Technology without Teeth: Evidence from e-POS Adoption in Pakistan

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Abstract

Digital technologies, such as electronic point-of-sale (POS) devices, promise to strengthen tax compliance by reducing information asymmetries through real-time transaction reporting. To spur voluntary adoption, a tax authority in Pakistan offered firms in the hospitality sector a reduced sales tax rate if they digitally integrated their POS systems with the tax authority. From December 2020 to June 2024, 234 businesses (189 integrating existing devices and 45 receiving government-supplied units) voluntarily linked to the tax authority. Exploiting this staggered adoption, we apply a doubly robust staggered difference-in-differences event-study design on monthly VAT return data. We find a large immediate surge in reported sales and tax payments—driven almost entirely by extensive-margin changes—but these gains vanish within a few months. On the intensive margin, firms exhibit smaller yet persistent increases in reported sales and value-added, while conditional tax liabilities remain flat due to the preferential rate. Integrated firms also show a sustained 20 percent drop in reported input purchases, suggesting potential shifts toward informal sourcing due to the incentive structure accompanying digital adoption. Finally, matching digital POS records to tax returns uncovers widespread underreporting and incomplete device use, indicating significant unrealized revenue potential from the digital system.

Keywords: Tax Compliance, E-Invoicing, Point-of-Sale (POS) Systems, Digital Taxation, Informal Economy

JEL Codes: H26, H25, O17

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1 Introduction

Digital technologies are increasingly reshaping governance in low- and middle-income countries, promising to improve state effectiveness and address persistent development challenges. A critical area where these technologies hold substantial promise is taxation, as weak tax compliance remains a significant barrier to financing essential public services (Slemrod, 2019; Pomeranz and Vila-Belda, 2019). By reducing information asymmetries between taxpayers and tax authorities, digital tools, such as electronic point-of-sale (ePOS) devices, which transmit real-time transaction data to authorities, offer the potential to significantly improve revenue collection through enhanced transparency and oversight (Kleven et al., 2011; Naritomi, 2019; Bellon et al., 2022).

Existing research suggests that electronic invoicing and ePOS systems can lead to significant improvements in reported sales and tax revenue (Fan et al., 2018; Eissa et al., 2014; Mascagni et al., 2021). However, much of this evidence emerges from contexts where the adoption of digital tools was mandated. Less clear is whether the voluntary adoption of these technologies, common in developing countries with limited capacities, yields similarly positive results. Understanding the effectiveness of digital interventions under voluntary adoption is crucial, as this scenario closely mirrors the practical constraints faced by many developing-country tax administrations.

In this paper, we address this gap by analyzing the voluntary adoption of ePOS devices integrated with the Khyber Pakhtunkhwa Revenue Authority (KPRA) in Pakistan's hospitality sector from December 2020 to June 2024. To encourage voluntary adoption, KPRA offered participating businesses a reduced sales tax rate without input tax adjustments. Utilizing a staggered difference-in-differences event study design (Sant'Anna and Zhao, 2020), we investigate how the introduction of this digital tool affected firms' reported sales, input purchases, value-added, and tax payments. In doing so, our analysis sheds new light on the role digital technologies can play in strengthening tax systems, especially under conditions of voluntary adoption and limited enforcement capacity.

We find an immediate and substantial increase in reported sales and taxes post-adoption,

primarily driven by an increased probability of reporting positive sales and taxes by the integrated businesses. However, these gains are short-lived, dissipating within a few months. On the intensive margin, businesses that report positive sales and taxes experienced smaller yet more persistent increases in reported sales and value-added. Notably, the preferential tax rate limited potential increases in tax payments despite higher reported economic activity. Additionally, we document sustained reductions in reported input purchases, suggesting shifts toward informal sourcing due to the tax incentive structure.

By matching ePOS transaction data with tax returns à la Almunia et al. (2024), we further reveal widespread underreporting and incomplete device usage, highlighting limited enforcement and considerable unexploited revenue potential. We estimate that if KPRA had enforced compliance among businesses that clearly underreported—those where both POS-recorded taxes exceeded declared amounts—it could have raised an additional PKR 460 million in tax revenue during the study period from the integrated devices. This represents nearly 19% of the PKR 2.42 billion collected from the hospitality sector during the study period.

Our paper contributes directly to the literature on digital technologies and third-party reporting as tools for enhancing tax compliance. Previous studies have documented the efficacy of third-party information in reducing evasion and increasing tax revenues across multiple contexts (Pomeranz, 2015; Slemrod et al., 2017; Naritomi, 2019; Adhikari et al., 2021). However, as emphasized by Jensen et al. (2024), recent research highlights important qualifications that may limit the effectiveness of digital interventions and third-party reporting in low- and middle-income countries. For example, firms can counteract increased scrutiny on revenue margins by shifting evasion to less verifiable categories, such as inflating loosely monitored input costs (Carrillo et al., 2017). In contrast, our setting restricted firms from claiming input tax adjustments, leading to more persistent increases in reported value-added on the intensive margin. Nonetheless, because the applicable tax rate was significantly reduced, these gains did not translate into proportionally increased tax revenues, highlighting potential limitations of relying solely on digital incentives in contexts with limited enforcement.

Moreover, the effectiveness of digital third-party reporting mechanisms depends critically on the tax authority's capacity to cross-verify reported data and taxpayers' belief in that capacity (Almunia et al., 2024). Our analysis provides direct evidence of substantial discrepancies between digital transaction records and reported tax returns, suggesting weak institutional ability to leverage digital information for enforcement. These discrepancies may explain the short-lived compliance gains observed after ePOS adoption, underscoring the importance of institutional and enforcement capabilities to sustain improvements from digital interventions.

We also engage with the broader literature examining how digital interventions influence taxpayer perceptions of audit likelihood and enforcement risk (Slemrod et al., 2001; Kleven et al., 2011; Bergolo et al., 2023). Consistent with prior evidence, we document an immediate surge in reported revenues following ePOS adoption, likely due to perceived increases in audit risk associated with the digital linkage. Yet these effects rapidly dissipate absent sustained enforcement, underscoring the importance of ongoing and credible enforcement strategies in maintaining compliance improvements from digital technologies. Furthermore, our findings suggest that in contexts with weak enforcement capacity, digital technologies could unintentionally signal limited state capability, potentially diminishing taxpayer perceptions of enforcement credibility.

Our study most directly contributes to the emerging literature on electronic invoicing (e-invoicing) and digital taxation in developing countries. Prior studies from Peru (Bellon et al., 2022), Rwanda (Eissa et al., 2014; Kotsogiannis et al., 2024), Ethiopia (Ali et al., 2021; Mascagni et al., 2021), Ecuador (Ramírez et al., 2018), and Indonesia (Chattha et al., 2023) have demonstrated robust positive effects from mandated e-invoicing. Similarly, evidence from China reveals substantial short-term effects, which diminish but remain positive over time (Fan et al., 2018). Our setting differs substantially, as we examine a voluntary adoption scenario combined with digital incentives (preferential tax rates), rather than mandated compliance. In contrast to predominantly positive and persistent effects documented in mandated contexts, we find transient compliance gains from voluntary ePOS adoption, highlighting the potential limitations of digital solutions without supporting enforcement

infrastructure in place.

Finally, our paper broadly contributes to discussions around the role of digital technologies in improving state effectiveness and enhancing tax compliance (Okunogbe and Santoro, 2023; Martínez-Vázquez et al., 2023; Okunogbe and Tourek, 2024; Brockmeyer and Somarriba, 2025). While previous studies underscore benefits from digital filing systems (Yilmaz and Coolidge, 2013; Kochanova et al., 2020; Okunogbe and Pouliquen, 2022) and geospatial databases (Dzansi et al., 2022), our findings emphasize that achieving sustained compliance improvements from digital interventions may require complementary investments in enforcement capacity, credible institutional structures, and supportive administrative systems. Our results thereby highlight the critical importance of integrating digital technologies with effective state institutions to unlock their full potential in strengthening tax systems.

2 Background

Point-of-sale (POS) systems are digital transaction recording devices widely used in retail and service industries to streamline sales processes and maintain accurate financial records. In tax compliance, POS devices play a crucial role by ensuring that sales transactions are properly documented, thereby reducing underreporting and tax evasion opportunities. Many tax authorities worldwide have leveraged POS systems as a tool for real-time tax enforcement, linking them directly to tax administration databases to improve transparency and oversight.

A POS device typically records transactions, prints receipts, and stores sales data for bookkeeping. When integrated with a tax authority's system, these devices automatically transmit sales information in near real-time, allowing tax officials to monitor business activity without relying solely on self-reported tax returns. This integration mitigates information asymmetry between businesses and the tax authority, strengthening compliance by increasing the perceived likelihood of detection.

In December 2020, the Khyber Pakhtunkhwa Revenue Authority (KPRA), a subnational tax authority in Pakistan, initiated the rollout of the Restaurant Invoice Monitoring System (RIMS) as part of its efforts to improve tax compliance in the hospitality sector. The

system enabled real-time integration of restaurant point-of-sale (POS) data with KPRA's tax monitoring infrastructure. To incentivize adoption, KPRA offered a preferential sales tax rate of 5%—without input tax adjustment—for businesses that had their POS systems "installed and working properly on regular basis" (Khyber Pakhtunkhwa Revenue Authority, 2022). For reference, unlinked restaurants that did not claim input tax were subject to a higher 8% rate, while those that claimed input tax credits faced the standard 15% rate. In 2023, KPRA further expanded the initiative by distributing the Restaurant Monitoring and Reporting System (RMRS), a more comprehensive package that included hardware and software tools for billing, inventory, and kitchen management. Linking of the POS device (RIMS or RMRS) enabled real-time transmission of sales data to the tax authority. Once linked, businesses also gained access to an online dashboard that facilitated record-keeping, transaction monitoring, and tax reporting. Throughout the paper, unless otherwise mentioned, we refer to both RIMS and RMRS systems collectively as point-of-sale (POS) devices, as both serve the same core function of linking real-time sales data to the tax authority.

As of June 2024, the Khyber Pakhtunkhwa Revenue Authority (KPRA) mandated using point-of-sale (POS) devices for all restaurants, beginning the mandatory adoption phase. This study focuses on the preceding period of voluntary adoption, spanning from December 2021 to June 2024. During this phase, 234 businesses were integrated into KPRA's POS-linked tax reporting system. Of these, 189 businesses integrated their existing devices, while 45 were equipped with new devices provided by KPRA. Figure 1 illustrates the month-wise distribution of device integrations, distinguishing between existing and new devices.

3 Data and Estimation Approach

This study leverages administrative data from the Khyber Pakhtunkhwa Revenue Authority (KPRA), comprising monthly VAT returns and tax payment records for businesses operating in the hospitality sector. The dataset spans January 2020 to June 2024, providing a rich longitudinal view of tax compliance behaviors before and after POS device integration.

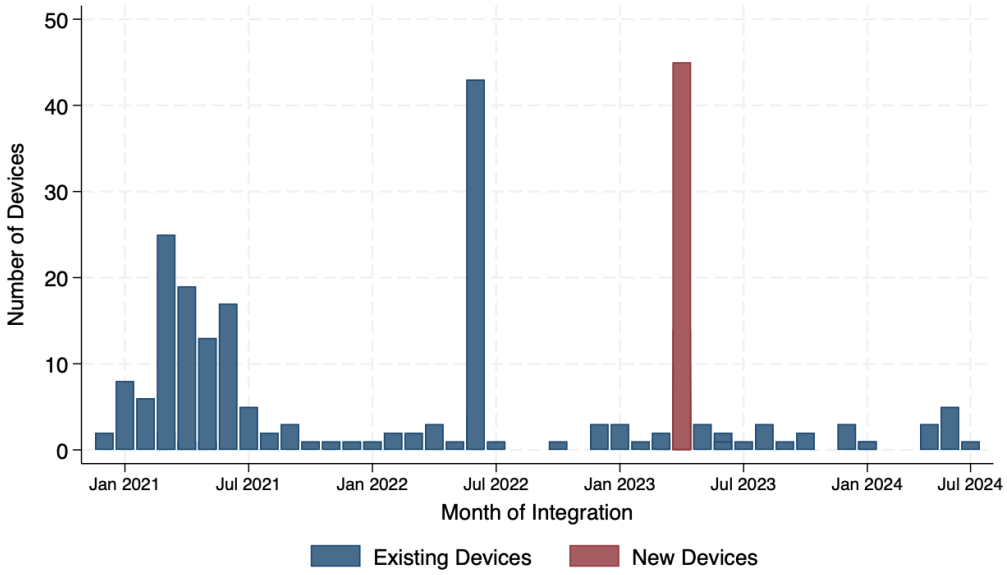


Figure 1: Rollout of e-POS Devices

Notes: This figure displays the monthly rollout of point-of-sale devices from December 2020 to June 2024, distinguishing between existing devices (already in use before formal integration) and new devices (handed out by the tax authority specifically for integration). The x-axis represents the month of integration, while the y-axis shows the number of devices integrated each month.

Table 1 reports summary statistics for four groups of businesses: those that received government-provided point-of-sale (POS) devices from KPRA and had them integrated ("New Devices"), those that integrated their own pre-existing POS devices ("Existing Devices"), the combined group of all device-integrated businesses ("All Devices"), and businesses that did not integrate any POS device ("No Devices"). Each row corresponds to a firm-month tax return, and the statistics are calculated over the full observation window from January 2020 to June 2024.

Firms with New Devices are considerably smaller than those with Existing Devices — reporting lower average monthly sales (PKR 232,000 vs. PKR 1.76 million), lower input purchases, and substantially lower output and input taxes. This suggests that KPRA's device distribution efforts targeted smaller, possibly more informal businesses. In contrast, firms with pre-existing devices that were integrated into the system appear to be larger and more formal. Businesses with No Devices also report low sales levels (PKR 296,000 on average), and exhibit lower filing rates and a higher share of null returns. Overall, the

table highlights important differences in scale, tax reporting, and service composition across integration status. Table 1 also presents the distribution of firm-month observations across districts and service types. Peshawar and Abbottabad account for the largest shares of observations across all groups, reflecting their relatively larger hospitality sectors. In terms of service types, Restaurants dominate the sample of device-integrated businesses, comprising 89% of New Device and 73% of Existing Device observations.

To estimate the dynamic effects of POS device adoption on firm outcomes, we employ the doubly robust Difference-in-Differences estimator developed by Sant'Anna and Zhao (2020).[1] This method is well-suited for settings with staggered treatment adoption and potential covariate imbalance across cohorts. Specifically, this method combines outcome regression and inverse probability weighting to identify average treatment effects on the treated (ATT) under a conditional parallel trends assumption. Our analysis focuses on firm-month-level outcomes and defines treatment as the first month in which a business is observed to have adopted a POS device. We estimate dynamic treatment effects in an event-study framework, controlling for unit and time fixed effects, and leveraging variation in the timing of treatment across firms. Importantly, the estimator is robust to misspecification in either the outcome model or the propensity score model, ensuring consistency of the ATT as long as one of the two is correctly specified. This approach allows us to flexibly capture treatment dynamics while minimizing bias from selection into treatment or differential trends.

4 Results

In this section, we examine the impact of POS integration on various dimensions of tax compliance, including filing behavior, reported sales, input purchases, and tax payments. We further assess the alignment between transactional data recorded through integrated POS devices and the figures reported in official tax returns.

[1] Estimated using 'csdid' command in Stata (Callaway and Sant'Anna, 2021).

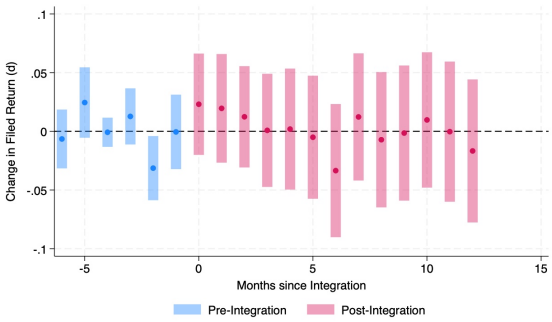
Table 1: Summary Statistics of Business Characteristics

	New Devices	Existing Devices	All Devices	No Devices
Month-Firm Observations	1,705 (100%)	8,550 (100%)	9,535 (100%)	63,206 (100%)
Firms	45	214	243	1,883
Monthly Sale (000)	232.2 (485.2)	1,760.0 (6,028.2)	1,591.7 (5,730.2)	296.0 (4,048.0)
Monthly Inputs (000)	2.1 (38.8)	305.1 (2,492.6)	273.6 (2,362.2)	76.8 (2,058.1)
Monthly Tax Output (000)	13.0 (26.5)	143.9 (630.0)	129.7 (598.0)	38.4 (603.1)
Monthly Tax Inputs (000)	0.3 (6.3)	39.2 (375.2)	35.1 (355.5)	25.7 (661.0)
Monthly Tax Paid (000)	12.9 (26.2)	103.6 (348.8)	93.6 (331.6)	24.2 (362.2)
Return Filing (d)	0.8 (0.4)	0.8 (0.4)	0.8 (0.4)	0.6 (0.5)
Null Return Filing (d)	0.2 (0.4)	0.2 (0.4)	0.2 (0.4)	0.4 (0.5)
District				
Peshawar	504 (34%)	2,911 (42%)	3,179 (40%)	13,992 (24%)
Abbottabad	530 (36%)	1,563 (22%)	1,879 (24%)	9,627 (17%)
Mardan	14 (1%)	527 (8%)	541 (7%)	4,078 (7%)
Kohat	71 (5%)	440 (6%)	458 (6%)	1,544 (3%)
Mansehra	30 (2%)	399 (6%)	429 (5%)	13,011 (22%)
Nowshera	14 (1%)	242 (3%)	256 (3%)	2,294 (4%)
D. I. Khan		234 (3%)	234 (3%)	3,424 (6%)
Haripur	53 (4%)	102 (1%)	155 (2%)	1,858 (3%)
Charsadda		148 (2%)	148 (2%)	2,252 (4%)
Islamabad		93 (1%)	93 (1%)	828 (1%)
Bannu	83 (6%)	42 (1%)	83 (1%)	1,741 (3%)
Other		53 (1%)	53 (1%)	273 (0%)
Service				
Restaurants	1,516 (89%)	6,244 (73%)	7,146 (75%)	14,803 (23%)
Hotel/Motel	106 (6%)	1,463 (17%)	1,463 (15%)	24,670 (39%)
Roadside Eateries (Dhabas)	83 (5%)	340 (4%)	423 (4%)	9,028 (14%)
Marriage Halls		369 (4%)	369 (4%)	9,559 (15%)
Club		53 (1%)	53 (1%)	1,588 (3%)
Hostels		53 (1%)	53 (1%)	168 (0%)
Caterers		28 (0%)	28 (0%)	3,390 (5%)

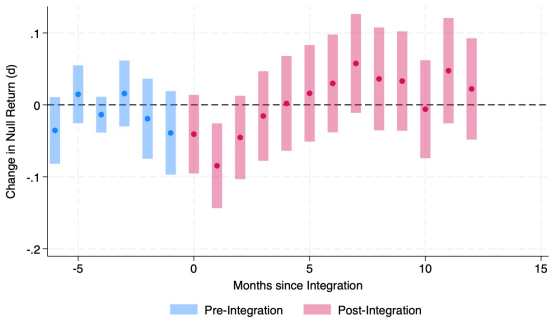
Notes: This table presents summary statistics for four groups of businesses based on their adoption and integration of electronic point-of-sale (ePOS) devices with the tax authority. "New Devices" refers to businesses that received the integrated device from KPRA. "Existing Devices" includes businesses that integrated their own pre-existing device with KPRA. "All Devices" combines both groups, and "No Devices" includes businesses that did not integrate any point of sale device. Each observation corresponds to a monthly tax return filed by a business between January 2020 and June 2024. The first row reports the total number of month-firm observations in each group, and the second row reports the number of unique firms. Financial variables—including monthly sales, input purchases, output tax, input tax, and tax paid—are reported as means, with standard deviations in parentheses (values in thousands of Pakistani Rupees). We also report the share of monthly returns filed (Return Filing) and the share of those that are null returns (Null Return Filing). The lower panel disaggregates these statistics by district and service type, reporting both the count of observations and their respective percentages within each column.

4.1 Tax Filing

Our setting is characterized by imperfect compliance, with many businesses either not filing returns or submitting null returns (reporting zero sales and taxes). Hence, it is instructive to investigate whether POS integration influences the filing behavior. Figure 2 presents event study estimates of the impact of POS integration on firms' likelihood of filing returns, distinguishing between any return and null returns. Panel (a) shows no significant change in the probability of filing a return following integration, suggesting limited effects on expanding the overall filing base. Panel (b), however, shows a sharp and statistically significant decline in the filing of null returns—returns with no reported sales or tax liability—immediately after integration. This decline indicates that POS adoption initially discouraged firms from reporting zero activity, potentially due to heightened perceived scrutiny. However, this effect is short-lived, with null filing rates returning to pre-integration levels within a few months.



(a) Effect on Return Filing (d)



(b) Effect on Null Return Filing (d)

Figure 2: Impact of POS Adoption on Return Filing

Notes: This figure presents event study estimates of the impact of POS integration on tax filing behavior. Panel (a) shows the effect on the probability of filing any return, while Panel (b) displays the corresponding effect on the probability of filing a null return (i.e., a return with zero reported sales or tax liability). Each point reflects the estimated change relative to the month of integration, with 95% confidence intervals.

4.2 Reported Sales, Input Purchases, and Value Added

We next examine how POS integration affects the key components of firms' self-reported tax liability — sales, input purchases, and value added. These variables directly influence tax payments and offer insight into whether firms adjust reported economic activity in response to POS integration. Figure 3 examines how POS integration affects firms' self-reported sales, input purchases, value-added, and taxes paid, disaggregating the response along both the intensive and extensive margins.

Panel 3a shows that reported **sales** (in logs) rise sharply immediately after integration, with the effect peaking at over 2 log points in the second month, equivalent to a more than 800% increase in reported sales. This dramatic jump is short-lived, with effects reverting to

baseline within a few months. To unpack this surge, Panel 3b isolates the intensive margin by restricting to firm-months with positive sales. Here, we observe a more modest but persistent increase of about 20–30%, suggesting that firms already in the reporting net slightly raised their declared sales following integration. Panel 3c focuses on the extensive margin - the likelihood of reporting any sales - and shows an immediate increase of around 10–15 percentage points in the first few months. This indicates that a substantial share of firms that were previously inactive or declaring zero sales began reporting some level of activity. Together, these patterns reveal that the initial surge in reported sales is driven primarily by the extensive margin (zero to positive sales), while the intensive margin contributes more gradually. However, the overall effects diminish over time, underscoring the transient nature of compliance gains in the absence of sustained enforcement.

Panel 3d shows that reported **input purchases** decline by about 20% and persistently following POS integration. This pattern is consistent with the disincentive structure introduced by the POS regime, which disallowed input tax credit adjustments, reducing firms' motivation to report high input expenditures. Panel 3e, which restricts to firm-months with positive purchases, reveals a sustained decline along the intensive margin — firms that continue to report inputs declare lower values after integration. In contrast, Figure 3f indicates a short-run increase in the probability of reporting any purchases, suggesting a temporary increase in reporting input adjustments at the extensive margin. Together, these findings imply that while some firms that previously did not report any input costs began doing so, existing reporters scaled back their reported input values.

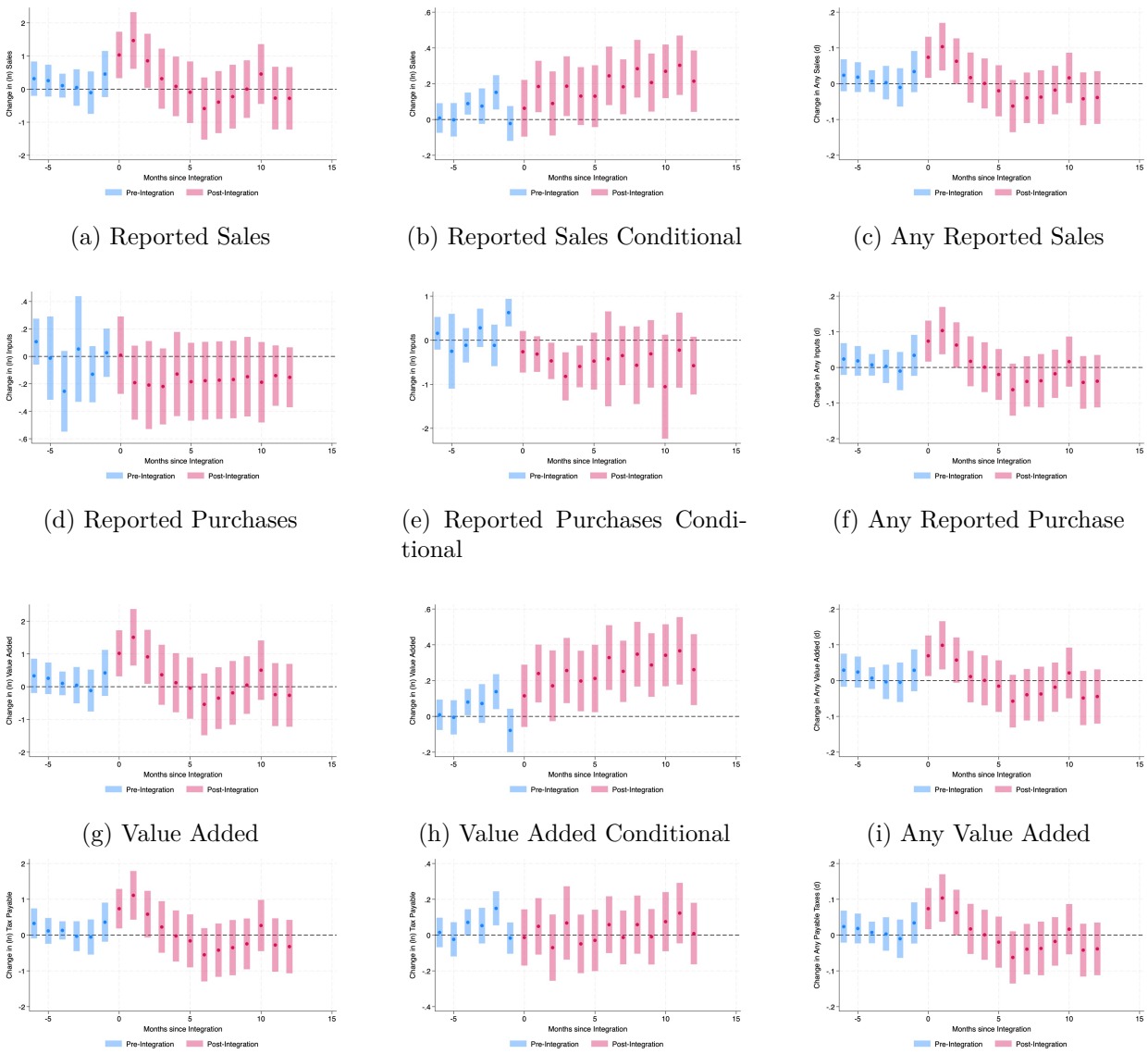
This decline in reported input purchases is a concerning behavioral response. It raises the possibility that firms, faced with weaker incentives to report formal input transactions, may increasingly source from informal suppliers. Such a shift could undermine the integrity of the VAT system, which relies on cross-verification of input and output declarations to create a self-enforcing paper trail. By encouraging transactions outside the formal supply chain, POS-induced reporting disincentives may inadvertently fuel informality, eroding one of the core benefits of value-added taxation: its potential to foster formalization through documentation of the full chain of economic activity (Pomeranz, 2015).

Taken together, the results on reported sales and input purchases suggest a modest and short-lived increase in **value added** following POS integration (Figure **??**). While value added increased persistently by around 20-30% on the intensive margin (Figure 3h), these gains are offset by the transitory nature of the extensive margin response (Figure 3i). Firms that initially began reporting positive value-added following integration quickly reverted to declaring zero activity, likely due to the absence of follow-up enforcement. This pattern indicates that the initial increase in value added was driven by a short-term compliance response from firms newly entering the reporting net, while, conditional on reporting positive value-added, firms made more modest but sustained adjustments in their declarations. As a result, the aggregate effect on value added fades over time, despite continued improvements on the intensive margin.

POS integration can influence **taxes** paid in our context through two opposing channels. On the one hand, greater visibility may lead firms to increase compliance, thereby raising their reported tax liabilities. On the other hand, the integration was accompanied by an incentive scheme offering a reduced statutory tax rate (without input tax credit), which may lower the taxes paid by firms, particularly along the intensive margin.

Panel 3j shows that the total taxes paid increased sharply following POS integration, peaking at around 1.2 log points, equivalent to a 232%, increase in the second month. The effect begins to decline thereafter and returns to baseline levels within four months, indicating that the initial increase in tax payments was large but short-lived. Panel 3k, which focuses on the intensive margin - conditional on firms paying positive taxes - shows little to no change in declared tax liabilities post-integration. This is particularly noteworthy given that these firms faced a lower statutory tax rate under the POS incentive scheme, yet did not reduce their reported payments. This also shows that the persistent increase in reported value added does not translate into higher tax payments on the intensive margin, suggesting that firms adjusted their value added to maintain similar tax liabilities. In contrast, Panel 3l shows a clear, albeit temporary, increase in the likelihood of paying any tax, indicating that POS adoption succeeded in expanding tax participation at the extensive margin only temporarily. Taken together, these results suggest that the observed rise in total tax payments was driven

almost entirely by increased participation rather than changes in payment intensity. While the incentive scheme appears to have encouraged short-term compliance among previously non-paying firms, its effects were not sustained over time.



(a) Reported Sales (b) Reported Sales Conditional (c) Any Reported Sales

(d) Reported Purchases (e) Reported Purchases Conditional (f) Any Reported Purchase

(g) Value Added (h) Value Added Conditional (i) Any Value Added

(j) Taxes (k) Taxes Conditional (l) Any Taxes

Figure 3: Impact of POS Integration on Sales, Purchases, Value Added, and Taxes

Notes: Each panel displays event-study coefficients ($\hat{\beta}_k$) from a doubly-robust difference-in-differences specification following Sant'Anna and Zhao (2020). The treated group comprises firms that voluntarily linked their point-of-sale devices to the tax server, with $k = 0$ denoting the first month of linkage. Regressions include firm and calendar-month fixed effects, and standard errors are clustered at the firm level; shaded bands show 95% confidence intervals. Panels (a)-(c) document outcomes for reported sales-overall logs, intensive-margin logs (conditional on positive sales), and an indicator for any sales, while panels (d)-(f) present analogous measures for input purchases. Panels (g)-(i) repeat the analysis for value added, defined as sales minus purchases, with the intensive margin restricted to months of positive value added. Panels (j)-(l) present the analysis for taxes paid. The horizontal dashed line indicates no treatment effect, and negative (positive) coefficients imply decreases (increases) relative to never- and not-yet-treated firms.

4.3 Device Usage

We now turn to comparing transactional data recorded through integrated POS devices with what firms report on their tax returns. This exercise helps us assess how these devices are actually being used post-integration and sheds light on why the initial compliance gains are not sustained. By examining the gap between recorded transactions and reported values, we aim to understand whether the lack of enforcement in response to POS data is undermining the long-term effectiveness of the integration.

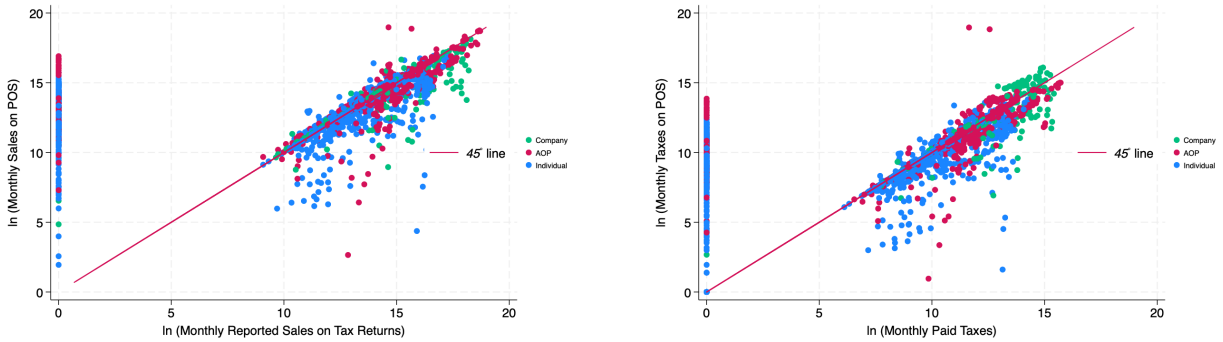
Figure 4 compares monthly sales and tax payments recorded through integrated devices with those reported on official tax returns, using data restricted to firm-months following POS adoption.[2] A striking pattern emerges: despite POS transactions being fully visible to the tax authority, many businesses continue to underreport both sales and taxes in their returns. This is evident from the widespread clustering of observations above the 45-degree line in both panels. A notable feature is the concentration of observations along the vertical axis at zero reported sales or taxes on the x-axis, paired with positive values on the y-axis—indicating that in many firm-months, businesses recorded transactions on their POS devices but reported zero sales or taxes on their returns.

While discrepancies where reported sales exceed POS-recorded sales may suggest potential overreporting, in our setting this pattern is more plausibly interpreted as indicative of incomplete POS usage. Unlike third-party data sources that are passively generated (e.g., Customs declarations in Almunia et al. (2024)), POS records depend on active firm compliance. Therefore, firm-months where return sales exceed POS sales likely reflect strategic or incomplete use of the device, rather than a reporting error as in Almunia et al. (2024).

Back-of-the-envelope calculations indicate that if KPRA had enforced compliance among businesses that clearly underreported—those where both POS-recorded taxes exceeded declared amounts—it could have raised an additional PKR 460 million in tax revenue during the study period from the integrated devices. This represents nearly 19% of the PKR 2.42

[2] This excludes businesses that were provided new POS devices by KPRA due to the unavailability of device usage data for those devices.

billion collected from the hospitality sector during the study period.[3] These findings underscore that while POS integration improves visibility, it does not automatically ensure compliance. Realizing the full potential of third-party data systems like POS requires institutional mechanisms, such as automated cross-verification, audit triggers, and targeted enforcement, to translate visibility into meaningful revenue gains.



(a) Comparison of Sales on POS and Tax Returns (b) Comparison of Taxes on POS and Tax Returns

Figure 4: Comparison of POS and Tax Return Records

Notes: Each dot represents a firm-month observation, color-coded by type of firm for post-integration months. Panel (a) compares monthly sales reported on tax returns with those recorded via integrated Point-of-Sale (POS) devices. Panel (b) presents a similar comparison for monthly tax payments. The 45° line in each plot represents parity between POS records and tax return declarations. Points above the line indicate underreporting on tax returns relative to POS data.

5 Conclusion

This study provides novel evidence on the compliance impacts of voluntarily integrating digital POS devices with tax authorities in a low-capacity developing-country context. We find that digital integration initially boosts reported sales, value added, and tax payments, primarily by increasing the likelihood that businesses report positive sales and taxes (extensive margin). However, these digitally induced compliance gains prove short-lived, fading as perceptions of enforcement weaken and real-time digital reporting alone becomes insufficient to sustain behavioral change.

In contrast, we document persistent effects on the intensive margin, where firms already filing returns consistently report higher sales and value added following digital integration.

[3] This estimate assumes businesses do not alter their use of POS devices in response to enforcement.

Yet, these improvements do not translate into increased tax revenues because the incentive for adopting digital tools involves a significantly reduced tax rate. Moreover, the absence of incentives for accurate reporting of input purchases appears to encourage informal sourcing, inadvertently undermining the VAT's digital self-enforcing mechanism.

Device logs clearly reveal discrepancies between actual POS-recorded sales and declared returns. Without active enforcement addressing these discrepancies, relying solely on digital real-time data collection risks further eroding tax morale by visibly highlighting the state's limited capacity to enforce compliance. Thus, achieving sustained improvements from digital interventions hinges critically on pairing digital monitoring with credible enforcement strategies.

From a policy standpoint, our results underscore the nuanced interplay among digital technologies, incentives, administrative capacity, and voluntary compliance. Digitally linking POS devices to tax authorities represents a promising initial step toward modernizing tax administration and broadening the tax base. However, maintaining these digital compliance gains requires supplementary measures such as follow-up audits, ongoing taxpayer education, and the eventual phasing out of preferential tax rates. Systematic monitoring, robust enforcement, and continuous taxpayer support must complement digital interventions to fully realize their potential.

Several important limitations in our analysis warrant emphasis. First, our study exclusively focuses on already-registered businesses, limiting our ability to assess whether digital integration influences decisions to formalize or exit into informality. In low-capacity settings, the boundary between formal and informal sectors is especially critical for evaluating digital reform effectiveness. Second, voluntary early adopters differ significantly from the broader business population; typically, these firms are either large, already-formal entities or very small businesses willing to experiment. Whether the effects observed here would scale more broadly remains an open question. Our ongoing research aims to evaluate whether mandatory integration and/or strengthened enforcement could convert the initial, temporary digital compliance improvements observed here into lasting revenue gains.

By explicitly highlighting both the potential and the constraints of digital tax inter-

ventions in resource-limited environments, our findings contribute directly to the emerging literature on digital tax administration and broader digital transformation in governance. While voluntary adoption of digital technologies can facilitate reform in settings characterized by limited enforcement capacity, effectively designing incentive structures and complementary institutional support remains essential. Further research should explore whether repeated digital audits, dynamic enforcement schemes, or broader modernization efforts in tax administration can enhance the long-term effectiveness of digital tax tools.

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