Transient Gains, Lasting Challenges: Evidence from e-POS Adoption in Pakistan

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February 10, 2025

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Abstract

In many low-income economies, limited state capacity and poor audit trails undermine tax compliance. This paper examines a voluntary point-of-sale (POS) linking reform in Pakistan, where businesses transmit real-time sales data to the tax authority. Using a difference-in-differences approach combined with propensity score matching, we show that adoption temporarily raises reported sales and tax payments, primarily by drawing in new filers and boosting reported sales among existing filers. However, these gains dissipate within a few months, suggesting that real-time monitoring alone may not anchor lasting behavioral change. Despite briefly reducing null returns, the intervention has little effect on overall filing. Taken together, these findings highlight the immediate yet ephemeral benefits of technology-based solutions in environments with weak enforcement. While voluntary POS adoption can produce early revenue gains, sustained compliance likely requires complementary measures—such as follow-up audits, taxpayer education, and robust enforcement—to reinforce and extend the program's initial successes.

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

JEL Codes: H26, H25, O17

We appreciate the support provided by staff at the Khyber Pakhtunkhwa Revenue Authority (KPRA), particularly Nawab Ali and Fazal Amin. We thank participants at the 2024 Western Economic Association International Conference (Seattle) and the 2023/2024 National Tax Association (NTA) Conferences (Detroit/Denver) for their valuable comments. We also acknowledge Hamza Sohail for excellent research assistance. This project was partially funded by the Sustainable Energy and Economic Development (SEED) program of the UK's Foreign, Commonwealth Development Office (FCDO).

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1 Introduction

Tax compliance remains a significant challenge in many low- and middle-income countries, which substantially limits the ability of governments to provide public services. Third-party information, which enables the government to uncover the true liability of the taxpayer, is one of the most effective tools for the accuracy of reporting and enforcement. Linked electronic point-of-sale devices (ePOS) report near real-time information on economic transactions to tax authorities, potentially allowing governments with limited enforcement capacity to improve compliance.

Though studies in Ethiopia, Peru, and China suggest the potential for revenue increases, the impacts of ePOS devices and the responses of taxpayers remain understudied. In practice, most past research has focused on mandated compliance, though governments – particularly in developing countries – often lack the ability to enforce, meaning reforms are either explicitly or functionally voluntary. Such voluntary policies may also be coupled with incentives, such as preferential tax rates. When firms choose whether to comply, it is ex-ante unclear whether we should expect policy changes – like the linking of ePOS devices – to affect behavior meaningfully.

To test these theories, we exploit a staggered rollout of the voluntary linkage of around 250 ePOS devices to the Khyber Pakhtunkhwa Revenue Authority (KPRA) of Pakistan from December 2020 to May 2023. We study the impact on hospitality-sector firms' reported sales, costs, tax payments, and exit using an event study specification that is free of contamination from treatment effect heterogeneity.

We find that the linkage of ePOS devices leads to a causal increase in the extensive margin of filing and paying VAT taxes in the first three to four months following the adoption of the device. However, the effect dissipates, and firms return to pre-intervention payment levels. The results indicate that monitoring alone may be insufficient to overcome compliance challenges in the absence of complementary reforms and verification, even for those who choose to submit themselves to additional monitoring.

We make several contributions to the rich literature on tax compliance in developing

countries. First, we contribute to the literature on policy responses to tax evasion (see Slemrod (2019) and Pomeranz and Vila-Belda (2019) for recent reviews), particularly the role of third-party information reporting on tax compliance. The literature (Slemrod et al., 2017; Naritomi, 2019; Adhikari et al., 2021) provides overwhelmingly positive evidence of the efficacy of third-party information reporting in improving compliance and reducing evasion. In contrast, our results show that, in the highly informal and limited enforcement capacity context of Khyber Pakhtunkhwa, the third-party information increased compliance only briefly. This result is broadly consistent with the Best et al. (2015) result that optimal policies in a developed country context might not be optimal in developing countries.

We also contribute to the literature that examines the effect of increased audit probability on taxpayer behavior (Slemrod et al., 2001; Kleven et al., 2011; Bergolo et al., 2023). Consistent with this literature, we observe that increased audit probability (due to e-invoicing) leads to an immediate increase in the reported revenues; however, we show that the effects are short-lived.

We contribute most directly to the emerging literature documenting the impact of e-invoicing on tax compliance in developing countries. Bellon et al. (2022) finds that e-invoicing improved tax compliance in Peru in the first year after adoption. Similarly, Eissa et al. (2014), Ali et al. (2021), and Ramírez et al. (2018) document strong positive effects of mandated electronic invoicing on tax compliance in Rwanda, Ethiopia, and Ecuador, respectively.[1] In addition, Mascagni et al. (2021) finds a positive impact of electronic sales registration machines on tax compliance in Ethiopia following the passage of a law requiring them. In contrast to this literature, we find only transient effects of e-POS integration in our context. Relatedly, Fan et al. (2018) documented a large effect size on VAT payments in China in the first five years following the (government-mandated) introduction of the technology; however, the effect dissipates in the long run, though remaining positive. Additionally, to our knowledge, we are the first to study a voluntary, early-stage reform.

In addition, the above literature on e-invoicing has looked at the overall combined impact

[1] In Rwanda, e-invoicing was mandated by legislation; in Ethiopia and Ecuador, it was required by the revenue authority.

on reported sales and taxes; we disaggregate the effects by intensive and extensive margins and show that most of the transient increase in reported sales and tax payments is driven by the extensive margin, i.e., firms reporting sales and paying taxes more often in the periods following the adoption of e-invoicing rather than firms complying more intensely by reporting more sales and paying more taxes.

Finally, we relate to a broader literature on the use of digital technologies to improve tax compliance (see Okunogbe and Santoro (2023) and Martínez-Vázquez et al. (2023) for recent reviews). For example, Yilmaz and Coolidge (2013); Kochanova et al. (2020); Okunogbe and Pouliquen (2022) examine the impact of electronic filing of tax returns on tax compliance. Brockmeyer and Somarriba (2024) examines the effect of electronic payment technology on firms' tax compliance in Uruguay. Dzansi et al. (2022) examines the impact of providing a geospatial database of properties to property tax collectors in Ghana.

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 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 Pakistan, a subnational tax authority, Khyber Pakhtunkhwa Revenue Authority (KPRA), initiated a reform to improve tax compliance by linking POS devices directly

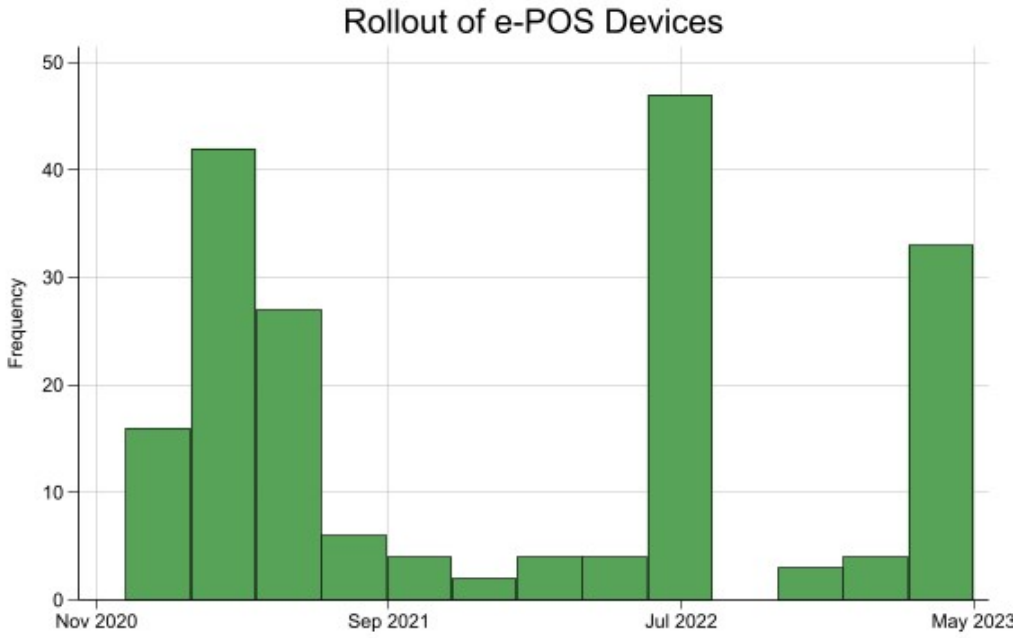
to its tax monitoring system. This intervention aimed to enhance transaction transparency by ensuring that all recorded sales were immediately reported to the tax authority. The policy was rolled out in early 2021, targeting businesses that already owned POS devices while facilitating the installation of new devices in firms without prior digital transaction tracking.

The POS linking process involved three key components. First, businesses with POS devices were encouraged to integrate their systems with KPRA's tax database, enabling real-time transmission of sales data to the tax authority. To expand digital transaction tracking, KPRA also installed POS devices in 47 businesses that previously operated without such systems, bringing them into the formal tax reporting framework. Once linked, businesses gained access to an online dashboard that facilitated record-keeping, transaction monitoring, and tax reporting.

As of May 2023, 196 businesses had linked their POS devices to KPRA, and the initiative was moving toward mandatory adoption. The rollout mainly targeted restaurants, which accounted for 90% of linked businesses, given their high cash flow and historically weak tax compliance. The linkage process was further incentivized through a preferential tax rate of 6% (without input tax adjustment), compared to the standard 13% VAT rate, encouraging voluntary participation. Figure ?? presents a visual representation of the adoption of POS-linked tax reporting across businesses in KP. The figure highlights the cumulative number of businesses that integrated their POS devices with the tax authority from the initiative's start in early 2021 through May 2023.

3 Data

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 August 2013 to August 2024, providing a rich longitudinal view of tax compliance behaviors before and after POS device integration. The intervention's staggered rollout, with POS linkages occurring between December 2020 and



Notes: The figure illustrates the cumulative rollout of POS-linked tax reporting in Khyber Pakhtunkhwa from early 2021 to May 2023

May 2023, offers substantial variation in post-installation periods across firms, allowing for a robust event-study analysis.

The primary sample includes 179 businesses that adopted POS devices between December 2020 and May 2023. Although some firms from other sectors participated, 90% of adopters belonged to the hospitality sector, primarily restaurants. The control group consists of 1,305 similar businesses that did not adopt POS integration, identified through a propensity score matching approach to ensure comparability based on pre-treatment characteristics. Table 1 presents that, on average, businesses paid PKR 23,000 monthly in taxes, though there was significant variation in reported revenues across firms. The monthly average sales value among POS adopters was significantly higher than that of non-adopters, suggesting that larger firms were more likely to opt into the system. Additionally, reported monthly input costs and tax payments were higher among adopters. The dataset includes businesses from multiple districts within Khyber Pakhtunkhwa, with Peshawar (31.4%), Abbottabad (20.9%), Mardan (6.0%) and Mansehra (5.1%) being the most represented locations.

The Matched column in Table 1 presents summary statistics for a sample of non-adopters

selected using propensity score matching to resemble POS adopters based on pre-treatment characteristics. The matched sample is very similar to the POS adopters in sales, inputs, tax output, and return filing behavior, suggesting that the matching procedure successfully created a comparable control group for causal analysis.

Table 1: Summary Statistics of Business Characteristics

	POS	NoPOS	Matched
N	8,558	58,482	
Firms	179	1,305	
Monthly Sale (000)	1,726.66 (6,255.39)	320.91 (4,274.82)	724.96 (7,614.87)
Monthly Inputs (000)	296.19 (2,412.49)	79.58 (2,096.19)	199.28 (3,599.52)
Monthly Tax Output (000)	140.67 (635.82)	41.64 (637.38)	98.47 (1,138.15)
Monthly Tax Inputs (000)	38.96 (377.18)	20.65 (430.32)	41.50 (651.37)
Monthly Tax Paid (000)	100.52 (356.55)	25.85 (376.91)	59.90 (638.13)
Return Filing (d)	0.79 (0.41)	0.64 (0.48)	0.68 (0.47)
Null Return Filing (d)	0.19 (0.39)	0.38 (0.49)	0.35 (0.48)
District			
Peshawar	2,689 (31.4%)	13,467 (23.0%)	13,709 (31.7%)
Abbottabad	1,787 (20.9%)	9,019 (15.4%)	6,378 (14.8%)
Mansehra	433 (5.1%)	12,578 (21.5%)	6,121 (14.2%)
Null	1,350 (15.8%)	4,658 (8.0%)	4,413 (10.2%)
Mardan	511 (6.0%)	3,835 (6.6%)	2,864 (6.6%)
D. I. Khan	216 (2.5%)	2,557 (4.4%)	2,076 (4.8%)
Charsadda	130 (1.5%)	2,313 (4.0%)	1,817 (4.2%)
Nowshera	249 (2.9%)	2,269 (3.9%)	1,221 (2.8%)
Haripur	96 (1.1%)	1,540 (2.6%)	1,068 (2.5%)
Kohat	431 (5.0%)	1,096 (1.9%)	873 (2.0%)
Islamabad	97 (1.1%)	846 (1.4%)	645 (1.5%)
Other	480 (5.6%)	2,765 (4.7%)	1,608 (3.7%)

Notes: The table presents summary statistics comparing businesses that adopted POS devices (POS), those that did not (NoPOS), and a matched sample of non-adopters (Matched) constructed using propensity score methods.

Table 2 summarizes key business attributes, highlighting the balance between the treated and control groups regarding pre-intervention sales, tax payments, and filing behavior. Before POS adoption, the average business filed VAT returns in 75% of months, indicating that a majority were already engaged in tax reporting to some extent. However, 55% of these filings were null returns, suggesting a high prevalence of underreporting or inactivity in more than half of the filing periods.

Table 2: Balance Table

Variable	POS	Matched Sample	p-value
`ln Sales Value`	2.90	2.81	0.690
`ln Purchases Value`	0.86	0.99	0.495
`ln Output Tax`	2.32	2.22	0.561
`ln Input Tax`	0.98	1.13	0.510
`ln Tax Paid`	2.20	1.82	0.023
`Return Filing`	0.80	0.76	0.042
`Null Return Filing`	0.57	0.56	0.703

Notes: The table presents the balance statistics comparing POS adopters and the matched sample. 'ln Sales Value' and 'ln Purchases Value' represent the natural logarithm of reported sales and input expenses, respectively. 'ln Output Tax,' 'ln Input Tax,' and 'ln Tax Paid' capture tax liability, input tax credits, and actual tax paid. 'Return Filing' indicates whether a business submitted a VAT return, while 'Null Return Filing' reflects zero-revenue filings

4 Results

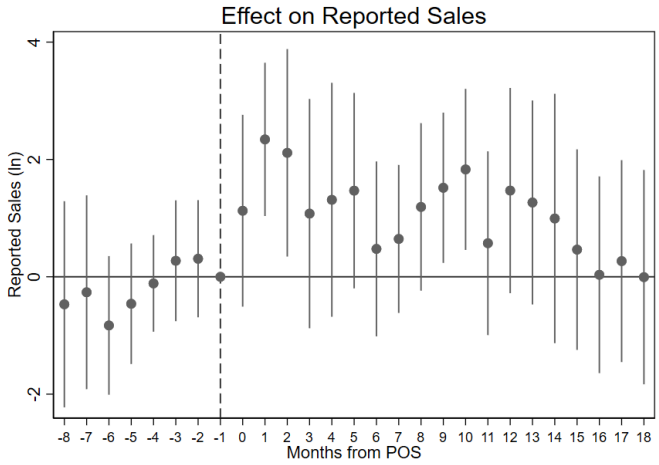
This section presents the impact of POS linkage on tax compliance, focusing on reported sales, purchases, tax payments, and filing behavior. The findings suggest that while POS adoption leads to an initial increase in reported sales and tax payments, these effects are not uniform across all firms and tend to decline over time.

4.1 Reported Sales

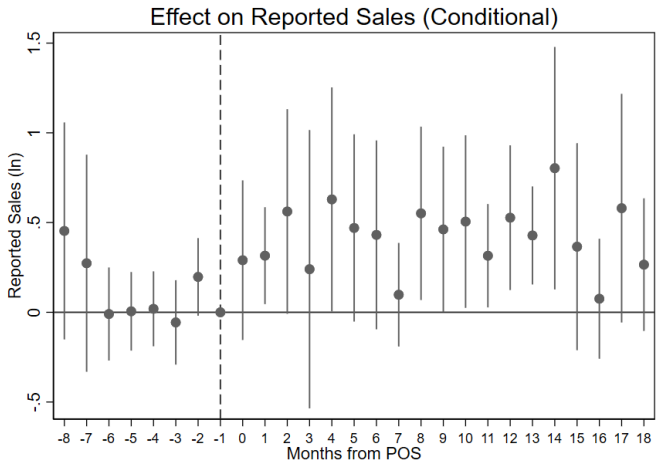
The results indicate that POS adoption led to a transient increase in reported sales, significantly affecting the first three months post-adoption. Figure 1a shows the overall impact, demonstrating a statistically significant rise in reported sales immediately after POS integration. Figure 1b, which conditions on businesses that reported sales, reveals that reported sales remained elevated after 12 months, indicating a lasting effect on firms that continued to file returns.

The extensive margin effect, presented in Figure 1c, shows that POS adoption also increased the likelihood of reporting any sales, meaning more businesses began filing returns with nonzero revenue after adoption. However, this effect dissipated quickly, suggesting that while some businesses initially responded by starting to report sales, they may have reverted to previous reporting behavior over time.

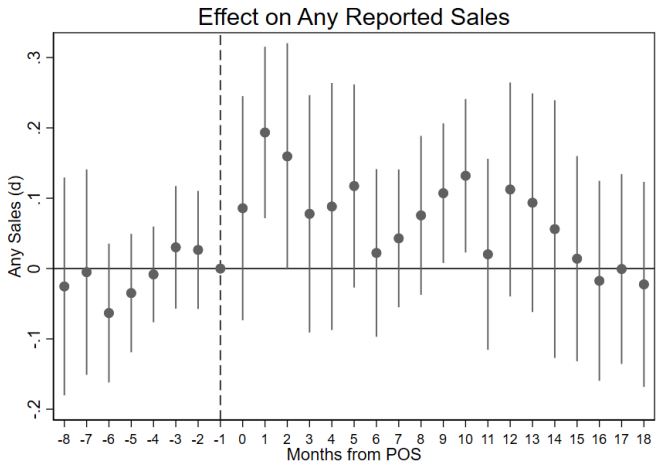
These findings suggest that POS adoption had both intensive and extensive margin effects: it increased reported sales among firms already filing and led some businesses to report positive sales for the first time. However, while the increase in any reported sales was short-lived, the rise in conditional reported sales persisted beyond 12 months, indicating that POS adoption had a more sustained effect on firms that remained in the tax system.



(a) Effect on Reported Sales (ln)



(b) Effect on Reported Sales Conditional (ln)



(c) Effect on Any Reported Sales (d)

Figure 1: Impact of POS Adoption on Reported Sales

We can also examine whether businesses accurately report electronically recorded sales in their tax filings. Figure 2 directly compares POS-recorded sales with reported sales, revealing a persistent gap that suggests underreporting despite automated transaction tracking.

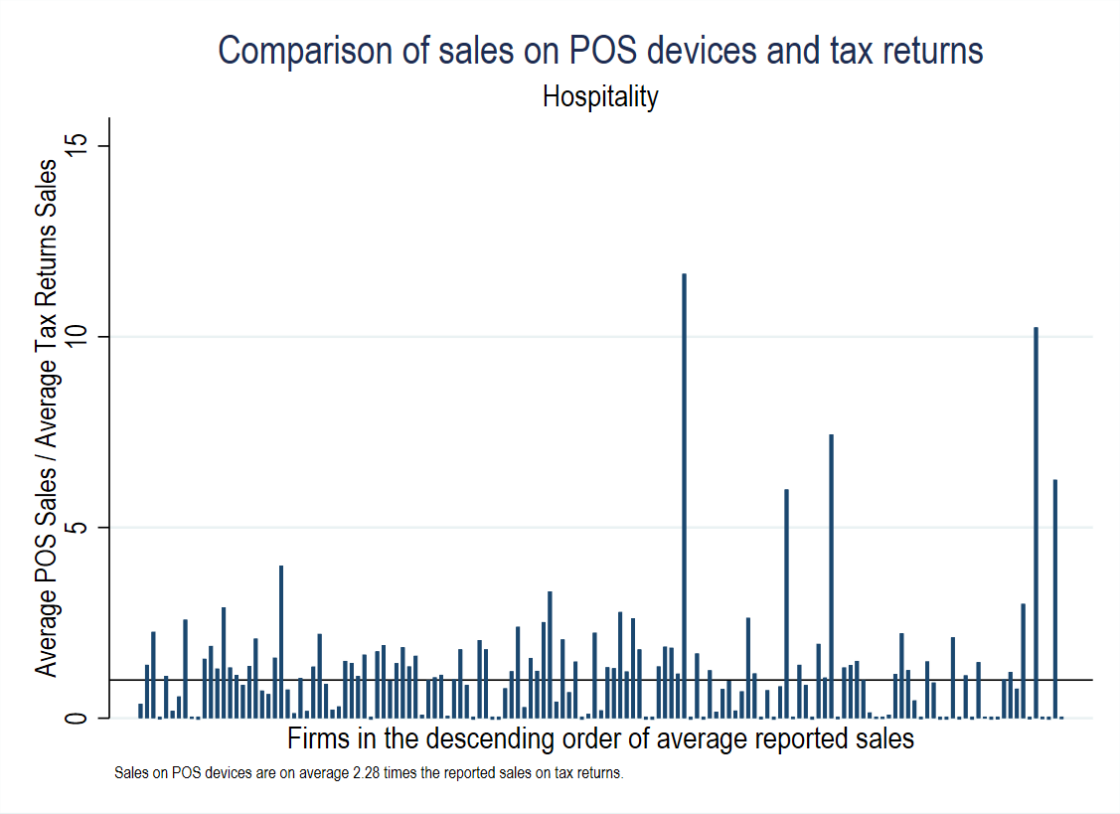
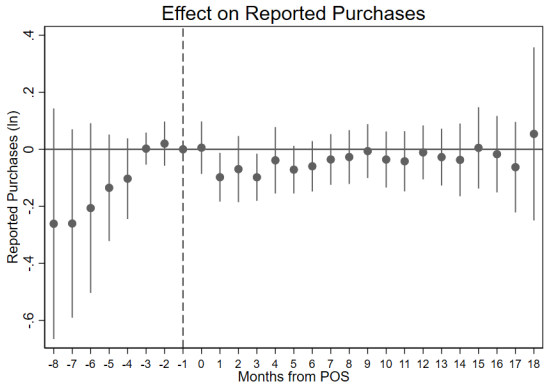


Figure 2: Comparison of Sales on POS and Tax Returns

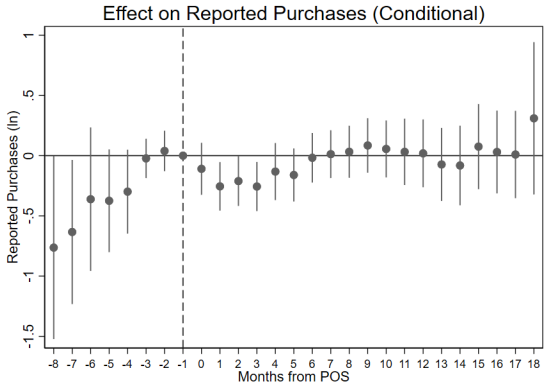
4.2 Reported Purchases

Figure 3a shows a slight decrease in reported purchases following POS integration. However, Figure 3b, which conditions on businesses that reported purchases, suggests that the intensive margin primarily drove this decline, as firms reduced their declared input costs. This pattern aligns with the incentive structure of POS adoption, which disallowed input tax adjustment, reducing the incentive to report higher input expenses. In contrast, the extensive margin effect, shown in Figure 3c, reveals that POS adoption increased the likelihood of reporting any purchases, indicating that more businesses began declaring input expenses post-adoption. This suggests that while some firms reduced the value of reported purchases, others that had previously not reported any inputs started doing so. These findings indi-

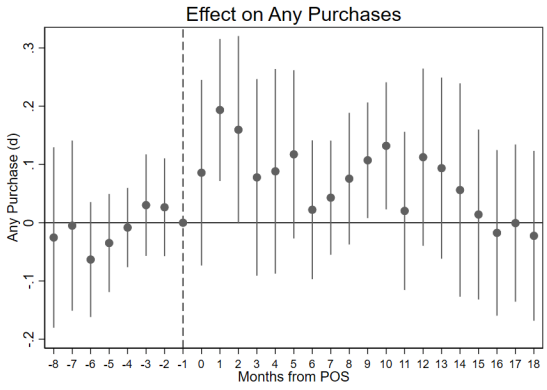
cate that POS adoption initially led to lower reported purchases due to reduced incentives for input declarations. Still, this effect was short-lived, with firms eventually reverting to pre-adoption reporting behavior.



(a) Effect on Reported Purchases (ln)



(b) Effect on Reported Purchases Conditional (ln)



(c) Effect on Any Reported Purchase (d)

Figure 3: Impact of POS Adoption on Reported Purchases

4.3 Value Added

The net effect of a temporary increase in reported sales and a decrease in reported purchases allows us to examine the impact on reported value added (Sales - Purchases). Figure 4 illustrates that POS adoption led to a causal increase in reported value-added, but this effect was short-lived, dissipating after a few months.

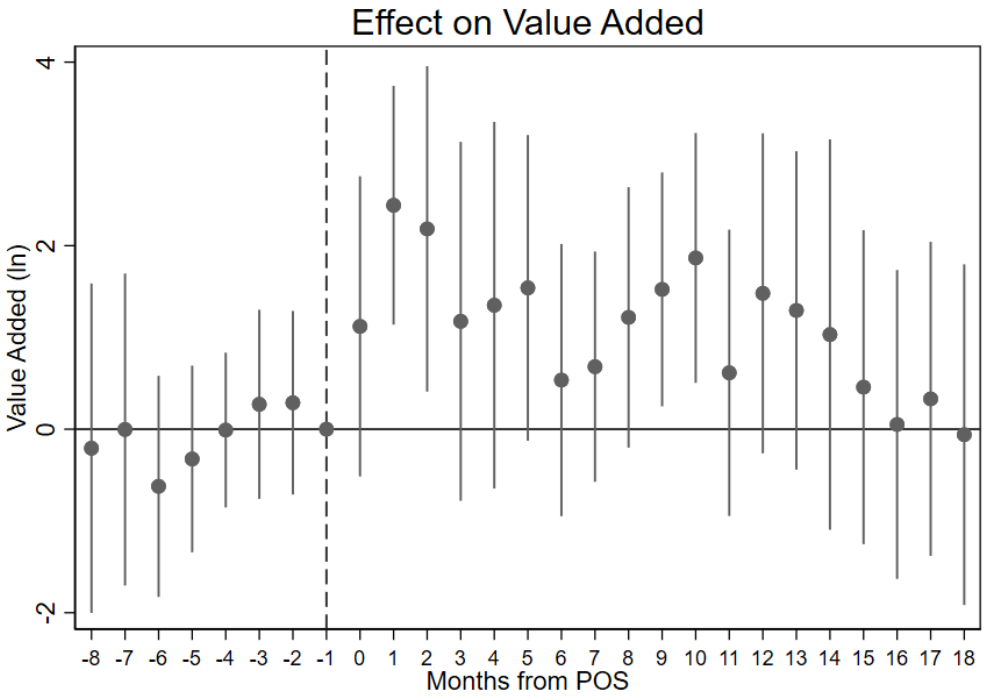
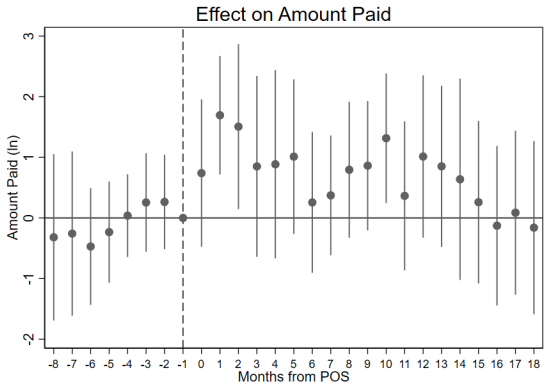


Figure 4: Effect on Value Added (ln)

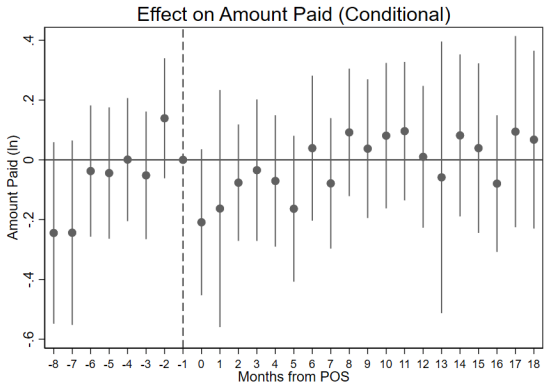
4.4 Taxes Paid

We present the impact of POS device adoption on taxes paid in Figure 5. Figure 5a shows that POS adoption led to an overall increase in taxes paid. However, taxes paid on the intensive margin declined (Figure 5b), likely due to the incentive scheme, which offered a reduced tax rate for POS adopters. While taxes decreased among those already paying positive taxes, encouragingly, POS adoption causally increased the probability of paying any tax. This increase outweighed the slight decline in the intensive margin, resulting in a net positive effect on tax revenue. These findings suggest that the incentive scheme successfully

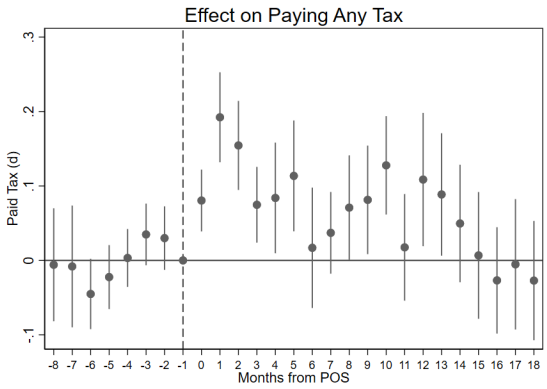
boosted overall tax collection by encouraging tax payments.



(a) Effect on Taxes Paid (ln)



(b) Effect on Taxes Paid Conditional (ln)

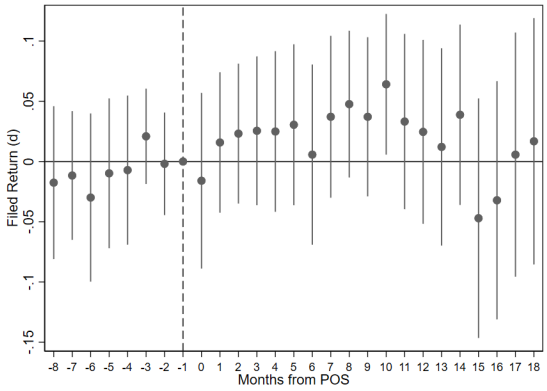


(c) Effect on Any Taxes Paid (d)

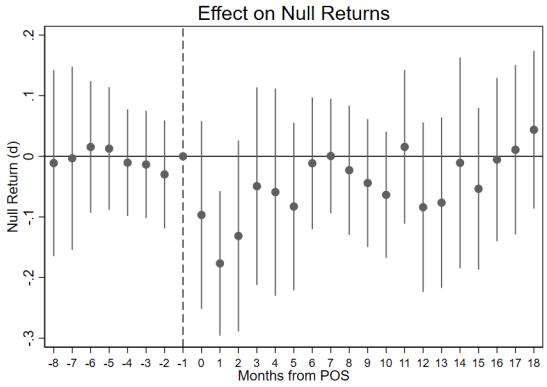
Figure 5: Impact of POS Adoption on Taxes

4.5 Return Filing

As mentioned, this 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 adoption influences the likelihood of filing or reporting null returns. Figure 6a indicates that POS adoption did not significantly affect the probability of filing a tax return. However, Figure 6b shows a significant decrease in the likelihood of filing null returns for at least three months following the adoption of a POS device.



(a) Effect on Return Filing (d)



(b) Effect on Null Return Filing (d)

Figure 6: Impact of POS Adoption on Return Filing

5 Conclusion

This study provides novel evidence on the compliance effects of voluntarily linking existing POS devices to a tax authority in a developing-country context. Leveraging an event-study approach with propensity score matching, we find that POS integration generates an initial boost in reported sales and tax payments. This effect arises partly from businesses that had not previously reported positive sales or paid taxes, suggesting that lower enforcement capacity does not necessarily eliminate short-run revenue gains from technology-driven reforms. However, the observed improvements in compliance taper off within a few months, indicating that mere real-time reporting and audit-risk perception may be insufficient for sustained behavioral change.

In disaggregating the effects, we observe distinct responses along the extensive and intensive margins. While more firms begin paying some tax immediately following adoption, conditional tax payments among prior filers decline, likely due to the preferential tax rate designed to incentivize POS adoption. Additionally, although POS adoption briefly reduces the filing of null returns, it does not significantly affect the overall probability of filing. These patterns underscore the complex interplay between incentives, administrative capacity, and voluntary compliance. From a policy standpoint, our results suggest that linking POS devices to the tax authority can be an effective initial step in broadening the tax base. However, supplementary measures—such as follow-up audits, continuous taxpayer education, and phasing out preferential rates—may be critical to ensuring the longevity of these gains. Sustained compliance likely hinges on reinforcing transparency and deterrence through systematic monitoring, robust enforcement, and ongoing taxpayer support.

Despite these insights, two important gaps in our analysis deserve emphasis: First, our focus on already-registered businesses precludes examining whether the POS intervention affects the broader decision to formalize or exit into informality. This limitation is crucial in contexts where state capacity is constrained, and many businesses operate outside the formal tax net. Future work that investigates how linking POS devices influences the boundary between formality and informality would deepen our understanding of the policy's general equilibrium effects on business dynamics.

Second, while our study zeroes in on the *impact* of POS adoption, it does not explore the drivers of adoption itself. Yet, understanding which businesses respond to the incentives—and whether they differ systematically in their compliance behavior, size, sector, or cost structure—is crucial for designing effective policies. Beyond identification concerns, which we address using the matching technique, the central question is which businesses are most motivated by the incentive scheme and how their participation ultimately shapes program outcomes.

In highlighting both the promise and limitations of e-invoicing in resource-constrained environments, our findings contribute to the emerging literature on digital tax technologies. While voluntary adoption can help scale reforms when enforceability is weak, designing incentive structures and complementary interventions that foster durable compliance remains a central challenge. Future research could explore how repeated audits, dynamic penalty schemes, or broader efforts to modernize tax administration might bolster the long-run impacts of e-invoicing programs. By illuminating the short-lived gains of a pioneering initiative, this study offers cautionary lessons for policymakers seeking to harness digital tools to improve tax collection in developing economies.

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