slowdown of 41% compared to the average growth rate, which is substantial and economically significant.

As discussed before, the dCDH estimator is a weighted average of two types of treatment effects – of joiners (firms which enter the slowdown window) and leavers (firms which exit the slowdown window). Columns 3 and 4 of Table 3 reports the treatment effects separately. For joiners, there is an 8 percentage point slowdown, while, for leavers, the slowdown is 18.9 percentage point which is much higher. This difference in magnitude is to be expected because, as seen in Figure 3, there is a spurt in growth as the threshold is crossed. Since the treatment effect for leavers compares firms exiting the slowdown window (and thus speeding up) with firms who remained in the treatment window in both $t-1$ and t, the treatment effect seems

[16] An alternative explanation for the visible slowdown below Rs. 15 million, could be that firms split production into multiple entities in order to claim the benefit of the SSI exemption for each entity. The parent entity would then appear to have slowed down at the threshold when it has in fact split. However, the SSI law contained provisions that prevented firms from splitting to claim benefits. Further, even if splitting of firms drove the slowdown, this should have occurred only very close to the threshold. Instead, we find that firms respond by slowing down far below the threshold.

large by comparison.

Next, we carry out a placebo analysis for the dCDH estimator. If treatment status first changes from $t-1$ to t, then we should not see significant 'treatment effects' when comparing treated firms which do not switch between $t-4$ to $t-3$, for instance, with those control firms that remain untreated in all 4 periods: $t-4$, $t-3$, $t-1$ and t . Similarly, we can conduct a placebo test for other pre-treatment time periods. This exercise is similar to verifying whether there are pre-trends in the standard difference-in-differences design. Figure 8 shows the results of the placebo analysis and Table 4 reports the coefficients. None of the pre-trends are significant.

We also check for the sensitivity of the results to changes in the size of the revenue bins and winsorization levels. In Panel A of Table 7 that the slowdown in growth is of similar magnitude for alternate bin widths. Before estimating the magnitude of the slowdown, we also re-estimate the slowdown window. We show in Panel B of Table 7 that at higher levels of winsorization, the results remain qualitatively unchanged.

Real Slowdown vs Reported Response

Having established a slowdown in growth due to the threshold, we examine whether this response is likely to be a real response or an evasion response. A real response would indicate that the firm chooses to stay artificially small below the threshold. This should reflect in the firm's reported costs which should correspondingly undergo a slowdown similar to revenue. We test whether this is the case. In its tax return, a firm reports different types of costs and states whether they are deductible or non-deductible while computing CenVAT.[17]

We calculate the dCDH estimate of slowdown in growth of costs after the firms enter the slowdown window and report the results in Table 5. Column 1 shows that there is no statistically significant slowdown in growth rates of deductible expenses. The next two columns show that within important non-deductible expense categories, such as fuel and wage expenses, there is no slowdown. We also estimate the slowdown in growth rate of value added which equals revenues less deductible expenses. Since there is a statistically significant slowdown in reported revenue but not in costs, we find that the growth rate of reported value-added is negative and significant at the 10% level. Thus, in the absence of a slowdown in costs, the firm's behavior is consistent with an evasion response but not with a real slowdown.

Heterogeneity in the Magnitude of the Slowdown

Next we explore some dimensions of heterogeneity in treatment effects to understand how information and incentives affect a firm's decision to misreport revenue growth to stay below the threshold. The heterogeneity results, along with the previous finding of a lack of slowdown

[17]Deductible costs include purchases of raw material and other inputs directly used in production. Non-deductible costs include wages, fuel, capital expenses and other indirect costs which are not directly used in manufacturing,such as office expenses.

below the tax notch at Rs. 40 million threshold, also provides suggestive evidence that the mechanism behind firm slowdown at the CenVAT threshold is not the increase in tax liability or compliance cost but rather an increase in the audit intensity.

All corporations must get their books of accounts audited by a *private* auditor. Using information on private auditors reported by firms in 2016, we classify manufacturing firms by whether they are part of a 'small' auditor cluster (below median) or a 'large' auditor cluster (above median) based on the number of other firms a given firm's private auditor audits. Firms which are part of large auditor clusters, would presumably have better information and be able to learn from the experience of other firms mediated by the common auditor. Consequently, we would expect such firms to slow down more sharply than firms which are part of smaller auditor clusters.

We also utilize the national Supply-Use tables (MOSPI 2016) to impute two ratios at the manufacturing sector level - Business to business sales to total sales (B2B ratio), and exports to total sales (export ratio). We then categorize manufacturing firms according to whether they belong to sectors with 'high' B2B ratios (above median) versus low B2B ratios (below median) and do the same for export ratio. Since firms in sectors with high B2B ratios are likely to generate much greater paper trails, the risk from being audited by the government is likely to be much greater for them. Therefore, we would expect such firms to slow down more sharply below the threshold. In the case of high export ratios, this pattern is likely to be reversed – being zero-rated, higher exports will lead to more instances of refunds on input taxes paid. To be able to claim those refunds, firms will have to register under CenVAT and once they have registered, they have fewer incentives to slow down.

Furthermore, manufacturing sectors with high dispersion in growth rates of firms will make it harder for government auditors to have stable reference growth numbers for the sector against which they can measure deviations in firm growth. Firms in volatile sectors can thus display wider variation in growth without fears of triggering audits. We therefore expect manufacturing firms in high volatility sectors (above median) to slow down more sharply below the threshold. [18] Appendix A.4 lists the variables used in the heterogeneity analysis and describes variable construction in more detail.

Table 6 reports the results of the heterogeneity analysis. The treatment effects are statistically significant in all the cases and along expected lines - firms that are part of larger auditor clusters, and firms that operate in industries having higher B2B sales, lower exports, and higher sales volatility tend to slow down more to avoid the threshold. Taken together these results also indicate that change in audit intensity rather compliance cost is the reason behind firm slowdown below the threshold. For instance, firms with high B2B ratios are likely to already have significant investments to satisfy compliance laws and therefore, the increase in compliance cost on registering under CenVAT is likely to be much lower for them. They would

[18]Volatility is calculated as the Coefficient of Variation i.e. the ratio of mean to standard deviation of growth in a sector as calculated from the corporate tax returns data.

thus have much lower incentives to slow down below the threshold if compliance costs were the key reason, which is opposite of what we find. Similarly, compliance costs are unlikely to be correlated with volatility in a sector. Therefore, firms in volatile sectors are unlikely to slow down more sharply at the threshold owing to compliance costs.

6 Deadweight loss due to growth slowdown

We define expected total welfare at any time t, as the sum of expected profit of the firm (π_t) and the expected revenue of the government (G_t). We implicitly assume that firms are owned by taxpayers and government revenue is returned lump-sum to the taxpayers. We therefore have:

$$E(W_t) = E(\pi_t) + E(G_t)$$

We assume a finite period model to calculate aggregate welfare, where time goes from $t = 1$ to $t = T$. In Appendix A.5, we derive an expression for the change in aggregate welfare due to a change in audit intensity which is given by:

$$\sum_{i=1}^{i=T} \beta^{i-1} \frac{dE(W_i)}{d\phi} = \sum_{i=1}^{i=T} \beta^{i-1} k_i' \frac{d\bar{y}_i}{d\phi} \tag{7}$$

Equation 7 shows that the aggregate discounted change in expected welfare from $t = 1$ to $t = T$ due to a small change in audit intensity is equal to the discounted sum of the change in resource cost of evasion multiplied by the reporting response of the firm. According to the formula, reducing enforcement intensity leads to increased evasion responses by the firm ($\frac{d\bar{y}_i}{d\phi} > 0$), which in turn reduces welfare due to increase in the resource cost of evasion (recall that $k(u_t)$ is a convex and increasing function). These costs are unproductive because they involve expenses incurred on hiding evasion, such as maintaining separate books of accounts, which do not add any real value to the economy. Payment of taxes constitute transfers from the firm to government and therefore, changes in payment of taxes due to changes in audit intensity do not affect welfare. This is analogous to the result for the static case, in Almunia and Lopez-Rodriguez (2018).

Estimate of deadweight loss

We use the insight from Equation 7 to provide a back-of-the-envelope estimate of the deadweight loss from the introduction of an audit threshold. We require – (i) estimates of the change in reported revenue because of the threshold; and (ii) the marginal change in resource cost of evasion. We consider a policy experiment where a representative firm reports revenue of Rs. 9 million in the first period and assume that $\beta = 1$.[19] We assume that without any audit threshold, this firm would have grown at the average rate of growth of manufacturing firms which are outside the slowdown window and thus, unaffected by the threshold. In our data, this is equal to 33.3%[20]. Analogous to our setting, the policy experiment involves introducing a 'Small Scale Industry' exemption at Rs. 15 million. Our empirical estimates show that the firm slows down its reported growth by 13.7 percentage points to 19.6% until it reaches the threshold of Rs. 15 million[21]. Thereafter, the firm grows at the counterfactual growth rate of 33.3%. The extra reduction in reported revenue due to the growth slowdown (which is an evasion response) compared to the counterfactual growth path will contribute to the deadweight loss arising from introducing the threshold.

Figure 9 illustrates the policy experiment. The blue line is the counterfactual growth path if we consider an exponential growth of 33.3% starting from a revenue of Rs. 9 million. The orange line displays the firm's growth path in response to a threshold at Rs. 15 million - slower growth by 13.7 percentage points up to Rs. 15 million and growth of 33.3% thereafter. The grey area between the lines in the figure measures the total change in reported revenue compared to the counterfactual till the firm reaches the threshold. This is approximately Rs. 2.59 million per year in the figure [22]. We call this the short-run response because it captures the evasion response from entering the slowdown window until the firm reaches the threshold.

Thereafter, since the firm only returns to the old growth path but does not overcompensate with extra growth, the revenue loss compared to the counterfactual continues adding up. This is shown by the blue area between the lines. The long-run response captures the evasion response from the time the firm enters the slowdown window until several years after the threshold is crossed. In the figure, the long-run response is given by the total area between the curves from $t = 0$ to $t = T$ (the sum of the grey and blue areas) divided by T. This is approximately Rs. 6.1 million per year on average.

Measuring the functional form of the resource cost of evasion is a difficult exercise. Estimates in the literature peg the marginal change in resource cost of evasion from 5% to 19% (see Chetty 2009; Almunia and Lopez-Rodriguez 2018). We make use of the assumption in Almunia and Lopez-Rodriguez (2018) that the marginal change in resource cost of evasion: $k'(u) = 0.059$. This gives the average estimated deadweight loss of $0.059 \times 2.59 =$ Rs. 0.15 million per year in the short run from the time the firm reaches the slowdown window till it crosses the threshold. The long-run estimate of deadweight loss is approximately $0.059 \times 6.1 =$ Rs. 0.36 million per

[19]We assume a revenue of Rs. 9 million because it is the start of the slowdown region according to our empirical estimates. Although firms reporting very low revenue are also affected by the threshold, we ignore them for this calculation and only focus on firms starting in the slowdown region.

[20]For simplicity, we assume that the growth is exponential. A more nuanced version of this thought experiment would involve using a bin-wise growth rate to calculate the counterfactual growth path outside the slowdown window. Instead, we have taken a weighted average of growth rates for bins outside the slowdown window.

[21]The slower growth rate of 19.6% is also assumed to be exponential

[22]Let $t = t'$ be the time at which the firm crosses the threshold which is also where the orange line intersects the threshold. The loss is reported revenue per year is calculated as the total area between the curves from $t = 0$ to $t = t'$, divided by t'.

year after the firm crosses the threshold. This is nearly 2.5 times the short run welfare loss. Such long run effects are typically ignored in static welfare analysis.

It bears reiteration that these estimates of deadweight loss from introduction of a threshold are for a representative firm that enters the slowdown window starting at Rs. 9 million. Furthermore, the deadweight loss can be attenuated by considering the savings from lower administrative costs incurred by the tax department. The reason is that as the firms slowdown and continue to remain in the low-audit regime, the administrative costs on government auditors incurred by the tax department will also fall. A full welfare analysis, to calculate the optimal threshold for instance, would have to take these aspects into account, but is beyond the scope of the present study.

7 Conclusion

In this paper, we study how firms adjust their growth rates in response to threshold-based policies in India. We demonstrate that firms reduce their reported growth rates well before reaching the threshold, an effect that is likely to be missed by the traditional static bunching approach. Using novel administrative data and policy-induced selective applicability of the CenVAT registration threshold on just the manufacturing firms, our difference-in-differences estimate suggests that, on average, small firms report 14 p.p. lower annual growth of revenue or roughly 42% lower than average growth to avoid the threshold. Once the threshold is crossed, firms revert to their old growth path and do not overcompensate for the slowdown by growing significantly faster. This leads to a loss in reported revenue growth for all future time periods.

Our theoretical framework generalizes firms' choice of evasion in a multi-period setting. We show that because of the slowdown, firms increase evasion which increases their resource cost of evasion. This causes significant gross deadweight loss because of the policy, both in the short and long run.

In future research, it would be important to extend models of optimal tax thresholds to take into account dynamic responses and long run effects. Furthermore, while we focus on Indian corporations, there may heterogeneity in responses depending on types of taxpayers, which would be important to study. For instance, it is possible that firms structured as non-corporate entities such as partnership firms might respond more strongly to such thresholds as they have lower reporting requirements. On the other hand, individual taxpayers may not change their growth path because of shorter optimization horizons, unlike firms. Finally, our analysis has shown that threshold-based tax laws which are supposed to reduce the compliance burden for small firms can also lead them to under-report revenue growth. If reported revenue growth is used for other purposes such as loan assessment by banks, then these laws can also become a real barrier of growth for small firms.

8 Tables

Table 1: Summary Statistics

	Manufacturing			
	N	Mean	Median	Std Dev
Outcome				
Turnover (Rs. million)	112358	13.2	12.5	6.76
Growth: turnover	99666	0.30	0.060	1.52
Cost				
Deductible expense (Rs. million)	112358	8.51	7.39	12.2
Growth: deductible expense	99473	0.97	0.062	8.80
Fuel expense (Rs. million)	112358	0.76	0.25	1.52
Growth: fuel expense	87016	0.24	0.048	1.39
Wages (Rs. million)	112358	1.95	1.33	3.05
Growth: wages	98167	0.27	0.076	1.05
Value added (Rs. million)	112358	4.70	3.89	11.6
Growth: value added	99664	0.18	0.023	3.08
Controls				
Firm age in years	112247	26.7	26	11.3
Dummy: private company	112338	0.95	1	0.23
Dummy: domestic company	112358	0.96	1	0.19
	Services			
	N	Mean	Median	Std Dev
Outcome				
Turnover (Rs. million)	263238	12.0	10.3	6.96
Growth: turnover	232937	0.40	0.071	1.95
Cost				
Deductible expense (Rs. million)	263238	5.53	2.30	15.9
Growth: deductible expense	230863	2.90	0.044	17.1
Fuel expense (Rs. million)	263236	0.30	0.034	1.05
Growth: fuel expense	148003	0.26	0.016	1.70
Wages (Rs. million)	263238	2.99	1.71	4.46
Growth: wages	226603	0.31	0.081	1.20
Value added (Rs. million)	263238	6.44	5.13	15.9
Growth: value added	232934	0.15	0.030	3.10
Controls				
Firm age in years	263135	22.7	20	10.3
Dummy: private company	263213	0.94	1	0.24
Dummy: domestic company	263238	0.96	1	0.18

Notes: The summary statistics are of Indian corporations which filed a corporate tax return and reported a non-zero revenue in every year from 2009 to 2016. We restrict the the sample to firms who reported annual turnover between Rs.3 million and Rs.27 million. The top panel consists of manufacturing firms while the bottom panel consists of services firms. Growth rates of all the variables are defined with the current year as the base, relative to the subsequent year. The count of observations refers to firm-years. We winsorize the growth rates of turnover, deductible expenses, fuel and wages above the 99th percentile to that level. Since value added or taxable income under CenVAT can take negative values, we censor the tales of the distribution of its growth at the 1st and the 99th percentiles.

Table 2: Origin of Growth Slowdown because of Audit Threshold

	Reference Bin = 16		Reference Bin = 17		Reference Bin = 18	
	(1) *Full*	(2) *No switchers*	(3) *Full*	(4) *No switchers*	(5) *Full*	(6) *No switchers*
Below Threshold:						
Manufacturing x Bin = 3	0.0488	0.0411	0.0537	0.0498	0.0568	0.0566
	(0.091)	(0.089)	(0.103)	(0.103)	(0.113)	(0.103)
Manufacturing x Bin = 4	0.0208	0.00249	0.0365	0.0112	0.0488	0.0180
	(0.063)	(0.063)	(0.082)	(0.082)	(0.085)	(0.079)
Manufacturing x Bin = 5	−0.0528	−0.0727	−0.0512	−0.0639	−0.0553	−0.0571
	(0.060)	(0.059)	(0.077)	(0.077)	(0.073)	(0.074)
Manufacturing x Bin = 6	-0.105^{**}	-0.108^{**}	−0.0746	−0.0996	-0.0939^{*}	−0.0928
	(0.043)	(0.044)	(0.059)	(0.061)	(0.055)	(0.056)
Manufacturing x Bin = 7	−0.0342	−0.0326	−0.0212	−0.0239	−0.0106	−0.0171
	(0.041)	(0.037)	(0.046)	(0.051)	(0.051)	(0.052)
Manufacturing x Bin = 8	-0.0743^{*}	-0.0764^{*}	−0.0664	−0.0676	−0.0463	−0.0608
	(0.042)	(0.042)	(0.056)	(0.060)	(0.043)	(0.048)
Manufacturing x Bin = 9	-0.129^{***}	-0.121^{***}	-0.118^{**}	-0.112^{**}	-0.0997^{*}	-0.105^{**}
	(0.039)	(0.037)	(0.057)	(0.054)	(0.052)	(0.049)
Manufacturing x Bin = 10	-0.123^{***}	-0.109^{***}	-0.122^{**}	-0.0997^{**}	-0.0978^{**}	-0.0930^{**}
	(0.040)	(0.030)	(0.048)	(0.042)	(0.046)	(0.044)
Manufacturing x Bin = 11	-0.144^{***}	-0.124^{***}	-0.148^{**}	-0.116^{*}	-0.122^{***}	-0.109^{**}
	(0.045)	(0.039)	(0.067)	(0.059)	(0.047)	(0.047)
Manufacturing x Bin = 12	-0.120^{***}	-0.0973^{**}	−0.104	-0.0885^{*}	−0.0914	−0.0817
	(0.046)	(0.043)	(0.064)	(0.052)	(0.062)	(0.051)
Manufacturing x Bin = 13	-0.175^{***}	-0.108^{***}	-0.129^{***}	-0.0995^{***}	-0.123^{***}	-0.0927^{***}
	(0.044)	(0.033)	(0.046)	(0.036)	(0.033)	(0.028)
Manufacturing x Bin = 14	-0.140^{***}	-0.0985^{***}	-0.134^{***}	-0.0897^{**}	-0.115^{***}	-0.0829^{***}
	(0.041)	(0.028)	(0.043)	(0.037)	(0.034)	(0.029)
Above Threshold:						
Manufacturing x Bin = 15	−0.0319	−0.0122	−0.00828	−0.00343	−0.00619	0.00336
	(0.050)	(0.037)	(0.062)	(0.047)	(0.056)	(0.041)
Manufacturing x Bin = 16	0	0	−0.0107	0.00875	0.0166	0.0156
	(.)	(.)	(0.053)	(0.038)	(0.044)	(0.033)
Manufacturing x Bin = 17	0.0107	−0.00875	0	0	0.0244	0.00680
	(0.053)	(0.038)	(.)	(.)	(0.049)	(0.037)
Manufacturing x Bin = 18	−0.0166	−0.0156	−0.0244	−0.00680	0	0
	(0.044)	(0.033)	(0.049)	(0.037)	(.)	(.)
Manufacturing x Bin = 19	−0.0497	−0.0474	−0.0471	−0.0386	−0.0271	−0.0318
	(0.044)	(0.037)	(0.052)	(0.042)	(0.043)	(0.036)
Manufacturing x Bin = 20	−0.0364	−0.0288	−0.0173	−0.0200	0.00357	−0.0132
	(0.056)	(0.046)	(0.065)	(0.053)	(0.053)	(0.048)
Manufacturing x Bin = 21	−0.0236	−0.0271	−0.0190	−0.0183	−0.00808	−0.0115
	(0.050)	(0.040)	(0.070)	(0.057)	(0.054)	(0.045)
Manufacturing x Bin = 22	−0.00230	−0.0280	−0.000457	−0.0193	0.0176	−0.0125
	(0.052)	(0.046)	(0.045)	(0.037)	(0.041)	(0.035)
Manufacturing x Bin = 23	−0.0626	−0.0510	−0.0643	−0.0422	−0.0366	−0.0354
	(0.047)	(0.040)	(0.045)	(0.039)	(0.042)	(0.037)
Manufacturing x Bin = 24	0.00714	0.00279	−0.0000624	0.0115	0.0108	0.0183
	(0.044)	(0.037)	(0.058)	(0.051)	(0.035)	(0.030)
Manufacturing x Bin = 25	−0.0496	−0.0207	−0.0243	−0.0119	−0.00974	−0.00515
	(0.036)	(0.034)	(0.043)	(0.039)	(0.027)	(0.024)
Manufacturing x Bin = 26	−0.0480	-0.0531^{*}	−0.0454	−0.0443	−0.0193	−0.0375
	(0.037)	(0.031)	(0.036)	(0.029)	(0.041)	(0.033)
Manufacturing x Bin = 27	0.0215	0.0222	0.0367	0.0309	0.0359	0.0377
	(0.062)	(0.055)	(0.057)	(0.049)	(0.057)	(0.048)

Notes: This table reports bin-wise differences in revenue growth rates of manufacturing versus services firms, as compared to the reference bin. We take three separate references bins to show robustness of the estimates. The coefficients in the first column, within each reference bin category, corresponds to the $\beta_j^{\prime} s$ of the Equation5. This specification includes sector-wise and year fixed effects. It also includes some firm-specific controls. The second column, within each reference bin category, reports estimates from bin-wise regressions as described by Equation 6. Each regression drops firms that switch between the reference bin and the bin corresponding to each row. All estimates are in percentage points. Note that the audit threshold was Rs. 15 million during the sample period. We use tax return data of Indian corporations from 2009-16 which had a revenue between Rs 3 million and Rs. 27 million.
Standard errors are reported in parentheses and clustered at the level of the industry in which the firm is operating. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Effect of Audit Threshold on Revenue Growth

	TWFE	dCDH		
		All Firms	Joiners	Leavers
Treatment Effect	$-.0307^{***}$	$-.1369^{***}$	$-.0802^{***}$	$-.1893^{***}$
	(.0094)	(.029)	(.0176)	(.05)
Include Firm FE	✓	✓	✓	✓
Include Year FE	✓	✓	✓	✓
Include Bin FE	✓	✓	✓	✓
N	319728	235264	208874	26390
Mean growth: manufacturing firms outside slowdown window		.333		

Notes: This table shows difference-in-differences estimates of the decrease in growth of reported revenue of manufacturing firms because of the threshold. All estimates are in percentage points. The first column shows estimate from the standard two-way fixed effects regression, as shown by Equation A-1, while the rest of the columns use the dCDH estimator. Column 2 shows the weighted average of the treatment effects of both manufacturing firms that enter the slowdown window (joiners) and the manufacturing firms that leave the the slowdown window (leavers). Columns 3 and 4 show the treatments effects separately for joiners and leavers, respectively. All the regressions include fixed effects for revenue bins of size Rs. 1 million each, besides firm and year fixed effects. The average growth rate of manufacturing firms outside of the slowdown window is 33% per annum. We use tax return data of Indian corporations from 2009-16 which had a revenue between Rs 3 million and Rs. 27 million. Bootstrapped standard errors are reported in parentheses and clustered at the level of the industry in which the firm is operating. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Placebo Estimates of Growth Slowdown.

	t-5 to t-4	t-4 to t-3	t-3 to t-2	t-2 to t-1	t-1 to t (Treatment Effect)
Estimate	-.0046	-.011	.0017	-.0033	$-.1369^{***}$
	(.0125)	(.012)	(.0118)	(.0174)	(.029)
Include Firm FE	✓	✓	✓	✓	✓
Include Year FE	✓	✓	✓	✓	✓
Include Bin FE	✓	✓	✓	✓	✓
N	55610	86349	127258	184196	235264

Notes: This table shows the period-wise average treatment effects using the dCDH estimator. The treatment effect is calculated by comparing the growth rates of all the manufacturing firms that switch their treatment status either by entering or exiting the slowdown window from $t-1$ to t to the rest of the firms. The treatment effects measures the differential slowdown in revenue growth in percentage points. Columns 1-4 show the treatment effects in years before the manufacturing firms switch their treatment status, while column 5 shows the treatment effect in the year of entering or exiting the slowdown window. For instance, the first column compares growth of treated firms who do not switch between $t-5$ to $t-4$ with control firms that remain untreated in all 4 periods: $t-5$, $t-4$, $t-1$, & t . An insignificant coefficient implies that, on average, firms in both the treatment and control groups are accelerating or decelerating at the same rate. All the regressions include fixed effects for revenue bins of size Rs. 1 million each, besides firm and year fixed effects. We use tax return data of Indian corporations from 2009-16 which had a revenue between Rs 3 million and Rs. 27 million.
Bootstrapped standard errors are reported in parentheses and clustered at the level of industry the firm is operating it. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Table 5: Impact of Threshold on Growth Rates of Costs and Value Added.

	Deductible Expenses	Fuel	Wages	Value Added
Treatment Effect	-.0165	.0214	-.0169	$-.1201^{*}$
	(.1185)	(.0396)	(.0162)	(.0623)
Include Firm FE	✓	✓	✓	✓
Include Year FE	✓	✓	✓	✓
Include Bin FE	✓	✓	✓	✓
N	232532	152675	228257	235261
Mean growth: manufacturing firms outside slowdown window	1.072	.254	.285	.187

Notes: This table shows the difference-in-differences estimates using the dCDH estimator. The treatment effect is calculated by comparing the growth rates of all the manufacturing firms that switch their treatment status either by entering or exiting the slowdown window to the rest of the firms, at a given point in time. The first column shows the threshold impact on expenses that the firms can deduct while calculating their taxable profits under CenVAT. These include input purchases, freight, spare parts, machinery repairs, audit fee and advertisement expenses. The next two columns show the changes in growth rates of expenses on fuel and wages, which are non-deductible under CenVAT, while the last column shows the slowdown in growth of taxable profits. All estimates are in percentage points. All the regressions include fixed effects for revenue bins of size Rs. 1 million each, besides firm and year fixed effects. We use tax return data of Indian corporations from 2009-16 which had a revenue between Rs 3 million and Rs. 27 million.

Bootstrapped standard errors are reported in parentheses and clustered at the level of the industry in which the firm is operating. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Heterogeneity in Slowdown of Revenue Growth

	Private auditor Cluster Size		B2B Ratio		Export Ratio		Volatility	
	Below Median	Above Median	Below Median	Above Median	Below Median	Above Median	Below Median	Above Median
Treatment Effect	$-.0837^{***}$	$-.1255^{***}$	$-.122^{***}$	$-.1413^{***}$	$-.1434^{***}$	$-.1114^{***}$	$-.1246^{***}$	$-.1459^{**}$
	(.0208)	(.042)	(.0401)	(.0376)	(.0378)	(.0274)	(.0246)	(.06)
Include Firm FE	✓	✓	✓	✓	✓	✓	✓	✓
Include Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Include Bin FE	✓	✓	✓	✓	✓	✓	✓	✓
N	123597	126068	131956	154092	153803	132241	191477	204035
Median values: manufacturing firms	6	6	.68	.68	.07	.07	5.2	5.2
Mean growth: manufacturing firms outside slowdown window	.452	.527	.372	.31	.338	.325	.391	.289

Notes: Since our sample consists of corporations, all firms in the sample must undergo annual audits by a private auditor. The first two columns divide manufacturing firms according to the number of firms their private auditor audits. For instance, private auditors of firms that are included in the 'above median' sample in Column 2 audited at least 6 other firms. The control group is not divided in this way and the full control group is taken. The rest of the columns divide manufacturing firms as per their industrial characteristics. Columns 3-6 divide manufacturing firms into industries that have high versus low Business-to-Business sales as a proportion of total sales and ratio of exports to total sales. We get information on these industrial characteristics from the National Supply-Use Tables for 2016. The control group is unchanged. The last two columns segregate manufacturing firms according to industrial-level volatility in sales. The control group is unchanged. We measure volatility in our data using coefficient of variation. Median values refers to the median cluster size, B2B ratio, export ratio and volatility for manufacturing firms. As before, all estimates are in percentage points. All the regressions include fixed effects for revenue bins of size Rs. 1 million each, besides firm and year fixed effects. We use tax return data of Indian corporations from 2009-16 which had a revenue between Rs 3 million and Rs. 27 million.
Bootstrapped standard errors are reported in parentheses and clustered at the level of the industry in which the firm is operating. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

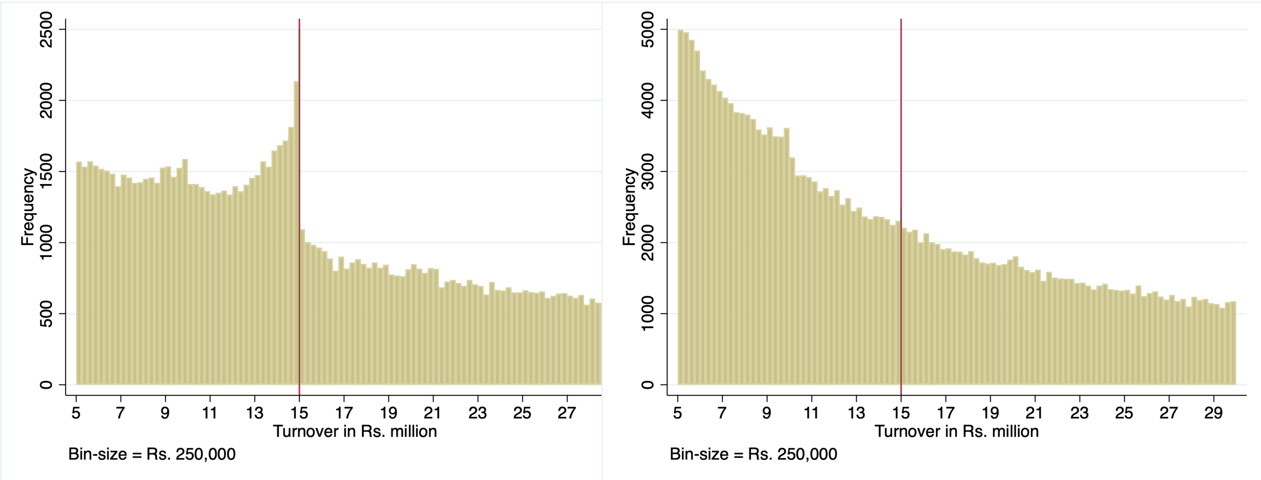
Table 7: Alternative estimates of Growth Slowdown

	Panel A: Robustness to Bin Size (in millions)		
	$BinSize = 0.75$	$BinSize = 1$	$BinSize = 1.5$
Treatment Effect	$-.1404^{***}$	$-.1369^{***}$	$-.1212^{***}$
	(.0213)	(.029)	(.0273)
Slowdown Bins	8.25 − 15	9 − 15	9 − 15
N	235264	235264	235264
Counterfactual Mean Growth	.326	.333	.333
	Panel B: Robustness to Winsorization Levels		
	98^{th} percentile	97^{th} percentile	
Treatment Effect	$-.1348^{***}$	$-.1258^{***}$	
	(.0261)	(.0266)	
Slowdown Bins	8 − 15	8 − 15	
N	235264	235264	
Counterfactual Mean Growth	.29	.261	

Notes: This table shows the difference-in-differences estimates of the decrease in growth of reported revenue of manufacturing firms because of the threshold, as compared to the control group. All the columns use the dCDH estimator. In Panel A, we vary the size of revenue bins. For each bin size, we estimate the bins where the firms slowdown, because of the threshold, using Equation 5. In Panel B, we censor the right tale of the distribution at the 98^{th} and 97^{th} percentiles. In the main regression, we used the 99^{th} percentile. All the regressions include bin fixed effects, besides firm and year fixed effects. The counterfactual mean growth refers to the average growth rate of manufacturing firms outside of the slowdown window . We use tax return data of Indian corporations from 2009-16 which had a revenue between Rs 3 million and Rs. 27 million. Bootstrapped standard errors are reported in parentheses and clustered at the level of the industry in which the firm is operating. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

9 Figures

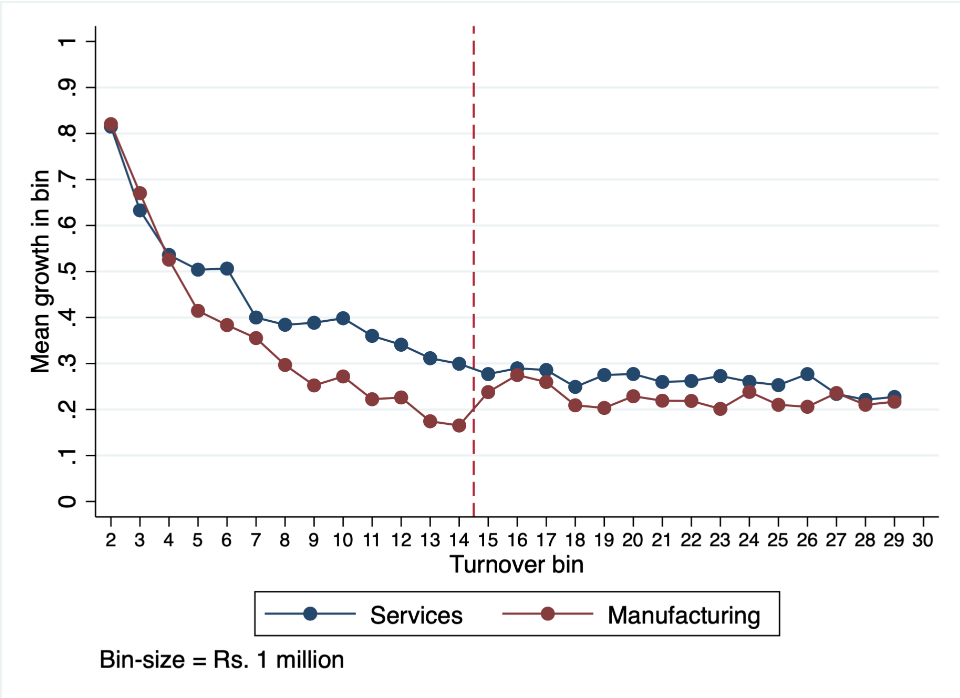
Figure 1: Bunching at the threshold: Manufacturing versus Services



(a) Manufacturing Firms (b) Services Firms

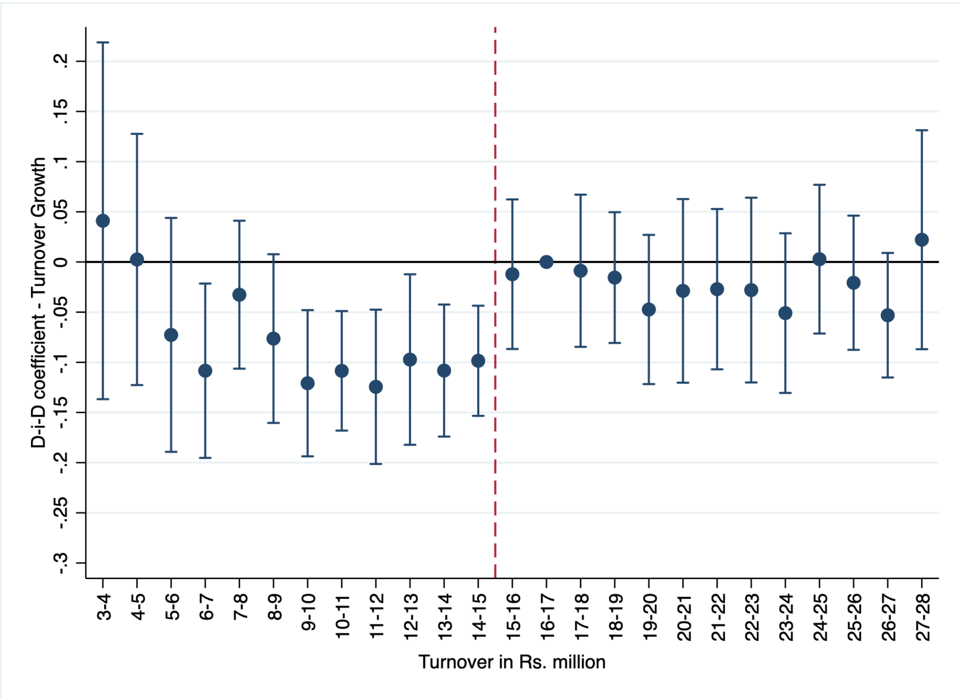
Note: This figure plots the pooled frequency distributions of corporations in India from 2009-16 separately for manufacturing and services firms. If a manufacturing firm reports a revenue greater than Rs. 15 million, then it had to mandatorily register under CenVAT. Services firms were entirely outside the purview of CenVAT.

Figure 2: Raw growth rates by revenue bin



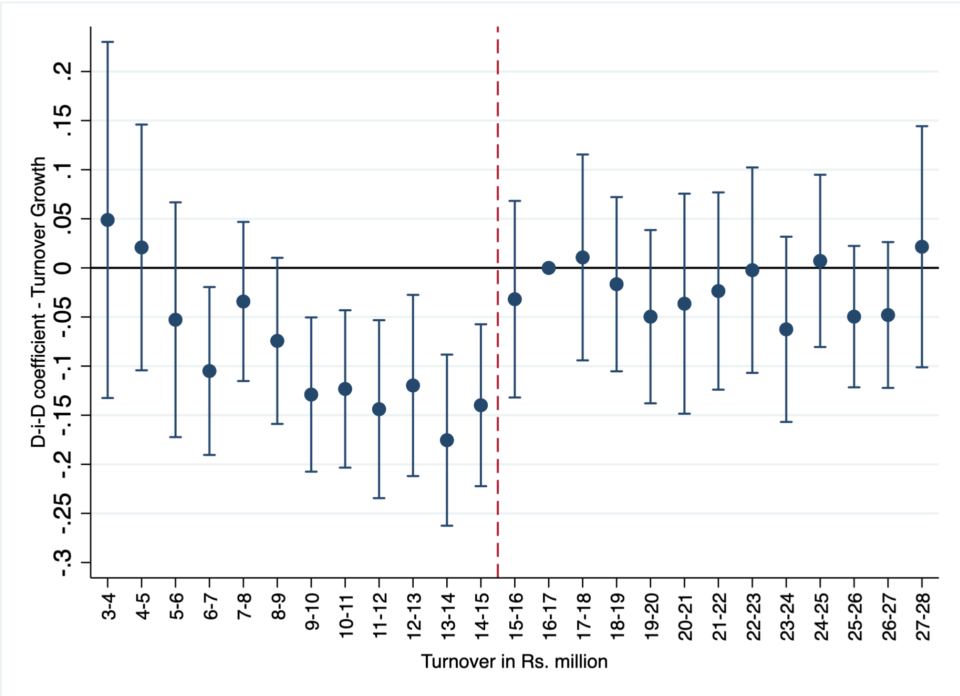
Note: This figure shows the bin-wise average reported growth rates of revenue by all corporations in India from 2009-16 separately for manufacturing and services firms.

Figure 3: Event Study - Main



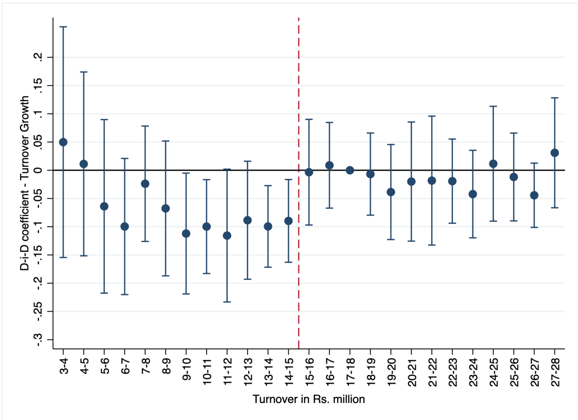
Note: This graph shows the β coefficients estimated using Equation 5. They represent the bin-level average differences between the growth rates of manufacturing versus services firms. We also show the 95% confidence intervals. The reference bin is Rs.16-17 million. The data consists of all corporations in India from 2009-16 which had a revenue between Rs 3 million and Rs. 27 million.

Figure 4: Event Study - Robustness with no switchers

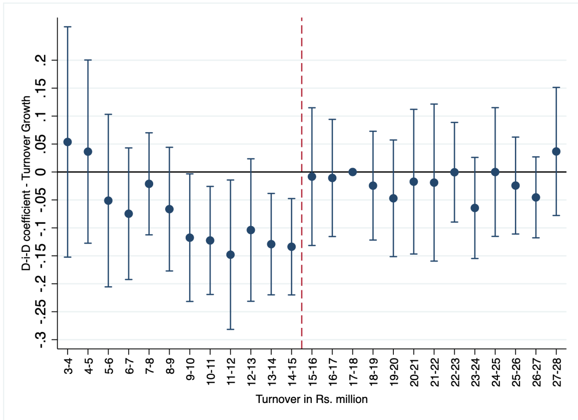


Note: This graph shows the β coefficients estimated using Equation 6. They represent the bin-level average differences between the growth rates of manufacturing versus services firms. We also show the 95% confidence intervals. The sample now drops firms that switched between treated and control bins during the sample period. The reference bin is Rs.16-17 million. We use data of Indian corporations from 2009-16 which had a revenue between Rs 3 million and Rs. 27 million.

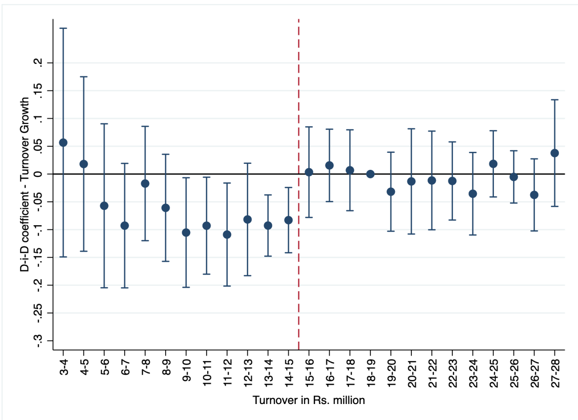
Figure 5: Event Study - Robustness with different bins



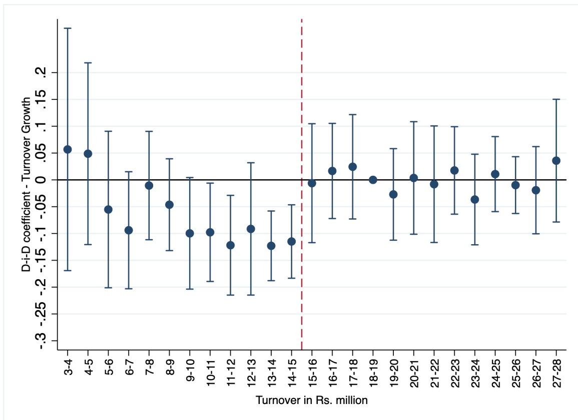
(a) Reference bin = 17. Full regression



(b) Reference bin = 17. No switchers



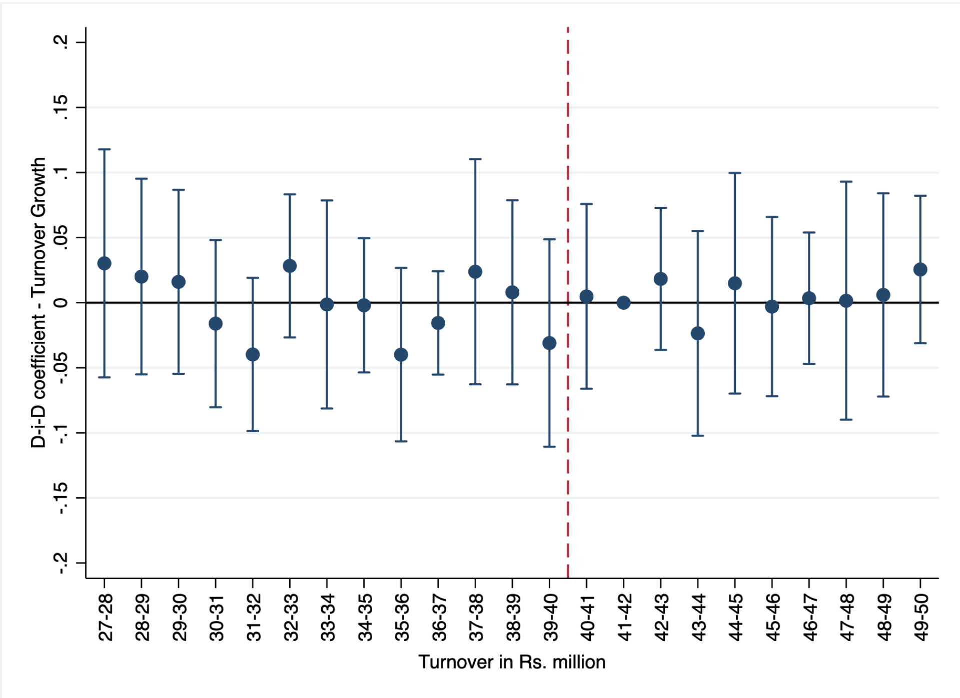
(c) Reference bin = 18. Full regression



(d) Reference bin = 18. No switchers

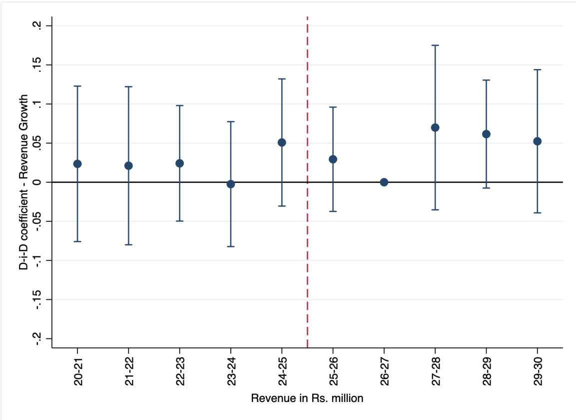
Note: This figure shows estimation results from Equation 5. Panels (a) and (c) are similar to Figure 3 except the changes in reference bins. Similarly, Panels (b) and (d) are similar to Figure 6 except the changes in references bins. Please refer to footnotes below Figure 3 and Figure 6 for more details.

Figure 6: Event Study - Placebo

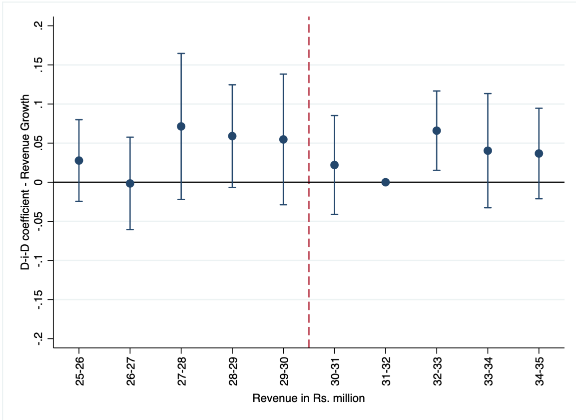


Note: This graph shows the β coefficients estimated using Equation 5. They represent the bin-level average differences between the growth rates of manufacturing versus services firms. We also show the 95% confidence intervals. The reference bin is Rs.40-41 million, while the threshold is misspecified at Rs.40 million. The data consists of all corporations in India from 2009-16 which had a revenue between Rs 27 million and Rs. 50 million.

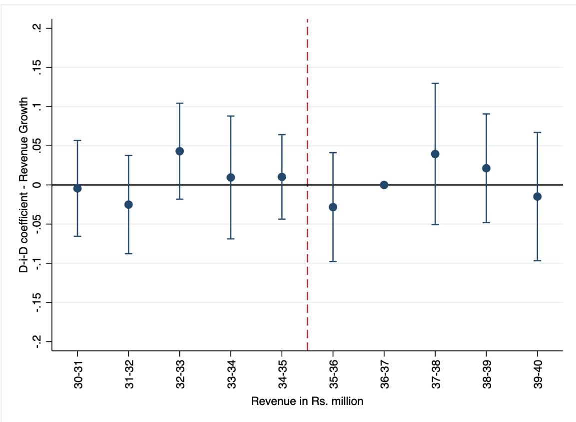
Figure 7: Event Study - Other placebo tests



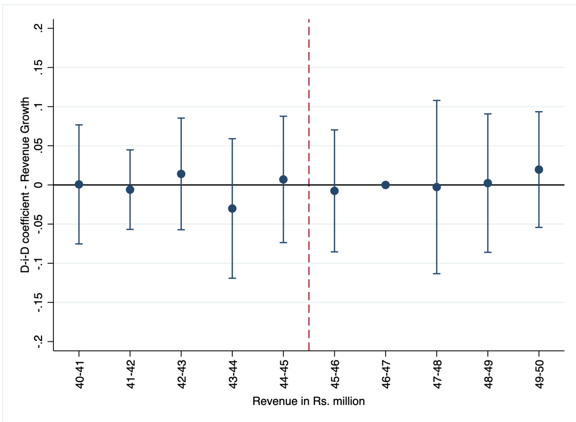
(a) Reference bin = 26



(b) Reference bin = 31



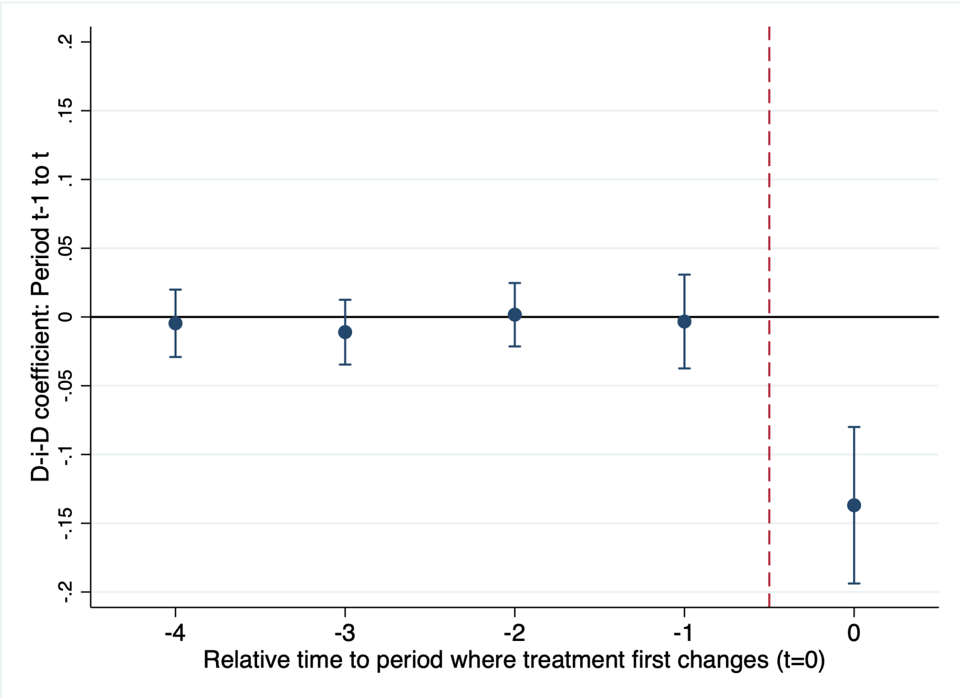
(c) Reference bin = 36



(d) Reference bin = 46

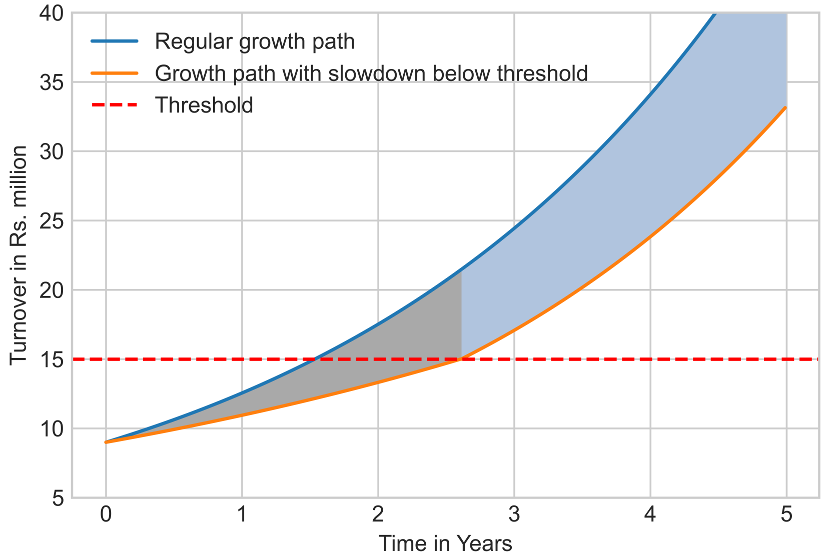
Note: This graph shows the β coefficients estimated using Equation 5. They represent the bin-level average differences between the growth rates of manufacturing versus services firms. We also show the 95% confidence intervals.

Figure 8: Placebo estimates of growth slowdown before the treatment



Note: This figure plots the period-wise average treatment effects using the estimator by Chaisemartin and D'Haultfœuille (2020), along with 95% confidence intervals. All manufacturing firms that either enter or exit the slowdown window from $t = -1$ to $t = 0$ are considered treated. Rest of the firms constitute the control group. This figure shows the differences in growth rates between the two groups in the period immediately after the treatment, as well as, up to 4 periods before. An insignificant coefficient implies that, on average, firms in both the treatment and control groups are accelerating or decelerating at the same rate.

Figure 9: Total Revenue Loss because of Audit Threshold



Notes: This figure shows the total revenue loss because of slowdown in a representative firm's revenue as it approaches the audit threshold. We assume that without the threshold, the firm would have grown at the rate of 33.3% per annum. This is shown by the blue line. The orange line displays the firm's growth path in response to a threshold at Rs. 15 million - slower growth by 13.7 percentage points up to Rs. 15 million and growth of 33.3% thereafter. The grey area between the lines in the figure measures the total change in reported revenue compared to the counterfactual till the firm reaches the threshold of Rs. 15 million. This is the 'short-run' revenue loss due to the threshold. The loss is approximately Rs. 2.59 million per year on average. The blue area between the lines measures the total change in reported revenue compared to the counterfactual after the firm crosses the threshold of Rs. 15 million. The 'long-run' revenue loss due to the threshold is given by the sum of the grey and blue areas. This is approximately Rs. 6.1 million per year on average.

A Appendices

A.1 Audit Strategy – Government of India

The CenVAT was administered by the Central Board of Excise and Customs (CBEC), which is the indirect tax administration of the Government of India. The Directorate General of Audit in the CBEC, made its audit manual publicly available (CBEC 2015). The manual lists the principles and policies that govern audits of taxpayers covered by the CenVAT as well as Service Tax. Notably, audits under the Income Tax Act, which includes the corporation tax, are administered by a separate body called the Central Board of Direct Taxes (CBDT), the direct tax administration of the Government of India. The CBDT does *not* make its audit manual publicly available. For the remainder of this section, we focus only on the audit manual of the CBEC, which covers the CenVAT.

In Chapter 5, the audit manual states that CBEC follows a risk-based audit strategy –

"Given the large number of registered assessees and taxpayers, under the Central Excise and Service Tax, it is impossible to subject every assessee/taxpayer to audit each year with the available resources...these assessees and taxpayers should be selected on the basis of assessment of the risk to revenue. This process, which is an essential feature of audit selection, is known as 'Risk Assessment'. It involves the ranking of assessees and taxpayers according to a quantitative indicator of risk known as a 'risk parameter'". (Para 5.1)

In Chapter 6, the manual states that 'revenue risk analysis' involves – (i) reconciling financial data with different documents; (ii) deriving certain data and comparing it with reported figures and; (iii) comparing key data of the taxpayer with industry averages as well as *past figures of the same assessee/taxpayer.* Thereafter, the audit manual states that 'trend analysis' is an important component of pre-audit analysis. It states that –

"For audit purposes, either absolute values or certain ratios are studied over a period of time to see the trend and the extent of deviation from the average values during any particular period". (Para 6.6.10)

"From the AMF (Assessee Master File), Trial Balance and Annual Financial Statements it is possible to work out important financial ratios. The said ratios should be compared with the ratios of earlier year and wherever significant variation is noticed, these areas may be selected for audit verification". (Para 6.6.6)

The sale value of finished goods is one of the parameters included in trend analysis. It is thus reasonable to assume that under the CenVAT, firms that display large deviation in revenue growth from historical trends have higher perceived probability of getting selected for audit. Although deviations can go both ways, we focus on negative deviations and our model assumes that firms showing slow revenue growth have higher perceived probability of audit.

A.2 Simulations

In this section we simulate the model outlined in the theoretical framework for a finite number of periods to determine the effect of the audit threshold. The intention is to qualitatively examine the effect of the notch – namely that it results in a growth slowdown as firms approach the notch. In these simulations, as in the model we assume true revenue, input costs and fixed costs to be exogenously given in every period, in order to compare the firm's reporting decision under the static and dynamic contexts. Table A-1 gives the functional forms and parameter values used in the simulation.

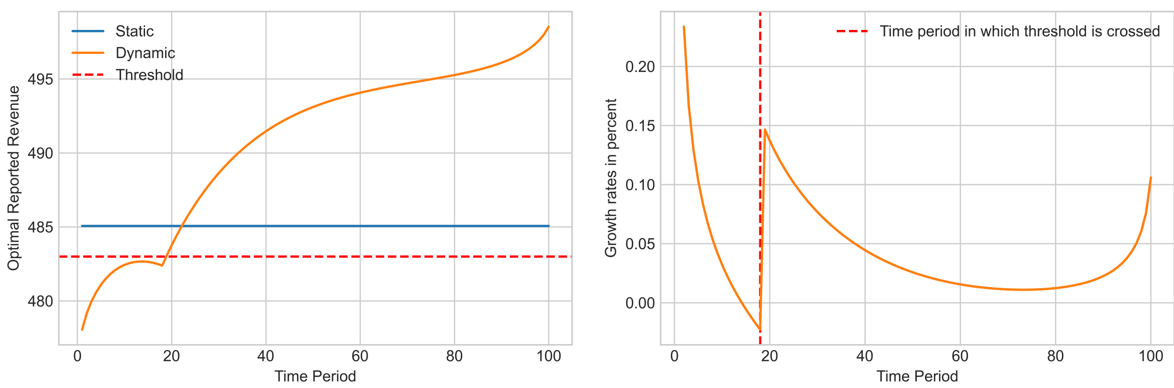
Table A-1: Model Calibration

Panel A: Functional Forms	
Function	*Value*
$h(u_t)$	αu_t^2
$k(u_t)$	νu_t^2
$g_t = g(\frac{\bar{y}_t - \bar{y}_{t-1}}{\bar{y}_{t-1}})$	$e^{-\gamma(\frac{\bar{y}_t - \bar{y}_{t-1}}{\bar{y}_{t-1}})}$
α	10^{-5}
ν	10^{-2}
γ	10^{3}
Panel B: Parameter Values	
Parameter	*Values*
T	100 periods
y_t	500 in each t
x_t	250 in each t
F	100 in each t
β	1
θ	1.2
τ	0.3
Panel C: Notch Parameters	
Parameter	*Values*
ϕ_{low}	0.05
ϕ_{high}	0.3
Threshold	483

Figure A-1 shows the firm's response to a notch in audit intensity ϕ. Panel A-1a plots the optimal reported revenue under both static and dynamic models whereas Panel A-1b plots the optimal growth in the dynamic model. As Panel A-1a shows, under the 'static' model when reported growth does not matter for audit probability, the firm reports the same revenue every period, since it essentially solves the same optimization problem in every period. Under the 'dynamic' model, when reported growth matters for audit probability, the firm's reported revenue is by and large positively sloped [23]. The firm starts reporting below the threshold but crosses the threshold at some point in its trajectory.

The presence of the notch however, incentivizes the firm to remain in the low intensity regime. It does so by slowing down growth as shown in Panel A-1b. However, the firm cannot indefinitely remain below the threshold because low growth will increase the likelihood of audit. The firm thus slows down but must ultimately cross over to the high audit regime.

Figure A-1: Firm's optimal response to Audit Threshold



(a) Optimal Reported Income (b) Optimal Reported Growth

Note: In this figure, we show simulation results from the model described in Section 2 for 100 time periods. The firms have a constant income of Rs.500 in each period. If they report an income above Rs.483 (represented by the dashed red line), the audit intensity increases. As shown by the blue line in panel A, under the static case, the firms report the same income in each period. The firm's optimal growth path in a dynamic framework is shown by the orange line. In panel B, we show the growth of income reported by the firm under the dynamic case.

[23] There is a small range below the threshold where the reported revenue curve becomes flat and then slopes down. This is a result of slowdown because of the notch. In the absence of a notch, reported revenue would be upward sloping.

A.3 TWFE vs dCDH

The Two Way Fixed Effects (TWFE) specification is given by:

$$g_{ijt}^{R} = \alpha_0 + \beta d_i^{Manf} \times \mathbb{1}(\text{Revenue}_{it} \in [j', \rho)) + \delta_i + \gamma_t + \eta_j + \epsilon_{ijt} \tag{A-1}$$

Where i, j, t denote a firm i, reporting revenue in bin $[j, j+1)$ (in Rs. million), in year t respectively. The interval $[j', \rho)$ denotes the slowdown window; δ_i denotes firm fixed effects; γ_t denotes year fixed effects; η_j denotes bin fixed effects and ϵ_{ijt} is the error term.

Using the TWFE estimator would lead to identification coming from the same firms moving from outside the slowdown window into the slowdown window or vice-versa, within the 8 years of our data. If there are heterogeneous treatment effects from spending multiple years in the slowdown window, that is, if firms that are in the window for multiple years slow down more sharply, the TWFE estimator can lead to biased estimates. The bias arises from forbidden comparisons between manufacturing firms that enter the slowdown window early with manufacturing firms that enter into the window in later years. Additionally, treatment status can turn off for a firm in our setting, for instance when a firm exits the slowdown window. The literature calls this a situation of 'non-absorbing treatment' that cannot be addressed by the TWFE estimator (see Roth et al. 2023).

Chaisemartin and D'Haultfœuille (2020) provide a diagnostic test to measure how severe the problem of these forbidden comparisons might be. They do this by decomposing the TWFE estimator into all possible D-i-D comparisons between consecutive time periods across pairs of groups [24]. Forbidden comparisons would lead to negative weights in these 2×2 comparisons. The diagnostic reports the number of negative weights among all possible individual Average Treatment Effect on the Treated (ATTs) estimated. Additionally the diagnostic reports the minimum standard deviation of the treatment effect such that the TWFE coefficient and the overall ATT could be of different sign. The smaller is the minimum standard deviation, the more likely it is that heterogeneous treatment effects are a concern. The dCDH estimator is robust to heterogeneous treatment effects (see Chaisemartin and D'Haultfœuille 2020 for more details).

The results of the diagnostic test in Chaisemartin and D'Haultfœuille (2020) are reported in Table A-2. In a simple TWFE regression roughly 7.5 % of the individual ATTs estimated will have negative weights due to forbidden comparisons. The minimum standard deviation compatible with the TWFE and the overall ATT being of different signs is 0.044, which is small enough for us to conclude that TWFE estimates are likely to be biased. Although there is no objective way to decide when the value is too small Chaisemartin and D'Haultfœuille (2020) and the companion Stata package *twowayfeweights* provides a conceptual test. If we

[24] In our analysis we take groups to be individual firms

assume that the individual treatment effects are drawn from a uniform distribution, then for the distribution to have a mean of 0, the treatment effects should be distributed uniformly between $[-0.044 \times \sqrt{3}, +0.044 \times \sqrt{3}]$ i.e. $[-0.076, 0.076]$. In our setting, a slowdown more than 7.6 percentage points is plausible for some firms and time periods, and therefore we conclude that the TWFE and overall ATT can be of different signs. Using the TWFE model is thus likely to yield biased estimates.

Table A-2: Diagnosis of Potential Bias in Standard TWFE

Number of Negative Weights	2410
Number of positive weights	29291
Total ATTs estimated	31701
β: TWFE coefficient	-.031
Minimum $\sigma(\Delta)$ compatible with β and ATT of different signs	.044

Notes: This table assesses the bias in the standard two-way fixed effects regression by using the methodology given by Chaisemartin and D'Haultfœuille (2020). We run the standard difference-in-differences specification given by Equation A-1 and calculate the number of negative and positive weights in all possible D-i-D comparisons, and the total number of such comparisons. These are reported in first three rows. Row 4 shows the magnitude of the standard TWFE regression. Next row reports the minimum standard deviation of the treatment effect such that the TWFE coefficient and the overall Average Treatment effect on the Treated(ATT) could be of different sign.

A.4 Data Construction

This section describes the variables and data sources used in the main analysis. We use administrative tax data from the ITR-6 return, which is filed annually by Indian corporations to comply with the Income Tax Act, 1961. Within the ITR-6, we obtained data fields from Part A - General information, Part A - Balance Sheet and Part A - P&L of the firms.

Turnover : Turnover is defined as the net sales of the business during the year, net of returns, refunds, duties and taxes. This is reported by the firm in its P&L account in ITR-6. Growth in turnover is defined as $\frac{\text{Turnover in Year } t+1 - \text{Turnover in Year } t}{\text{Turnover in Year } t}$.

Expenses : Expenses are reported in the P&L account of the firm's ITR-6. Wages are defined as total compensation given to employees which includes salary, bonus, leave encashment, reimbursement of medical expenses and contribution to gratuity and other funds. Fuel expenses are reported as a distinct category by the firm. The CenVAT law (Central Excise Credit Rules, 2004) does not recognize wages and fuel, specifically, diesel and petrol as deductible inputs and these expenses are reported separately in Table 5. Deductible expenses are defined as the aggregate of the following expenses which are deductible under CenVAT – purchases of inputs, freight expenses, consumption of stores and spare parts, repairs incurred on machinery, audit fee expense (for audit by private auditor), sales promotion expenses, advertisement expenses and expenses on building repairs. Value-added is defined as Turnover less deductible expenses. Growth in expenses is defined in the same way as growth in turnover.

Firm Age : The date of incorporation of the firm is reported in ITR-6. Firm age is defined as the age of the firm in Financial Year 2016-17 (the last year in our dataset).

Private and Domestic Companies : Under Indian law, companies can either be privately held or publicly held. Publicly held companies (whether listed or unlisted on a stock exchange) can offer shares to the general public, whereas privately held companies have restrictions on transfer of shares and can have only limited numbers of shareholders. The firm reports whether it is privately held or publicly held in ITR-6. Domestic companies are those which are incorporated under the Indian Companies Act.

Sectoral Business Codes : Firms report the nature of their activity from a pre-defined list of business codes that is part of the ITR-6. The list of business codes is given in Table A-3. Firms can report up to 5 business codes. We take a firm to belong to the manufacturing sector if it reports its sector as manufacturing (business codes 0101 to 0124). If the firm reports more than one business code, it is labeled as manufacturing if it is classified as manufacturing in every business code. All non-manufacturing firms are classified as services firms. Since firms can technically change their business code in the ITR-6 form every year, we drop all firms from our dataset that change their status from manufacturing to services and vice-versa even once in the years for which we have data.

Heterogeneity – Auditor Cluster : To calculate the private auditor cluster size, we start by taking the entire database of corporate tax returns for 2016, that includes all revenue bins. In 2016 (but not in other years), our dataset includes an identifier for the private auditor hired by a firm. We use this identifier to calculate the total number of firms that a private auditor audited in 2016. For each firm, we therefore obtain the cluster size of number of firms audited by its private auditor in 2016. Within the window of revenue bins that we analyze, we then take the median auditor cluster size of manufacturing firms. We separately run and report dCDH estimates for manufacturing firms that have auditor cluster size below and above the median respectively in 2016. The sample of non-manufacturing firms is not restricted according to the cluster size in these regressions.

Heterogeneity – Volatility : Within the window of revenue bins that we analyze, we use the coefficient of variation (CV) at the business code level in order to measure volatility. The CV is given by the ratio of the mean and standard deviation of revenue within a business code. We take the median CV for manufacturing firms and run separate dCDH regressions for manufacturing firms that have CV below and above the median respectively. The sample of non-manufacturing firms is not restricted by CV in these regressions.

Heterogeneity – B2B and Export ratios : We use the Supply-Use tables published by the Ministry of Statistics and Programme Implementation, India to calculate the B2B ratio and export ratio for manufacturing sub-sectors. The Supply-Use tables contain data on product-wise intermediate use as well as total use at producer prices for 140 products. The tables also provide data on total export for each of the 140 products. Using the tables for 2016 (MOSPI 2016) which is the last year of our dataset, we first calculate two ratios – (i) B2B ratio defined as the ratio of intermediate use to total use at producer prices; and (ii) Export ratio, defined as the ratio of export to total use at producer prices respectively, for each of the 140 products listed in the Supply-Use Tables. We then carry out a manual concordance to assign products from the Supply-Use table to manufacturing business codes in the corporate tax return (ITR-6), wherever possible. Table A-4 contains the details of this exercise. Note that a particular manufacturing business code from the tax return can have multiple products from the Supply-Use table assigned to it.

For each manufacturing business code from the tax return which has been matched with the products from the Supply-Use table, we calculate the total supply at business prices from the table. This is done by aggregating the supply of all the individual products within that business code. Then, we take the ratio of the supply of that product to the total supply within that business code. This provides supply weights for the different products within a manufacturing business code. We use these weights to calculate the weighted average of the B2B ratio and export ratio for a manufacturing business code. Within the window of revenue bins that we analyze, we calculate the median of B2B ratio and export ratio for manufacturing firms. We report separate dCDH regressions for manufacturing firms that have B2B ratios below and above the median, as well as for manufacturing firms that have export ratios below and above the median respectively. The sample of non-manufacturing firms is not restricted by B2B ratio or export ratio.

Table A-3: Sectoral business codes in ITR 6.

Sl No	Sector	Sub-Sector	Business Code
1	Manufacturing Industry	Agro-based industries	0101
		Automobile and auto parts	0102
		Cement	0103
		Diamond cutting	0104
		Drugs and pharmaceuticals	0105
		Electronics including computer hardware	0106
		Engineering goods	0107
		Fertilizers, chemicals, paints	0108
		Flour and rice mills	0109
		Food processing units	0110
		Marble and granite	0111
		Paper	0112
		Petroleum and petrochemicals	0113
		Power and energy	0114
		Printing and publishing	0115
		Rubber	0116
		Steel	0117
		Sugar	0118
		Tea and coffee	0119
		Textiles, handlooms and power looms	0120
		Tobacco	0121
		Tyre	0122
		Vanaspati and edible oils	0123
		Others	0124
2	Trading	Chain stores	0201
		Retailers	0202
		Wholesalers	0203
		Others	0204
3	Commission Agents	General commission agents	0301
4	Builders	Builders	0401
		Estate agents	0402
		Property developers	0403
		Others	0404
5	Contractors	Civil contractors	0501
		Excise contractors	0502
		Forest contractors	0503
		Mining contractors	0504
		Others	0505
6	Professionals	Chartered accountants, company secretaries etc	0601
		Fashion designers	0602
		Legal professionals	0603
		Medical professionals	0604
		Nursing homes	0605
		Specialty hospitals	0606
		Others	0607
7	Service Sector	Advertisement agencies	0701
		Beauty parlours	0702
		Consultancy services	0703
		Courier agencies	0704
		Computer training/ educational and coaching institutes	0705
		Forex dealers	0706
		Hospitality services	0707
		Hotels	0708
		IT Enabled services, BPO service providers	0709
		Security agencies	0710
		Software development agencies	0711
		Transporters	0712
		Travel agents, tour operators	0713
		Others	0714
8	Financial Service Sector	Banking companies	0801
		Chit funds	0802
		Financial institutions	0803
		Financial service providers	0804
		Leasing companies	0805
		Money lenders	0806
		Non banking finance companies	0807
		Share brokers, sub-brokers etc	0808
		Others	0809
9	Entertainment industry	Cable TV productions	0901
		Film distribution	0902
		Film laboratories	0903
		Motion picture producers	0904
		Television channels	0905
		Others	0906
10	Other sector	Other than (1) to (9)	1001

Table A-4: Concordance – ITR and SUT Codes

Sl No	ITR Manufacturing Sub-Sector	SUT product
1	Agro-based industries	Industry Wood; Firewood Other Forestry products; Inland fish Marine fish; Paddy Wheat; Coarse cereals Gram; Arhar Other pulses; Groundnut Rapeseed and mustard; Other oil seeds Kapas; Jute, hemp and mesta Sugarcane; Coconut Rubber; Fruits Vegetables; Other food crops Milk; Wool Egg and poultry; Other livestock products
2	Automobile and Auto-parts	Tractors and other agricultural equipment Motor vehicles; Motorcycles and scooters Bicycles, cycle-rickshaw
3	Cement	Cement
4	Diamond-cutting	Gems and jewellery
5	Drugs and pharmaceuticals	Drugs and medicine
6	Electronics including computer hardware	Electronic equipment including TV Medical precision, optical instrument Electrical appliances; Other electrical machinery
7	Engineering goods	Industrial machinery for food and textile industry Industrial machinery (except food and textile); Machine tools Other non electrical machinery; Electrical industrial machinery Electrical cables, wires; Hand tools, hardware
8	Fertilizers, Chemical and Paints	Inorganic chemicals; Organic chemicals Fertilizers; Paints, varnishes and lacquers Pesticides
9	Flour and rice mills	Grain mill products, starch and starch products
10	Food processing units	Processed poultry meat and poultry meat products Processed other meat and meat products Processed fish and fish products Processed fruits and processed vegetables Dairy products; Bread and bakery products Miscellaneous food products
11	Paper	Paper, paper products and newsprint
12	Petroleum and Petrochemicals	Petroleum products; Crude petroleum
13	Power and energy	Electricity; Gas
14	Printing and Publishing	Publishing, printing and allied activities
15	Rubber	Rubber products
16	Steel	Iron and steel ferro alloys Iron and steel casting and forging; Iron and steel foundries
17	Sugar	Sugar
18	Tea, Coffee	Tea processed Coffee processed; Tea; Coffee
19	Textiles, handloom, power looms	Cotton yarn and cotton textiles Synthetic yarn and synthetic textiles; Wool yarn and woollen textiles Silk yarn and silk textiles; Ready made garments Carpet weaving; Miscellaneous textile products
20	Tobacco	Tobacco products; Tobacco
21	Tyre	Other transport equipment
22	Vanaspati and edible oils	Edible oils and fats
23	Others	Miscellaneous manufacturing Coal and lignite; Natural gas Iron ore; Manganese ore Bauxite; Copper ore Other metallic minerals Limestone; Mica Alcoholic beverages; Non-alcoholic beverages Leather footwear; Leather and leather products except footwear Wood and wood products except furniture Furniture and fixtures; Plastic products Coal tar products; Soaps, cosmetics and glycerin Synthetic fibres, resin; Other chemicals and chemical products Non ferrous basic metals (including alloys); Miscellaneous metal products Batteries; Communication equipment Watches and clocks; Ships and boats Rail equipment; Aircrafts and spacecrafts

A.5 Welfare

In this section, we calculate the effect of change in audit intensity on total welfare in a dynamic setting. Our result closely mirrors but generalizes the calculation for the static context in Almunia and Lopez-Rodriguez (2018). We utilize the model developed in the main text of our paper, consider a finite number of periods, and calculate the discounted sum of welfare over all time periods. Expected welfare is defined as the sum of expected firm and government revenue in a time period.

According to Equation 3 in the main text, the first-order-condition for the firm is

$$k'(u_t) + \delta_t(1+\theta)\tau + \tau(1+\theta)\phi u_t \left(h'(u_t) - \frac{g'_t}{\bar{y}_{t-1}}\right) = \tau - \frac{\beta\tau(1+\theta)\phi u_{t+1}\bar{y}_{t+1}g'_{t+1}}{\bar{y}_t^2} \tag{A-2}$$

Using $\delta_t = \phi h_t + \phi g_t$, denoting $k'(u_t) = k'_t$, $h'(u_t) = h'_t$ and dividing both sides by $\tau(1+\theta)\phi$, we can rewrite Equation A-2 as

$$h_t + g_t + u_t h'_t - \frac{u_t g'_t}{\bar{y}_{t-1}} = \frac{\tau - k'_t}{\tau(1+\theta)\phi} - \frac{\beta u_{t+1}\bar{y}_{t+1}g'_{t+1}}{\bar{y}_t^2} \tag{A-3}$$

The expected profit of the firm in period t can be written as

$$E(\pi_t) = (1-\tau)(y_t - x_t) + \tau u_t - \tau(1+\theta)\phi u_t h_t - \tau(1+\theta)\phi u_t g_t - k_t \tag{A-4}$$

If the firm is reporting optimally in every period, we can use the envelope theorem to calculate $\frac{dE(\pi_t)}{d\phi}$. We do not need to consider the effect of the change in audit intensity on the reported income and can directly differentiate Equation A-4 with respect to ϕ. This gives

$$\frac{dE(\pi_t)}{d\phi} = -\tau(1+\theta)(u_t h_t + u_t g_t) \tag{A-5}$$

Expected government revenue in period t is given by

$$E(G_t) = \tau(\bar{y}_t - x_t) + \tau(1+\theta)\delta_t u_t \tag{A-6}$$

In the case of the government, we cannot apply the envelope theorem to calculate $\frac{dE(G_t)}{d\phi}$. We must consider the effect of the change in audit intensity on the reported income. We get

$$\frac{dE(G_t)}{d\phi} = \tau\frac{d\bar{y}_t}{d\phi} + \tau(1+\theta)(u_t h_t + \phi h_t\frac{du_t}{d\phi} + \phi u_t\frac{dh_t}{d\phi}) + \tau(1+\theta)(u_t g_t + \phi g_t\frac{du_t}{d\phi} + \phi g_t\frac{du_t}{d\phi} + \phi u_t\frac{dg_t}{d\phi}) \tag{A-7}$$

Using the fact that

$$\begin{aligned} u_t &= y_t - \bar{y}_t \implies \frac{du_t}{d\phi} = -\frac{d\bar{y}_t}{d\phi} \\ h_t &= h(u_t) \implies \frac{dh_t}{d\phi} = -h'_t\frac{d\bar{y}_t}{d\phi} \\ g_t &= g(\frac{\bar{y}_t}{\bar{y}_{t-1}} - 1) \implies \frac{dg_t}{d\phi} = \frac{g'_t}{\bar{y}_{t-1}}\frac{d\bar{y}_t}{d\phi} - \frac{g'_t\bar{y}_t}{\bar{y}^2_{t-1}}\frac{d\bar{y}_{t-1}}{d\phi} \end{aligned}$$

Substituting these values as well as the RHS of Equation A-5 in Equation A-7 and simplifying, we get

$$\frac{dE(W_t)}{d\phi} \equiv \frac{dE(G_t)}{d\phi} + \frac{dE(\pi_t)}{d\phi} = k'_t\frac{d\bar{y}_t}{d\phi} - \frac{\tau(1+\theta)\phi u_t g'_t\bar{y}_t}{\bar{y}^2_{t-1}}\frac{d\bar{y}_{t-1}}{d\phi} + \frac{\tau(1+\theta)\phi\beta u_{t+1}\bar{y}_{t+1}g'_{t+1}}{\bar{y}^2_t}\frac{d\bar{y}_t}{d\phi} \tag{A-8}$$

Equation A-8 gives an expression for the change in welfare (the sum of expected firm profit and government revenues) for small changes in audit intensity in a given time period t. We assume a finite number of periods for welfare calculation where time periods vary from t = 1 to t = T. As a boundary condition, we impose the requirement that the firm reports true revenue at $t = 0$ and $t = T + 1$ which is outside of the time-frame where time is measured ($u_0 = 0, u_{T+1} = 0$).

Then,

$$\begin{aligned} \frac{dE(W_1)}{d\phi} &= k'_1\frac{d\bar{y}_1}{d\phi} - \frac{\tau(1+\theta)\phi u_1 g'_1\bar{y}_1}{\bar{y}^2_0}\frac{d\bar{y}_0}{d\phi} + \cancel{\beta\frac{\tau(1+\theta)\phi u_2\bar{y}_2 g'_2}{\bar{y}^2_1}\frac{d\bar{y}_1}{d\phi}} \\ \beta\frac{dE(W_2)}{d\phi} &= \beta k'_2\frac{d\bar{y}_2}{d\phi} - \cancel{\beta\frac{\tau(1+\theta)\phi u_2 g'_2\bar{y}_2}{\bar{y}^2_1}\frac{d\bar{y}_1}{d\phi}} + \cancel{\beta^2\frac{\tau(1+\theta)\phi u_3\bar{y}_3 g'_3}{\bar{y}^2_2}\frac{d\bar{y}_2}{d\phi}} \\ &\vdots \\ \beta^{T-1}\frac{dE(W_T)}{d\phi} &= \beta^{T-1}k'_T\frac{d\bar{y}_T}{d\phi} - \cancel{\beta^{T-1}\frac{\tau(1+\theta)\phi u_T g'_T\bar{y}_T}{\bar{y}^2_{T-1}}\frac{d\bar{y}_{T-1}}{d\phi}} + \beta^T\frac{\tau(1+\theta)\phi u_{T+1}\bar{y}_{T+1}g'_{T+1}}{\bar{y}^2_T}\frac{d\bar{y}_T}{d\phi} \end{aligned}$$

On adding, the terms get canceled as shown above. We get:

$$\sum_{i=1}^{i=T} \beta^{i-1} \frac{dE(W_i)}{d\phi} = \sum_{i=1}^{i=T} \beta^{i-1} k_i' \frac{d\bar{y}_i}{d\phi} + \frac{\tau(1+\theta)\phi u_1 g_1' \bar{y}_1}{\bar{y}_0^2} \frac{d\bar{y}_0}{d\phi} + \beta^T \frac{\tau(1+\theta)\phi u_{T+1} \bar{y}_{T+1} g_{T+1}'}{\bar{y}_T^2} \frac{d\bar{y}_T}{d\phi} \tag{A-9}$$

As $\delta = \phi h + \phi g$ is the audit probability lying between 0 and 1, $g(.)$ is bounded above. Therefore, g_1' and g_{T+1}' must be finite numbers and the last two terms in Equation A-9 go to 0. We thus get:

$$\sum_{i=1}^{i=T} \beta^{i-1} \frac{dE(W_i)}{d\phi} = \sum_{i=1}^{i=T} \beta^{i-1} k_i' \frac{d\bar{y}_i}{d\phi} \tag{A-10}$$

The discounted sum of change in welfare in T time periods due to a change in audit intensity is equal to the discounted sum of change in resource cost of evasion multiplied by the reporting response in the T time periods.

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