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Information, Asymmetric Incentives, or Withholding? Understanding the Self-Enforcement of Value-Added Tax

Abstract

During the period 1996-2000, the coverage of VAT in Pakistan rose by twenty times in terms of the number of firms in the tax net and by ten times in terms of the volume of transactions subject to it. This paper leverages this staggered introduction of VAT in the country to estimate its enforcement spillovers. Focusing on firms already in the tax net, I explore if their tax compliance improves as VAT gets extended to their trading partners. Using differential responses to upward and downward extension of the tax, I characterize the mechanisms underlying the self-enforcement response.

JEL-Codes: H250, H260, O170.

Keywords: VAT, tax evasion, informality.

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I Introduction

Since 1975, the share of value added tax (VAT) in total government revenue has risen from 9% to 20% in the OECD countries. At the same time, the share of income tax has fallen from 30% to 24% (OECD, 2017). The shift toward VAT is even stronger in emerging economies, where the tax is replacing falling revenues from international trade (Baunsgaard & Keen, 2010; Cagé & Gadenne, 2018). VAT has now been adopted by almost every country in the world, its rates are increasing steadily over time, and it has become the major source of revenue for governments around the world (International Tax Dialogue, 2013).[1] Yet, the tax has not received as much attention from empirical public finance researchers as other tax instruments have.

VAT is a broad-based tax on consumption, levied on all production stages. Firms charge VAT on their output, deduct the tax already paid on inputs, and remit the balance due to the government. The tax thus does not distort input prices, keeping the production efficient. It is also considered to facilitate enforcement as the credit-invoice mechanism built into it reduces a firm's ability and incentive to evade the tax, especially on inter-firm transactions. These two considerations jointly underpin the steady expansion of VAT around the world. In this paper, I focus solely on the latter consideration. I leverage a novel source of variation—the staggered roll out of VAT in Pakistan—to study if the tax indeed creates enforcement spillovers and if so how strong they are.

Pakistan decided in principle to implement VAT in its standard, broad-based form in 1990. The political costs of introducing a new levy, however, are large, and perhaps to reduce these costs the tax was rolled out in phases. In its initial phase lasting till 1995,[2] VAT was applied to a few manufacturing industries only. The base was expanded steadily from 1996, and the tax was extended to all areas of economic activity in the next five years. These extensions were carried out at the level of a production stage. Specifically, the tax was extended to all manufacturers in 1996; to importers in 1997; to distributors, wholesalers, and retailers in 1998; to energy sector in 1999; and to service providers in 2000. As a result of these extensions, the penetration of VAT in the country increased by almost twenty-fold in terms of the number of firms in the tax

[1] Other than the US and a few oil-rich states, VAT has now been adopted by every country in the world. In the the OECD countries, where VAT was adopted at the earliest, its standard rate has gone up on average from 11.7% at its introduction to 18.7% now, increasing by more than 60% (see Table 1 in the International Tax Dialogue, 2013).

[2] Pakistan's financial year begins from July. Any reference to year t in this paper refers to the financial year from July t to June $t+1$.

net and by almost ten-fold in terms of the volume of transactions subject to it. I use this variation to identify the causal impact of VAT on firm compliance, along both the intensive and extensive margins.

For this purpose, I focus on manufacturers—the firms who enter the tax net at the earliest—and see how their outcomes respond as the tax gets extended to their buyers and suppliers. To the extent that VAT is self-enforcing, the compliance of existing firms will improve as their trading partners become subject to the tax (intensive-margin response). The increasing exposure to VAT will also push informal firms into the formal sector as their returns from operating informally squeeze (extensive-margin response).

One useful feature of the Pakistani setting is that I can compare these enforcement spillovers with the effects of another policy experiment through which tax enforcement in the country was tightened using more traditional measures. Pakistan launched a countrywide tax survey from May 2000 during which inspectors from the tax administration and other law enforcement agencies visited firms to assess their compliance with the tax laws. The survey, which continued for more than twenty-four months, arose out of political compulsions of the country at the time and was not connected with the planned trajectory of VAT in the country. It, however, was a large enforcement shock in the sense that within a short span of time the majority of firms in the country—both registered and unregistered—were visited by tax inspectors. I estimate the effects of the survey on firm compliance and compare them to VAT spillovers. The comparison helps me put the VAT spillovers into perspective to see how significant they are relative to the direct enforcement.

To estimate VAT spillovers, I focus on two key events: July 1998, when VAT was extended to distributors, wholesalers, and retailers, the production stages downstream to manufacturers; and July 1999, when the tax was extended to energy sector, the production stage upstream to manufacturer. Since all manufacturers were affected by these events, the key empirical challenge is to isolate the VAT spillovers from contemporaneous macro shocks and secular trends in outcomes. To achieve this, I follow a simple difference-in-differences research design, comparing the outcomes of manufacturers and importers over time. Importers are a natural control group in this setup as they are the least exposed to the domestic expansion of VAT. Identification in this research design rests on two key assumptions. First, the control outcomes are not affected by the VAT expansion to the same degree the treated outcomes are. I exploit transaction-level data to show that importers' exposure to the downstream stages where VAT was extended in 1998 is two times and to the upstream stage where VAT was extended in

1999 is fifteen times less intense than that of manufacturers. Second, the treatment and control outcomes evolve similarly in periods of no policy change. Exploiting a long panel of tax records spanning fourteen years, I show that it is indeed true for a number of pre- and post-intervention periods during which the policy remained stable. Another factor helping identification is that the VAT changes are so sharp that their impacts can be distinguished from any long-standing trends or slow-moving shocks visually, through the event-study graphs.

Using administrative data comprising the universe of VAT returns, I document four key findings. First, I show that VAT is indeed self-enforcing. Taxable sales reported by manufacturers rise considerably as their exposure to VAT deepens. The effect is strong and robust to a variety of specification checks. Second, the spillovers are far weaker along the extensive margin. While the increasing penetration of VAT accelerates the registration of informal manufacturers, the new registrants do not begin filing returns. Nor do they begin remitting the tax until the enforcement survey begins and inspectors start visiting their premises. Third, the upward extension of VAT bites much more than the downward extension. The outcomes of manufacturers begin to diverge from those of importers exactly from the time the energy sector enters the tax net. In contrast, the extension of VAT to the three downstream production stages does not produce significant response. And finally, the enforcement survey generates strong compliance response, particularly along the extensive margin: it causes unregistered firms to register and dormant firms to become active and begin remitting the tax.

VAT encapsulates three distinct mechanisms that can give it its self-enforcing character. In a VAT, each inter-firm transaction is recorded at two places, which creates third-party information that the government can use to enforce the tax better (Kopczuk & Slemrod, 2006; Pomeranz, 2015). It creates asymmetric incentives between sellers and buyers to cheat (Pomeranz, 2015). Specifically, underreporting by a seller hurts buyers who cannot claim tax credit to the full extent of inputs used by them. And lastly, VAT contains a built-in withholding element to it, as the tax paid on inputs purchased from registered suppliers gets deducted at the upstream stage (Keen, 2008). These three mechanisms, though intricately linked to each other, have features that permit their separation in the empirical application. Withholding works downwards, from an upstream to a downstream stage. Asymmetric incentives, on the other hand, act in the opposite direction, as buyers induce sellers to report truthfully or collude. Third-party information works in either directions. The empirical results show that the upstream extension elicits a large response in comparison to the insignificant re-

sponse produced by the downstream extension. In the Pakistani setting, I can also rule out that the upstream extension generates any new third-party information. Together, the three empirical facts suggest that withholding—tax collection on inputs of a firm—is the likely mechanism that drives the self-enforcement response I document.

In the standard tax compliance model, a firm makes its compliance choice trading off the benefits of evasion against costs, and withholding can enter this calculus only if it affects the evasion costs. I propose a simple model that rationalizes it in a VAT setting. In the model, the costs of evasion are a smooth, increasing, and convex function of evasion as long as the reported VAT liability is positive. The costs, however, jump at the point the liability becomes negative. Negative VAT liability implying taxable sales lower than taxable purchases is not a common occurrence for firms other than exporters, making the tax administration more likely to select firms who report negative liability frequently for audit. This creates a notch in evasion costs at the zero-liability point, inducing firms to locate just to the right of the point. I take this prediction of the model to the data, finding extremely sharp bunching at the notch point.[3] Comparing bunching across 1998 and 1999, the years before and after the energy sector became taxable, I show that firms close to the zero-liability point absorb the increase in their input tax, reporting higher sales and thereby reducing the amount they evade. Higher reported sales mean that the government receives more aggregate revenue from the two production stages combined. More specifically, before 1999 the government was receiving no consumption tax from the energy sector. After 1999, it received VAT from the energy sector without its full pass-through to the next stage as tax credit, thus obtaining higher aggregate revenue—the enforcement spillover of VAT.

Lack of response to the downstream extensions of VAT observed in my setting is puzzling because it goes against empirical evidence from other setting similar to Pakistan's (see for example Pomeranz, 2015; Carrillo *et al.*, 2017; Naritomi, 2018). Exploiting heterogeneity in response across firms more and less exposed to the downstream extensions, I show that this apparently anomalous result in part reflects that the downstream extensions in my setting are a much weaker treatment. They bring roughly ten times lower volume of transactions into the tax net than do the upstream extensions, creating much weaker forces of self-enforcement. More generally, I document a com-

[3]Note that the taxable input costs of a firm do not include labor costs and the costs of other inputs that may be exempt at the time. The bunching therefore cannot be explained by any *real* phenomenon such as market competition (zero profits), liquidity constraints, or any feature of the technology. Nor can it be explained by transaction costs, as firms can carry forward the balance amount costlessly by ticking a cell on the tax return.

plementarity between self-enforcement and traditional enforcement, showing that the expansion of VAT bites much more if new firms brought into the tax net are formal and compliant.

This paper contributes to a small but growing literature that uses microdata to estimate the enforcement properties of VAT in low-tax-capacity settings (see for example de Paula & Scheinkman, 2010; Pomeranz, 2015; Carrillo *et al.*, 2017; Naritomi, 2018; Fan *et al.*, 2018). I add to this literature by documenting the enforcement spillovers along both intensive and extensive margins. Exploiting the difference in response between the upstream and downstream extensions of VAT, I characterize mechanisms underlying the spillovers, highlighting the importance of withholding mechanism in the self-enforcement of VAT. This upstream channel of compliance, to my knowledge, has not been studied in any of the existing works. On a broader level, I contribute to a rich empirical literature that studies how enforcement technologies, both traditional and nontraditional, impact reporting and participation choices of economic agents, especially in low- and middle-income countries (see for example Bachas & Soto, 2017; Brockmeyer & Hernandez, 2017; Waseem, 2018a,b; Slemrod *et al.*, 2018).

II Context

II.A Introduction and Growth of VAT in Pakistan

Like many other developing countries, Pakistan introduced VAT in the 1990s. The country was facing a gradual decline in revenues at the time from falling import tariffs, and a broad-based consumption tax was seen as the long-term solution to bridge the gap. The legislation to implement VAT was enacted in July 1990, but to reduce the political costs of introducing a major new levy, its roll out was staggered into phases. Figures I and A.I show this visually. They plot the number of firms who file a VAT return at least once in a given quarter, highlighting three distinct phases in the development of the tax in the country: introduction (1990-1995), expansion (1996-2000), and steady state (2001 onward). In the introductory phase, the new tax was applied to a very narrow base consisting of a few manufacturing industries only. The tax was systematically expanded after that. It was first extended to the rest of manufacturers and later to the other production stages. Specifically, it was extended to almost all manufacturers in 1996; to importers in 1997; to distributors, wholesalers, and retailers in 1998; to energy suppliers in 1999; and to service providers in 2000. Each extension was

announced in the June of year t to be effective from the beginning of July of that year. With these extensions, the number of firms in the tax net grew sharply from around 3,500 in 1995 to 80,000 in 2000.

Figures II and A.II plot the entry of new firms into the VAT regime, disaggregating the analysis by production stage. It shows that the sharp expansion of the tax during 1996-2000 was largely driven by the statutory changes. The majority of firms of a given production stage entered the VAT net immediately after the tax was extended to the stage.[4] There was no anticipation of the change, and the rule was almost perfectly implemented. The figure also shows that relative to the large spikes created by the statutory events, the macro-driven changes in entry are small. This can be seen by focusing at the post-2002 period during which the tax policy and enforcement environment remained stable. Throughout this fairly long period, the entry of new firms continued to be flat, exhibiting no secular trend, and the macro shocks to the process remained minimal.

The widening scope of the tax also meant that increasingly more firm transactions came under its coverage. Figures III and A.III illustrate this. Starting from a low base, sales and inputs covered by VAT rose steadily, with quarterly taxable sales increasing from PKR 80 billion at the start of 1996 to around 750 billion by the end of 2000.[5] The increase was particularly sharp in 1999 when the tax was extended to the energy sector, which includes electricity, gas, petroleum and other forms of fuel.

Collectively, Figures I-III illustrate that in the short period between 1996 and 2000 the coverage of VAT in the country expanded by almost twenty-fold in terms of the number of firms in the tax net and almost ten-fold in terms of the volume of transactions subject to the tax. I exploit this variation to estimate how the compliance of incumbent firms changes as their exposure to VAT deepens, meaning more of their input and sales transactions become subject to the self-enforcing forces of the tax.

II.B Tax Design

During the period covered in this study, the design of VAT in the country remained quite similar to its standard form. Firms whose supplies were not exempt were re-

[4]Note that some firms enter even before VAT was extended to their production stage. For example, the entry series for the energy sector features a small peak in July 1996. Such entry reflects either voluntary registration or the fact that firms may register when one of their byproducts becomes taxable. Figure III shows that the volume of VAT-covered transactions of firms of a given production stage remains trivial as long as VAT does not extend to the stage.

[5]One US$ was worth around fifty PKR in 1999.

quired to register with the tax administration. Exemptions were of two types. A small-firm exemption was available to manufacturers and retailers if their annual turnover did not exceed PKR 1 million (2.5 million from 1999 and 5 million from 2004) and 5 million respectively.[6] Other than this, a generic exemption applied to firms whose supplies fell in the negative list. The negative list, as noted above, largely operated at the production stage level. After the withdrawal of these exemptions in 1996-2000, the list contained only a few items such as unprocessed food. Firms not required to register could do so voluntarily.

While registered, whether voluntarily or otherwise, firms were obliged to charge VAT on their sales and were allowed to adjust the tax paid on their inputs. In case the adjustment exceeded the output tax, they could carry forward or obtain the refund of the balance amount. There were no transaction costs of claiming a carry forward as firms could do so on their own by ticking a cell on the return form. Obtaining refunds, on the other hand, was costly, as refunds were sanctioned only after a preaudit of the claim. A seller was required to issue a tax invoice for each sale transaction, and the buyer could claim the tax credit only if it possessed the invoice issued in its name. The tax was destination-based: imports into the country were taxed at the standard rate and exports were zero-rated. Any tax remitted on inputs used for exports was refunded. Throughout this paper, I focus solely on the domestic taxable sales of firms, abstracting from exports. Figure A.IV plots the standard VAT rate in the country. It generally remained at 15% other than two brief episodes during which it was first decreased to 12.5% and then increased to 18%.

Firms were required to file a return and remit the tax due every month. The filing was based on the principle of self-assessment and there was no preaudit contact between taxpayers and tax collectors. The filed returns were considered final unless selected for audit. The tax administration at the time did not have the capacity to cross-match transactions electronically. Accordingly, the audit selection was largely based on the limited information received through the single-paged return form. One of the more salient cells on the return form was if the tax liability exceeded zero. Negative tax liability is a rare event for taxpayers other than exporters. Going into the red frequently, in particular by a manufacturer, therefore must have been one of the major triggers of audit.

[6]The manufacturers and retailers below the exemption threshold were required to pay turnover tax under a simplified scheme. The turnover tax was introduced in 1996 and was withdrawn in 2004.

II.C Enforcement Survey

I contrast VAT spillovers with the effects of another policy experiment that tightened enforcement in the country through more traditional measures. The experiment—a nationwide survey of enterprises—took place in 2000-02, soon after VAT had been extended to all production stages. The objective of the survey was to document the national economy, hoping it would bring in more taxpayers and revenue. In the original design of the survey, teams comprising officials of the tax administration and other law enforcement agencies were to visit both registered and unregistered firms, gathering information such as their sales, income, assets, liabilities, and inventories. The information was to be reconciled with data from other sources, and assessment orders were to be issued in case of discrepancies.

Unsurprisingly, the survey was unpopular and met resistance from small traders, who boycotted it immediately after its announcement on May 24, 2000. After a protracted period of strikes, closedowns, and negotiations, the government and traders reached an agreement on August 22, 2000. The agreement softened the survey, removing its most unpopular provision requiring the physical verification of inventories. The revised survey was completed over the next two years.

Two facts about the survey need emphasizing. First, it arose out of political compulsions of the country at the time and was not connected with the planned trajectory of VAT in the country. Pakistan had an unanticipated change in government in October 1999, and the survey was one of the measures the new government took to promote compliance in the country. Second, although the survey consisted of traditional enforcement measures such as inspectors' visits and audits, it was different in the sense that the threat from these measures was credible. The government invested considerable political stock in the exercise and took measures to ensure that the survey protocol was followed as far as possible.

III Conceptual Framework

III.A Self-Enforcement Under VAT

The central focus of this paper is to test if VAT is self-enforcing, and if so what drives this process. To develop intuition on how self-enforcement works, consider a firm that uses taxable inputs costing $c(s_j)$ to produce s_j units of revenue. The subscript j indexes the ordered set of production stages $j \in 1, 2, ..., J$ through which a good passes

before its ultimate consumption. For simplicity, I assume that each production stage contains one firm only. The firm reports taxable sales $\hat{s}_j$ and taxable input costs $\hat{c}_j$ to the government, remitting the VAT of $T_j = \tau(\hat{s}_j - \hat{c}_j)$, where τ is the tax rate. The government does not observe real sales or costs so that the firm can underreport sales $\hat{s}_j < s_j$ and/or overreport costs $\hat{c}_j > c_j$ on paying a resource cost of $g(s_j - \hat{s}_j, \hat{c}_j - c_j)$.

Note that the notion of self-enforcement makes sense in this second-best world only. If the government can costlessly observe s_j and c_j, the enforcement problem disappears and there is no distinction between VAT and its alternative consumption taxes such as the retail sales tax. I therefore assume that the enforcement problem is non-trivial, meaning that the evasion costs $g(s_j - \hat{s}_j, \hat{c}_j - c_j)$ are finite. Self-enforcement is a statement on these costs, asserting that they are strictly greater under VAT than the alternatives. Theoretically, the higher evasion costs under VAT could result from one or more of the following three mechanisms.

Third-Party Information: In a VAT, each inter-firm transaction is recorded at two places, creating a paper trail on such transactions. The trail makes one-sided evasion, where the two reports do not match, almost infeasible and two-sided evasion, where the two reports do match, more costly. In both cases, evasion decreases relative to the counterfactual where the transaction is recorded at one place only. This is the mechanism most discussed in literature in relation to the self-enforcement of VAT (see, for example, Kopczuk & Slemrod, 2006; Pomeranz, 2015). But evidence has started to emerge recently that casts doubt on the effectiveness of third-party information in low-enforcement-capacity setting (Carrillo *et al.*, 2017).

Asymmetric Incentives: VAT makes a downstream firm a stakeholder in the tax paid at the upstream stage, creating asymmetric incentives between sellers and buyers to cheat. Specifically, in a firm-to-firm transaction the seller would like to under-report its sales but doing so would hurt the buyer who would not be able to adjust VAT on inputs used by it. In fact, if a seller under-reports $\hat{s}_j < s_j$ and the buyer cooperates so that $\hat{c}_{j+1} = \hat{s}_j$, the buyer would be left owing the underreported tax from the previous stage.[7] This is a unique feature of VAT: truthful reporting at one stage recovers the unremitted tax from all previous stages of the production chain. Because of this, underreporting by an upstream firm is feasible only if it either takes the extreme risk of one-sided evasion or colludes with the downstream firm.

[7] In this particular example, the buyer—assuming that it reports truthfully—will pay $\tau(s_{j+1} - \hat{s}_j)$ in place of $\tau(s_{j+1} - s_j)$ if it goes along with the underreporting of seller, matching its input purchases with the sales reported by the seller i.e. $\hat{c}_{j+1} = \hat{s}_j$. Thus, it will pay $\tau(s_j - \hat{s}_j)$ over and above its true tax liability, which exactly equals the tax evaded by the seller at the upstream stage.

Tax Withholding: One important feature of VAT that often gets overlooked is that it also embeds a withholding mechanism into it. Consider for example a formal firm in stage j that sells intermediates valuing s_j to a downstream firm. The seller will remit VAT amounting to τs_j on the transaction, and the buyer can deduct the tax from its tax liability if it is registered. The tax remitted at the upstream stage thus functions as a withholding tax if the downstream firm is formal and as an input tax if it is not (see Keen, 2008 for the theoretical implications of this mechanism). Note that in the first-best setting such withholding has no effect on behavior; it only means that the tax is collected at two stages rather than one. But in a setting where evasion is feasible, withholding can affect behavior, especially if the upstream stage is more formal. Withholding in this case creates a floor the reported sales of the downstream firm cannot cross without triggering a significant jump in the audit probability. As I noted in section II.B, when a firm's input tax adjustment exceeds its output tax, it opts for either the refund or carry forward of the balance amount. Both cases raise a flag with the tax administration if the firm is not an exporter, raising its likelihood of facing an audit discretely. The discontinuity in the audit probability at zero tax liability can compel firms to stay in the black, giving withholding a bite it lacks in the standard setting. I explain this mechanism in greater details in section V of the paper.

The above three mechanisms, though intricately linked to each other, have features that permit their separation in the empirical application. The withholding mechanism works downwards, from an upstream to a downstream stage. Asymmetric incentives, on the other hand, act in the opposite direction, as buyers induce sellers to remit tax or collude. Third-party information works in either direction. In the Pakistani setting, VAT was first introduced on manufacturers and was later extended to the other production stages. If we focus on manufacturers only, the impacts of the three mechanisms can be disentangled using their differential responses to the upstream and downstream extensions.

How important is it to differentiate the three mechanisms? Note that while VAT has a few standard features, its design can always be tweaked to strengthen a given mechanism. For example, if withholding deters noncompliance the most, the tax rate at the upstream stages can be raised to make the effect stronger. In fact, many countries impose a higher tax rate and/or deploy additional withholding on imported raw materials for this purpose (see Table 1 in Keen, 2008 for details). Similarly, the absence of the other two mechanisms in firm-to-consumer transactions makes the retail stage a particularly vulnerable point for VAT. The tax can potentially unravel from this

point if the two mechanisms are the principal drivers of compliance. This has led a few countries, including Argentina, Bolivia, China, Chile, Colombia, Indonesia, Italy, Portugal, Puerto Rico, South Korea and Slovakia, to introduce schemes that create incentives among consumers to obtain receipts of their purchases and report them to the authorities (Naritomi, 2018).

The above framework applies regardless of whether noncompliance occurs along the intensive or extensive margin. The double-recording of transactions, tax withholding by sellers, and push from buyers for correct payments make evasion by a registered firm harder (intensive margin). These forces make operating without registration costly, too (extensive margin). Information concerning sales to, and purchases from, an informal firm exposes the firm to a greater risk of getting caught. Withholding reduces tax savings from operating informally. And an informal firm can lose customers if it cannot issue tax invoices. To the extent that these mechanisms work, the expansion of VAT over time will push informal firms into formality in the same way it will push registered firms to greater tax compliance.

III.B Empirical Strategy

The principal econometric challenge in estimating the enforcement spillovers of VAT in my setting is to distinguish them from contemporaneous macro shocks. To see this formally, let i index firms and t units of time. Reported taxable sales of a firm $\hat{s}_{it}$ are potentially a nonlinear function of tax rate τ_t, firm characteristics $\boldsymbol{X}_{it}$, demand and supply shocks λ_t, and government policy θ

$$\hat{s}_{it} = f(\tau_t, \boldsymbol{X}_{it}, \lambda_t; \theta). \tag{1}$$

The dependence of the outcome on the policy regime θ captures the intuition developed above that the cost of misreporting varies with the regime chosen by the government. Suppose that in period t' the regime changes from θ to θ'. In the Pakistani context, it could mean either extending VAT to a hitherto untaxed production stage—making more inter-firm transactions subject to the tax—or tightening the enforcement directly through the tax survey. Using the terminology of the Neyman-Rubin-Holland potential outcomes framework, the effect of the policy change can be expressed as $\Delta_{it'} = \hat{s}_{it'}(\tau_{t'}, \boldsymbol{X}_{it'}, \lambda_{t'}; \theta') - \hat{s}_{it'}(\tau_{t'}, \boldsymbol{X}_{it'}, \lambda_{t'}; \theta)$. Because the second term in this expression—counterfactual sales—is not observed, the effect cannot be estimated without making some assumptions. The first assumption I make is the following

Assumption 1: *The functional form of reported sales is log-linear, and the effect of the policy is additive in percentage terms.*

Under this assumption, equation (1) can be written in its estimating form as

$$\log \hat{s}_{it} = \alpha_i + \beta \,.\, \mathbb{1}(t > t') + \tilde{\boldsymbol{X}}_{\boldsymbol{it}}'\boldsymbol{\gamma} + \tilde{\lambda}_t + \varepsilon_{it}, \tag{2}$$

where $\tilde{\boldsymbol{X}}_{\boldsymbol{it}}$ now contains the time-varying covariates only and $\tilde{\lambda}_t$ absorbs the tax rate.The parameter of interest in this equation β is not identified, being indistinguishable from the shocks $\tilde{\lambda}_t$. To get around this problem, I follow the standard difference-in-differences methodology, comparing the outcome across manufacturers and importers.

I focus on manufacturers for two reasons. First, they are the first group to enter the tax net and therefore experience the maximum tax variation. Over time, a production stage immediately upstream to them—the energy sector—and three production stages downstream to them—distributors, dealers, wholesalers, and retailers—switch from being exempt to taxable. Focusing on them therefore allows me to utilize all the post-1996 variation. It also lets me see if the effects of down and upstream extensions differ from each other. I use this evidence to understand the mechanisms underlying the self-enforcement. Second, manufacturers are also the most important group in terms of tax revenue, contributing roughly 90% of the domestic VAT collected in the country each year. Their responses are therefore the most consequential in term of both revenue and welfare.

Importers are a natural control group in this setup. They are much less exposed to the domestic expansion of VAT than manufacturers. Using transaction-level data, I show below that they are around two times less exposed to the 1998 downward extension and fifteen times less exposed to the 1999 upward extension of VAT than manufacturers. Their ability to respond to the VAT exposure is also limited. Their purchases are directly observed by the government as they pass through the customs station. Sales reported by them therefore must at least match the purchases observed by the government. Nor can they operate in the informal sector, as registration with VAT is a necessary prerequisite to import. Note that I do not assume that importers are insulated from the expansion of VAT, but rather that their exposure to the expansion is much less intense relative to manufacturers. In this sense, any relative difference in the two groups' outcomes will represent a lower bound on the response of manufacturers.

Thus, to the extent that the following assumption

Assumption 2: *Conditional on controls, the reported taxable sales of manufacturers* $i \in M$

and importers $i \in I$ on average follow the same time path as long as the enforcement regime chosen by the government remains unchanged

$$\mathbb{E}\left[\hat{s}_{it}(\theta \mid \alpha_i,\, \tilde{\boldsymbol{X}}_{it};\, i \in M)\right] = \mathbb{E}\left[\hat{s}_{it}(\theta \mid \alpha_i,\, \tilde{\boldsymbol{X}}_{it};\, i \in I)\right], \tag{3}$$

is satisfied, β_3 in the following regression captures the causal effects of the policy change on manufacturers

$$\log \hat{s}_{it} = \alpha_i + \beta_1.\mathbb{1}(i \in M) + \beta_2.\mathbb{1}(t > t') + \beta_3.\mathbb{1}(i \in M).\mathbb{1}(t > t') + \tilde{\boldsymbol{X}}_{\boldsymbol{it}}'\boldsymbol{\gamma} + \tilde{\lambda}_t + \varepsilon_{it}. \tag{4}$$

I offer two pieces of evidence to support the assumption. First, I estimate placebo specifications corresponding to Equation (4), establishing that the difference in outcomes between the two groups remains statistically insignificant for a large number of pre- and post-intervention periods during which the policy environment remains stable. Second, I always complement the regression-based analysis with nonparametric event studies. A typical event study takes the following form

$$\log \hat{s}_{it} = \alpha_i^{'} + \sum_{r=1}^{r=T} \lambda_r^{'} + \varepsilon_{it}^{'}. \tag{5}$$

The key objects of interest in this equation are the $\lambda_r^{'}$'s. These coefficients denote the log-change in outcome in period r relative to the first period $(r = 0)$ once the firm fixed effects have been partialled out. I run these regressions separately for the two groups and plot the coefficients over a long time horizon, indicating the times from which the policy changes take effect. These event study charts permit transparent, visual assessment of the identification assumptions underlying equation (4). All specifications I estimate, whether the nonparametric event study or the difference-in-differences model, allow unrestricted variance-covariance structure over time at the firm level.[8]

III.C Data

The data for this project comprise the universe of VAT returns filed in Pakistan. I focus principally on the period 1997-2003 but extend the analysis to other periods for robustness checks. The VAT return consists of three main sections. In the first section, firms report the aggregate value of their sales, breaking it down into three—domestic

[8] Bertrand *et al.* (2004) show that this technique works well when the number of entities in the panel are large, which is the case in my empirical application.

taxable, domestic exempt, and exports—components. In the second section, the aggregate value of inputs purchased are reported, divided likewise into the three components. In the final section, firms calculate their tax liability, indicating the tax charged on sales, the tax credited on inputs, and the final tax payable. They select one of the two options—carry forward or refund—in case the tax payable is negative. Pakistan introduced a major amendment to its VAT return in 2008. The amended return requires firms to also file an "invoice summary" as a part of the return. Under this new amendment, firms report transaction-wise details of their sales and purchases, aggregating them at the level of individual sellers and buyers. I use this data for the years 2008-2010 to construct forward and backward linkages between firms of various production stages.

Each firm in the VAT net is assigned a unique registration number and is expected to file every tax period (month). The data, therefore, have a panel structure. In addition to the return data, I use information on firm characteristics from the tax register. This information includes the 4-digit industry, date of registration, production stage, and geographic location of the firm. The production stage and 4-digit industry together form the 2-tier system the tax administration uses to classify firms. The broader tier—production stage—classifies firms into seven categories described in detail in the next section. Firms may undertake more than one of these activities, in which case the data indicate both the principal and secondary activities. The second tier classifies firms on the basis of goods or services they supply, using the 4-digit Harmonized Commodity Description and Coding System (HS Code).[9] This system characterizes the industry within a given production stage a firm operates in. For example, I observe whether a given manufacturer is a supplier of energy.

III.D Forward and Backward Linkages

The variation I exploit is at the level of production stage. Firms are assigned to a production stage depending upon the principal activity they undertake. This assignment takes place at the time of registration after physical examination of the firm's business process. Figures II and III show that the assignment has been done quite rigorously: the entry and volume of transactions of firms assigned to a production stage spike exactly at the time the exemption to the production stage is withdrawn. The Pakistani tax code recognizes seven production stages, called principal activities: import, manufacturing,

[9] This system is commonly used by customs administrations around the world to classify traded goods and services.

distribution, wholesale, retail, services, and export. These activities are defined in the tax code. Manufacturing, for example, is defined as "any process in which an article singly or in combination with other articles, materials, components, is either converted into another distinct article or product or is so changed, transformed or reshaped that it becomes capable of being put to use differently". I reproduce the definitions of other activities in Appendix A.1. This scheme of classification of firms corresponds roughly to their position in the supply chain. The typical supply chain for the domestic consumption of goods is shown in Figure A.V. Importers are the first stage in the chain, followed by manufacturers, distributors, wholesaler, and retailers.

For my empirical strategy to work it must be that manufacturers are more exposed to the expanding coverage of VAT than importers. Specifically, for the downstream extension it must be that manufacturers sell their goods more to distributors, wholesalers, and retailers than importers. And similarly for the upstream extension, it must be that manufacturers consume more energy as input than importers. Table I explores this. Using transaction level data for the years 2008-2010, I construct the forward and backward linkages of firms. These linkages are largely consistent with the scheme shown in Figure A.V. Manufacturers, as expected, supply their goods to the final consumer through the middle tiers of the chain. The proportion of their sales to these tiers is almost twice that of importers. Similarly, manufacturers consume 10-15 times more energy as input than importers. It should not be surprising given that importers sell same-state goods so that the primary usage of energy for them is to light and heat the offices. Two other points on the input-output linkages need emphasizing. First, more than half of the sales of manufacturers are to other manufacturers.[10] This would potentially amplify the shocks coming from other production stages. For example the extension of VAT to the energy sector will have a first-order impact on every manufacturer. But the shock will then strengthen as it propagates through multiple firms within the manufacturing stage. I will come back to this point in section IV of the paper. Second, importers are located upstream to manufacturers and hence any improvement in compliance at the manufacturing stage may in time spill over to them. For this reason, as noted above, I treat the compliance effect I estimate for manufacturers as a lower bound on the total effect.

Ideally, I would have liked to use *firm-level* forward and backward linkages ob-

[10]This again should not be surprising as goods pass through multiple manufacturing stages before turned into the finished product. For example, the supply chain from raw cotton to finished ready-made garment involves at least five manufacturing processes: ginning, spinning, weaving, dying, and stitching.

served at the baseline to construct the first stage of my empirical strategy. Unfortunately, this is not feasible as the transaction level data are not available prior to 2008. But Table I demonstrates that the input-output relationships between production stages are remarkably persistent over time: there is little or no variation across the three years, 2008 to 2010. The persistence implies that the evidence in the table is relevant to the period I focus on (1997-2003), showing that the staggered roll out of the tax indeed creates the first-stage variation needed for my reduced-form equation (4) to deliver the estimates of interest.

III.E Key Outcomes

My two primary outcomes of interest are the number of firms in the VAT net and taxable sales reported by them. Under the assumption of no one-sided evasion, an increase in taxable sales caused by a policy change is a sufficient condition that the government receives more revenue after the change. I show this formally in section VI.B of the paper.

Note that I cannot use VAT revenue or input costs to measure the causal effects of VAT expansion. As VAT coverage expands, these outcomes change due to both mechanical and behavioral reasons. For example, after an upstream extension downstream firms remit less revenue for the pure mechanical reason that their input tax credit goes up. Looking at the input costs is even more problematic. As I mention above, firms in my data report input costs in four cells: (i) domestic taxable inputs, (ii) domestic exempt inputs, (iii) imports, and (iv) total inputs. When a production stage switches from being exempt to taxable, firms in the next stage begin reporting inputs acquired from the hitherto exempt stage in the first rather than the second cell. The evolution of the two cells will therefore be contaminated by these mechanical effects. Even more crucially, when an input becomes taxable the incentive to record and report it accurately increases discretely. It means that the evolution of total input costs, although free from any mechanical effect, will conflate behavioral responses arising from VAT expansion and lazy reporting. The evolution of reported sales, on the other hand, provides a clean measure of the effect of interest. I focus solely on firms whose sales remain taxable throughout the sample period so that any change in the outcome can only reflect a behavioral response to a policy change. The causal effects of a policy change in this paper are accordingly measured along the intensive margin as the increase in reported sales it induces and along the extensive margin as the number of informal firms it pushes into the formal sector.

Table II presents the descriptive statistics of these two outcomes at three points in time, stratifying the sample by production stage.[11] Between 1997 and 2003, the number of firm-month observations grows by 70% for manufacturers and 271% for importer (columns 1-3). The growth largely results from the entry of new firms, although some of it may reflect that filing becomes more regular with time. My baseline specification includes firm fixed effects, which mitigates any selection issues arising from this. To address such concerns even further, I create two other samples that shut down entry and exit. The first of these (Balanced Panel 1) consists of firms who file a return at least once in every quarter included in the sample (columns 4-6). These firms remain active throughout the sample period, although they may not file in every tax period. The second restricted sample (Balance Panel 2) has a more stringent criterion. It consists of firms who file the return in every tax period included in the sample (columns 7-9). I always obtain very similar results from the three samples. One other important feature of the data is that the distribution of reported sales is quite skewed: the mean is generally larger than the 75th percentile. To ensure that my results are not driven by few large firms, I also estimate specifications where I drop firms larger than a given size threshold.

III.F VAT Expansion and the Real Economy

Since VAT does not distort input prices faced by registered firms,[12] its partial implementation does not create production inefficiency in the registered sector. It, however, could distort production in the unregistered sector. It could also distort consumption. I discuss below how these distortions can influence the two outcomes of interest, conflating the real and compliance effects produced by the policy changes.

Demand-side effects.—Imposition of VAT on a commodity increases its consumer price relative to the others, creating the following three effects: (i) own-price substitution effect; (ii) cross-price effects; and (iii) income effect. Of these, the first is entirely absent in my setting as I focus solely on commodities that remain taxable throughout the sample period. The Pakistani VAT extensions, as noted above, operate at the broadly-

[11] For space considerations, I collapse sectors other than manufacturing and imports into the "other" category.

[12] Note that it is true even if compliance in the registered sector is not complete. In case a transaction is reported, the buyer pays VAT on the input and claims adjustment. On the other hand, if the transaction is not reported neither VAT is paid nor adjustment claimed. In both cases, the input stays free of any VAT.

defined commodity-group level: they bring all substitutes into the tax net together.[13] For this reason, we can also rule out the cross-price effects on substitutes. We, however, cannot rule out the other demand-side effects. For example, the VAT extension to the energy sector may depress the demand of all goods in general (income effect) and complements of energy in particular (cross-price effect). These two effects work in opposite direction to the enforcement spillovers and will make finding the spillovers harder.

Supply-side effects.—Expansion of VAT can boost formal sector production through the input prices channel in three ways. First, informal firms cannot claim credit of the tax remitted on their inputs. VAT, thus, induces such firms to substitute toward untaxed inputs. Inefficient production in the informal sector can spur the registered sector if the goods produced by the two are close substitutes. Second, if the supply chain of an intermediate used by the formal sector is incomplete, the VAT remitted at the upstream stages gets loaded into the price of the intermediate. The expansion of VAT, to the extent that it completes the broken chains, can reduce the price of such intermediates, making formal manufacturing more efficient. Third, a downward extension of VAT to a hitherto untaxed stage improves production efficiency in the stage, which may stimulate the demand of good supplied by the upstream stage.

I take two measures to establish that my results represent compliance and not real responses. First, I conduct subgroup analysis at the industry level. To the extent that the demand and supply elasticities, and other factors such as the degree of competition from the informal sector, vary across industries, uniform industry-level response will rule out large real-side effects. Second, I also estimate the impact of VAT extensions on the entry of firms in the already-taxed industries. If supply-side factors stimulate production in these industries, the impact would show up in the entry series.

IV Empirical Results

IV.A Taxable Sales Response

Nonparametric Event Study.—Figure IV plots the results from equation (5). For Panel A, I estimate the equation on the period July-1997 to June-2003, dropping the dummy for July 1997. The regression is run separately for manufacturers and importers, and the

[13] For example, the 1999 extension brought all energy inputs—including electricity, gas, and petroleum products—into the tax net at the same time.

coefficients $\lambda_r^{'}$'s are plotted. Each coefficient in the plot shows the average log change in domestic taxable sales from July 1997 to the given month, once the firm fixed effects have been partialled out. Panel B displays a difference-in-differences version of the plot, assessing the statistical significance of the relative difference between the two groups in the given month.

I begin the analysis from July 1997. Before that, importers were not required to remit VAT on their sales. Between 1997 and 2003 four events occur that might impact the reported sales of manufacturers: VAT gets extended to distributors, wholesalers, and retailers in July 1998; to energy suppliers in July 1999; and to service providers in July 2000; and the tax survey begins from May 2000. I demarcate these events in the diagram by broken vertical lines. It is important to emphasize that sales of firms depicted in this figure remained taxable throughout the sample period (1997-2003). Any change in reported sales would therefore reflect a behavioral response to the four events and not a mechanical change arising, for example, from the extension or withdrawal of VAT to an industry.

Four facts stand out from these plots. First, the outcome trends similarly in the two groups during the periods of no policy change. The DD coefficient remains statistically insignificant in all the twelve months—July 1997 and June 1998—during which no change to the enforcement environment takes place. Second, the extension of VAT to the downstream stages elicits almost no response. The relative difference between the two groups continues on the preexisting trend in 1998-99, hovering around zero and remaining indistinguishable from it in nine out of the twelve months. Third, the outcomes of manufacturers and importers begin to diverge immediately after the energy sector enters the VAT net: the DD coefficient become significant immediately in July 1999 and remains so in later periods. And finally, the two trends diverge even further as the final two events occur, stabilizing only after the survey gets closer to its conclusion in 2002-03. The final two events of interest are too close to each other, and I separate the causal impact of the two in Table IV below.

The key identification assumption in this setting (Assumption 2 in section III.B) requires that the outcome trends similarly in the two groups in the absence of a policy change. The figure shows that it is indeed true for the twelve pre-reform months (July 1997 to June 1998) shown in Panels A-B. Twelve months, however, is a relatively short duration and may not be enough to assess the validity of the assumption. Note that I cannot look at the period prior to July 1997 due to reasons outlined above. But given that I have access to a long panel, I can look at the period after 2003, when the im-

pact of the VAT roll out and enforcement survey had already been dissipated. Panels C-D do that. I replicate the top two panels to the period between July 2004 to June 2010. Clearly, importers are a good control group for manufacturers: reported sales of the two groups track each other quite tightly during the 84 months shown in the plots. A subsample of importers were allowed to file their returns on a quarterly rather than monthly basis for two years included in these plots—July 2006 to June 2008. This creates spikes around the mean for the importers' series but overall the outcome still evolves very similarly in the two groups.

Difference-in-Differences Results.—Table III reports the results from estimating equation (4). The outcome variable is the log of domestic taxable sales, and I collapse, for the time being, the last three events into one, denoting the period after June 1999 by the $Post$ dummy. I show results for the complete and two balanced panel samples separately. Panel B conducts a placebo analysis. The placebo specification is an exact replica of the baseline specification. I estimate equation (4) on the next seven years 2004-2010, defining the period after June 2006 as the $Post$ period.

Unsurprisingly, the results are in line with the nonparametric event study. The coefficient on the interaction term $manuf \times 1998$ is weak and insignificant, demonstrating that bringing the three downstream stages into the VAT net does not generate significant enforcement dividend up the production chain. In contrast, the coefficient on $manuf \times post$ is both strong and significant, capturing on average a larger than 40 log point growth in the sales of manufacturers relative to importers after June 1999. The placebo exercise validates the empirical strategy. In combination with the graphical evidence above, it confirms that absent any policy changes the outcome indeed evolves similarly in the two groups in a large number of pre- and post-intervention periods. Lastly, the results from the three alternative samples are almost identical, putting to rest any concerns from selective entry into or exit from the complete panel sample.

Table IV explores the dynamics of the response. I now focus solely on the complete panel sample and partition the $manuf \times post$ dummy into two. The new $manuf \times year$ term captures the additional sales response in the given year. The sales of manufacturers continue to outgrow those of importers until the end of 2003, becoming indistinguishable from each other after that. The dynamic analysis shows that the upstream extension of VAT creates around 24 log-point increase in the sales of manufacturers in 1999. To put this magnitude into perspective, note that roughly 15% of the purchases of manufacturers are from the energy sector (see Table I). With the extension of VAT to the sector, the taxable inputs of manufacturers would roughly rise by this amount

for the pure mechanical reason that energy has become taxable. I show later that manufacturer largely absorb this increase in taxable inputs, increasing their reported sales by almost the amount their taxable input costs go up by. The upward extension of VAT would thus cause a nearly 15% rise in taxable sales reported by manufacturers over time. This first-round rise will trigger a second-round rise in the taxable inputs of manufacturers as around 55% of their purchases are from other manufacturers. In this way, the initial shock will get amplified as it propagates back and forth within the manufacturing sector. Reflecting this phenomenon, the taxable sales of manufacturers go up in multiple steps rather than in one go (see Figure IV).

The responses in year 2000 and later potentially conflate the effects of the last two events: the enforcement survey which begins from May 2000 and the extension of VAT to services which occurs in July 2000. Table I, however, shows that manufacturers and importers have very little exposure to the services sector, especially in terms of backward linkages. The post-1999 response therefore very likely reflects the effects of the enforcement survey (more evidence on this is presented in section IV.B below). One important agenda in this paper is to contrast the compliance impact of VAT expansion with that of direct enforcement. The evidence in Table IV suggests that enforcement spillovers from the upstream extension of VAT are of comparable magnitude to those from a very large enforcement intervention.

Robustness.—Tables A.I-A.III conduct two sets of robustness checks. I first show that the results in Table III are not driven by large firms. Restricting focus to Balanced Panel 1, I replicate the table dropping firms greater than a given cutoff. I use predetermined firm size, dropping firms on the basis of turnover in 1997-1998 in Table A.I and 1997 in Table A.II. The results from these restricted samples are similar to the baseline results. As I note in section II.B, some firms in my sample operate in more than one production stages. For instance, some manufacturers combine their principal activity of manufacturing with a secondary activity such as distribution or retail. Forces created by the expansion of VAT may not act on these multistage firms the same way they do on single-stage firms. Table A.III addresses this concern. I replicate Table III after reducing the sample to firms who operate in only one sector—manufacture or import—throughout the sample period 1997-2003. There is no meaningful difference between the two set of results. Finally, Tables A.IV and A.V allow firms in each industry and tax office to have a separate time trend. The tables show results from equation (4) after including a full set of industry, tax office, period, industry $\times$ period, and tax office $\times$ period fixed

effects. I obtain comparable results from these specifications.[14]

IV.B Participation Response

Does the tightening of enforcement—caused indirectly by the increasing penetration of VAT and directly by the tax survey—push informal firms into the formal sector? I now turn to this question, comparing the entry of new manufacturers and importers into the tax net over time. The entry of importers, as I explained above, is driven entirely by macro forces and cannot respond to the enforcement shocks.[15] To the extent that the two groups of firms experience similar macro forces, the difference in entry isolates the impact of the enforcement events.

Graphical Evidence.—Figure V presents this analysis. The entry of a firm can be defined to occur at three different points in time: *(i)* when the firm registers, *(ii)* when it files its first return, and *(iii)* when it files its first positive-activity return.[16] The LHS panels plot the raw data of these three outcomes, while the RHS panels show the corresponding plot in the difference-in-differences format. The domestic supplies of importers become taxable from July 1997. Due to this, their entry remains noisier than usual in the next few periods, stabilizing only around the end of the tax year (see Figure II-C). I, accordingly, begin the analysis from July 1998.

Importers, clearly, provide a good counterfactual for manufacturers. For a long period during which the enforcement environment remains stable 2002-05, the three outcomes of manufacturers and importers evolve indistinguishably from each other. The other striking feature of the plots is that the entry of new manufacturers spikes dramatically in June 2000, jumping roughly eight-fold from an average of around 250 to more than 2,000 (see Panel C). This large jump is caused either by the tax survey, which begins from May 2000, or by the extension of VAT to service-providers, which takes effect from July 2000, and I disentangle the two effects below. In distinction to the large influx of new manufacturers from June 2000, bringing the energy sector under VAT in 1999 produces only a modest effect. It clearly pushes more manufacturers

[14] The only exception to this is the Balanced Panel 2 specification in Table A.V, which produces a significantly lower DD coefficient. The specification includes a full set of period, industry, and industry × period fixed effects and the lower coefficient likely reflects the smaller sample I get by imposing the restriction of having filed in every tax period included in the sample.

[15] An importer cannot operate without VAT registration, as it needs to produce the registration certificate before getting the delivery of its import consignment from the customs station.

[16] I define positive-activity return as a return in which at least one of the cells showing sales or purchases made by the firm during the tax period is nonzero.

to register (Panel A) but has little or no effect on their decision to file a VAT return, positive-activity or otherwise (Panels B and C).

To see what triggers the sudden and sharp entry of manufacturers into the formal regime, I zoom in on the period around July 2000. Figure A.VI shows the weekly registration of new firms between April and December of 2000, comparing manufacturers to both importers and service providers. Vertical lines in the plots denote four important events during this period: the government announces the tax survey on May 24 and the extension of VAT to services on June 17; the extension takes effect on July 1; and small traders end their resistance to the survey on August 21. The registration of new manufacturers accelerates at the time the survey is announced, gaining momentum from early July as the survey gets underway. It loses steam as resistance to the survey strengthens, but regains pace again when the resistance ends. These movements are largely mirrored in the time series of services. But, importantly, the entry of service-providers lags that of manufacturers and therefore cannot have caused it. In fact, very few service-providers register when their supplies become taxable. The subsequent surge in their arrival, especially the peak after August 21, demonstrates that their own entry in large part results from the survey and is not voluntary.

Regression Results.—Table V formalizes the above analysis. Using importers as counterfactual, I estimate how many manufacturers move from informality into the VAT regime in response to the enforcement shocks. Columns (4), (7), and (10) of the table report this number for the three definitions of entry. I obtain the standard error on the number using a nonparametric bootstrap procedure explained in greater detail below the table. The results show that eliminating the exemption on electricity, gas, and other energy inputs causes more manufacturers to register (columns 2-4). The registration is around 58% higher in 1999 than it would have been in the counterfactual world. However, the majority of new registrants do not begin filing their returns in 1999 (columns 3-10). The enforcement survey, on the other hand, leads to both more registration and filing. Registration grows by 83%, filing by 144%, and positive-activity filing by 270% in 2000. Registration and filing continue to be significantly higher than the counterfactual as the survey progresses.

The above results, although unequivocal in highlighting a large shift towards the formal sector in 1999-2003, need further probe along two dimensions. The post-99 entrants potentially include firms who were not legally obliged to register at the time of their entry and did so only out of fear of the survey. Their entry is an undesirable byproduct of the survey and needs to be separated. Figures A.VII and A.VIII compare

the first-year turnover of firms by their entry period.[17] While doing this exercise, I drop the firms whose first-year turnover exceeds PKR 1 billion. These are excessively large firms, whose exclusion reduces noise in the plots without altering the message.[18] Bottom panels of the two figures look at the same question using another metric, illustrating the proportion of firms whose first-year turnover is above the exemption cutoff.[19] Clearly, the 2000-2001 entrants are on average smaller than the 1999-2000 entrants. The proportion of firm above the exemption cutoff also drops at the time the survey kicks in, but the drop is less pronounced, and recovers quicker, than the decline in the average turnover.

If the firms who enter after 2000 do so solely out of the fear of physical enforcement, they are expected to drop out once the threat ceases. To test this, Figures A.IX and A.X plot medium to long-term survival probability of firms by their entry period. The post-2000 entrants are less likely to last the next four to ten years in the tax net, but this effect is noticeable for the initial few periods only. Survival likelihood then becomes similar to the counterfactual, especially when I define entry as the period a firm registers in (Figure A.X). Overall, the evidence thus suggests that the survey indeed pushes few not-liable-to-register firms into the tax net. But this effect is generally small, and accordingly the extensive margin response to the survey in large part represents the firms who should have been in the tax net but would not have done so without the government intervention through the enforcement survey.

One other result in Table V needs mentioning. The filing response to the survey is significantly larger than the registration response in its first year (compare column 4, 7 and 10 in the second row). The difference suggests a buildup of registered firms inside the VAT net as its coverage deepens. These firms register but do not begin remitting the tax until the government takes more intrusive and direct enforcement measures. The behavior suggests a model wherein firms (a) derive benefit from VAT registration independent of filing and (b) face fixed adjustment costs or other frictions in moving from registration to filing that they cannot overcome without an extraneous force. On a broader level, the results therefore demonstrate that physical- and self-enforcement are complements, and that self-enforcement on its own is insufficient to compel informal firms into compliance.

[17] The first year here is defined as the tax year immediately succeeding the one in which the firm enters. For example, if a firm enters in August 2000, its first-year turnover is the aggregate value of its sales in the tax year 2001-02.

[18] Their inclusion creates large spikes in the outcome variable for the periods during which one or more of such large firms enter. These spikes do not affect the trend, which is the matter of interest here.

[19] Note that the exemption cutoff applies only to manufacturers. I use the same cutoff for importers.

V Mechanism Underlying Self-enforcement

I have documented above that the extension of VAT to the downstream stages causes no significant change in the reported sales of manufacturers. The downstream extension brings the first two self-enforcing mechanisms of VAT into play: the third-party information available to the government increases and the buyers become stake holders in the tax paid at the upstream stage after the extension. The reform, however, has no withholding element to it, as the tax extends to a downstream stage.

I have also documented that the upstream extension of VAT to the energy sector causes a significant increase in the reported sales of manufacturers. In distinction to a downstream extension, this reform has a large withholding element to it. Energy is a major input to the manufacturing process, and once it becomes taxable a significant proportion of VAT payable by manufacturers gets withheld at the upstream stage. It can also be argued that the reform creates no new information trails. Energy in Pakistan is predominantly supplied by a few large suppliers, the majority of whom are in public ownership.[20] Information on the sales transactions of these companies were always accessible to the government, making it highly unlikely that the information flows increased significantly after the reform.[21] The evidence thus suggests that withholding is the likely mechanism driving the VAT spillovers documented above.

In the standard tax compliance model, a firm makes its reporting decision trading off the benefits of evasion against costs, and it is not clear *a priori* how withholding would affect this calculus. In Appendix A.2, I propose a simple model that shows withholding may have a large bite in a low-enforcement-capacity settings similar to Pakistan's. The intuition for the result is simple. Given the weak enforcement and hence low evasion costs, it is optimal for firms to report taxable sales just above their taxable inputs. Points just above the zero-liability threshold dominate the points just below because in the latter case the firm has to seek the refund or carry forward of the balance amount and both cases raise the firm's likelihood of facing an audit discretely. In this setup, when an upstream production stage is brought into the tax net making more inputs of the firm taxable, the firm absorbs some of the increase in input tax by reporting higher sales.

Figures A.XI and A.XII show this mechanism visually. I trace the behavior of two

[20] For example, electricity and gas, which constitute the major component of the energy sector, are almost entirely supplied by four public sector companies.

[21] In fact, the legislation requires taxpayers to maintain their electricity and gas bills and make them available during the time of audit. Thus, even before the extension of VAT to the energy sector, the information on input transactions with the sector was available to the government.

firms to a reform whereby an intermediate used by them becomes taxable from time t'. The experiment is akin to the Pakistani policy change of 1999 whereby energy was made taxable. Such a reform will have no affect on the high-evasion-cost firm shown in Figure A.XI other than that its tax liability will go down for the pure mechanical reason that its input tax deduction goes up. In contrast, the reform will induce a behavioral response from the low-evasion-cost firm shown in Figure A.XII. This firm was bunching at the zero-liability point before the reform and will continue to do so afterward, increasing its reported sales by the amount its taxable inputs go up by. Increasing reported sales is optimal for this firm because otherwise it would fall into the negative liability region where evasion costs are discretely higher. The behavior of the latter firm is closer to the Pakistani setting with weak enforcement.

V.A Bunching at Zero Tax Liability

The model in Appendix A.2 generates two predictions: (1) there will be bunching of firms toward the right side of the zero-liability point, and that (2) bunching will persist even when more intermediates used by firms become taxable. Figure VI tests these predictions. I plot the VAT base (the difference between taxable sales and input costs) reported by manufacturing firms in their monthly returns in bins of PKR 5,000, zooming in on the region around zero. I drop observations where reported taxable sales exactly equal taxable input costs as almost all of these relate to inactive firms who report zero in all cells of the return. Panel A of the figure plots the distribution for the tax year 1998, showing sharp bunching of firms just above the zero-liability point: the bin just above zero contains 14 times as many firms as the one just below zero. Note that taxable inputs costs in 1998 do not include energy (which is still not taxable in 1998) and labor (which is always nontaxable). The variable plotted in the figure (taxable sales minus taxable costs) hence bears no relevance to the real production side of the firm. Its value lies somewhere in between the turnover and profits of the firm. Bunching in its distribution at the point zero therefore cannot be explained by any real phenomenon such as market competition (zero profits), liquidity constraints, or any feature of the production technology. Nor can it be explained by transaction costs, as firms can costlessly carry forward the excess amount of input tax to the next period. Taxable inputs acquired by a firm in a given month do not need to match exactly with the taxable sales made by it in the period. The only plausible explanation of the bunching therefore is that firms tend to remain in the positive-tax-liability region to avoid attracting the attention of tax authorities.

Panels B-D of the figure test the second prediction of the model. In 1999, electricity, gas, and other energy inputs become taxable. Because of the mechanical increase in taxable input costs, the distribution of the VAT base should shift leftwards, pushing many of the firms just above zero into the negative liability region. And the distribution indeed shifts leftwards: the 1999 distribution is stochastically (first-order) dominated by the 1998 distribution at all points. Yet, extremely few firms fall into the negative-liability region, and the bunching persists—in fact it becomes even sharper. Figure A.XIII tests the robustness of these findings. It replicates Figure VI, reducing the bin width to just PKR 1000 (US$ 20 in 1998-99). The results are very comparable.

V.B Taxable Inputs Response

The causal story linking the 1999 policy change to the rise in the reported sales of manufacturers, as outlined in the model in Appendix A.2, goes like this. The deductible VAT of manufacturers goes up in 1999 as one of their major inputs—energy—becomes taxable. To avoid falling into the negative-liability region where evasion costs are discretely higher, some manufacturers absorb the increased deduction instead of passing it on to the tax liability, thereby reporting higher sales. Since it is the rise in VAT-paid inputs that drives the rise in sales, another way to test this story is by looking at how taxable inputs reported by manufacturers behave around this time. I have already mentioned in section III.E that changes in taxable inputs conflate both mechanical and behavioral effects. But if the increase in taxable inputs (sum of mechanical and behavioral effect) nearly equals the increase in taxable sales (pure behavioral effect), it will be another evidence that the withholding mechanism drives the self-enforcement response documented in this paper.

Table A.VI conducts this analysis. I replicate Table III but use taxable inputs as the outcome variable in place of taxable sales. One difficulty with looking at this response is that firms do not apportion their taxable inputs by how much of those are utilized in making taxable sales (some manufacturers in the sample export part of their output). To get around this problem, I drop firms who report any exports or nontaxable sales in any of the periods included in the sample.[22] The taxable sales response of firms in this restricted sample is shown in Table A.VII. The results are indistinguishable from those

[22]Some of the firms classified as manufacturers export the goods produced by them. Throughout this paper, I have focused on domestic taxable sales reported by firms as this variable captures the self-enforcing impact of VAT more cleanly. To be consistent with my earlier analysis, I restrict focus here to taxable inputs utilized in making domestic taxable sales only, dropping manufacturers who report any exports in any of the periods included in the estimation.

in Table III, confirming that the sample restriction does not create any selection concern. The results are also strictly consistent with the causal story laid out above. The taxable inputs of manufacturers rise substantially relative to importers after 1999. The increase is almost as large as that in taxable sales (see the corresponding Table A.VII). Together, the two facts show that the increased withholding of tax at the upstream stage does not reduce, one-for-one, the tax liability of downstream firms. In fact, firms absorb some of the increase by reporting higher sales. Tax evasion reduces and aggregate tax payment increases as a result—the self-enforcement dividend of VAT.

V.C Why do firms not respond to the downstream extensions?

Lack of response to the downstream extension of VAT as I document above is puzzling because it goes against empirical evidence from other setting similar to Pakistan's (see for example Pomeranz, 2015; Carrillo *et al.*, 2017; Naritomi, 2018). Here I explore two mutually reinforcing explanations of the result: (1) the Pakistani downstream extensions are a weaker treatment than the upstream extension; and (2) self-enforcement and traditional enforcement are complementary. On the first explanation, Figure III-D shows that the extension of VAT to three downstream sectors brought around PKR 20 billion worth of transactions into the tax net. It is roughly ten times smaller than the corresponding amount for the upstream extension (see Figure III-E). This weaker treatment is exacerbated by the relatively weaker compliance in the downstream stages (noncompliant buyers would not have pushed the upstream sellers for receipts). Figure A.III, for example, shows that the downstream extensions of VAT did not produce as sharp a rise in reported transactions as did other extensions. Note that weaker compliance at the downstream stages (wholesale and retail) is not peculiar to Pakistan and is observed elsewhere as well, known as the final-mile problem of VAT. In Table A.VIII, I investigate the weaker-treatment explanation further. Using the transaction-level data I divide the sample of manufacturers into two groups: those with an above-median proportion of sales to registered firms in the three downstream stages and the others. For the former group the downstream extensions represent a relatively stronger treatment and are therefore expected to elicit stronger response.

The table estimates an augmented version of model (4). The dummy variable *Exposure Intensity* in the two triple-interaction terms denotes that the manufacturer belongs to the former group mentioned above. Because I construct this dummy variable using the transaction-level data (which is available only for the years 2008-2010), I restrict the sample (both treatment and control) to firms who feature in the transaction-level data.

Column (1) of the table shows that this sample restriction does not create significant selection concern (the $Manuf \times Post$ coefficient for this restricted sample is quite identical to the baseline coefficient). The results in the next columns support the weak-treatment hypothesis. Manufacturers with more intense exposure to the downstream stages indeed report higher sales in 1998. The corresponding triple-interaction coefficient is positive, large, and statistically significant in all three specifications. While there are a few caveats to this result,[23] the overall evidence in the table is consistent with the above hypothesis, suggesting that the insignificant response to the downstream extensions in part reflects that they create much weaker forces of self-enforcement than does the upstream extension. More generally, the result highlight the complementarity between self-enforcement and traditional enforcement, showing that the expansion of VAT bites much more if new firms brought into the tax net are formal and compliant.

VI Discussion and Conclusion

VI.A Identification Concerns

Given the difference-in-differences research design, the principal identification concern in my setting is that importers may not be a good control group for manufacturers. They, for example, could be more sensitive to external shocks than manufacturers. The responses documented above, for instance those in Table III, could thus be explained by a negative exchange rate shock that occurs in July 1999 and reduces the demand of imported goods relative to domestically manufactured goods. Figure A.XIV addresses this concern. I plot the USD-PKR exchange rate for the period 1997-2010. The exchange rate was quite stable in periods leading up to the VAT reform in July 1999 and therefore cannot explain the sharp increase in the sales of manufacturers relative to importers during the period 1999-2003 (see Figure IV). In contrast, there was a large depreciation of the exchange rate in 2008, yet the reported sales of manufacturers did not diverge from those of importers significantly.[24]

[23] The placebo triple-interaction coefficient is statistically significant in two of the three specifications, indicating that reported sales of more intensely exposed manufacturers may have been growing faster than others even in periods of no policy change. In addition, the triple-interaction coefficient for the upstream extension is also significant, which suggests that intensely exposed manufacturers may be more responsive to VAT expansion in general.

[24] One other external event that could have affected the relative outcomes of manufacturers and importers is the Pakistan's entry into WTO. Pakistan became a member of WTO on January 1, 1995. This is quite a long time (30 months) before the period considered in my main set of results (Figures IV & V and Tables III & V), and the pretrends rule out any residual impact of the event on the outcomes.

More generally, the following four pieces of evidence strongly support my empirical strategy. First, the outcomes of the treatment and control groups evolve similarly in periods during which the policy does not change. Figure IV and Table III demonstrate it for taxable sales; Figure V for entry; Figures A.IX-A.X for survival; and Table A.VI for taxable input costs. Parallel trends over a long horizon covering both pre- and post-intervention periods across a variety of outcomes makes it highly unlikely that the estimated effects represent differential macro shocks rather than the VAT spillovers.

Second, any demand or supply shock that favors domestic production relative to imports would also accelerate entry into the manufacturing sector relative to imports. But we do not observe such acceleration in the financial year 1999 when the reported sales of manufacturers was growing consistently (see Panels D and F of Figure V). Stagnant entry and increasing sales of manufacturers cannot be explained by a coherent real-side story under plausible market structures.

Third, I conduct subgroup analysis estimating the taxable sales response separately for each industry. Figure A.XV performs this exercise. I estimate equation (4) restricting the sample to firms of one industry only. Panel A plots the $Manuf \times Post$ coefficient and 95% confidence interval around it from these regressions, comparing it against the baseline coefficient of 0.48 (see column (1) of Table III). Panel B and C replicates the exercise, showing the $Manuf \times 1998$ and placebo coefficients respectively.[25] The response is quite homogeneous across industries. The coefficient of interest is positive and significant in all but two instances, and the 95% confidence interval around it contains the baseline coefficient for all but four industries. In contrast, the $Manuf \times 1998$ and placebo coefficients are almost always trivial and insignificant. To the extent that macro shocks affect different industries differently, homogeneous industry-level response rules out any macro-based explanation of the observed response even further.[26]

Finally, strong bunching of manufacturers at the zero-liability point and the subsequent shifting of the distribution in 1999 (Figure VI) reinforce the conclusion that the response is primarily driven by the withholding mechanism built into VAT as shown above.

[25]The industry classifications used here comes from the 2-digit aggregation scheme of the HS Code. The scheme along with the description of the industries is shown in Table A.IX.

[26]Table A.X explores the characteristics of firms in the four industries—wood products; footwear; arms and ammunition; and furniture, where the response is significantly weaker than the average. Firms in these industries are on average smaller, employ less capital, have lower input to output ratios, and are much less likely to register voluntarily. They are thus the least likely to be affected by the expansion of VAT, in particular to its extension to inputs such as electricity and gas, reinforcing the conclusion that the response represents VAT spillovers.

VI.B Effect on Government Revenue

How much additional revenue did the government receive from the VAT spillovers? Table III documents that the expansion of VAT caused a significant rise in sales reported by manufacturers. Under the assumption of no one-sided evasion, a rise in sales reported at a given production stage is a sufficient condition that the government collects more revenue from that and any upstream production stages. To see this formally, consider an economy composed of two production stages only (energy and manufacturing sectors in my empirical application). For simplicity, assume that the upstream production stage sells all its output to the downstream production stage as an intermediate. The aggregate VAT revenue collected from both production stages is given by

$$T = \tau \hat{s}_1 + \tau(\hat{s}_2 - \hat{c}_2), \tag{6}$$

which equals $T = \tau \hat{s}_2$ if we rule out one-sided evasion meaning that $\hat{c}_2 = \hat{s}_1$. One-sided evasion in this particular setup means that manufacturers forge their electricity and gas bills to over-claim VAT paid on these inputs i.e. $\hat{c}_2 > \hat{s}_1$. This is highly unlikely as (1) forgery is treated as tax fraud entailing prosecution and (2) electricity and gas bills can easily be verified at the time of audit because they are supplied solely by publicly-owned firms. Due to these strong paper trails we can safely rule out one-sided evasion in this setting, meaning that purchases of energy reported by manufacturers would match with the sales reported by energy suppliers exactly. Note that the government was not receiving any consumption tax from the energy sector prior to the extension of VAT to the sector in 1999. The rise in sales documented in Table III would therefore result in a rise in VAT revenue of comparable magnitude ($\Delta T = \tau.\Delta\hat{s}_2$). As I mention in section III.E, I cannot look at the firm-level VAT revenue directly as an outcome variable because doing so would largely capture the mechanical and not the behavioral effect of VAT expansion. In this section, I look at the *aggregate* VAT collected in Pakistan to get some sense of the additional revenue generated by the VAT spillovers.

Table A.XI conducts this analysis. The FBR report commodity-wise VAT collected in the country in their annual reports. These reports are publicly available, and I access the 2001-02 to 2004-05 reports to construct this table. The first two columns of the table show that the VAT revenue grew sharply between 1999 and 2002, in particular in 1999.[27] Some of this growth results from the mechanical expansion of the base,

[27] The standard VAT rate changed during this period for two brief episodes (see Figure A.IV). To make

the rest from the behavioral responses (VAT spillovers). To provide a clean lower-bound on the behavioral component of the growth, columns (3)-(4) exclude the revenue remitted by the energy sector. The commodities included in these columns remain taxable throughout the sample period, meaning that any growth in revenue would necessarily reflect the behavioral effect. The numbers provide a lower bound because they do not take into account the VAT deducted by manufacturers on their energy inputs. Columns (5) and (6) take into account these deductions. Using data from the Pakistan Economic Survey, I compute the proportion of energy used as an intermediate good by manufacturing firms.[28] I then add that proportion of revenue remitted by the energy sector to compute the aggregate revenue.

It is important to emphasize that these time-series aggregates are not directly comparable to the results in Table III: they do not control for macro factors and may be more sensitive to the performance of large firms (the results in Table III include firm fixed effects). Despite these caveats, the aggregate revenue growth is generally in line with the firm-level sales growth documented in Table III. VAT revenues were almost stagnant but grew sharply from 1999 as the energy sector came into the tax net. The results thus confirm that the government received a significant enforcement dividend from the expansion of VAT: the already-taxed sector remitted more revenue as their exposure to VAT deepened (see columns 5-6 of the table, which are conceptually closest to the estimates in Table III).

VI.C Conclusion

Value-added tax has seen unparalleled growth in the past few decades. The growth in part has been driven by the belief—held by both public finance academics and policy practitioners—that VAT facilitates enforcement. This paper uses the staggered introduction of VAT in Pakistan to test if the tax creates significant enforcement spillovers and, if yes, what underpins this process.

I present three primary findings. First, VAT indeed creates enforcement spillovers: taxable sales reported by firms already in the tax net go up as their exposure to VAT expands. This effect is strong, precisely estimated, and robust. Second, the tax has a much weaker effect on informality. While the increasing penetration of VAT accelerate the

the revenue comparable across years, I normalize it to a rate of 15% throughout the sample period.

[28] Specifically, I use Table 14 of the Pakistan Economic Survey 2005-06 to compute this proportion for the years 1997 to 2004. The survey shows that on average around 33% of electricity, 66% of gas, and 70% of other petroleum products (including furnace oil) are used as input by manufacturing firms. The survey can be accessed here.

registration of informal manufacturers, the new registrants do not begin filing returns or begin remitting the tax until the tax inspectors start visiting their premises. Third, the enforcement spillovers of VAT are primarily driven by the withholding mechanism built into it, whereby the tax on inputs of a firm is collected at the upstream stage. When more inputs of firms become taxable, they absorb some of the increase in input tax thereby reporting higher sales.

I compare the indirect enforcement effects of VAT with those of a tax survey, which tightens enforcement in the country directly using traditional measures. I find that the survey also generates strong compliance response, especially along the extensive margin. It caused unregistered firms to register and dormant firms to become active and begin remitting the tax. Once in, these firms were not more likely to quit the formal sector, illustrating large, persistent, and long-term gains from a one-time enforcement effort. Comparing the compliance responses produced by the VAT expansion and enforcement survey, I find that VAT spillovers from the upstream extension are of comparable magnitude to those from a very large enforcement intervention.

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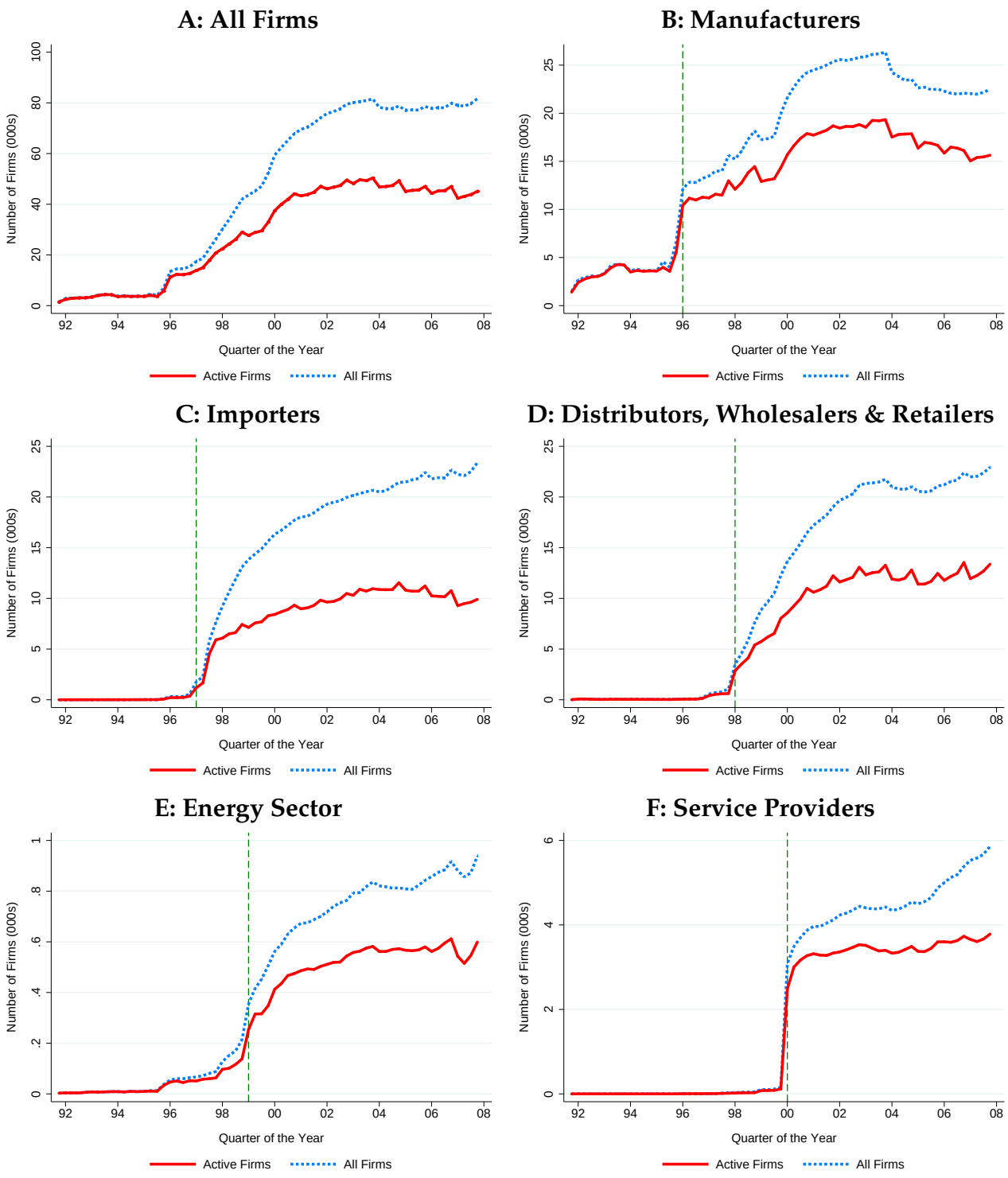
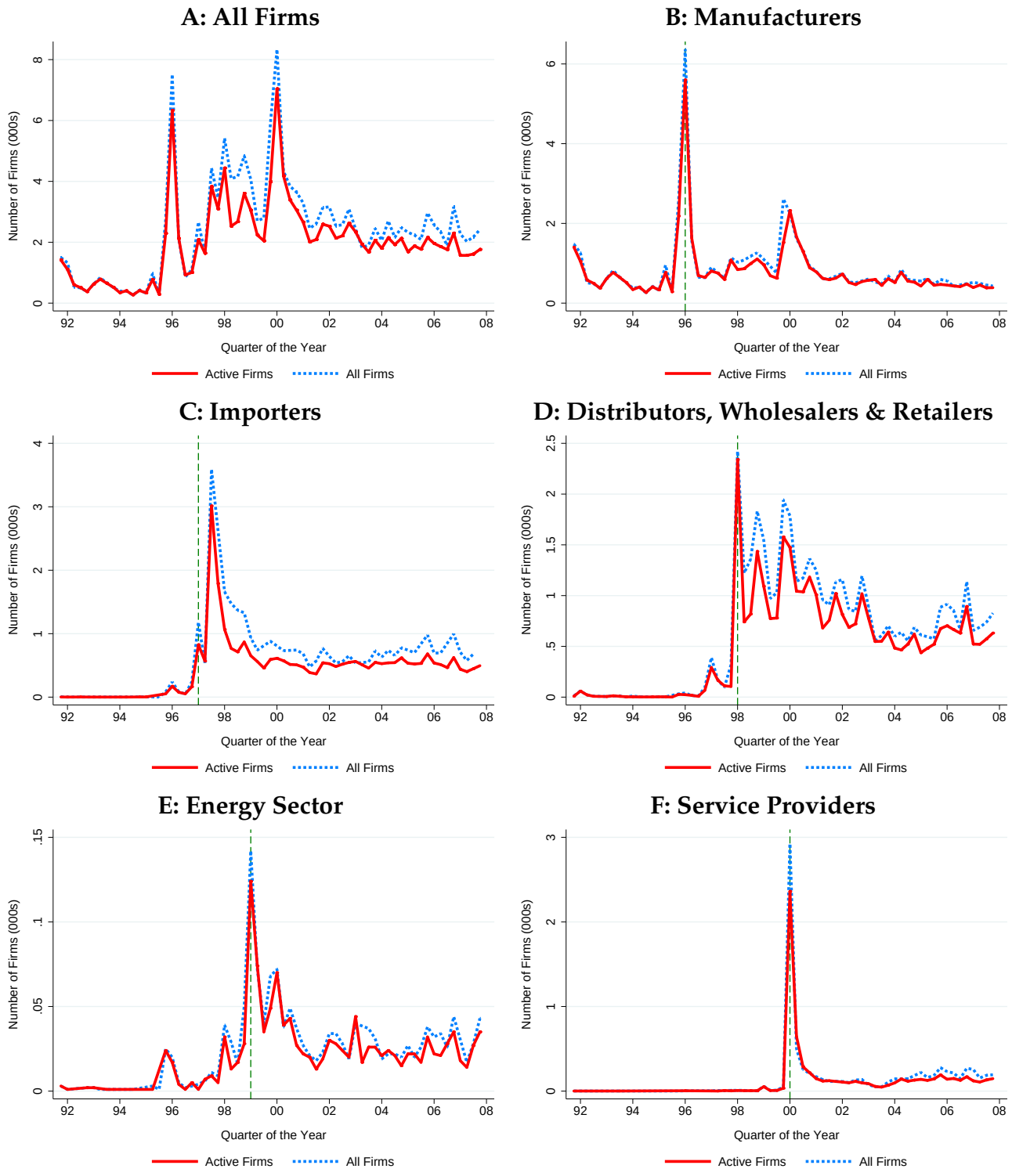
FIGURE I: **DEVELOPMENT OF VAT IN PAKISTAN – NUMBER OF FIRMS**



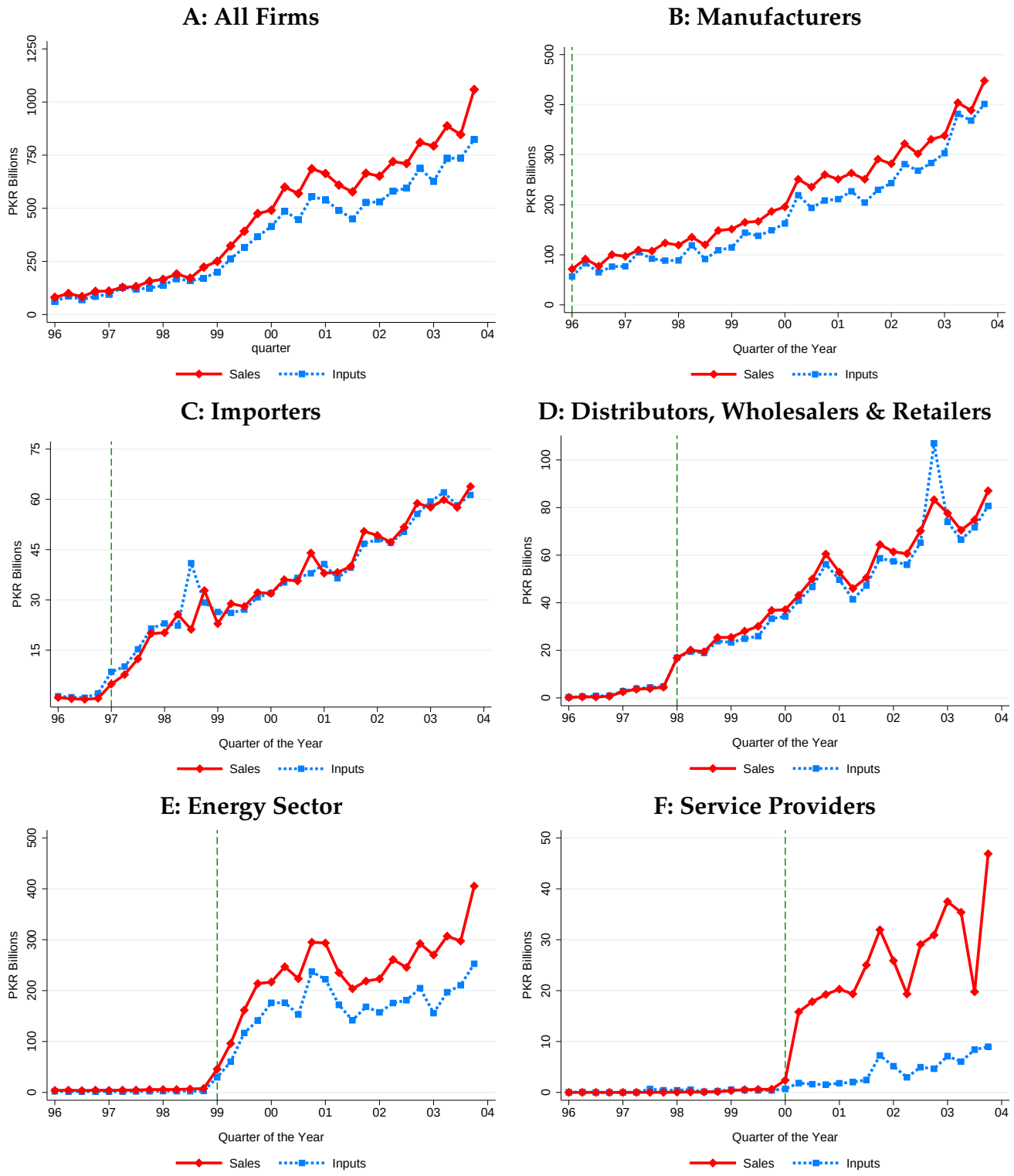
Notes: The figure illustrates the introduction and growth of VAT in Pakistan by tracking the stock of firms in the tax net between 1992 and 2008. It plots the number of firms who file their monthly VAT return at least once in the quarter indicated on the horizontal axis. Year t on the horizontal axis denotes the beginning of the financial year and therefore indicates the July-September quarter. Active firm is defined as a firm who reports nonzero activity in at least one of the cells in the return. Vertical dashed line in each panel demarcate the exact time from which supplies of the production stage became subject to VAT. Please see Appendix A.1 for the classification of firms into manufacturers and other categories.

FIGURE II: **DEVELOPMENT OF VAT IN PAKISTAN – ENTRY OF NEW FIRMS**



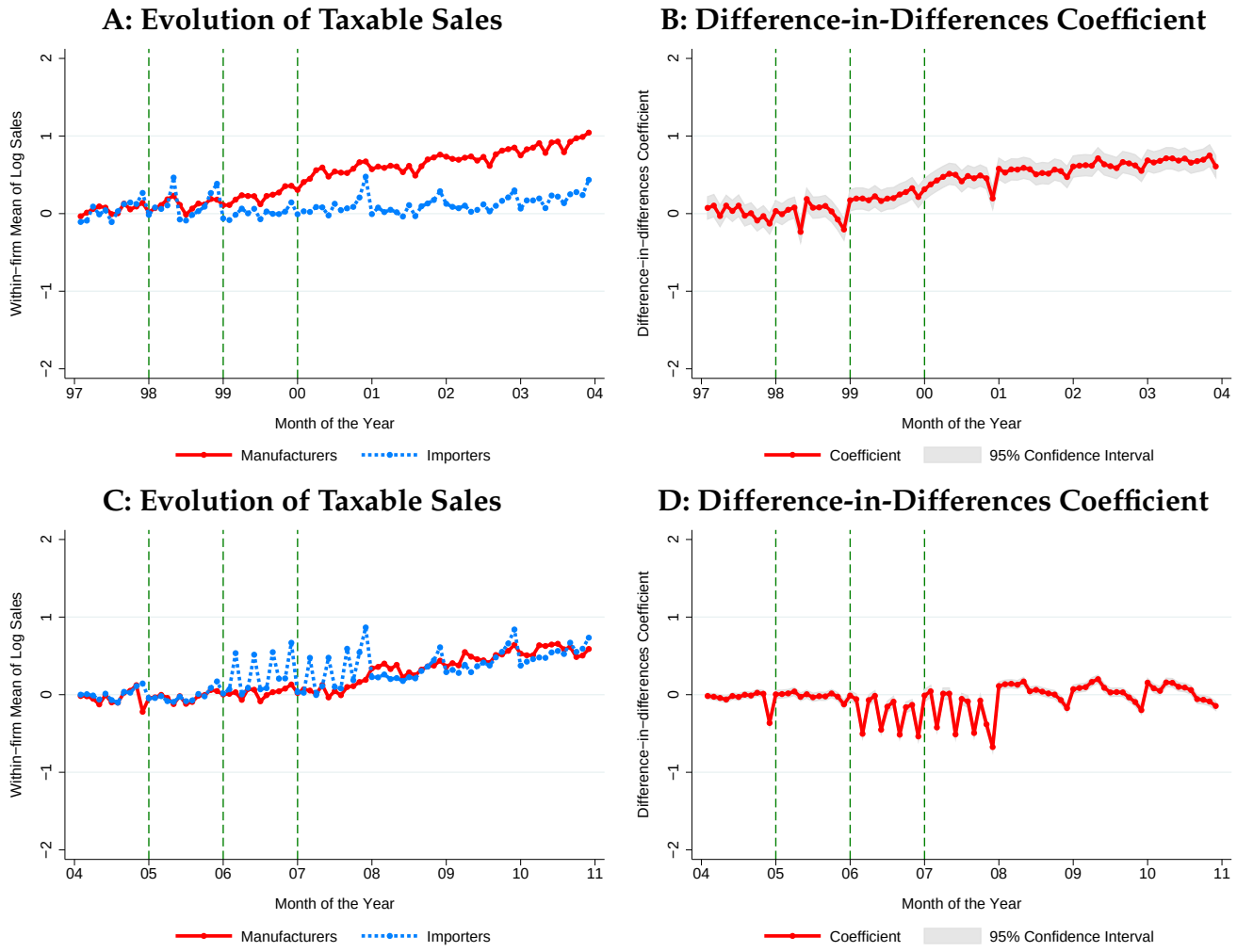
Notes: The figure illustrates the introduction and growth of VAT in Pakistan by tracking the entry of new firms into the tax net between 1992 and 2008. It plots the number of firms who file their first VAT return in the quarter indicated on the horizontal axis. Year t on the horizontal axis denotes the beginning of the financial year and therefore indicates the July-September quarter. Active firm is defined as a firm who reports nonzero activity in at least one of the cells in the return. The difference between All Firms and Active Firms represents "Nil Filers"—the inactive firms who report zero in all cells of the return. Vertical dashed line in each panel demarcate the exact time from which supplies of the production stage became subject to VAT. Please see Appendix A.1 for the classification of firms into manufacturers and other categories.

FIGURE III: **DEVELOPMENT OF VAT IN PAKISTAN – VOLUME OF TRANSACTIONS**



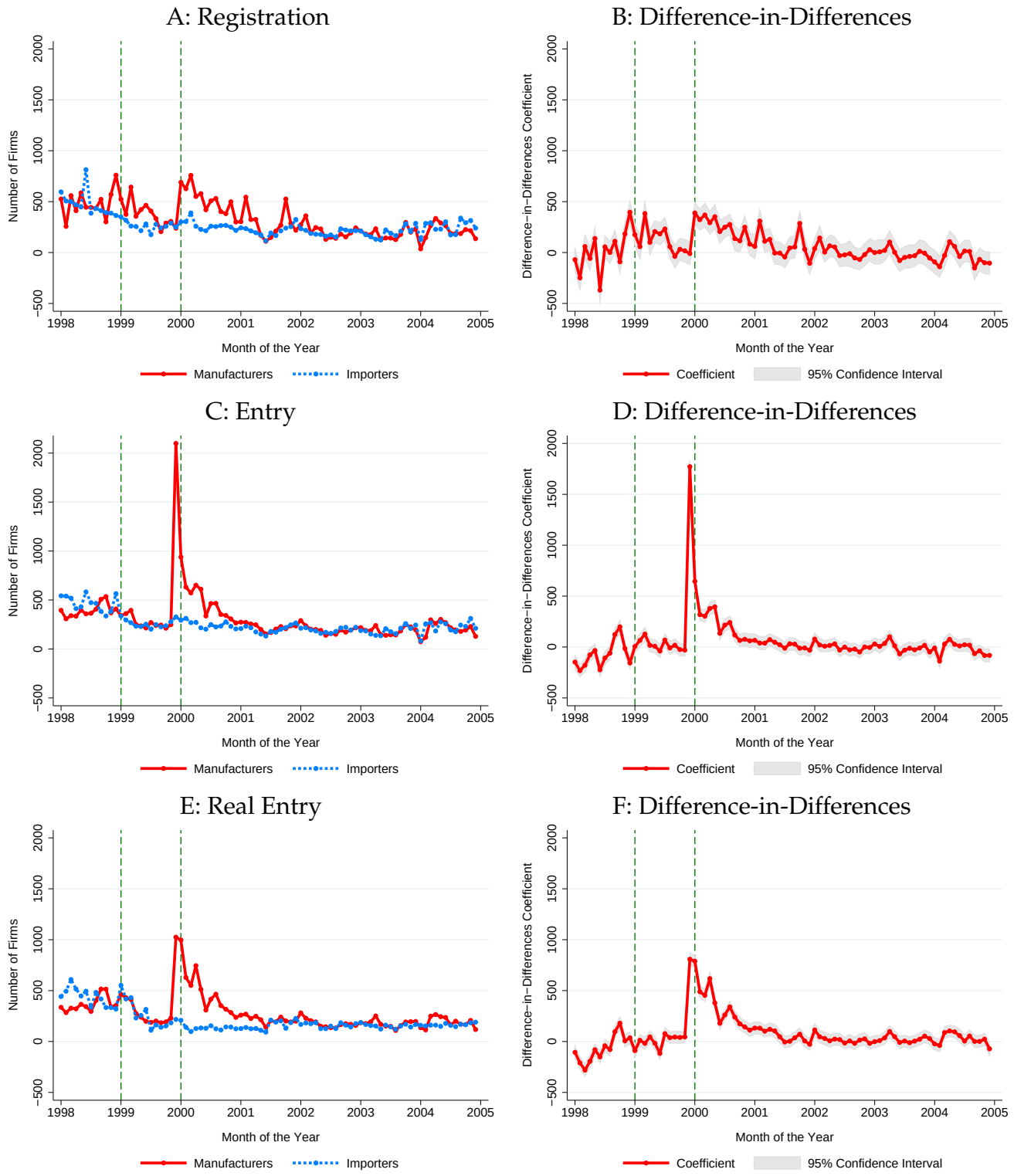
Notes: The figure illustrates the introduction and growth of VAT in Pakistan by tracking the volume of transactions covered by the tax between 1992 and 2008. It plots the aggregate value of taxable sales and taxable input costs reported by firms in the quarter indicated on the horizontal axis. Year t on the horizontal axis denotes the beginning of the financial year and therefore indicates the July-September quarter. Vertical dashed line in each panel demarcate the exact time from which supplies of the production stage became subject to VAT. Please see Appendix A.1 for the classification of firms into manufacturers and other categories.

FIGURE IV: **TAXABLE SALES RESPONSE**



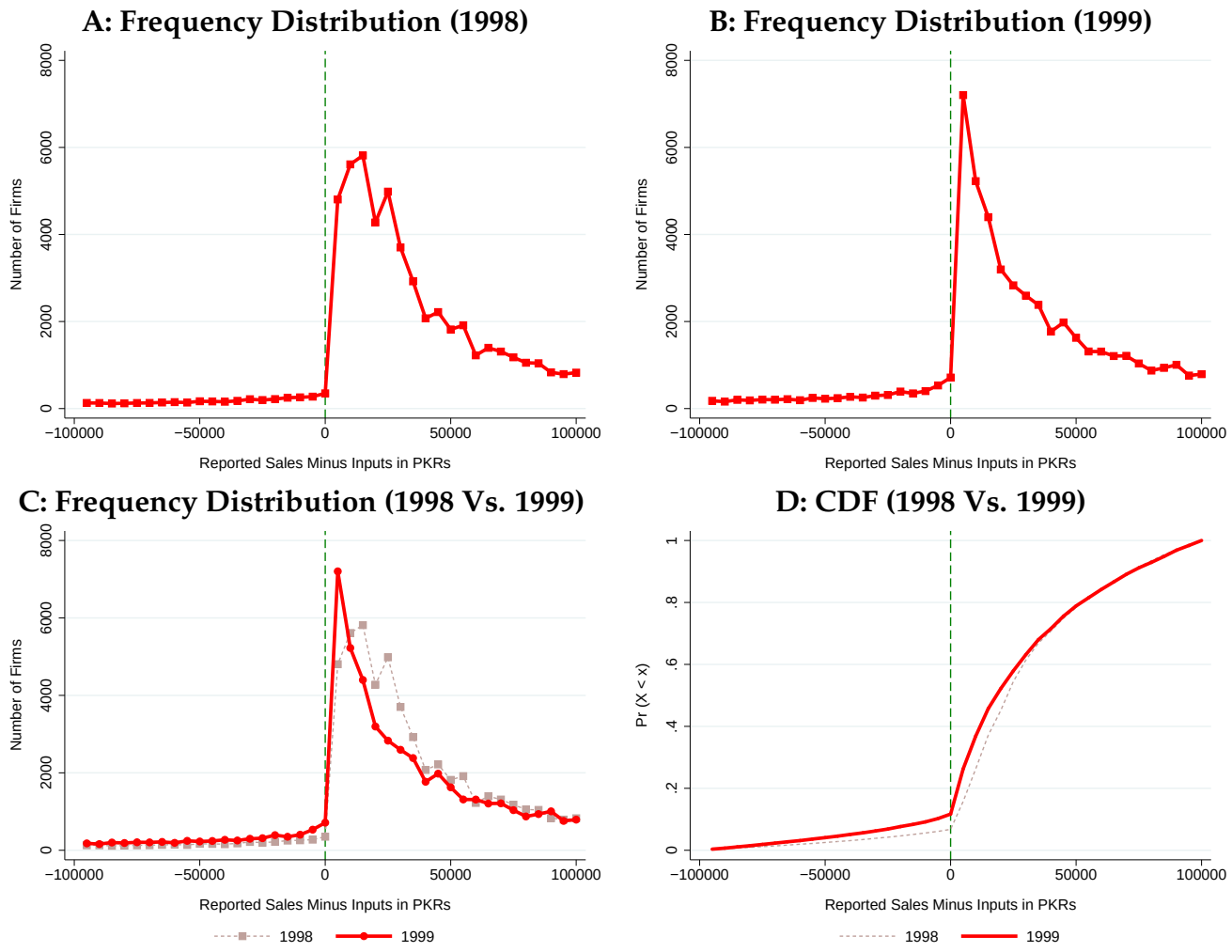
Notes: The figure compares the evolution of taxable sales reported by manufacturers and importers between July 1997 and June 2010. To construct the LHS panels, I regress the log of taxable sales on the full set of firm and month fixed effects, dropping the dummy for July 1997 in Panel A and July 2004 in Panel B. I plot the coefficients on the time dummies of these regressions, run separately for the two groups of firms. The marker for each period, accordingly, approximates the average within-firm sales growth relative to the baseline month for the corresponding group of firms. Year t on the horizontal axis indicates the month July of the year. The RHS panels are the difference-in-differences analogues of the LHS panels. Vertical dashed lines in the top two plots demarcate three important event during the period: the extension of VAT to distributor, wholesalers and retailers (1998); energy sector (1999); and services (2000). The last event is almost contemporaneous with the enforcement survey, which was announced by the end of May 2000.

FIGURE V: **PARTICIPATION RESPONSE**



Notes: The figure illustrates the effects of the increasing exposure to VAT and tax survey on firms' entry into the formal sector. The LHS panels show the numbers of firms who register (Panel A), file their first return (Panel B), and file their first positive-activity return (Panel C) in the month indicated on the horizontal axis. The RHS panels plot the corresponding difference-in-differences analogue of the two series. Year t on the horizontal axis indicates the month July of the year. The vertical dashed lines demarcate the start of the financial years 1999 and 2000. VAT was extended to the energy sector in 1999 and to the services sector in 2000; the tax survey was announced on May 24, 2000.

FIGURE VI: **BUNCHING AT ZERO TAX LIABILITY**



Notes: The figure explores if the discontinuity in evasion costs at the zero-liability point induces firms to bunch towards the right of the point. Panel A-C plot the distribution of $\hat{s}_i - c_i$ in bins of 5,000 rupees. Vertical dashed line denote the point where reported taxable sales equal reported taxable input costs and the tax liability becomes zero. The tax liability is negative to the left of this point. Panels A and B show the distribution for 1998 and 1999, the years immediately before and after energy inputs such as electricity and gas were made taxable. Panel C compares the two distributions, displaying the leftwards shift of the 1999 distribution. Panel D shows the leftwards shift formally. It plots the corresponding Cumulative Distribution Functions, illustrating that the 1999 distribution is stochastically (first-order) dominated by the 1998 distribution at all points.

TABLE I: **FORWARD AND BACKWARD LINKAGES**

	Manufacturers			Importers		
	2008	2009	2010	2008	2009	2010
	(1)	(2)	(3)	(4)	(5)	(6)
A: Forward Linkages						
Manufacturer	54.0	55.4	54.9	54.3	57.4	60.8
Importer	4.1	4.1	4.5	15.1	16.5	14.0
Exporter	2.1	0.8	0.6	2.4	1.5	1.3
Distributor, Wholesaler, and Retailer	31.8	32.5	30.7	16.8	16.7	14.7
Energy	5.2	4.5	6.3	2.0	1.5	1.5
Services	2.7	2.5	2.8	9.2	6.3	7.4
B: Backward Linkages						
Manufacturer	45.7	45.7	44.5	11.5	11.5	15.4
Importer	10.4	12.3	11.8	11.7	11.7	9.7
Exporter	0.4	0.6	0.7	1.2	1.0	0.9
Distributor, Wholesaler, and Retailer	7.8	7.6	9.1	8.0	8.6	5.6
Energy	14.3	11.9	11.6	0.9	0.6	1.5
Services	2.1	2.4	2.7	1.0	0.8	1.1

Notes*:* Using transaction level data, I explore forward and backward linkages across firms in various production stages. Columns (1)-(3) shows the percentage of sales made to production stage j in the year indicated in the row heading for manufacturers. Columns (4)-(6) list the corresponding percentages for importers. Panel B replicate the exercise for purchases. Around 66% of purchases of importers and 18% of manufacturers are from foreign sellers. Here I show domestic purchases only.

TABLE II: **SUMMARY STATISTICS**

	Manufacturers			Importers			Others		
	1997	2000	2003	1997	2000	2003	1997	2000	2003
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A: Complete Panel									
# Observations	133,877	203,773	228,293	38,053	121,848	141,377	6,945	149,004	197,410
Reported Sales:									
Mean	6.367	6.016	7.848	2.181	2.000	2.557	3.374	1.675	2.138
Median	0.476	0.441	0.547	0.828	0.550	0.596	0.926	0.159	0.194
75th Percentile	2.854	2.030	2.295	2.045	1.597	1.811	2.722	0.752	0.894
90th Percentile	13.726	10.042	11.074	4.735	4.033	4.937	7.741	2.615	3.112
99th Percentile	88.986	88.184	111.449	22.620	22.503	30.761	35.807	27.183	28.269
B: Balanced Panel 1									
# Observations	64,667	65,448	65,250	9,195	9,703	9,706	2,756	2,953	2,941
Reported Sales:									
Mean	8.465	11.373	17.329	3.181	4.477	5.045	3.798	4.086	5.049
Median	0.750	0.991	1.380	1.282	1.511	1.495	1.141	1.406	1.596
75th Percentile	4.386	4.776	6.677	3.196	4.040	4.499	3.378	3.913	4.191
90th Percentile	20.062	21.149	33.057	7.502	9.482	11.782	9.391	9.822	9.428
99th Percentile	119.017	172.919	235.177	28.720	49.657	58.463	36.746	43.379	63.315
C: Balanced Panel 2									
# Observations	24,972	24,972	24,972	1,908	1,908	1,908	396	396	396
Reported Sales:									
Mean	12.297	18.631	27.032	3.543	5.936	6.151	7.638	9.191	9.276
Median	1.078	1.483	2.078	1.458	1.645	1.728	2.458	3.942	4.117
75th Percentile	7.081	8.945	12.981	3.450	4.536	5.843	6.185	10.515	9.875
90th Percentile	27.331	37.499	54.312	8.608	12.621	16.377	25.478	29.774	20.520
99th Percentile	174.985	276.431	346.271	31.315	85.784	66.379	52.628	52.879	68.634

Notes*:* The table reports the descriptive statistics of the two main variables used in the empirical analysis. I report the number of observations and five moments of the reported taxable sales distribution at three different points in time. I show the statistics separately for manufacturers, importers, and all other firms excluding exporters. The Balanced Panel 1 sample in Panel B contains the firms who file VAT return at least once in every quarter during the period 1997-2003. These firms remain in the sample throughout the period but may not file the return every tax period. In distinction, the Balanced Panel 2 sample in Panel C has a more stringent criterion, including only those firms who file VAT return in every month during the period 1997-2003.

TABLE III: **TAXABLE SALES RESPONSE**

	All Firms		Balanced Panel 1		Balanced Panel 2	
	(1)	(2)	(3)	(4)	(5)	(6)
A: 1997-2003						
Manuf × *Post*	0.481	0.498	0.440	0.438	0.434	0.416
	(0.016)	(0.022)	(0.029)	(0.036)	(0.068)	(0.081)
Manuf × 1998		0.024		-0.004		-0.035
		(0.018)		(0.027)		(0.057)
Observations	1,288,552	1,288,552	429,510	429,510	153,873	153,873
B: 2004-2010						
Manuf × *Post*	0.013		0.029		0.037	
	(0.015)		(0.018)		(0.055)	
Observations	1,293,097		742,846		200,414	

Notes*:* The table report the results from the difference-in-differences model (4). The standard errors are in parenthesis, which have been clustered at the firm level. The sample includes both manufacturers and importers. Balanced Panel 1 sample in columns (3)-(4) contains only the firms who file their VAT return at least once in every quarter included in the sample period. In distinction, the Balanced Panel 2 sample includes a firm only if it files its VAT return every tax period included in the sample. The results in Panel B are from a placebo specification exactly similar to one in Panel A but estimated on the 2004-2010 period. The *Post* dummy indicates a tax period (month) after June 1999 in Panel A and June 2006 in Panel B.

TABLE IV: **TAXABLE SALES RESPONSE OVER TIME**

Year $\leq$	1999 (1)	2000 (2)	2001 (3)	2002 (4)	2003 (5)	2004 (6)	2005 (7)
Manuf $\times$ *Post*	0.249	0.233	0.332	0.395	0.450	0.489	0.490
	(0.014)	0.014	0.014	0.015	0.016	0.016	0.017
Manuf $\times$ *2000*		0.206					
		(0.013)					
Manuf $\times$ *2001*			0.198				
			(0.011)				
Manuf $\times$ *2002*				0.195			
				(0.011)			
Manuf $\times$ *2003*					0.190		
					(0.011)		
Manuf $\times$ *2004*						0.008	
						(0.012)	
Manuf $\times$ *2005*							0.030
							(0.019)
Observations	360,669	569,495	799,627	1,042,084	1,288,552	1,516,133	1,673,981

Notes: The table investigates the dynamics of the taxable sales response. I partition the $Manuf \times Post$ dummy in model (4) into two dummies: $Manuf \times Post$ and $Manuf \times Year$. I estimate the model on the complete panel sample, restricting it to the period 1997-$Year$, where $Year$ is the financial year indicated in the title of the column. The $Manuf \times Year$ dummy captures the additional sales response in the given financial year. The standard errors are in parenthesis, which have been clustered at the firm level. The sample includes both manufacturers and importers. The $Post$ dummy indicates a tax period (month) after June 1999.

TABLE V: **PARTICIPATION RESPONSE**

Year	Registration			Entry			Real Entry		
	# Obs.	# Counter.	% Difference	# Obs.	# Counter.	% Difference	# Obs.	# Counter.	% Difference
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1999	5,349	3,382	0.582	3,541	3,478	0.018	3,489	3,417	0.021
			(0.061)			(0.030)			(0.032)
2000	5,993	3,277	0.829	7,714	3,157	1.443	6,549	1,772	2.696
			(0.061)			(0.035)			(0.061)
2001	3,728	2,454	0.519	2,780	2,321	0.198	2,717	1,725	0.575
			(0.077)			(0.048)			(0.059)
2002	2,563	2,516	0.019	2,404	2,420	-0.007	2,207	1,994	0.107
			(0.081)			(0.044)			(0.054)
2003	2,252	2,294	-0.018	2,251	2,220	0.014	2,059	1,853	0.111
			(0.083)			(0.048)			(0.056)
2004	2,556	2,941	-0.131	2,525	2,625	-0.038	2,337	1,908	0.225
			(0.070)			(0.041)			(0.052)

Notes*:* Does the tightening of enforcement caused indirectly by the expansion of VAT and directly by the tax survey force informal firms into the formal sector? The table investigates this. Column (2) reports the number of manufacturing firms who register in the financial year indicated in the first column. Column (3) reports the corresponding numbers for importers, whom I take as the counterfactual for manufacturers (see Figure V). The difference between the two numbers as a percentage of the counterfactual is reported in Column (3). I calculate the standard error on the difference using a nonparametric bootstrap procedure. I first create a vector of errors as the difference between the monthly registration of manufacturers and importers. I then create a bootstrapped registration series for manufacturers by adding scrambled errors to the registration series of importers. Finally, I calculate the difference between the bootstrapped and counterfactual series for each financial year. The standard error is the average percentage difference between the two series. I draw 100 bootstrapped series for this purpose. Columns (4)-(10) are created analogously, only difference being that I investigate the outcomes entry and real entry in place of registration. Entry here is defined as the month a firm files its first return and real entry as the month the firm files its first positive-activity return.

A Online Appendix

A.1 Definition of Variables

(*i*) **Taxable Sales** The value of taxable goods and services supplied by a firm in a given tax period excluding exports.

(*ii*) **Taxable Inputs Costs.** The value of taxable intermediates purchased by a firm in the given tax period whether imported or acquired locally.

(*iii*) **Manufacturer.** A firm whose principal business activity is the manufacture of goods. Manufacturing is the process whereby a firm converts inputs into a distinct article capable of being put to use differently than inputs and includes any process incidental or ancillary to it.

(*iv*) **Importer.** Any person who imports any goods into Pakistan.

(*v*) **Distributor.** A person appointed by a manufacturer, importer or any other person for a specified area to purchase goods from him for further supply and includes a person who in addition to being a distributor is also engaged in supply of goods as a wholesaler or a retailer.

(*vi*) **Wholesaler.** Wholesaler' includes a dealer and means any person who carries on, whether regularly or otherwise, the business of buying and selling goods by wholesale or of supplying or distributing goods, directly or indirectly, by wholesale for cash or deferred payment or for commission or other valuable consideration or stores such goods belonging to others as an agent for the purpose of sale; and includes a person supplying taxable goods to a person who deducts income tax at source under the Income Tax Ordinance, 2001.

(*vii*) **Retailer.** A person, supplying goods to general public for the purpose of consumption.

(*viii*) **Industry.** The Pakistani tax administration uses 4-digit Harmonized Commodity Description and Coding System (HS code) to classify firms into industry. The code, used by customs administrations throughout the world, divides all goods and services into 99 chapters (the first two digits in the code) and 21 sections. The sections broadly correspond to major industries in the country. I

take the section a firm falls in as its industry. Table A.IX shows the sections, HS code, and description of these industries.

(*ix*) **Tax Office.** The variable indicates the tax office whose jurisdiction a firm's head office falls in. These tax offices are located in nine major cities of the country. The tax office fixed effects, accordingly, capture all time-invariant characteristics of both the tax office and city in which a firm carries out its business activity.

A.2 Tax Withholding in Low-Enforcement-Capacity Setting

A continuum of manufacturing firms of measure one is indexed by $i \in I$. Each firm is characterized by a two-dimensional ability vector $\boldsymbol{\phi} = \{\phi^r, \phi^e\}$ determining its costs to produce real output and evade taxes. A firm i combines taxable inputs costing $c(s_i; \boldsymbol{\phi})$ and nontaxable inputs costing $\psi(s_i; \boldsymbol{\phi})$ to produce s_i units of output that can be sold at a fixed price, normalized to one. The government implements the standard VAT, whereby the firm is required to charge the tax at a rate τ of its output and is allowed to deduct the tax paid on inputs. The government's ability to observe output is limited and the firm can underreport its sales $\hat{s}_i < s_i$ on paying a resource cost of $g(s_i - \hat{s}_i; \boldsymbol{\phi})$. VAT can be evaded by underreporting sales and/or overreporting costs. Here I abstract from costs overreporting to keep the exposition simple, assuming that taxable inputs are acquired from the organized sector and their misreporting is therefore not feasible. The firm's profit in this setting (compressing some notation) are given by

$$\text{(7)}\quad \pi(s_i, \hat{s}_i; \boldsymbol{\phi}) = s_i - c_i - \psi_i + \underbrace{\tau s_i}_{\text{output tax}} - \underbrace{\tau c_i}_{\text{input tax}} - \underbrace{\tau\left(\hat{s}_i - c_i\right)}_{\text{tax remitted}} - \underbrace{g\left(s_i - \hat{s}_i; \boldsymbol{\phi}\right)}_{\text{evasion costs}}.$$

The above expression implicitly assumes that the firm recovers VAT from its buyers on all its sales s_i but remits only $\tau\left(\hat{s}_i - c_i\right)$ to the government. The evaded sales $(s_i - \hat{s}_i)$ thus should be seen as sales made to the unregistered sector, where buyers have no incentive to obtain the VAT invoice so that the firm can appropriate all the

surplus from tax evasion to itself.[29] Equation (7) can be written more compactly as

$$\pi(s_i, \hat{s}_i; \boldsymbol{\phi}) = s_i - c_i - \psi_i + \underbrace{\tau\,(s_i - \hat{s}_i)}_{\text{tax evasion}} - \underbrace{g\,(s_i - \hat{s}_i; \boldsymbol{\phi})}_{\text{evasion costs}}. \tag{8}$$

I assume here that the evasion costs $g(s_i - \hat{s}_i; \boldsymbol{\phi})$ are a function of the evaded amount only and do not depend on the real output produced by the firm (the two elements of productivity ϕ^r and ϕ^e are independent of each other). The separability between evasion and production costs along with the fact that VAT does not distort input prices allows me to focus solely on the tax compliance decision of the firm, abstracting from real decisions such as substitution between taxable and nontaxable inputs. One distinguishing feature of VAT is that in it a firm's tax liability can become negative if the input tax τc_i exceeds the reported output tax $\tau \hat{s}_i$. I assume that the costs of evasion faced by the firm are of the following form

$$g(s_i - \hat{s}_i; \boldsymbol{\phi}) = \begin{cases} \gamma(s_i - \hat{s}_i; \boldsymbol{\phi}) & \text{if } \hat{s}_i > c_i \\ \alpha\gamma(s_i - \hat{s}_i; \boldsymbol{\phi}) & \text{if } \hat{s}_i \leq c_i, \end{cases} \tag{9}$$

where $\gamma(.)$ is an increasing and convex function of the evaded amount $(s_i - \hat{s}_i)$ and $\alpha > 1$, which means that the costs jump at the point tax liability becomes negative. The jump reflects the intuition that the likelihood of a firm facing an audit rises discretely as its reported sales fall below the taxable inputs costs. It is because the firm opts for either the refund or carry forward of the balance amount $\tau(\hat{s}_i - c_i)$ when this happens, and both cases raise a flag with the tax administration, as negative liability is not a common occurrence for firms other than exporters. The jump could potentially be large, particularly because the government has limited pre-audit information available to it to select cases for audit and negative tax liability is one very salient piece of such information.

Optimizing behavior in this setup implies that the firm would evade up to the point that the marginal cost of evasion equals the tax rate $g'\,(s_i - \hat{s}_i; \boldsymbol{\phi}) = \tau$. Given

[29] Note that this assumption is for notational economy only and can be relaxed easily. In a general model where the seller and buyer bargain over the evasion surplus, everything here goes through other than that the benefit of evasion to the seller is $\sigma\tau(s_i - \hat{s}_i)$ rather than $\tau\,(s_i - \hat{s}_i)$, where σ is the seller's bargaining weight. We are effectively assuming here that $\sigma = 1$, so that the buyer receives no surplus from evasion.

the discontinuity in evasion costs, the firm may end up at the zero-liability point if

$$\begin{cases} \gamma'\left(s_i - \hat{s}_i; \boldsymbol{\phi}\right) < \tau & \text{for } \hat{s}_i = c_i + \epsilon; \text{ and} \\ \alpha\gamma'\left(s_i - \hat{s}_i; \boldsymbol{\phi}\right) > \tau & \text{for } \hat{s}_i = c_i - \epsilon, \end{cases} \tag{10}$$

with $\epsilon > 0$.

Heterogeneity: Firms draw their productivities from the joint distribution $f(\phi^r, \phi^e)$ on the domain $(\underline{\phi^r}, \overline{\phi^r}) \times (\underline{\phi^e}, \overline{\phi^e})$. Under regularity conditions similar to Spence-Mirrlees, the smooth distribution of productivities translates into smooth distributions of real and reported sales as long as $\alpha = 0$. The jump in evasion costs ($\alpha > 1$), however, will cause bunching of firms at the zero-liability point.[30] The bunching firms draw $\boldsymbol{\phi}$ in the set $\boldsymbol{\phi} \in \Phi_z$ where condition (10) binds: their optimal reported sales equal their deductible inputs costs. The first testable prediction of the model with $\alpha > 1$ therefore is

PREDICTION 1: *The discontinuity in evasion costs will cause bunching of firms at, and to the right of, the point zero in the reported tax liability distribution.*

Now consider that the government extends the coverage of VAT from time t', making a nontaxable intermediate used by all firms taxable. The experiment is akin to the Pakistani policy change of 1999, whereby energy—an input used by all manufacturers—was brought into the tax net. Given that the tax paid on inputs is deductible, the change will not distort the input mix used by firms. For pure mechanical reasons, however, c_i will go up and ψ_i will go down by the same amount. Figures A.XI and A.XII trace the impact of the change on two representative firms. The change will not affect the high-evasion-cost (low ϕ^e) firm other than that its tax liability $\tau\left(\hat{s}_i - c_i\right)$ will go down because of the mechanical increase in c_i (see Figure A.XI). In contrast, the low-evasion-cost (high ϕ^e) firm will continue to bunch at the zero-liability point if condition (10) still binds at the new level of c_i. The firm will increase its reported sales $\hat{s}_i$ by the same amount as the increase in c_i (see Figure A.XII).

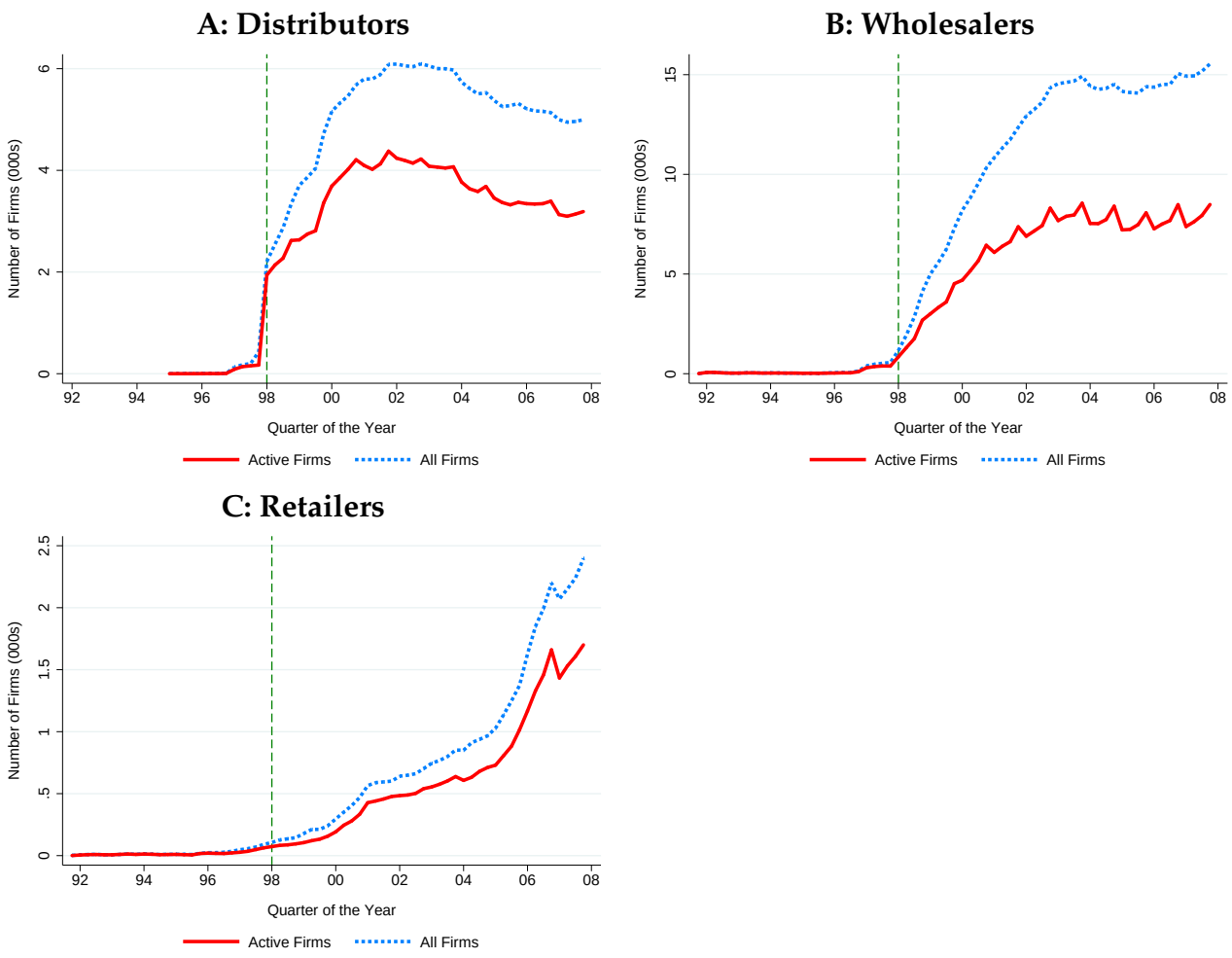
PREDICTION 2: *Making a hitherto untaxed input used by all firms taxable will cause the distribution of reported tax liability to shift leftwards. To the extent that evasion costs are of*

[30] The model presumes frictionless behavior. But with real-world considerations such as some discreteness in reported sales the bunching will not be concentrated exactly at the zero-liability point but will be spread toward the right of it.

the form (9), bunching at the zero-tax-liability point will persist even after the reform.

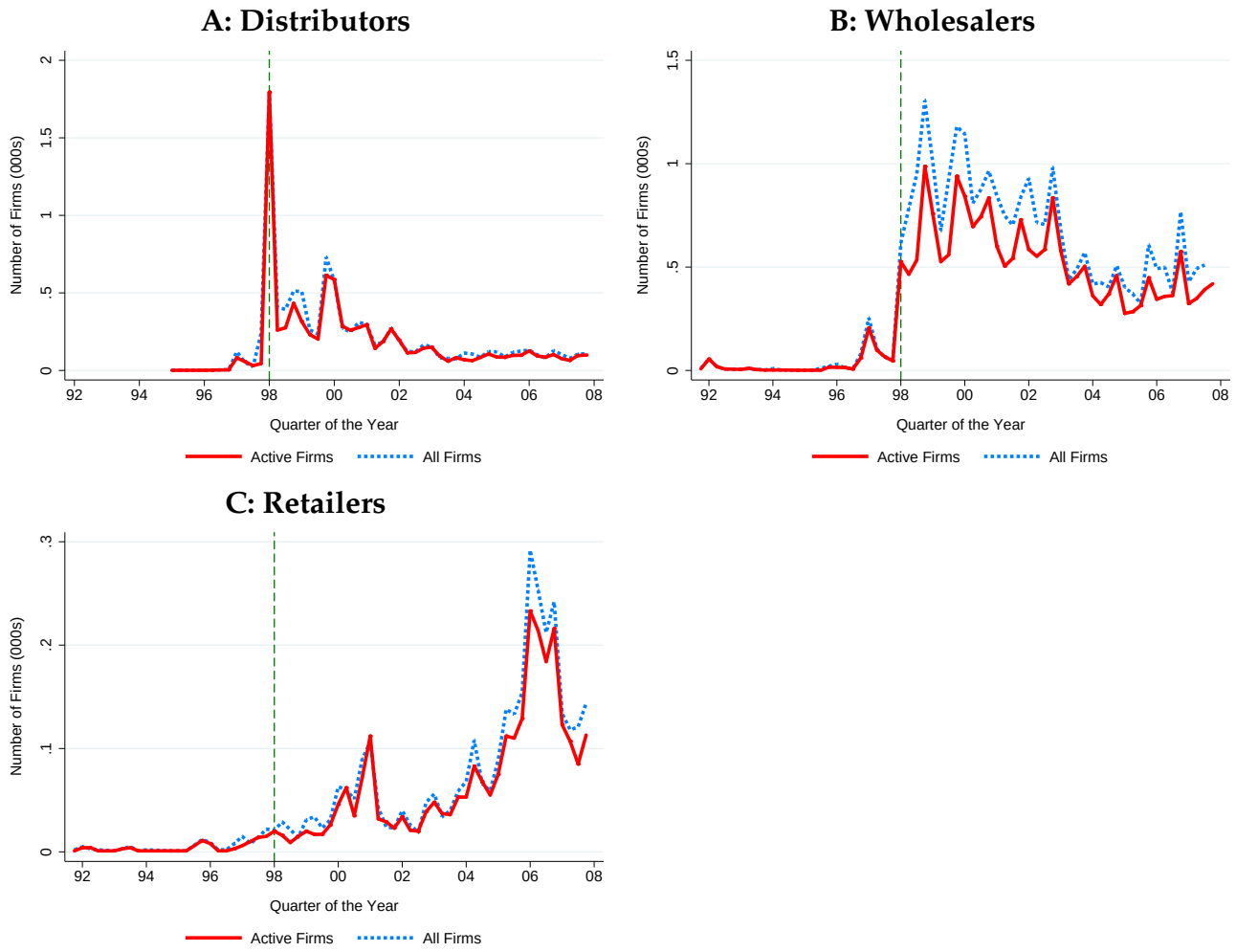
The leftward shift of the distribution results from the mechanical decrease in tax liability of firms after the reform. The persistence of bunching, on the other hand, results from the behavioral response, whereby firms report higher sales to avoid falling into the high evasion cost region.

FIGURE A.I: **DEVELOPMENT OF VAT IN PAKISTAN – NUMBER OF FIRMS**



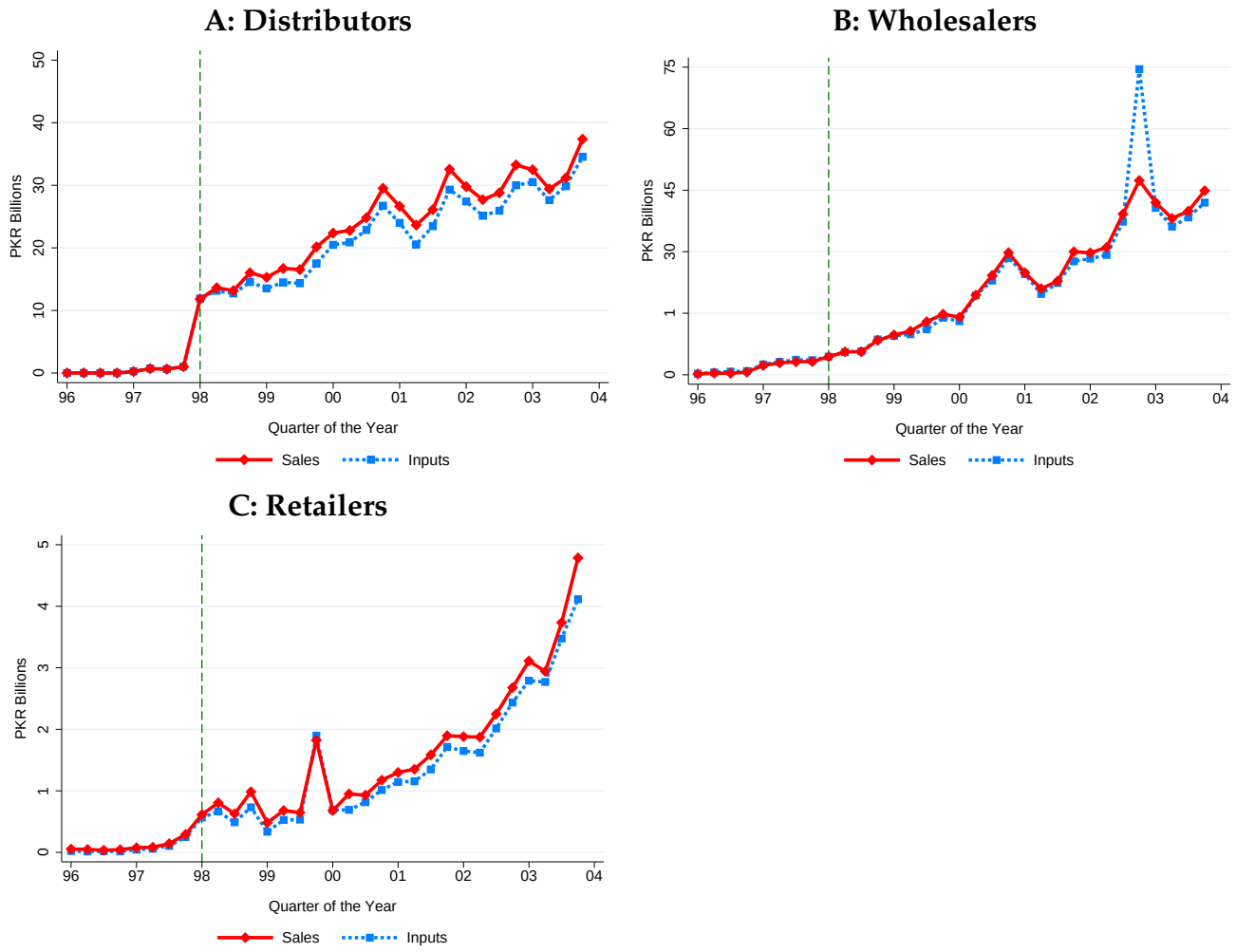
Notes: The figure illustrates the introduction and growth of VAT in Pakistan by tracking the stock of firms in the tax net between 1992 and 2008 for the three downstream stages separately. These stages were collectively shown in the Panel D of Figure I. Each panel of the figure plots the number of firms of the corresponding production stage who file their monthly VAT return at least once in the quarter indicated on the horizontal axis. Year t on the horizontal axis denotes the beginning of the financial year and therefore indicates the July-September quarter. Active firm is defined as a firm who reports nonzero activity in at least one of the cells in the return. Vertical dashed lines in each panel demarcate the exact time from which supplies of the production stage became subject to VAT. Please see Appendix A.1 on how firms are classified as Distributors, Wholesalers, and Retailers.

FIGURE A.II: **DEVELOPMENT OF VAT IN PAKISTAN – ENTRY OF NEW FIRMS**



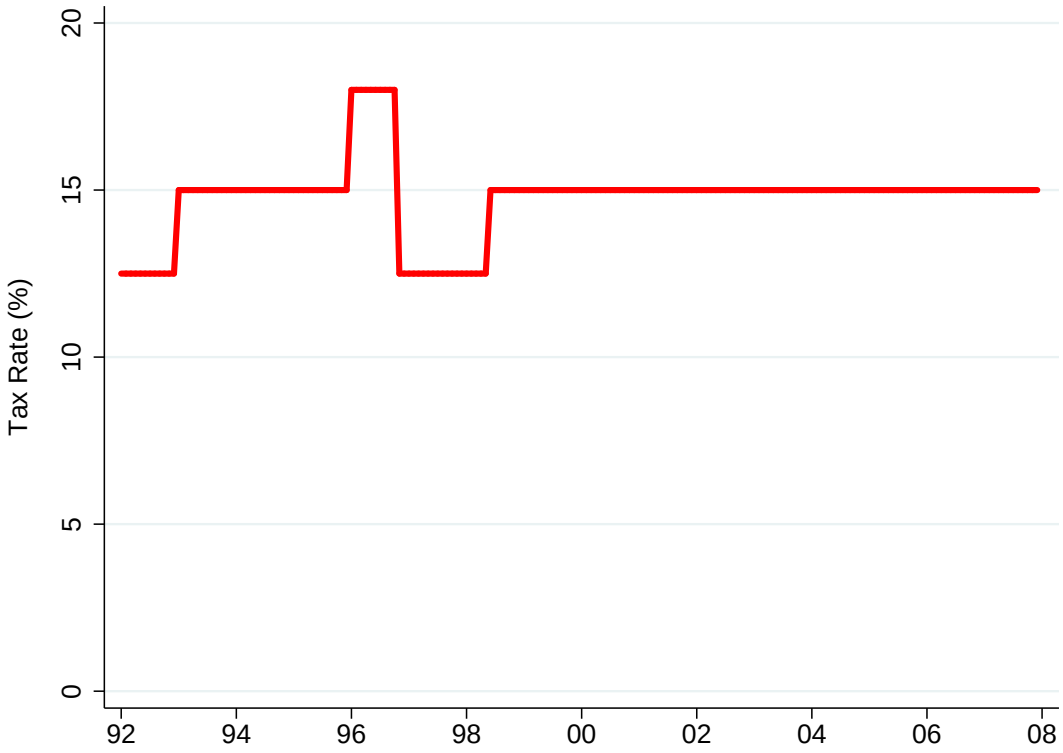
Notes: The figure illustrates the introduction and growth of VAT in Pakistan by tracking the entry of new firms into the tax net between 1992 and 2008 for the three downstream stages separately. These stages were collectively shown in the Panel D of Figure II. Each panel of the figure plots the number of firms who file their first VAT return in the quarter indicated on the horizontal axis. Year t on the horizontal axis denotes the beginning of the financial year and therefore indicates the July-September quarter. Active firm is defined as a firm who reports nonzero activity in at least one of the cells in the return. The difference between All Firms and Active Firms represents "Nil Filers"—the inactive firms who report zero in all cells of the return. Vertical dashed line in each panel demarcate the exact time from which supplies of the production stage became subject to VAT. Please see Appendix A.1 on how firms are classified as Distributors, Wholesalers, and Retailers.

FIGURE A.III: **DEVELOPMENT OF VAT IN PAKISTAN – VOLUME OF TRANSACTIONS**



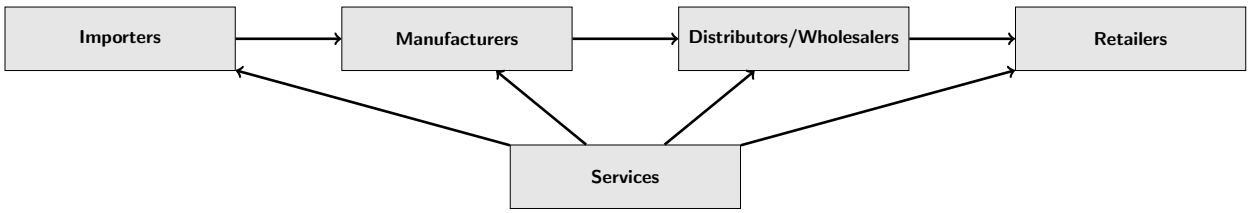
Notes: The figure illustrates the introduction and growth of VAT in Pakistan by tracking the volume of transactions covered by the tax between 1992 and 2008 for the three downstream stages separately. These stages were collectively shown in the Panel D of Figure III. Each panel of the figure plots the aggregate value of taxable sales and taxable input costs reported by firms in the quarter indicated on the horizontal axis. Year t on the horizontal axis denotes the beginning of the financial year and therefore indicates the July-September quarter. Vertical dashed line in each panel demarcate the exact time from which supplies of the production stage became subject to VAT. Please see Appendix A.1 on how firms are classified as Distributors, Wholesalers, and Retailers.

FIGURE A.IV: **STANDARD TAX RATE**



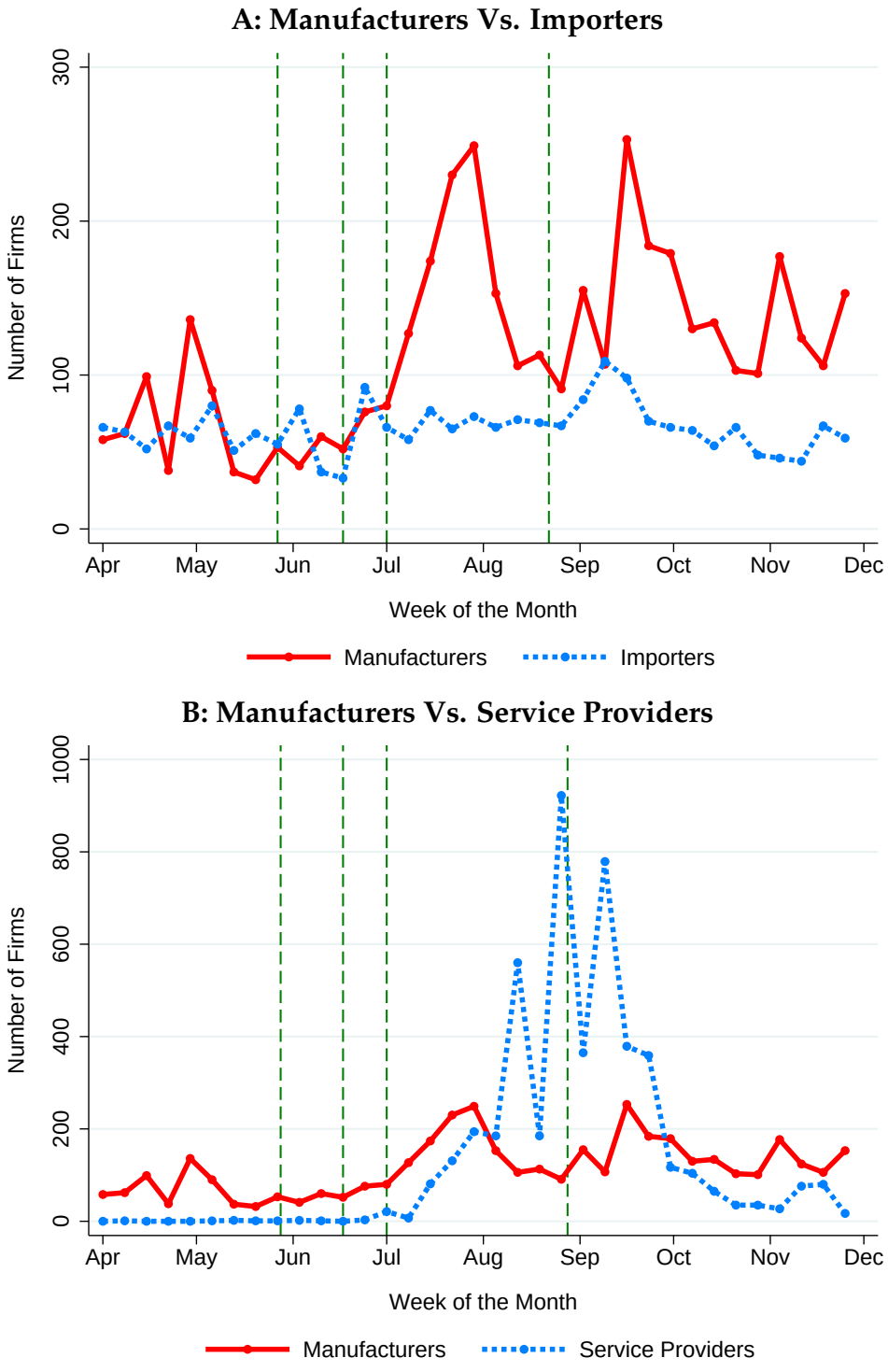
Notes: The figure shows the standard VAT rate in Pakistan from 1992 to 2008. The rate largely stayed at 15%. It was increased to 18% in July 1996, reduced to 12.5% in April 1997, and was brought back to 15% in December 1998.

FIGURE A.V: **TYPICAL SUPPLY CHAIN**



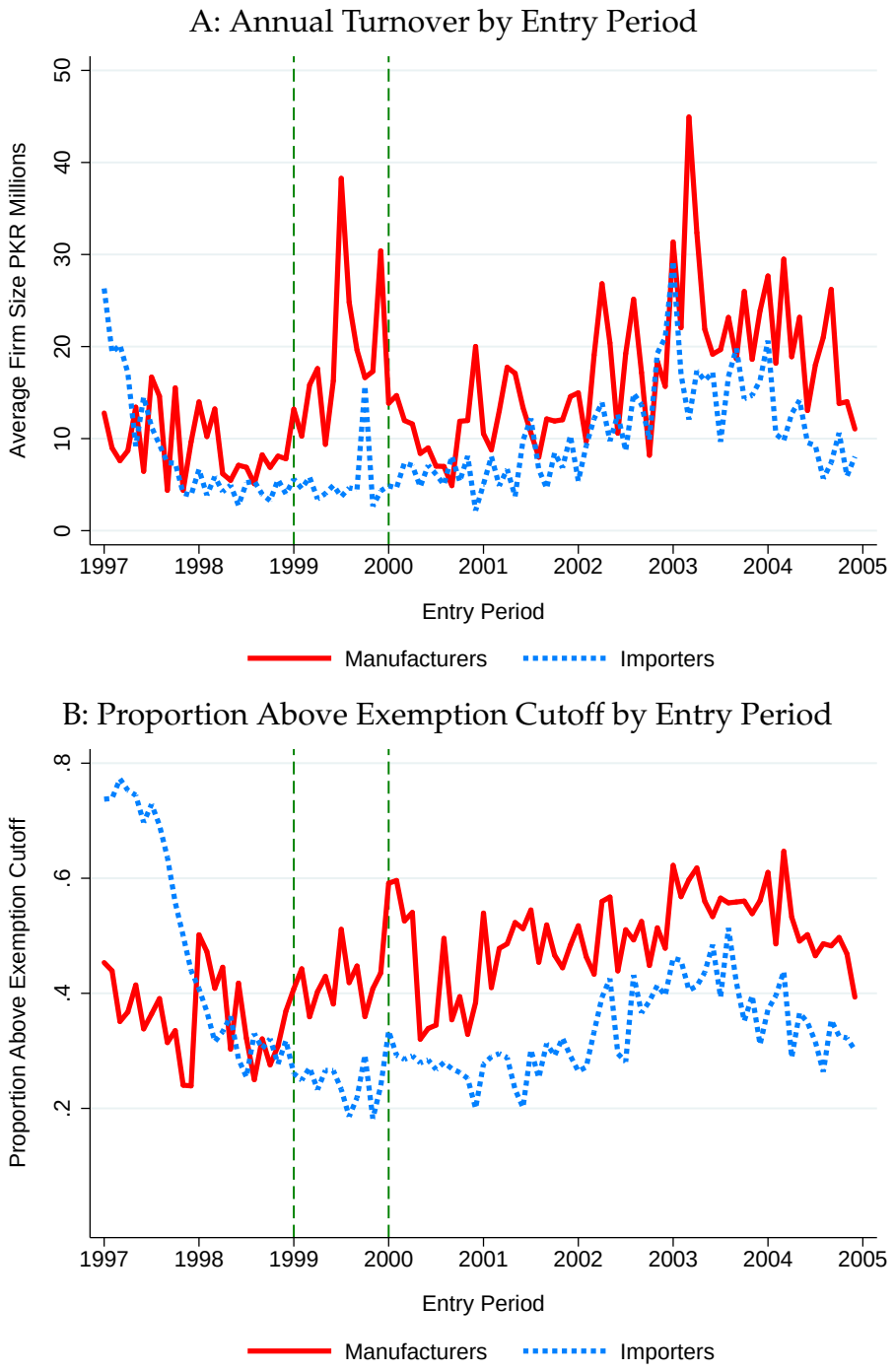
Notes: The figure displays a typical supply chain through which a good passes before its consumption in Pakistan. The input output linkages between firms in these production stages, reported in Table I, conform to this general scheme.

FIGURE A.VI: **WEEKLY REGISTRATION OF NEW FIRMS**



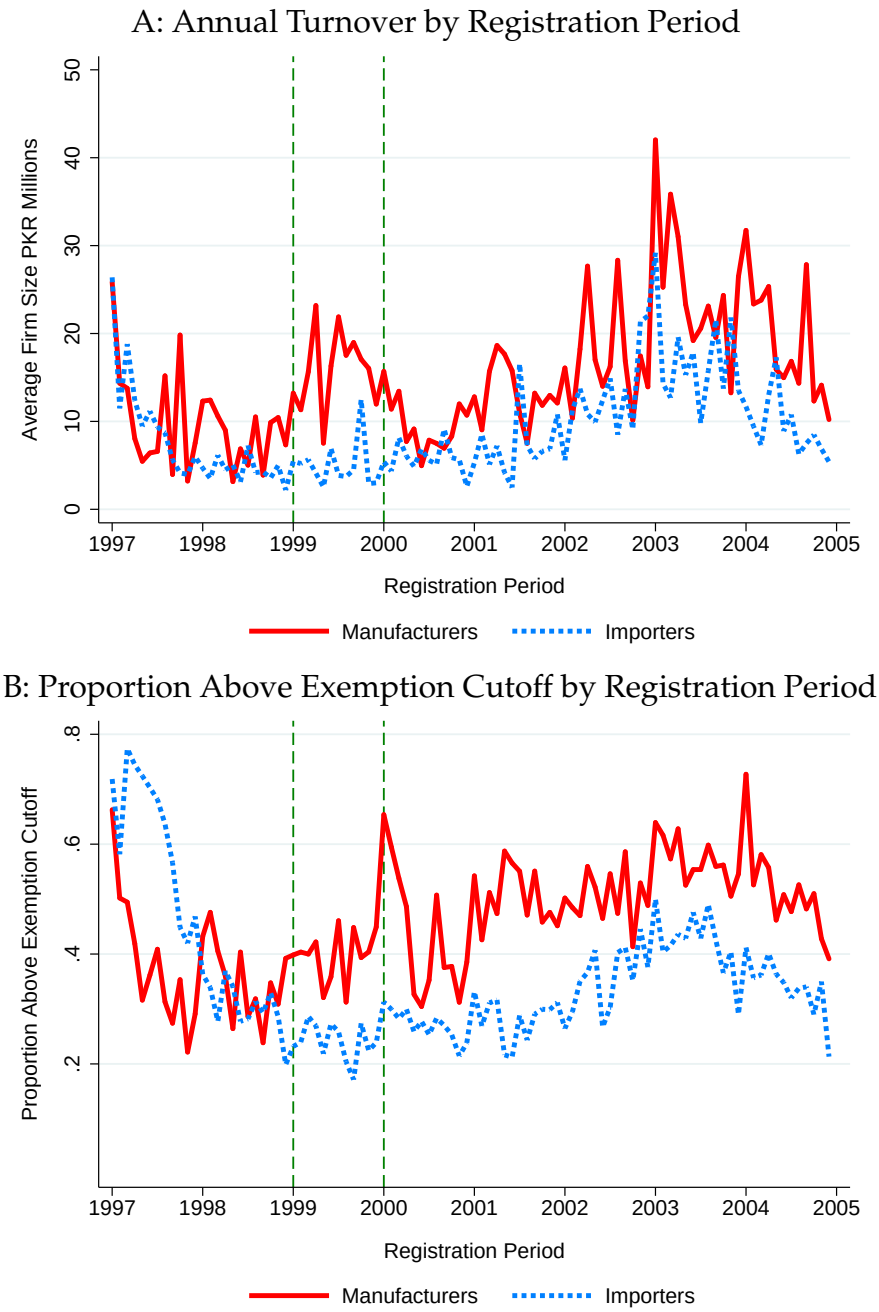
Notes: The figure explores if the large influx of manufacturing firms into the formal sector around July 2000 was caused by the extension of VAT to services or by the enforcement survey. It plots the number of new firms who register in the given week, zooming in on the period between the 1st of April and the 1st of December 2000. Panel A compares manufacturers to importers and Panel B to service providers. Vertical lines in the plots denote four important dates during this period: the government announces the tax survey on May 24 and the extension of VAT to services on June 17; the extension takes effect on July 1; and small traders end their resistance to the survey on August 21.

FIGURE A.VII: **FIRM SIZE BY ENTRY PERIOD**



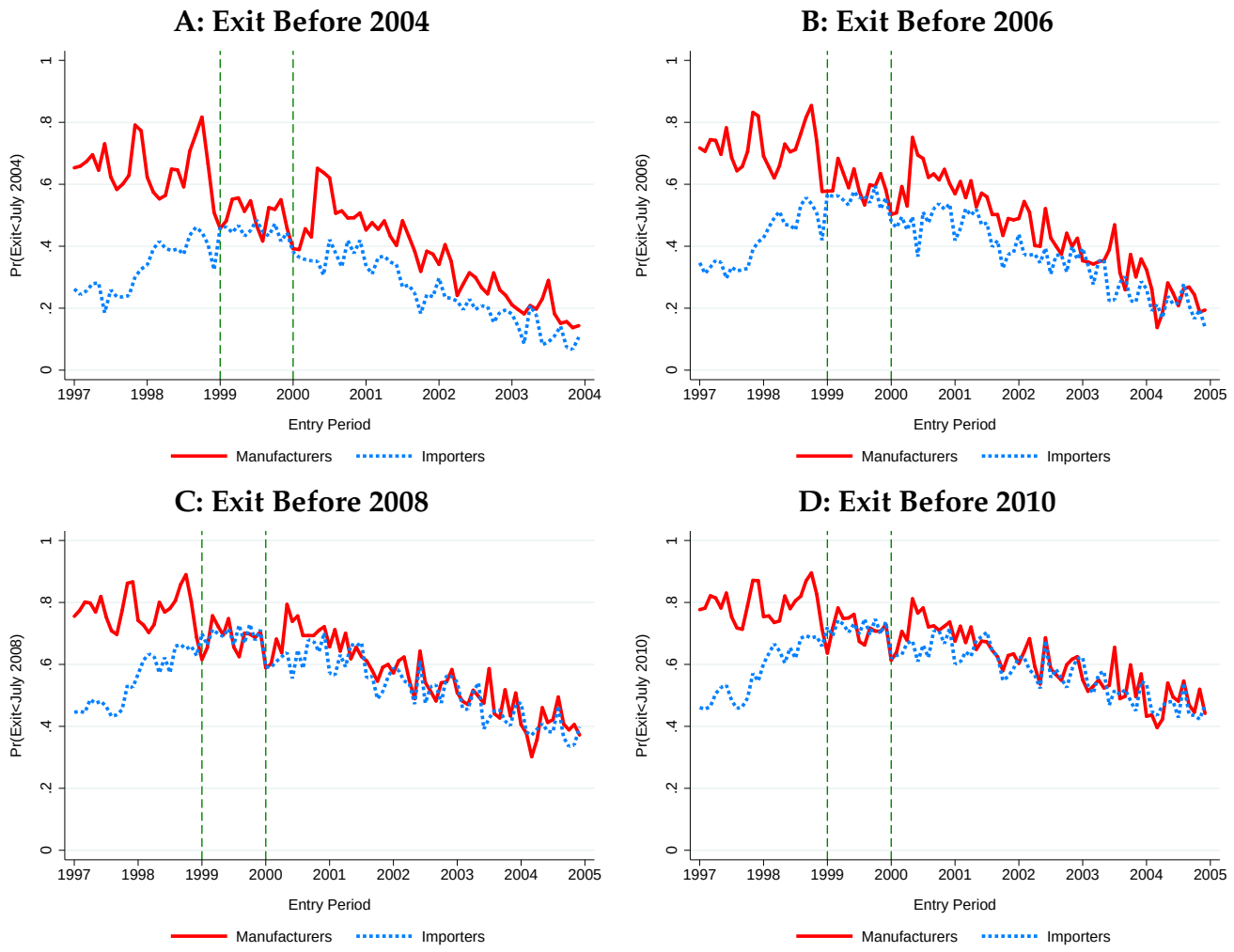
Notes: The figure investigates if firms who came into the formal sector in response to the increasing exposure to VAT and enforcement survey were any different from the other firms. Panel A plots the first-year turnover of firms by their entry period. The first-year here is defined as the tax year immediately succeeding the one in which a firm files it first VAT return. For example, if a firm files its first return in August 2000, its first-year turnover is the aggregate value of its sales in the tax year 2001-02. While doing this exercise, I drop firms whose first-year turnover exceeds PKR 1 billion. Panel B of the figure depicts the proportion of firms whose first-year turnover is above the exemption cutoff. Note that the exemption cutoff applies only to manufacturers. I use the same cutoff for importers. Vertical lines in the plots denote important events during this period: VAT was extended to the energy sector in July 1999 and to the services sector in July 2000; and the enforcement survey commences from the end of May 2000.

FIGURE A.VIII: **FIRM SIZE BY REGISTRATION PERIOD**



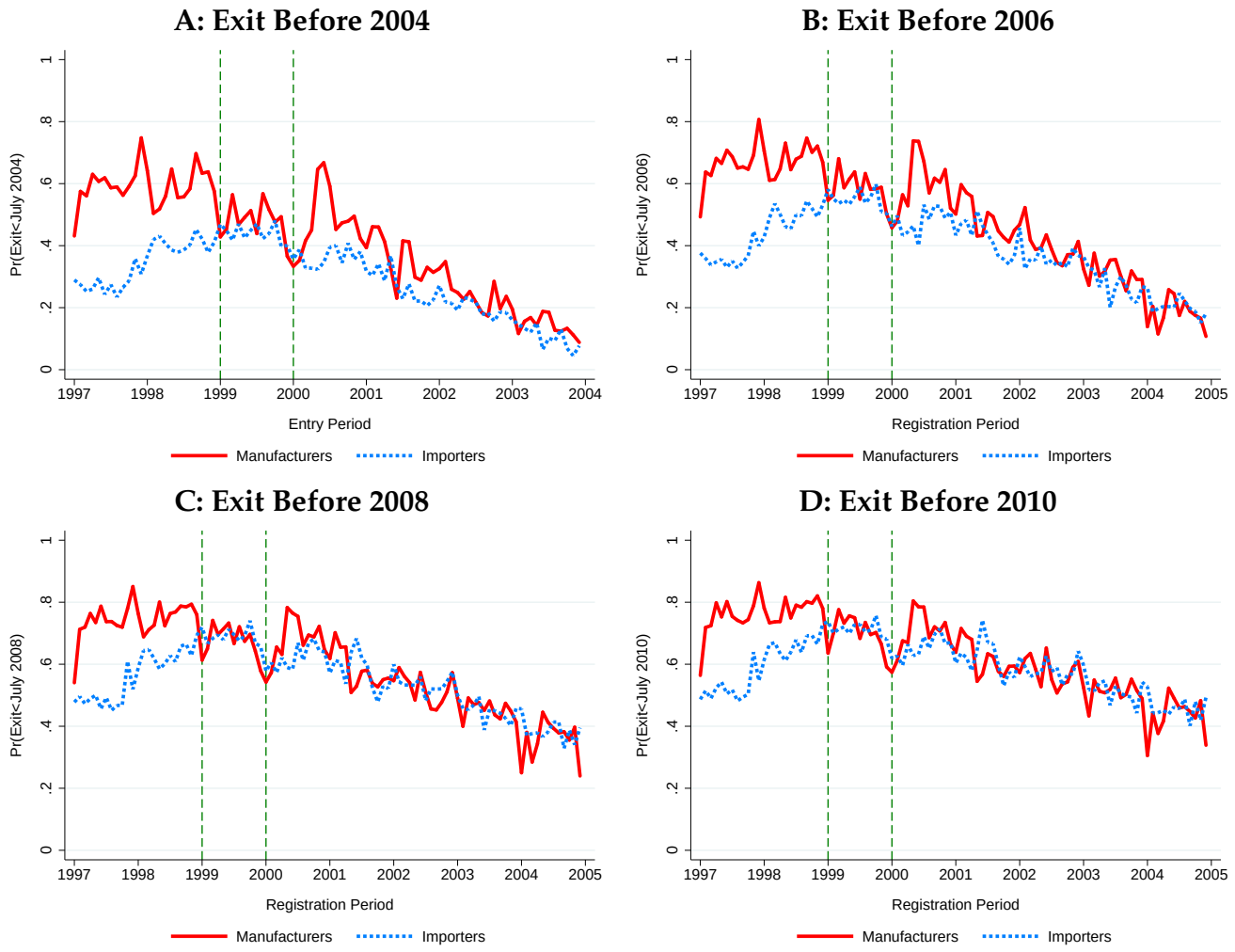
Notes: The figure investigates if firms who came into the formal sector in response to to the increasing exposure to VAT and enforcement survey were any different from the other firms. It replicates the analysis in Figure A.VII but takes the period a firm registers in as its period of entry. Panel A plots the first-year turnover of firms by their entry period. The first-year here is defined as the tax year immediately succeeding the one in which a firm files it first VAT return. For example, if a firm files it first return in August 2000, its first-year turnover is the aggregate value of its sales in the tax year 2001-02. While doing this exercise, I drop firms whose first-year turnover exceeds PKR 1 billion. Panel B of the figure depicts the proportion of firms whose first-year turnover is above the exemption cutoff. Note that the exemption cutoff applies only to manufacturers. I use the same cutoff for importers. Vertical lines in the plots denote important events during this period: VAT was extended to the energy sector in July 1999 and to the services sector in July 2000; and the enforcement survey commences from the end of May 2000.

FIGURE A.IX: **EXIT PROBABILITY BY ENTRY PERIOD**



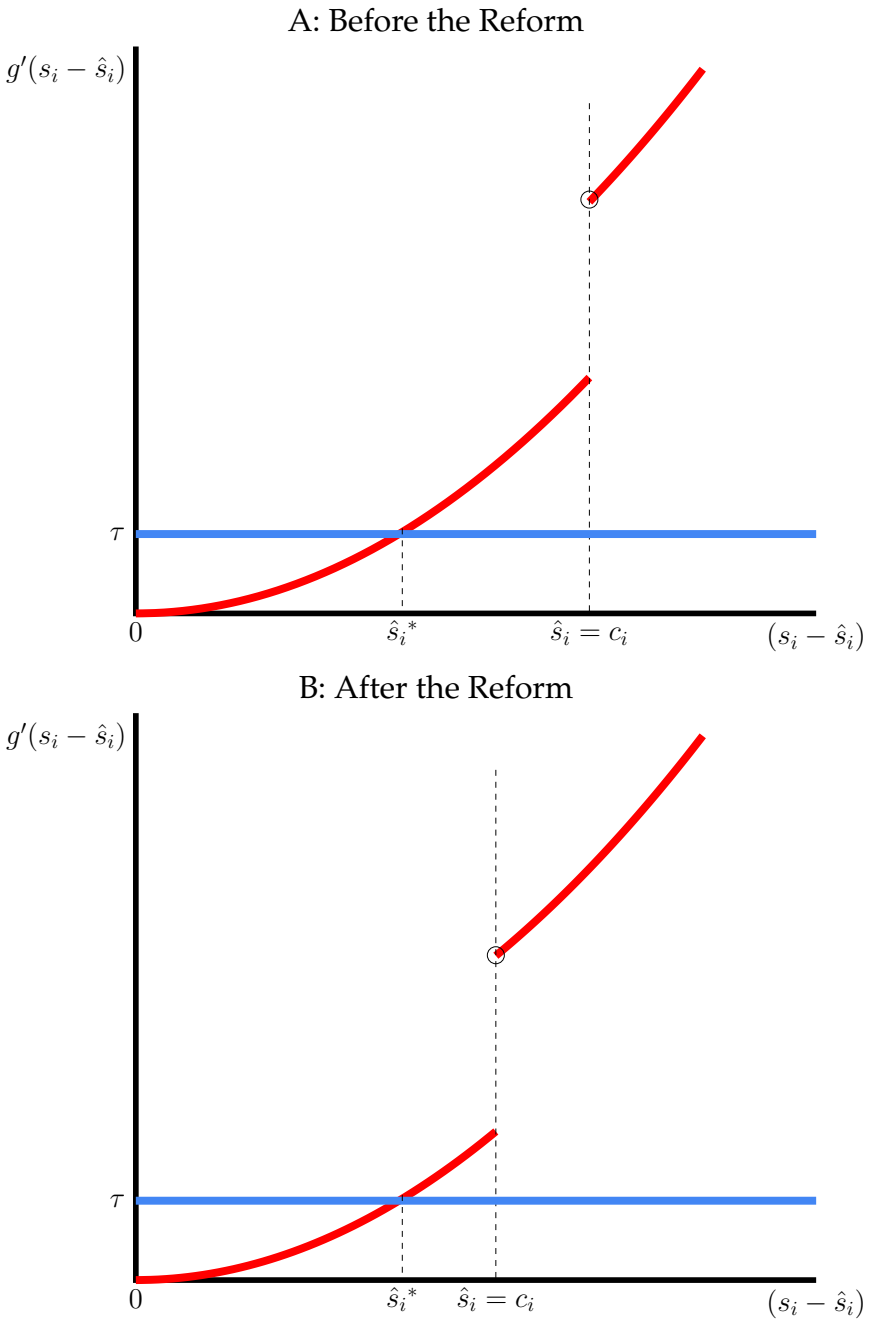
Notes: The figure explores if firms who came into the formal sector in response to the increasing exposure to VAT and tax survey were any different from the other firms. It plots the proportion of firms who exit before the given cutoff date by their entry month. The cutoff date is the 1st of July 2004 for Panel A; the 1st of July 2006 for Panel B; the 1st of July 2008 for Panel C; and the 1st of July 2010 for Panel D. Vertical lines in the plots denote important events during this period: VAT was extended to the energy sector in July 1999 and to the services sector in July 2000; and the enforcement survey commences from the end of May 2000.

FIGURE A.X: **EXIT PROBABILITY BY REGISTRATION PERIOD**



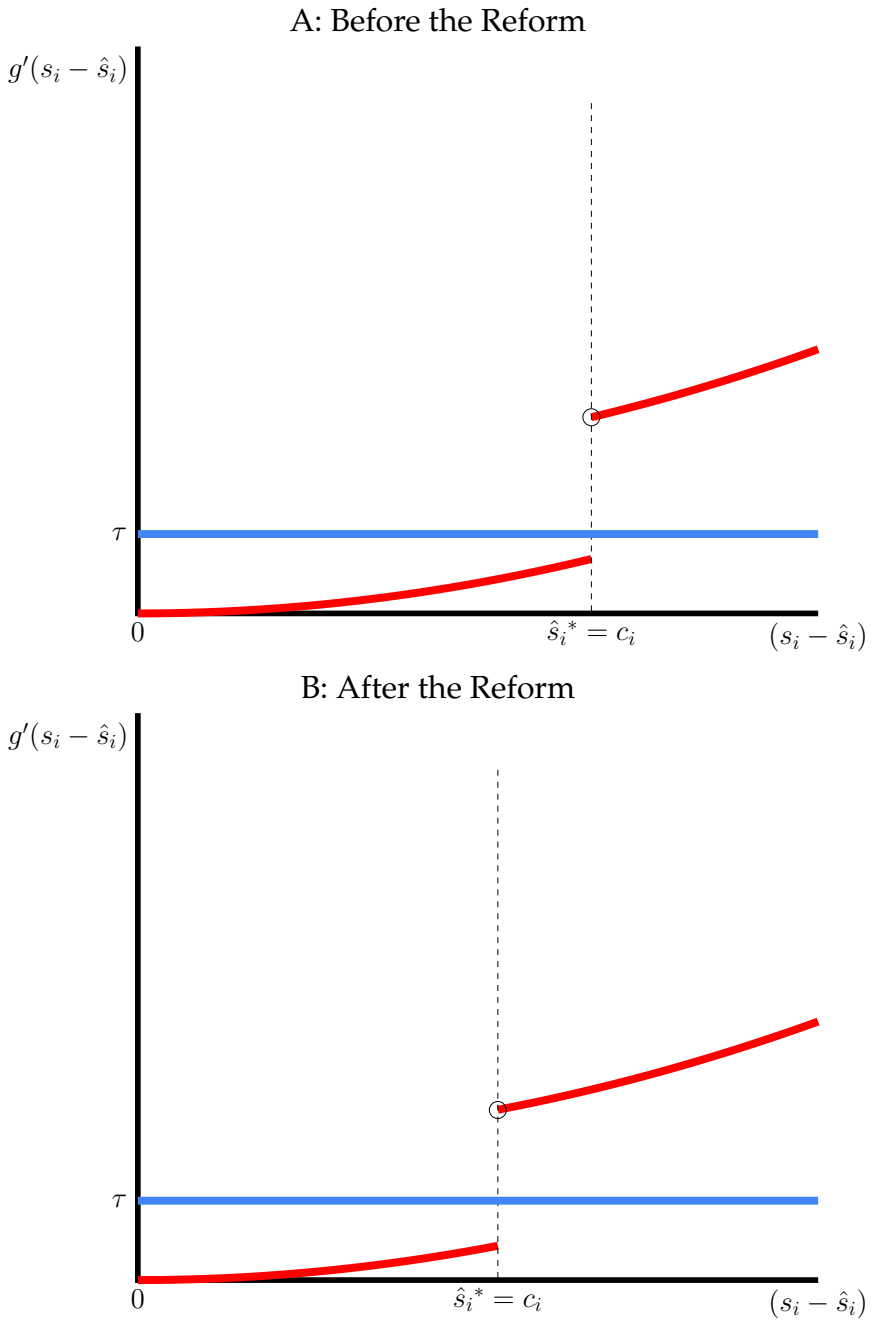
Notes: The figure investigates if firms who came into the formal sector in response to to the increasing exposure to VAT and enforcement survey were any different from the other firms. It replicates the analysis in Figure A.IX but takes the period a firm registers in as its period of entry. It plots the proportion of firms who exit before the given cutoff date by their entry month. The cutoff date is the 1st of July 2004 for Panel A; the 1st of July 2006 for Panel B; the 1st of July 2008 for Panel C; and the 1st of July 2010 for Panel D. Vertical lines in the plots denote important events during this period: VAT was extended to the energy sector in July 1999 and to the services sector in July 2000; and the enforcement survey commences from the end of May 2000.

FIGURE A.XI: **EFFECT OF INCREASED WITHHOLDING ON A HIGH-EVASION-COST FIRM**



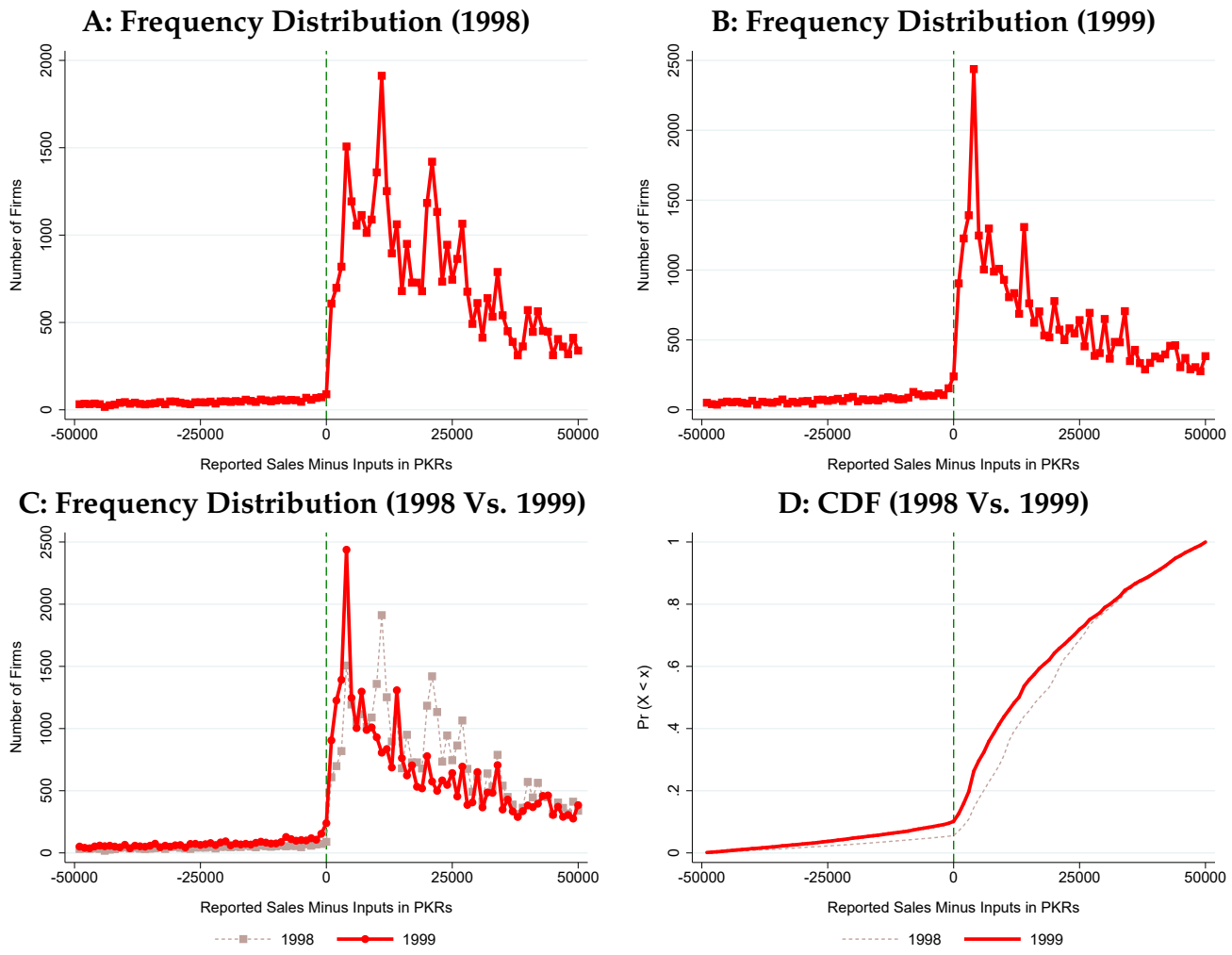
Notes: What happens when more inputs of a firm become taxable? This figure explores the behavior of a high-evasion-cost firm to such a reform. The plots show marginal evasion costs faced by the firm as a function of the amount evaded. At the origin, reported sales equal true sales and the evasion is zero. Evasion increases as we move toward right. At the point denoted by the long dashed vertical line, reported sales equal taxable inputs costs of the firm, and as a consequence its tax liability becomes zero. Marginal evasion costs jump at the point, as the tax administration is more likely to select firms who report negative liability for audit. When more inputs of the firm become taxable, the zero-liability point shifts to the left (long dashed vertical line in Panel B). Note that the change has no effect on the firm as its optimal sales choice was already to the left of the new zero-liability point. But the taxable liability reported by the firms $\tau\left(\hat{s}_i - c_i\right)$ will shrink as c_i is higher now.

FIGURE A.XII: **EFFECT OF INCREASED WITHHOLDING ON A LOW-EVASION-COST FIRM**



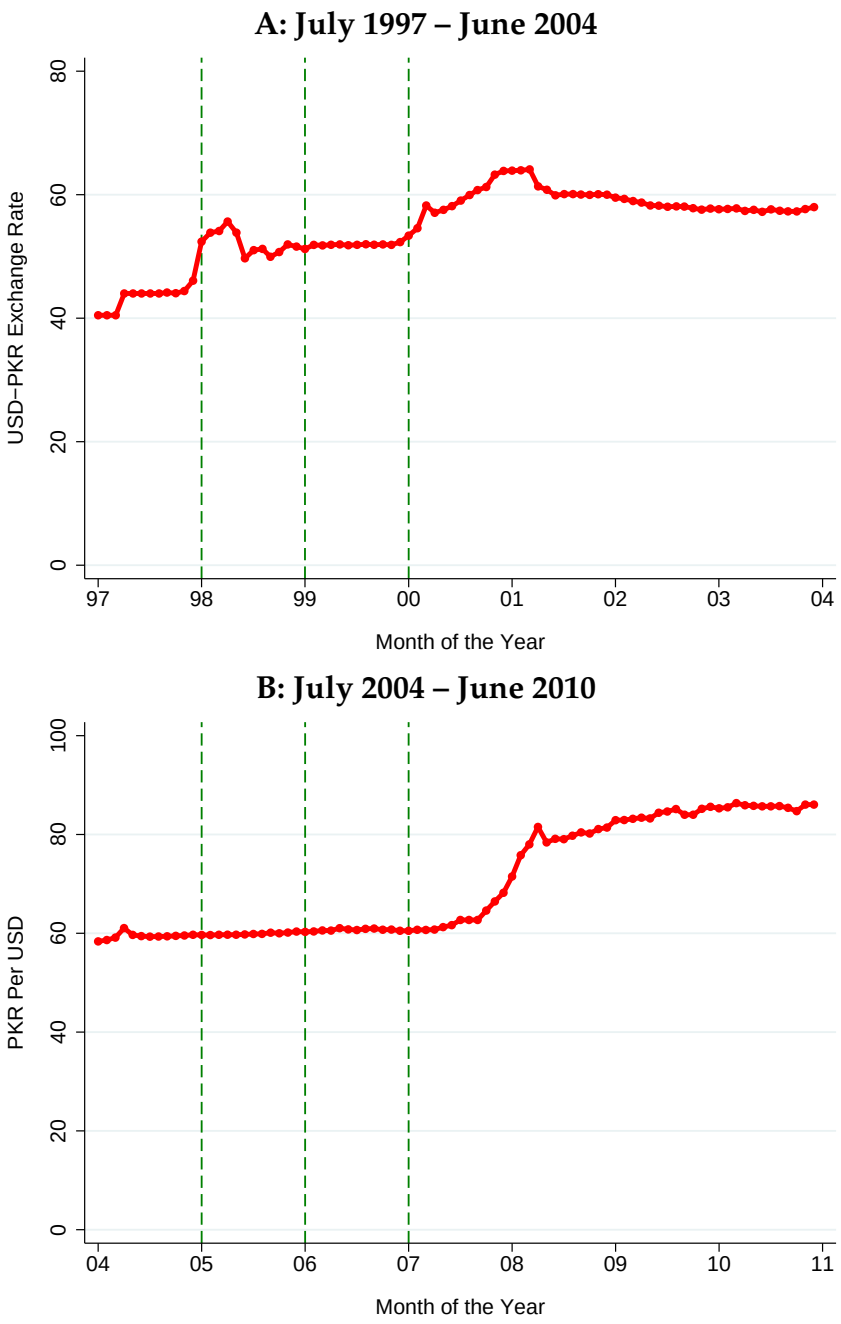
Notes: What happens when more inputs of a firm become taxable? This figure explores the behavior of a low-evasion-cost firm to such a reform. The plots show marginal evasion costs faced by the firm as a function of the amount evaded. At the origin, reported sales equal true sales and the evasion is zero. Evasion increases as we move toward right. At the point denoted by the long dashed vertical line, reported sales equal taxable inputs costs of the firm, and as a consequence its tax liability becomes zero. Marginal evasion costs jump at the point, as the tax administration is more likely to select firms who report negative liability for audit. When more inputs of the firm become taxable, the zero-liability point shifts to the left (long dashed vertical line in Panel B). After the reform, the firm increases its reported sales such that the new $\hat{s}_i^*$ equals the increased c_i. The increase in reported sales means that the government collects more revenue in aggregate (input plus output) from the firm.

FIGURE A.XIII: **BUNCHING AT ZERO TAX LIABILITY**



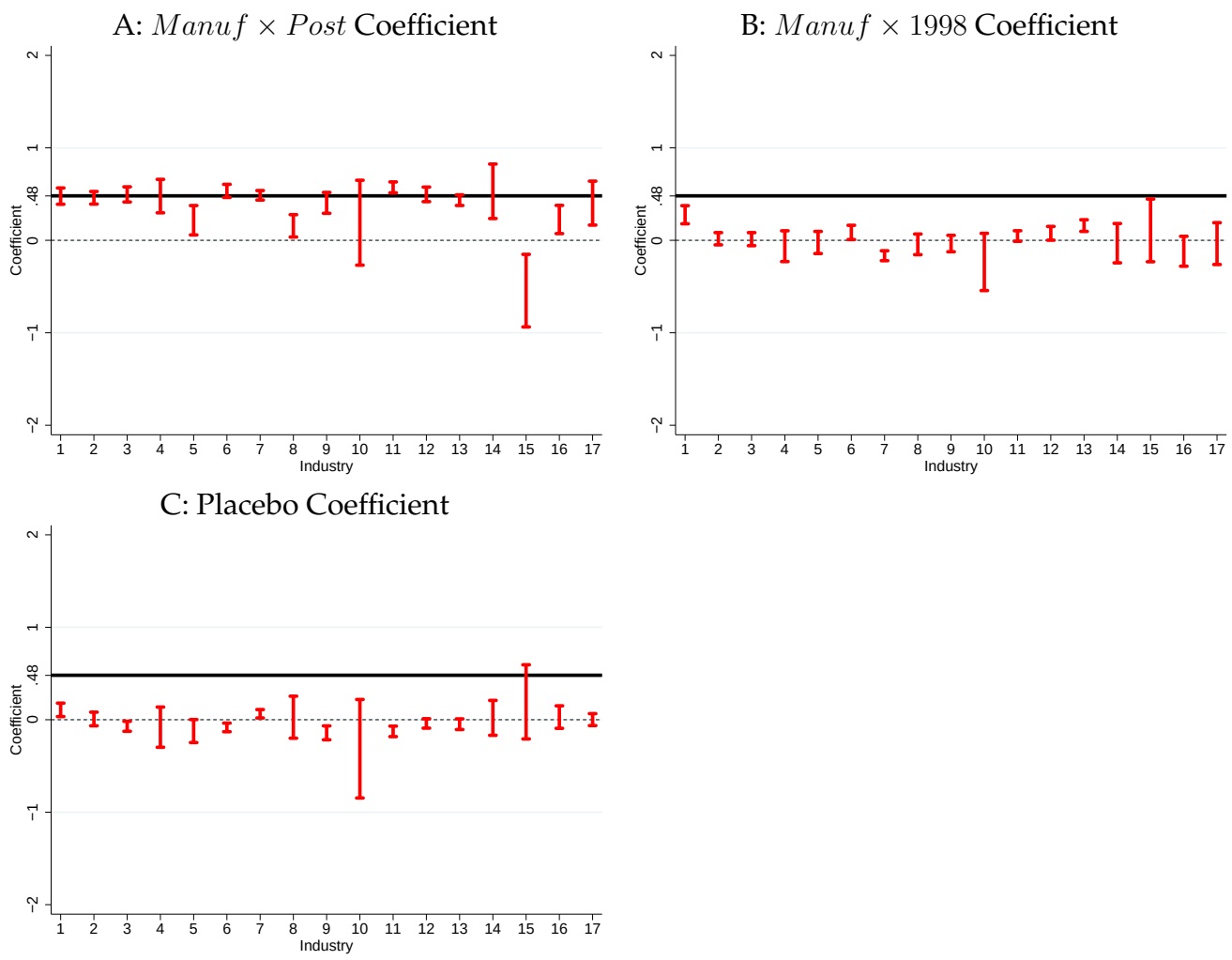
Notes: The figure explores if the discontinuity in evasion costs at the zero-liability point induces firms to bunch towards the right of the point. Panel A-C plot the distribution of $\hat{s}_i - c_i$ in bins of 1,000 rupees. Vertical dashed line denote the point where reported taxable sales equal reported taxable input costs and the tax liability becomes zero. The tax liability is negative to the left of this point. Panels A and B show the distribution for 1998 and 1999, the years immediately before and after energy inputs such as electricity and gas were made taxable. Panel C compares the two distributions, displaying the leftwards shift of the 1999 distribution. Panel D shows the leftwards shift formally. It plots the corresponding Cumulative Distribution Functions, illustrating that the 1999 distribution is stochastically (first-order) dominated by the 1998 distribution at all points.

FIGURE A.XIV: **USD-PKR EXCHANGE RATE**



Notes: The figure shows the USD-PKR exchange rate between July 1997 to June 2010. The data was assessed from the website investing.com in November 2018 and shows the average value of the exchange rate for the given month. Year t on the horizontal axis indicates the month July of the year. Vertical dashed lines in the top panel demarcate three important events during the period: the extension of VAT to distributor, wholesalers and retailers (1998); energy sector (1999); and services (2000). The last event is almost contemporaneous with the enforcement survey, which was announced by the end of May 2000.

FIGURE A.XV: **TAXABLE SALES RESPONSE BY INDUSTRY**



Notes: The figure breaks down the taxable sales response reported in Table III by industry. I estimate equation (4) restricting the sample to firms of one industry only. Panel A plots the $Manuf \times Post$ coefficient and 95% confidence interval around it from these regressions, comparing it against the baseline coefficient of 0.48 (see column (1) of the table). Panel B and C replicates the exercise, showing the $Manuf \times 1998$ and placebo coefficients respectively. The placebo regressions are run on the period 2004-2010, defining 2006 and after as the post period. The industry classifications used here comes from the 2-digit aggregation scheme of the HS Code. The scheme along with the description of the industries is shown in Table A.IX.

TABLE A.I: **TAXABLE SALES RESPONSE AFTER DROPPING LARGE FIRMS**

	All Firms		$\leq$ 99th Percentile		$\leq$95th Percentile		$\leq$90th Percentile	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A: 1997-2003								
Manuf $\times$ *Post*	0.440	0.438	0.434	0.437	0.444	0.440	0.479	0.493
	(0.029)	(0.036)	(0.029)	(0.035)	(0.030)	(0.036)	(0.031)	(0.038)
Manuf $\times$ 1998		-0.004		0.005		-0.008		0.025
		(0.027)		(0.027)		(0.028)		(0.029)
Observations	429,510	429,510	422,783	422,783	396,086	396,086	365,003	365,003
B: 2004-2010								
Manuf $\times$ *Post*	0.029		0.021		-0.006		-0.037	
	(0.018)		(0.018)		(0.019)		(0.020)	
Observations	742,846		729,695		683,412		628,291	

Notes*:* The table illustrates that the results in Table III are not driven by large firms. I estimate the difference-in-differences model (4) after dropping firms larger than the cutoff indicated in the heading of each column. The model is estimated on the Balanced Panel 1 sample, so that the composition of the sample stays fixed throughout the period of estimation. I define large firm on the basis of predetermined firm characteristics, taking average annual sales reported in the financial years 1997 and 1998 as the measure of its size. The standard errors are in parenthesis, which have been clustered at the firm level. The results in Panel B are from a placebo specification exactly similar to one in Panel A but estimated on the 2004-2010 period. The *Post* dummy indicates a tax period (month) after June 1999 in Panel A and June 2006 in Panel B.

TABLE A.II: **TAXABLE SALES RESPONSE AFTER DROPPING LARGE FIRMS**

	All Firms		≤ 99th Percentile		≤95th Percentile		≤90th Percentile	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A: 1997-2003								
Manuf × *Post*	0.440	0.438	0.436	0.433	0.449	0.452	0.457	0.462
	(0.029)	(0.036)	(0.029)	(0.036)	(0.030)	(0.037)	(0.032)	(0.039)
Manuf × 1998		-0.004		-0.004		0.006		0.010
		(0.027)		(0.028)		(0.028)		(0.030)
Observations	429,510	429,510	422,790	422,790	396,466	396,466	365,996	365,996
B: 2004-2010								
Manuf × *Post*	0.029		0.018		-0.016		-0.041	
	(0.018)		(0.018)		(0.019)		(0.019)	
Observations	742,846		730,279		686,161		633,237	

Notes*:* The table illustrates that the results in Table III are not driven by large firms. I estimate the difference-in-differences model (4) after dropping firms larger than the cutoff indicated in the heading of each column. The model is estimated on the Balanced Panel 1 sample, so that the composition of the sample stays fixed throughout the period of estimation. I define large firm on the basis of predetermined firm characteristics, taking annual sales reported in the financial year 1997 as the measure of its size. The standard errors are in parenthesis, which have been clustered at the firm level. The results in Panel B are from a placebo specification exactly similar to one in Panel A but estimated on the 2004-2010 period. The *Post* dummy indicates a tax period (month) after June 1999 in Panel A and June 2006 in Panel B.

TABLE A.III: **TAXABLE SALES RESPONSE**

	All Firms		Balanced Panel 1		Balanced Panel 2	
	(1)	(2)	(3)	(4)	(5)	(6)
A: 1997-2003						
Manuf × *Post*	0.476	0.479	0.389	0.396	0.436	0.435
	(0.019)	(0.026)	(0.037)	(0.044)	(0.093)	(0.101)
Manuf × 1998		0.005		0.013		-0.002
		(0.020)		(0.033)		(0.059)
Observations	782,044	782,044	244,776	244,776	75,844	75,844
B: 2004-2010						
Manuf × *Post*	-0.004		-0.018		-0.084	
	(0.023)		(0.027)		(0.117)	
Observations	563,457		324,566		73,792	

Notes*:* The table report the results from the difference-in-differences model (4). The standard errors are in parenthesis, which have been clustered at the firm level. Here I drop the firms from the sample who combine more than one production stages, for example manufacturing and distribution. The sample includes both manufacturers and importers. Balanced Panel 1 sample in columns (3)-(4) contains only the firms who file their VAT return at least once in every quarter included in the sample period. In distinction, the Balanced Panel 2 sample includes a firm only if it files its VAT return every tax period included in the sample. The results in Panel B are from a placebo specification exactly similar to one in Panel A but estimated on the 2004-2010 period. The *Post* dummy indicates a tax period (month) after June 1999 in Panel A and June 2006 in Panel B.

TABLE A.IV: **TAXABLE SALES RESPONSE**

	All Firms		Balanced Panel 1		Balanced Panel 2	
	(1)	(2)	(3)	(4)	(5)	(6)
A: 1997-2003						
Manuf × *Post*	0.440	0.459	0.420	0.421	0.274	0.208
	(0.030)	(0.044)	(0.059)	(0.070)	(0.150)	(0.173)
Manuf × 1998		0.025		0.002		-0.122
		(0.036)		(0.054)		(0.124)
Observations	1,288,552	1,288,552	429,510	429,510	153,873	153,873
B: 2004-2010						
Manuf × *Post*	-0.032		-0.007		0.124	
	(0.020)		(0.025)		(0.063)	
Observations	1,293,097		742,846		200,414	

Notes*:* The table report the results from the difference-in-differences model (4). Here I include $Industry$, $Period$, and $Industry \times Period$ fixed effects into the model, allowing firms in each industry to have their own trend over time. The standard errors are in parenthesis, which have been clustered at the firm level. The sample includes both manufacturers and importers. Balanced Panel 1 sample in columns (3)-(4) contains only the firms who file their VAT return at least once in every quarter included in the sample period. In distinction, the Balanced Panel 2 sample includes a firm only if it files its VAT return every tax period included in the sample. The results in Panel B are from a placebo specification exactly similar to one in Panel A estimated on the 2004-2010 period. The $Post$ dummy indicates a period after June 1999 in Panel A and June 2006 in Panel B.

TABLE A.V: **TAXABLE SALES RESPONSE**

	All Firms		Balanced Panel 1		Balanced Panel 2	
	(1)	(2)	(3)	(4)	(5)	(6)
A: 1997-2003						
Manuf × *Post*	0.504	0.522	0.485	0.477	0.505	0.459
	(0.020)	(0.028)	(0.034)	(0.041)	(0.073)	(0.087)
Manuf × 1998		0.027		-0.013		-0.087
		(0.022)		(0.031)		(0.060)
Observations	1,288,552	1,288,552	429,510	429,510	153,873	153,873
B: 2004-2010						
Manuf × *Post*	-0.036		-0.021		0.060	
	(0.017)		(0.020)		(0.058)	
Observations	1,293,097		742,846		200,414	

Notes*:* The table report the results from the difference-in-differences model (4). Here I include *Tax Office*, $Period$, and *Tax Office* × $Period$ fixed effects into the model, allowing firms in each region to have their own trend over time. The standard errors are in parenthesis, which have been clustered at the firm level. The sample includes both manufacturers and importers. Balanced Panel 1 sample in columns (3)-(4) contains only the firms who file their VAT return at least once in every quarter included in the sample period. In distinction, the Balanced Panel 2 sample includes a firm only if it files its VAT return every tax period included in the sample. The results in Panel B are from a placebo specification exactly similar to one in Panel A estimated on the 2004-2010 period. The $Post$ dummy indicates a period after June 1999 in Panel A and June 2006 in Panel B.

TABLE A.VI: **TAXABLE INPUTS RESPONSE**

	All Firms		Balanced Panel 1		Balanced Panel 2	
	(1)	(2)	(3)	(4)	(5)	(6)
A: 1997-2003						
Manuf × *Post*	0.367	0.411	0.454	0.501	0.479	0.501
	(0.020)	(0.027)	(0.032)	(0.039)	(0.067)	(0.083)
Manuf × 1998		0.065		0.086		0.043
		(0.021)		(0.031)		(0.064)
Observations	772,879	772,879	205,584	205,584	65,458	65,458
B: 2004-2010						
Manuf × *Post*	-0.104		-0.099		-0.041	
	(0.019)		(0.022)		(0.069)	
Observations	792,859		368,017		89,093	

Notes: The table report the results from the difference-in-differences model (4). The outcome variable here is the log of taxable input costs instead of the log of taxable sales as in Table III. As I am unable to apportion inputs used in taxable sales and exports, I drop from the sample all firms who export even once in the sample period. The standard errors are in parenthesis, which have been clustered at the firm level. The sample includes both manufacturers and importers. Balanced Panel 1 sample in columns (3)-(4) contains only the firms who file their VAT return at least once in every quarter included in the sample period. In distinction, the Balanced Panel 2 sample includes a firm only if it files its VAT return every tax period included in the sample. The results in Panel B are from a placebo specification exactly similar to one in Panel A estimated on the 2004-2010 period. The *Post* dummy indicates a period after June 1999 in Panel A and June 2006 in Panel B.

TABLE A.VII: **TAXABLE SALES RESPONSE**

	All Firms		Balanced Panel 1		Balanced Panel 2	
	(1)	(2)	(3)	(4)	(5)	(6)
A: 1997-2003						
Manuf × *Post*	0.492	0.510	0.465	0.473	0.425	0.408
	(0.018)	(0.024)	(0.033)	(0.039)	(0.072)	(0.089)
Manuf × 1998		0.026		0.015		-0.034
		(0.019)		(0.030)		(0.064)
Observations	999,111	999,111	263,221	263,221	80,874	80,874
B: 2004-2010						
Manuf × *Post*	-0.029		-0.029		0.008	
	(0.018)		(0.022)		(0.060)	
Observations	823,540		392,719		92,459	

Notes*:* The table report the results from the difference-in-differences model (4). The sample here is the same as in the last table, wherein I report the corresponding taxable inputs response. The standard errors are in parenthesis, which have been clustered at the firm level. The sample includes both manufacturers and importers. Balanced Panel 1 sample in columns (3)-(4) contains only the firms who file their VAT return at least once in every quarter included in the sample period. In distinction, the Balanced Panel 2 sample includes a firm only if it files its VAT return every tax period included in the sample. The results in Panel B are from a placebo specification exactly similar to one in Panel A estimated on the 2004-2010 period. The *Post* dummy indicates a period after June 1999 in Panel A and June 2006 in Panel B. Single-activity firms only

TABLE A.VIII: **TAXABLE SALES RESPONSE**

	All Firms		Balanced Panel 1		Balanced Panel 2	
	(1)	(2)	(3)	(4)	(5)	(6)
A: 1997-2003						
Manuf × *Post*	0.408	0.406	0.432	0.386	0.374	0.327
	(0.023)	(0.037)	(0.037)	(0.049)	(0.077)	(0.100)
Manuf × 1998		0.041		-0.010		-0.007
		(0.030)		(0.038)		(0.072)
Manuf × *Post* × *Exposure Intensity*		0.128		0.147		0.166
		(0.038)		(0.040)		(0.057)
Manuf × 1998 × *Exposure Intensity*		0.093		0.103		0.136
		(0.031)		(0.030)		(0.045)
Observations	550,147	550,147	243,665	243,665	96,278	96,278
B: 2004-2010						
Manuf × *Post*	0.003		0.009		0.059	
	(0.019)		(0.021)		(0.059)	
Manuf × *Post* × *Exposure Intensity*	0.054		0.051		0.034	
	(0.020)		(0.021)		(0.034)	
Observations	878,781		589,489		175,453	

Notes: The table report the results from a triple-difference version of model (4). The sample here is restricted to firms who feature in the transaction-level data for the years 2008-2010. The dummy variable $Exposure\ Intensity$ denotes a manufacturer with an above-median proportion of sales to registered firms in the three downstream stages i.e. distribution, wholesale, and retail. The standard errors are in parenthesis, which have been clustered at the firm level. The sample includes both manufacturers and importers. Balanced Panel 1 sample in columns (3)-(4) contains only the firms who file their VAT return at least once in every quarter included in the sample period. In distinction, the Balanced Panel 2 sample includes a firm only if it files its VAT return every tax period included in the sample. The results in Panel B are from a placebo specification exactly similar to one in Panel A estimated on the 2004-2010 period. The $Post$ dummy indicates a period after June 1999 in Panel A and June 2006 in Panel B. Single-activity firms only

TABLE A.IX: **INDUSTRY DESCRIPTION**

Industry Label (1)	HS Code Heading (2)	Industry Description (3)
1	1600-2499	Food and Beverages
2	2800-3899	Chemicals
3	3900-4099	Plastics
4	4100-4399	Leather
5	4400-4699	Wood Products
6	4700-4999	Paper and Paperboard
7	5000-6399	Textile
8	6400-6799	Footwear
9	6800-7099	Cement and Cement Products
10	7100-7199	Jewelry
11	7200-8399	Metal and Metal Products
12	8400-8599	Machinery
13	8600-8999	Vehicles and Vehicle Parts
14	9000-9299	Medical or Surgical Instruments
15	9300-9399	Arms and Ammunitions
16	9400-9699	Furniture
17	9700-9899	Restaurants

Notes: The table displays the HS code and description of the industry variable used in Figure A.XV. The HS code used by the Pakistani tax administration divides all goods and services into 99 chapters (the first two digits in the code) and 21 sections. The sections broadly correspond to major industries in the country. I drop firms belonging to four industries (sections) from the sample where VAT on manufacturing was extended after 1996. First column reports the Industry Label used in the horizontal axis of Figure A.XV. The second column shows the range of HS codes included in the industry and the third column the industry description. Note that arms and ammunitions is largely a cottage industry in Pakistan, wherein firearms are manufactured by artisans of small firms.

TABLE A.X: **CHARACTERISTICS OF INDUSTRIES WITH BELOW-AVERAGE RESPONSE**

	Average Firm Size (1)	Low Initial Capital (2)	Input to Output Ratio (3)	Input $\leq$ 0.05* Output (4)	Voluntary Registered (5)	Sales Growth (6)
Below-Average	-0.319	0.076	-0.413	0.097	-0.130	
	(0.028)	(0.019)	(0.052)	(0.013)	(0.019)	
Below-Average $\times$ *Post*						0.019
						(0.040)
Observations	244,005	244,005	91,067	244,005	244,005	143,052

Notes: The table explores the characteristics of firms in four industries where taxable sales response is weaker than the average (see Figure A.XV). These industries are labeled 5 (Wood Products), 8 (Footwear), 15 (Arms and Ammunition), and 16 (Furniture) in the diagram. Column (1)-(5) report the results from the regression of outcome variable mentioned at the top of the column on a dummy indicating that the firms belongs to one of these four industries. Initial Capital is the amount of capital reported by a firm at the time of its registration, a proxy for firm size. For the definition of other variables please see Appendix A.1. The final column reports the results from the difference-in-differences model (4) estimated on the period 1997-1998 only, with the latter year defined as the *Post* period. The idea behind the column is to show that taxable sales reported by firms in the four industries behaved similar to the other firms in the pre-99 period.

TABLE A.XI: **VAT REVENUE**

Year	Including Energy		Excluding Energy		Including Energy as an Intermediate Good	
	PKR Mill.	Percent Increase	PKR Mill.	Percent Increase	PKR Mill.	Percent Increase
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1997	29,085	-	28,106	-	28,601	-
1998	30,735	5.67	29,484	4.90	30,116	5.29
1999	49,666	61.60	36,795	24.80	43,633	44.88
2000	65,011	30.89	43,976	19.52	54,758	25.50
2001	73,782	13.49	49,502	12.57	61,709	12.69
2002	89,534	21.35	54,859	10.82	71,230	15.43
2003	93,292	4.20	55,886	1.87	73,950	3.82

Notes: The table reports the domestic VAT collected in Pakistan from 1997 to 2003. I compile these data from Table 33 of the 2001-02 and Tables 32 of the 2003-04 and 2004-05 FBR Year Books. These books are available online here. Columns (2), (4), and (6) report aggregate non-import VAT revenue in PKR millions. The standard VAT rate changed during the sample period for two brief episodes (see Figure A.IV). To make the revenue comparable across years, I normalize the standard rate to 15% for the entire period. More specifically, I multiply the 1997 revenue by a factor 0.15/0.125 and the 1998 revenue by a factor of 0.15/0.142, where 0.142 is the weighted average of the standard VAT rate in 1998. Columns (3), (5), and (7) show the corresponding year-on-year increase from the previous year. Columns (2) and (3) do not exclude any commodity. Columns (4) and (5), on the other hand, exclude three commodities of the energy sector: electricity, gas, and POL products. Columns (6) and (7) include 33% of revenue from electricity, 66% of revenue from gas, and 70% of revenue from POL products. These proportions represent the fraction of electricity, gas, and POL products used in manufacturing as intermediate goods. These proportions have been calculated from the data in the Pakistan Economic Survey 2005-06 (Table 14). The survey can be accessed here.