## Introduction:

Developing countries seeking new ways to finance development increasingly turn to digitalization, using technology to modernize weak bureaucracies. In El Salvador, where the Ministry of Finance lacks the technical and administrative depth of agencies like the U.S. IRS, digital tools offer a substitute for low state capacity. Among these, e-invoicing stands out for offering administrative benefits like lower costs, greater responsiveness to taxpayers, and improved data security. Yet implementation imposes burdens such as staff training and IT upgrades, especially for weak tax administrations (Bellon et al., 2020, p. 5).

Prior studies find largely positive fiscal impacts of e-invoicing reforms. Reported earnings or assessed tax rose significantly in Brazil (22%), Ecuador (18–25%), and Mexico and Argentina (6–11%) (Naritomi, 2015; Ramírez et al., 2017; Fuentes et al., 2016; Artana and Templado, 2017). Uruguay saw a smaller 3.7% gain in tax payments (Bergolo et al., 2017). In contrast, China’s early gains later faded (Fan et al., 2018, cited in Bellon et al., 2020). These results suggest that well-implemented e-invoicing can raise revenue, particularly where tax evasion is common and administrative enforcement is weak. However, these studies should be interpreted cautiously: none applied modern DiD methods to measure causality, and some may have weighted treatment effects inaccurately.

Firm effects are even more heterogeneous. Peru saw 7–12% increases in reported value-added tax (VAT) in the first year of its mandatory e-invoicing rollout, and these effects were strongest among small firms and in low-compliance sectors like retail and construction. However, firms in these sectors also experienced temporary declines in survival rates as increased scrutiny led to firm exits (Bellon et al. 2020, p. 2-3). Small and medium firms may face steep adjustment costs and require support, underscoring the importance of gradual rollout (Review on pros and cons).

Existing literature shows that technology and human enforcement are complementary. Many empirical studies link increases in tax revenue to combinations of digital reforms with staffing increases and performance incentives (Basri et al., 2017; Khan et al., 2015, 2018; cited in Okunogbe and Tourek, 2024). Digital systems reduce time spent on routine tasks, allowing tax authorities to focus limited resources on audits and investigations (Okunogbe and Tourek, 2024, p. 84). El Salvador’s rollout attempts to capitalize on technological and human complementarities through the creation of e-invoicing help centers.

El Salvador is a promising case study. VAT accounts for 38% of public revenue, yet the tax base remains narrow due to high informality — approximately two-thirds of the workforce. The 2023 World Bank Enterprise Survey shows 80.3% of formal firms already pay taxes electronically, yet internet access remains limited (68%). While over 70% of firms report the tax process as overly complex, only 10% cite tax administration as a major obstacle, suggesting openness to digital reforms.

This paper provides the first firm-level, causal analysis of e-invoicing in El Salvador. To date, no published studies have evaluated this reform in the Salvadoran context, despite its ambitious national rollout. I leverage the policy’s staggered implementation across ten treatment cohorts and apply modern difference-in-differences (DiD) methods to measure its impact on two outcomes: log reported VAT revenue and the probability that a firm remits VAT in a given month. While previous studies often rely on two-way fixed effects, I use the Callaway and Sant’Anna (2021) estimator, which produces unbiased estimates in staggered rollout settings by avoiding negative weighting and cohort contamination. These results contribute to a growing literature on tax digitalization in low-capacity settings and offer insight for policymakers considering similar enforcement technologies.

## Context:

### A. Historical Context:

After a civil war ended in 1992, decades of increasing poverty and gang violence preceded the election of President Nayib Bukele in 2019, who campaigned as a “non-party” candidate promising to end corruption and modernize the state. His decisive COVID-19 response — declaring repeated states of emergency and allocating emergency funds for new hospitals — paved the way for virtually unopposed one-party rule. Within months, the legislative majority replaced Supreme Court judges and the attorney general with Bukele loyalists, eliminating any judicial check on his decrees and even permitting him to seek re-election past the constitutional term limit.

Under Bukele’s administration, public debt has soared to more than USD 30 billion, or 87.6% of the country’s gross domestic product (GDP) — much higher than in neighboring countries. To fund his ambitious infrastructure agenda (e.g., high-speed rail and a new international airport), inherited anti-poverty programs, and sizable COVID-19 relief, Bukele has pursued high-profile technological reforms. One such initiative — the sale of Bitcoin-denominated bonds — failed; another, which this study examines, is the tax authority’s rollout of a mandatory e-invoicing program.

### B. E-invoicing:

El Salvador’s Ministry of Finance identified e-invoicing as a “high impact” project — central to modernizing state administration and improving revenue collection. Prior to its rollout, tax policy had not been overhauled since the 1990s. The standard 13% VAT generates 38% of public revenue, yet approximately 70% of the workforce is informal. Heavy reliance on remittances — about a quarter of the country’s gross national product —supports household incomes but may reduce incentives or the capacity for small and rural firms to adopt electronic billing.

Like most countries, El Salvador levies VAT at each stage of production and distribution. Producers pay VAT on sales to retailers, who in turn apply the same rate to consumer sales. Certain sectors — such as public, financial, and insurance services — are exempt (PwC). By contrast, U.S. states typically rely on a single-stage retail sales tax. While both systems can raise equivalent revenue, VAT’s invoicing trail and detailed reporting mechanisms enhance enforcement.

By 2018, more than 50 countries — including ten in Latin America and the Caribbean — had implemented e-invoicing, four years before El Salvador’s initial reform legislation. Like El Salvador, Peru’s rollout required significant upgrades to tax administration and taxpayer IT capabilities. Implementation was gradual, beginning with larger firms, while smaller firms were given additional time to comply.

Prior to the reform, tax enforcement in El Salvador relied on paper-based invoicing and ex-post audits, with limited cross-checking and no real-time monitoring. Tax and customs inspections were slow and paper-intensive, reflecting low administrative capacity. Mandatory e-invoicing introduced real-time monitoring of commercial transactions, aiming to improve transparency and enforcement efficiency.

In 2019, El Salvador launched a voluntary e-invoicing pilot with approximately 50 large VAT taxpayers, but the program was delayed by the COVID-19 pandemic (VATCalc, EDICOM). In July 2023, the government mandated e-invoicing for the first rollout group, replacing paper invoices with fully electronic ones via the Finance Ministry’s eFacturaSV system. Suppliers generate invoices through the Ministry’s web portal or approved accounting software, producing a standardized, machine-readable file. The platform verifies the format, credentials, and VAT calculation before issuing an authorization. Once approved, the supplier forwards the invoice to the buyer. The system is government-controlled and operates in real time, so tax authorities can monitor compliance in real time. Unlike more decentralized European models, El Salvador’s system is fully state-mediated and archives every VAT invoice upon issuance.

Notifications began in February 2023 — five months before the initial mandate — and the ten-group rollout remains incomplete. Firms may opt-in early but must comply by their assigned date. Of a USD 3 million loan from the Inter-American Development Bank to modernize tax administration, USD 170,000 supported key e-invoicing components in 2023-2024, including a mobile app, website, and six support centers that trained over 50,000 users. According to the Ministry of Finance, the reform contributed to a USD 2 billion increase in VAT revenue from 2022 and 2023, reduced evasion, and shortened service times. By September 2024, it also reportedly saved 29,157 trees and 208.6 million liters of water (IADB 2024).

This ten-group rollout allowed tax authorities to onboard firms in manageable batches, test the eFacturaSV system and support centers, and tailor training for each wave. Phasing by cohort size concentrated resources, prevented system overload, and eased the transition for small firms unfamiliar with e-invoicing — mirroring approaches in other Latin American countries, such as Chile, Peru, and Mexico.

Alongside the e-invoicing mandate, El Salvador adopted additional tax measures that may influence VAT outcomes. As of January 2025, e-tickets became mandatory for business-to-consumer transactions, expanding digital traceability in retail (IADB, 2023). Unlike e-invoices, which govern business-to-business transactions and require stricter documentation, e-tickets are simplified digital receipts. The termination of tax amnesty in late 2024 may also signal a broader shift toward stricter enforcement (Auxadi, 2024). While this study isolates the effects of staggered e-invoicing, concurrent reforms likely reinforce compliance trends and introduce upward bias. Still, because e-invoicing defines the core mechanism for recording VAT, it remains the most consequential reform and an appropriate focus of analysis.

## Data:

This study uses monthly firm-level tax remittance data from 2022 to 2025, publicly available through El Salvador’s Fiscal Transparency Portal, maintained by the Ministry of Finance. The data include declassified firm-level records on monthly payments, payment types, economic activity, and municipality. The dataset covers 30,167 unique firms — slightly below the approximately 37,000 officially notified — likely due to delayed entry, as many firms appear only in later periods.

Firm identifiers are not provided, so firms are approximated using unique combinations of municipality and economic activity codes. A balanced monthly panel is constructed from January 2022 to May 2025. Municipality and activity codes are matched to names using official dictionaries from the Fiscal Transparency Portal. Analysis is restricted to VAT revenue, identified using tax codes from the Portal’s public dictionary, which includes:

* VAT Internal Transactions
* VAT on Imports
* VAT Transactions via Withholding and Collection
* VAT Withholding Non-Residents
* VAT Advance Payment (e.g., 2% on credit card purchases)

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Since rollout dates were not publicly available, notification and implementation timelines, along with cohort sizes, were obtained through direct contact with the Ministry of Finance and the Transparency Portal support offices. Assignment criteria are also undisclosed, but increasing cohort sizes and the 2019 pilot targeting large firms suggest sorting by pre-treatment size. Firms with no reported revenue in the month before the first notification (February 2023) are excluded to ensure comparability and valid dynamic treatment estimation.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Group 1** | **Group 2** | **Group 3** | **Group 4** | **Group 5** | **Group 6** | **Group 7** | **Group 8** | **Group 9** | **Group 10** |
| **Notification Date** | 2/1/2023 | 5/1/2023 | 8/1/2023 | 12/1/2023 | 2/1/2024 | 5/1/2024 | 8/1/2024 | 12/1/2024 | 2/1/2025 | 5/1/2025 |
| **Treatment Date** | 7/1/2023 | 10/1/2023 | 1/1/2024 | 4/1/2024 | 7/1/2024 | 10/1/2024 | 1/15/2025 | 4/1/2025 | 7/1/2025 | 10/1/2025 |
| **Firm Count** | 233 | 239 | 249 | 345 | 657 | 701 | 704 | 4982 | 14286 | 15000 |

Firms are classified as large (over USD 1 million/year in total tax remittances), medium (USD 100,000—1 million), or small taxpayers (under USD 100,000) based on average pre-treatment VAT revenue. [SLIDESHOW SOURCE] Firms were notified approximately five months before their assigned implementation date.

A known limitation is an under-reporting error affecting October 2023, which corresponds to the second cohort’s treatment month; this month is excluded from the sample. Other limitations include the absence of firm-level covariates (e.g., firm age, digital readiness, or tax history) and the inability to identify firms that voluntarily adopted e-invoicing before the mandate.

## Methods:

To estimate the causal effects of e-invoicing on firm tax behavior, I apply a difference-in-differences (DiD) event study design proposed by Callaway and Sant’Anna (2021), exploiting the staggered rollout. DiD compares changes in outcomes before and after treatment between treated and control groups, assuming similar pre-treatment trends. Since e-invoicing was the primary tax-related change affecting VAT revenue during this period, post-treatment differences are attributed to the intervention under the parallel trends assumption.

Standard DiD methods using two-way fixed effects (TWFE) can produce biased estimates under staggered treatment timing. As Callaway and Sant’Anna (2021) show, TWFE may yield incorrect signs when treated units serve as controls for later-treated units, leading to invalid comparisons.

To address these concerns, I implement the doubly robust event study estimator developed by Callaway and Sant’Anna (2021). This method estimates group-time average treatment effects (ATTs), defined as:

which is the expected outcome difference at time for units in treatment group . By fixing firms to a group and varying time, the method traces treatment effects over time. Each group is compared only to units not yet treated at time , ensuring that control groups remain untreated and avoiding invalid comparisons.

Identification in Callaway and Sant’Anna (2021) relies on several assumptions. The most important is that, before the policy, treated and not-yet-treated firms followed similar trends — a condition I test using pre-treatment data. I also account for limited treatment anticipation by incorporating the five-month gap between notification and implementation. Because my dataset does not include firm-level characteristics such as age, digital readiness, or tax history, I cannot adjust for differences across firms. Instead, I make a stronger assumption: that firms in different groups would have shown similar outcomes over time, even without controlling for these characteristics. This assumption is more plausible in this setting, as my sample includes only formal tax-filing firms, which are more similar in administrative behavior than the broader population of firms.

Treatment effects are measured using the log of firms’ monthly VAT revenue. Because some firms do not remit every month, resulting in zero values, I apply a standard transformation. This approach follows guidance from Dzielinski et al. (2023) and preserves zero observations while enabling logarithmic comparisons across firms and time. Although the adjustment introduces minor bias for small values, it avoids losing data or excluding firms with valid outcomes.

In addition to firm-level analysis, I estimate treatment effects using a balanced panel of 189 group-industry-month units, where each unit represents all firms within a taxpayer size group and industry in a given month. This aggregation smooths irregular reporting, reducing noise — particularly among smaller firms. Compared to the firm-level panel defined by industry and municipality, the group-industry aggregation sacrifices granularity for greater stability and interpretability in fiscal behavior. These results are more informative for policymakers evaluating the mandate’s impact across economic sectors.

To examine how treatment effects evolve over time, I construct an event study that re-indexes outcomes relative to each group’s treatment date. Letting denote event time (i.e., how many periods before or after treatment), I estimate the average treatment effect at each event time:

This expression aggregates group-time effects observed at event time , weighting by group size. Negative values of correspond to pre-treatment periods (used to assess parallel trends), while positive values reflect post-treatment effects.

I implement this estimator in two steps using the did package in R. This modern DiD approach provides more credible estimates under staggered rollout. Unlike Bellon et al. (2020), which used traditional TWFE in their Peru study, the event study framework explicitly models treatment dynamics and restricts comparisons to untreated units. As a result, the Callaway and Sant’Anna (2021) method avoids common biases and offers a clearer view of the policy’s timing and impact.

## Results:

The Callaway and Sant’Anna (2021) event study model fits the data well and confirms parallel pre-treatment trends. I find no evidence that El Salvador’s e-invoicing mandate significantly or rapidly increased VAT remittance or compliance during the initial rollout period. However, long-term effects — particularly among smaller firms — remain uncertain and may strengthen as firms adapt and enforcement scales. These results reject the hypothesis that the policy produced immediate gains in public revenue collection.

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### A. Effects on VAT Remittance:

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I estimate treatment effects on log monthly VAT revenue using the Callaway and Sant’Anna (2021) event study model. Figure 1 plots group-time ATT estimates, and the results confirm parallel pre-treatment trends. Through the end of 2024, there is no statistically significant increase in VAT revenue following e-invoicing adoption. The overall average treatment effect on the treated (ATT is 0.012 (SE = 0.041), with a 95% confidence interval of [-0.068, 0.091]. These null results are visualized in a flat post-treatment path.

These findings suggest that mandatory e-invoicing did not raise reported VAT revenue in the short run. This may reflect gradual firm adaptation, limited enforcement, or transitional frictions. This event study model accounts for staggered rollout and avoids cohort contamination, lending credibility to the null result. While short-term effects are limited, longer-run gains remain plausible, especially for smaller firms slower to adopt digital reporting.

### Changes in Remittance Probability

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To test whether e-invoicing affected firms’ likelihood of remitting, I estimate dynamic effects on the probability of positive monthly VAT payment. The ATT is –0.0006 (SE = 0.0037), with a 95% confidence interval of [–0.0078, 0.0066], indicating no statistically significant change. Because the sample excludes firms with no reported revenue prior to the first notification date, estimates reflect compliance behavior among firms already filing VAT returns. These results suggest that e-invoicing had little short-run effect on the extensive margin of compliance: firms that previously remitted continued to do so, while non-remitting firms largely remained noncompliant. This aligns with the earlier finding of no significant revenue gains.

### Aggregate Revenue and Compliance Effects

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### A graph with lines in the middle AI-generated content may be incorrect.(Panel B)

To assess broader fiscal effects, I estimate event studies using group-industry-month units, where each unit includes all firms within a taxpayer size group and industry code. Panel A reports effects on log total VAT revenue; Panel B shows the probability that any firm in the unit remits VAT. All ATT estimates are calculated using not-yet-treated group-industries as controls. For log revenue, the estimated ATT is –0.059 (SE = 0.100), with a 95% confidence interval of [–0.255, 0.136]; the event study plot shows no post-treatment increase. For remittance probability, the ATT is 0.009 (SE = 0.011), with a 95% confidence interval of [-0.013, 0.031], also statistically insignificant. These results suggest that e-invoicing had no measurable short-run effect on aggregate revenue or compliance through the end of 2024, consistent with firm-level findings.

### Industry-Specific Treatment Effects

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(Public administration and defense; compulsory social security plans)

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(Agriculture, livestock, forestry and fishing)

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(Human health care and social care activities)

Industry-level event studies show that only three sectors — health care and social assistance; agriculture, livestock, forestry and fishing; and public administration and social security — exhibit statistically significant post-treatment effects. These sectors stand out among the top twenty by firm count, where most industries show no measurable response to the e-invoicing mandate.

The concentration of effects in these areas suggests that the policy’s early impact is strongest where firms are already involved in formal systems (e.g., public contracts, health licensing) or where informal firms interact regularly with the state, such as agricultural exporters. These results support the hypothesis that e-invoicing is most effective in raising compliance and VAT remittance in sectors at the boundary of informality and state regulation.

### Recent Cohorts and Possible Late-Stage Treatment Effects

While later cohorts show potential increases in VAT remittance, I do not interpret these results as causal due to possible changes in firm classification and reporting practices in 2025. The validity of the event study depends on stable unit definitions, which may not hold in the final months of the panel. I therefore present these patterns descriptively.

For early treatment groups, VAT remittance does not deviate from historical seasonal trends. Later cohorts, composed primarily of smaller firms, show pronounced increases around treatment dates that mirror seasonal spikes already observed in larger groups. By law, firms report VAT monthly but remit it by the 10th business day of the following month. As a result, December consumption drives remittance in January or February. Additionally, public and private contract spending is often concentrated at the start of the fiscal year. These factors explain the consistent first-quarter spikes and increased remittance among small firms.

The sharper increase in remittance for small firms may reflect stronger compliance effects following treatment. Larger firms, already more compliant, show no break from historical patterns. Interpretation is limited by the inclusion of 2025 data, during which classification rules or administrative practices may have changed. Still, the results suggest potential long-run compliance gains for smaller firms: the ATT on remittance probability is 0.019 (SE = 0.0029), significant at the 5% level. However, this increase does not yield substantial revenue gains; the estimated ATT on log VAT revenue is 0.049 (SE = 0.0284), and not statistically significant. While not causal, these findings indicate that e-invoicing may bring more small firms into the tax net, but their aggregate revenue contribution remains modest.

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Overall summary of ATT's based on event-study/dynamic aggregation:

ATT Std. Error [ 95% Conf. Int.]

0.0491 0.0284 -0.0066 0.1048

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Overall summary of ATT's based on event-study/dynamic aggregation:

ATT Std. Error [ 95% Conf. Int.]

0.0193 0.0029 0.0136 0.025 \*

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Overall summary of ATT's based on event-study/dynamic aggregation:

ATT Std. Error [ 95% Conf. Int.]

-0.011 0.1011 -0.2091 0.1872

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Overall summary of ATT's based on event-study/dynamic aggregation:

ATT Std. Error [ 95% Conf. Int.]

0.0151 0.0106 -0.0056 0.0358

## Conclusion:

This paper examines the early effects of El Salvador’s e-invoicing mandate on reported VAT revenue and compliance, using public firm-level data and correspondence with the Ministry of Finance. I find no significant revenue increase for large firms, likely due to preexisting digital infrastructure and consistent compliance. Effects are heterogeneous, with greater impacts among smaller firms and sectors with lower noncompliance risk, suggesting e-invoicing works primarily through deterrence and improved traceability.

Treatment effects build gradually, suggesting the reform’s full impact may not yet be realized — consistent with findings from Peru’s rollout. The Ministry of Finance plans to add more than ten cohorts and continues to support firms through physical help centers. While such support is widely seen as essential for successful adoption (CITE), my results show no compliance gains among large and medium firms, implying that complementarities may yield greater returns for small or digitally inexperienced taxpayers. Future research should evaluate effects once rollout concludes—both to identify causal impacts on smaller firms and to assess potential spillovers to sectors like public administration, social security, or health care, where early results suggest stronger compliance linked to state ties.

This study is among the first to apply modern difference-in-differences methods to measure firm- and group-level responses to staggered e-invoicing rollout in a low-capacity tax administration. Using the Callaway and Sant’Anna (2021) estimator ensures valid cohort comparisons and avoids biases common to traditional DiD. The findings offer early insight into how digital enforcement tools influence compliance in low-capacity settings and may inform policy in other developing or low-compliance countries pursuing similar reforms.