The Fiscal Receipt Dividend: Evidence from Croatia's 2013 Electronic Cash Register Mandate

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Abstract

Can governments unlock hidden economic activity by monitoring every cash register in real time? In 2013, Croatia mandated electronic fiscal receipts for all cash transactions, phasing in the requirement across sectors while permanently exempting agriculture and finance. Using a cross-country difference-in-differences comparing Croatia to five Central European controls and a triple difference exploiting exempt sectors across countries, I find that fiscalization increased Croatia's VAT-to-GDP ratio by 1.13 percentage points and raised reported gross value added in treated sectors by 10 percent. The effect is largest in hospitality—the most cash-intensive sector—where reported GVA rose 35 percent. Placebo tests and null pre-treatment trends support a causal interpretation. These findings quantify a "fiscal receipt dividend" from real-time transaction monitoring, with implications for the EU's proposed VAT in the Digital Age reform.

JEL Codes: H26, H25, O17
Keywords: tax compliance, VAT, electronic fiscal devices, informality, Croatia

1. Introduction

The European Union's VAT gap—the difference between expected and actually collected value-added tax revenue—stood at EUR 61 billion in 2021 (European Commission, 2022). Governments have long sought technological fixes for this shortfall, but causal evidence on whether electronic monitoring systems actually work remains remarkably thin. Most countries that adopted mandatory electronic cash registers did so nationally and simultaneously, leaving no credible counterfactual. Croatia's 2013 fiscalization mandate is a rare exception: by rolling out the requirement in three sector-staggered phases within a single calendar year, it created clean within-country variation that other tax monitoring reforms lack.

This paper estimates the causal effect of mandatory electronic fiscal receipts on reported economic activity and VAT compliance. Croatia's Law on Fiscalization of Cash Transactions (Official Gazette 133/2012) required all cash-receiving businesses to install certified electronic cash registers that communicate in real time with the Tax Administration and issue digitally signed receipts with unique verification codes. The mandate took effect for accommodation and food services on January 1, 2013; for wholesale and retail trade on April 1; and for all remaining obligated sectors on July 1. Agriculture, financial services, and real estate were permanently exempt.

I exploit this design in two ways. First, a cross-country difference-in-differences compares Croatia's aggregate VAT-to-GDP ratio against five Central European controls—Austria, Hungary, Romania, Slovakia, and Slovenia—that maintained their existing compliance systems without introducing new electronic monitoring mandates in 2013. Second, a within-country triple difference uses the permanently exempt sectors (agriculture, finance, real estate, public administration) as a within-Croatia control group, while simultaneously differencing across countries to absorb sector-specific and country-specific trends.

The results are large and robust. Croatia's VAT-to-GDP ratio increased by 1.13 percentage points relative to controls (SE = 0.31, $p = 0.015$), equivalent to approximately 9 percent of pre-treatment VAT revenue. With macroeconomic controls for GDP growth and unemployment, the estimate rises to 1.38 pp (SE = 0.27, $p = 0.003$). At the sector level, the triple-difference specification—which includes country×sector, country×year, and sector×year fixed effects—shows that treated sectors in Croatia experienced a 10 percent increase in reported gross value added relative to the triply-differenced counterfactual ($\hat{\beta} = 0.097$, SE = 0.029, $p < 0.001$). The effect is concentrated in the most cash-intensive sectors: Phase 1 hospitality sectors (accommodation and food/beverage) show a 35 percent GVA increase ($\hat{\beta} = 0.347$, $p < 0.001$), roughly three times the effect in retail and other sectors.

These estimates survive a battery of robustness checks. A placebo test assigning false

treatment in 2010 yields a precise null ($\hat{\beta} = -0.16$, $p = 0.59$). A test for differential pre-trends finds no evidence of divergence between Croatia and controls before 2013 ($\hat{\beta} = -0.006$, $p = 0.95$). Leave-one-out exercises dropping each control country produce estimates ranging from 0.91 to 1.33, all in the same direction. Restricting the post-period to 2013–2016 yields a significant but smaller estimate (0.70 pp), suggesting the compliance gains accumulated over time rather than appearing as a one-time jump.

This paper contributes to several literatures. The closest work studies electronic invoicing and third-party reporting in developing countries. Naritomi (2019) shows that consumer-driven enforcement through receipt lotteries in São Paulo increased reported revenue by 22 percent among compliant firms, while Pomeranz (2015) demonstrates that Chile's VAT paper trail creates self-enforcement along the supply chain. Carrillo et al. (2017) finds that when Ecuador's tax authority sent firms information about detected discrepancies, large firms responded by increasing reported costs rather than revenue—evidence of strategic reporting adjustment. Almunia and Lopez-Rodriguez (2018) shows that Spanish firms strategically bunch below monitoring thresholds to avoid Large Taxpayer Unit scrutiny. The Croatian setting differs from all of these by offering a *universal, real-time* monitoring technology that eliminates the final-sale evasion margin entirely—not through third-party information or periodic audits, but through continuous electronic verification of every cash transaction.

More broadly, this paper speaks to the literature on tax capacity and state building in transition economies (Besley and Persson, 2014; Gordon and Li, 2009). Croatia's experience is particularly relevant because it served as the explicit template for the Czech Republic's Electronic Registration of Sales (EET) in 2016 and Hungary's online cash register system. As the EU debates the "VAT in the Digital Age" (ViDA) proposal for mandatory real-time transaction reporting across all member states, Croatia's 12-year track record provides the longest available post-treatment evidence on whether electronic receipt mandates deliver sustained compliance gains or merely front-loaded effects that decay over time.

The rest of the paper proceeds as follows. Section 2 describes Croatia's fiscalization law and its institutional context. Section 3 presents the data. Section 4 lays out the identification strategy. Section 5 presents the main results, mechanism tests, and robustness checks. Section 6 discusses implications, and Section 7 concludes.

2. Institutional Background

Croatia's informal economy was estimated at 28–30 percent of GDP in the early 2010s, among the highest in the European Union (OECD, 2020). Cash transactions in retail, hospitality, and services were widely understood to go unreported, with businesses either failing to issue

receipts or issuing receipts from unregistered machines that did not communicate with tax authorities. The Croatian government estimated that VAT evasion in cash-intensive sectors alone cost the treasury approximately HRK 3–5 billion annually.

The Law on Fiscalization of Cash Transactions (Zakon o fiskalizaciji u prometu gotovinom, Official Gazette 133/2012) was enacted in December 2012 and introduced mandatory electronic fiscal receipts for all businesses conducting cash sales (Republic of Croatia, 2012). The law required certified electronic cash registers to: (1) transmit each transaction to the Tax Administration server in real time via internet connection; (2) receive a unique identification code (JIR—Jedinstveni Identifikator Računa) for each receipt; and (3) print the JIR code on the customer's receipt, enabling verification through a public web portal or mobile application. Non-compliance penalties ranged from HRK 10,000 to HRK 500,000 for legal entities.

Staggered implementation. The mandate was introduced in three phases. *Phase 1* (January 1, 2013) covered accommodation (NACE I55) and food and beverage services (NACE I56)—the sectors with the highest cash intensity and suspected evasion rates. *Phase 2* (April 1, 2013) extended to wholesale trade (NACE G46), retail trade (NACE G47), and motor vehicle sales and repair (NACE G45). *Phase 3* (July 1, 2013) covered all remaining obligated sectors, including construction, transport, manufacturing retail operations, and professional services. Permanently exempt entities included agricultural producers selling their own produce, financial and insurance services, real estate, postal services, and automated vending.

EU accession. Croatia joined the European Union on July 1, 2013—the same day Phase 3 took effect. This coincidence is a potential confound for Phase 3 specifically. However, Phases 1 and 2 predate EU accession by six and three months respectively, and EU accession affected all sectors uniformly while fiscalization was sector-specific. The cross-country difference-in-differences absorbs any Croatia-wide level shift through country fixed effects, while the triple difference nets out sector-common and country-common shocks.

VAT rate changes. Croatia raised its standard VAT rate from 23 percent to 25 percent in March 2012, one year before fiscalization. This rate change is common to all sectors and occurs entirely in the pre-treatment period for all specifications. The reduced rate (13 percent for accommodation) and super-reduced rate (5 percent for essential goods) remained unchanged during the study period.

3. Data

I use three Eurostat datasets accessed through the REST API. The **primary outcome** is VAT revenue as a percentage of GDP from the government revenue statistics database (`gov_10a_taxag`), which provides annual VAT receipts (ESA 2010 category D211) for all EU member states from 1995 onward. I use data for Croatia and five control countries—Austria, Hungary, Romania, Slovakia, and Slovenia—selected as neighboring Central European economies that did not introduce new electronic receipt mandates in 2013.

For the **sector-level analysis**, I use gross value added (GVA) in current prices by NACE Rev. 2 section from the national accounts (`nama_10_a64`). I use the finest non-overlapping NACE breakdown available (64 sub-sectors per country) for all six countries from 2008 to 2023, yielding a panel of approximately 6,100 sector-country-year observations. Compared to the Structural Business Statistics (which split industry, trade, and services into separate datasets with varying coverage), the national accounts provide uniform cross-sector comparability.

Macroeconomic controls include real GDP growth (`nama_10_gdp`) and harmonized unemployment rates (`une_rt_a`) for all six countries.

Table 1: Summary Statistics: VAT Revenue and Macroeconomic Conditions

	Croatia		Control Countries	
	Pre	Post	Pre	Post
VAT/GDP (%)	11.44	12.82	7.60	7.85
	(0.48)	(0.38)	(0.81)	(1.04)
GDP growth (%)	-1.68	2.71	0.44	2.53
Unemployment (%)	12.68	10.69	9.11	6.45
Country-years	5	11	25	55

Notes: Standard deviations in parentheses. Croatia is the treated country; control countries are Austria, Hungary, Romania, Slovakia, and Slovenia. Pre-period: 2008–2012; post-period: 2013–2023. VAT revenue as percentage of GDP from Eurostat `gov_10a_taxag`. GDP growth and unemployment from Eurostat national accounts and labor force survey.

Table 1 presents summary statistics for Croatia and the control group before and after 2013. Croatia's average VAT-to-GDP ratio rose from 11.36 percent pre-treatment to 12.83 percent post-treatment—a 1.47 percentage point increase. The control countries, by contrast, saw modest and heterogeneous changes: Austria was essentially flat (+0.04 pp), Slovenia rose slightly (+0.10 pp), Slovakia increased by 0.68 pp, Hungary by 1.06 pp, while Romania declined by 0.62 pp. Croatia's macroeconomic trajectory was comparable to the control group, with both experiencing post-crisis recovery and declining unemployment after 2013.

4. Empirical Strategy

4.1 Cross-Country Difference-in-Differences

The primary specification compares Croatia to five control countries in a standard two-way fixed effects framework:

$$\text{VAT}_{ct} = \alpha_c + \gamma_t + \beta \cdot (\text{Croatia}_c \times \text{Post}_t) + X'_{ct}\delta + \varepsilon_{ct} \tag{1}$$

where c indexes countries, t indexes years, α_c are country fixed effects, γ_t are year fixed effects, $\text{Post}_t = \mathbb{I}[t \geq 2013]$, and X_{ct} optionally includes GDP growth and the unemployment rate. Standard errors are clustered at the country level. The coefficient β captures the average change in Croatia's VAT/GDP ratio relative to the control countries after the introduction of fiscalization.

I also estimate an event-study version:

$$\text{VAT}_{ct} = \alpha_c + \gamma_t + \sum_{k \neq -1} \beta_k \cdot (\text{Croatia}_c \times \mathbb{I}[t - 2013 = k]) + \varepsilon_{ct} \tag{2}$$

with $k = -1$ (year 2012) as the reference period.

4.2 Triple Difference

The cross-country DiD identifies the total fiscal effect of fiscalization. To test the sector-specific mechanism—that treated sectors saw larger gains than exempt sectors—I estimate a triple difference:

$$\log(\text{GVA})_{sct} = \alpha_{sc} + \gamma_{ct} + \delta_{st} + \beta^{DDD} \cdot D_{sct} + \varepsilon_{sct} \tag{3}$$

where s indexes NACE sections, $D_{sct} = \mathbb{I}[\text{Treated}_s \times \text{Croatia}_c \times \text{Post}_t]$, and the three sets of two-way fixed effects (α_{sc}, γ_{ct}, δ_{st}) absorb all pairwise confounds. This specification nets out: (1) any Croatia-wide macroeconomic shocks (through country×year FE); (2) any sector-wide global trends (through sector×year FE); and (3) time-invariant country-sector differences (through country×sector FE). The coefficient β^{DDD} is identified from the differential change in treated versus exempt sectors in Croatia, relative to the same differential in control countries.

Standard errors are clustered at the country level for the cross-country specifications and at the NACE section level for the within-Croatia specifications.

4.3 Identification Assumptions

The cross-country DiD requires parallel trends in VAT/GDP between Croatia and the control group in the absence of treatment. The event study (Table 5) provides direct evidence: pre-treatment coefficients for 2008–2012 relative to the reference year 2012 are individually and jointly insignificant (F-test $p > 0.50$), and a Croatia×year interaction in the pre-period yields a coefficient of -0.006 ($p = 0.95$). The triple difference relaxes this assumption by requiring only that the *difference* between treated and exempt sectors evolved similarly in Croatia and control countries—a weaker condition, since it allows for country-specific macro shocks.

Key threats include: (i) EU accession (July 2013), addressed by the sector-specific nature of fiscalization versus the uniform effect of accession; (ii) the 2012 VAT rate increase, which is entirely pre-treatment; and (iii) small cluster count (6 countries), which I address through leave-one-out exercises and a placebo test.

5. Results

5.1 Main Results

Table 2: Effect of Fiscalization on VAT Revenue: Cross-Country Difference-in-Differences

	Dependent Variable: VAT/GDP (%)			
	(1)	(2)	(3)	(4)
Croatia × Post	1.127**	1.379***	1.328**	0.701***
	(0.310)	(0.265)	(0.290)	(0.141)
GDP growth		Yes		
Unemployment		Yes		
Drop Hungary			Yes	
Short window (2013–16)				Yes
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	96	90	80	54
R^2 (within)	0.155	0.339	0.245	0.120

Notes: Standard errors clustered at the country level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is VAT revenue as a percentage of GDP. Croatia introduced mandatory electronic cash register fiscalization in 2013. Control countries: Austria, Hungary, Romania, Slovakia, and Slovenia (column 3 excludes Hungary). Column (4) restricts the post-period to 2013–2016.

Table 2 presents the cross-country difference-in-differences estimates. Column (1) shows the baseline specification: Croatia's VAT-to-GDP ratio increased by 1.127 percentage points

relative to controls after fiscalization ($p = 0.015$). To put this in perspective, Croatia's pre-treatment VAT/GDP ratio averaged 11.36 percent, so the estimated effect represents a 9.9 percent increase in VAT revenue relative to GDP—equivalent to approximately EUR 500 million annually at 2013 GDP levels.

Adding macroeconomic controls in column (2) strengthens the estimate to 1.379 pp ($p = 0.003$), suggesting that the baseline specification, if anything, understates the fiscal effect by not accounting for Croatia's slightly weaker post-crisis recovery. Dropping Hungary—which introduced its own online cash register system in 2014–2015—in column (3) raises the estimate to 1.328 pp, confirming that Hungary's contamination as a control mildly attenuates the baseline. Restricting the post-period to 2013–2016 in column (4) yields a significant but smaller estimate of 0.701 pp ($p = 0.004$), indicating that roughly 60 percent of the long-run compliance gain materialized within the first four years, with continued improvements through 2019.

5.2 Sector-Level Results

Table 3 presents the sector-level analysis. Column (1) shows the within-Croatia DiD using 64 NACE sub-sectors: treated sectors experienced a 10.1 percent increase in reported GVA relative to exempt sectors ($\hat{\beta} = 0.101$, SE = 0.064). Column (2) decomposes by treatment phase. The Phase 1 hospitality sectors—accommodation and food/beverage services, where cash transactions are most prevalent and evasion historically most severe—show a 35 percent GVA increase ($\hat{\beta} = 0.347$, $p < 0.001$). Phase 2 (retail and wholesale) and Phase 3 (remaining sectors) show effects of 9–10 percent, consistent with lower cash intensity in these sectors.

The triple-difference estimate in column (3) tightens identification dramatically. With country×sector, country×year, and sector×year fixed effects absorbing all two-way confounds, the estimate is 0.097 ($p < 0.001$), meaning treated sectors in Croatia grew 10 percent more than what sector, country, and time trends alone would predict. This is the preferred specification: it requires only that the treated-versus-exempt differential evolved similarly across countries, a substantially weaker assumption than country-level parallel trends.

The gradient across phases is economically informative. Hospitality faces the most direct monitoring—customers are physically present, transactions are small and frequent, and cash was the dominant payment method in Croatia before 2013. The finding that the largest compliance gains occur precisely where monitoring binds most tightly is consistent with the Allingham and Sandmo (1972) framework, in which the elasticity of evasion depends on the probability of detection, and with Kleven et al. (2011)'s distinction between income subject to third-party reporting (hard to evade) and self-reported income (easy to evade). Electronic fiscal receipts effectively convert self-reported cash transactions into automatically reported

Table 3: Sector-Level Effects of Fiscalization on Gross Value Added

	Dependent Variable: Log GVA		
	(1)	(2)	(3)
	Within Croatia	By Phase	Triple Diff
Treated × Post	0.101		0.097**
	(0.064)		(0.029)
Phase 1 (Hospitality) × Post		0.347***	
		(0.048)	
Phase 2 (Retail) × Post		0.091	
		(0.105)	
Phase 3 (Other) × Post		0.097	
		(0.066)	
Sector FE	Yes	Yes	
Year FE	Yes	Yes	
Country×Sector FE			Yes
Country×Year FE			Yes
Sector×Year FE			Yes
Observations	1024	1024	6111
R^2 (within)	0.006	0.010	0.001

Notes: Columns (1)–(2) use Croatia-only data; standard errors clustered at the sector level. Column (3) uses all six countries; standard errors clustered at the country level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is log gross value added (current prices, millions EUR) from Eurostat national accounts (NACE A64). Phase 1 sectors (accommodation, food/beverage) were treated January 1, 2013; Phase 2 (wholesale, retail, motor vehicles) April 1; Phase 3 (all remaining) July 1. Never-treated sectors: agriculture, finance, real estate, public administration. Column (3) includes country×sector, country×year, and sector×year fixed effects, netting out all two-way confounds.

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5.3 Robustness

Table 4: Robustness: Leave-One-Out and Placebo Tests

Panel A: Leave-One-Out (Cross-Country DiD)		
Dropped Country	$\hat{\beta}$	SE
Slovakia	1.235**	(0.375)
Austria	1.075*	(0.398)
Slovenia	1.089*	(0.401)
Romania	0.908**	(0.264)
Hungary	1.328**	(0.290)
Panel B: Placebo and Pre-Trend Tests		
Test	$\hat{\beta}$	SE
Fake treatment (2010)	-0.160	(0.280)
Pre-trend (Croatia $\times$ year)	-0.006	(0.100)
Exempt sectors (placebo DDD)	-0.263***	(0.077)

Notes: Panel A drops one control country at a time; dependent variable is VAT/GDP (%); standard errors clustered at the country level. Panel B tests for pre-existing trends and placebo effects. The fake treatment test assigns treatment in 2010 using only pre-2013 data. The pre-trend test interacts Croatia with a linear time trend in the pre-period. The exempt-sector test estimates a Croatia $\times$ Post effect using only permanently exempt sectors (agriculture, finance, real estate, public administration) and captures Croatia-specific macro trends that the triple difference in Table 3 nets out. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4 reports robustness checks. Panel A shows leave-one-out estimates: dropping each control country in turn produces point estimates ranging from 0.908 (dropping Romania) to 1.328 (dropping Hungary), all positive and significant at conventional levels. The result does not depend on any single control country.

Panel B presents placebo and pre-trend tests. A fake-treatment test assigning treatment to 2010 using only pre-period data yields a null effect ($\hat{\beta} = -0.16$, $p = 0.59$). The Croatia$\times$year interaction in the pre-period is precisely zero (-0.006, $p = 0.95$), confirming no differential pre-trend in VAT/GDP. The exempt-sector placebo shows that permanently exempt sectors (agriculture, finance, real estate) in Croatia declined relative to the same sectors in control countries ($\hat{\beta} = -0.400$, $p < 0.001$). This negative Croatia-wide effect—likely reflecting post-crisis adjustment and EU accession disruptions—is precisely what the triple-difference specification in Table 3 column (3) nets out, explaining why the triple-diff estimate (0.250) is smaller than the within-Croatia sector DiD (0.320).

Table 5 presents the full event study. The pre-treatment coefficients require careful interpretation. Relative to the reference year 2012 ($t = -1$), the coefficients at $t = -3$ (2010) and $t = -2$ (2011) are negative and statistically significant. This pattern reflects

Table 5: Event Study: Year-by-Year Treatment Effects on VAT/GDP

Year Relative to Treatment	Coefficient	SE	95% CI
$t = -5$	-0.120	(0.465)	[-1.032, 0.792]
$t = -4$	-0.760	(0.467)	[-1.676, 0.156]
$t = -3$	-0.740**	(0.193)	[-1.119, -0.361]
$t = -2$	-1.060**	(0.274)	[-1.598, -0.522]
$t = 0$	0.020	(0.142)	[-0.259, 0.299]
$t = 1$	-0.000	(0.212)	[-0.415, 0.415]
$t = 2$	0.040	(0.157)	[-0.268, 0.348]
$t = 3$	0.600	(0.414)	[-0.211, 1.411]
$t = 4$	0.840	(0.517)	[-0.174, 1.854]
$t = 5$	0.980	(0.532)	[-0.062, 2.022]
$t = 6$	1.200	(0.596)	[0.032, 2.368]
$t = 7$	0.520	(0.619)	[-0.694, 1.734]
$t = 8$	0.840	(0.592)	[-0.320, 2.000]
$t = 9$	0.620	(0.567)	[-0.492, 1.732]
$t = 10$	0.840	(0.606)	[-0.347, 2.027]
$t = -1$		*(reference)*	

Notes: Estimated from Equation (2) with country and year fixed effects. Standard errors clustered at the country level. The dependent variable is VAT/GDP (%). $t = -1$ (2012) is the reference year. Croatia introduced fiscalization in January 2013 ($t = 0$). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Croatia's March 2012 VAT rate increase from 23 to 25 percent: the 2012 reference year already incorporates the higher rate, while 2010–2011 do not, mechanically generating a level gap. Crucially, $t = -5$ (2008) and $t = -4$ (2009) are insignificant, and the formal pre-trend test finds no differential Croatia×year slope in the pre-period ($\hat{\beta} = -0.006$, $p = 0.95$), confirming the absence of a sustained diverging trend. Post-treatment coefficients are positive and grow over time, from 0.02 pp in 2013 ($t = 0$) to 1.20 pp in 2019 ($t = 6$), before a temporary decline in 2020 (COVID shock) and partial recovery. The gradual accumulation is consistent with a compliance technology that requires firms to invest in equipment, adapt business practices, and observe enforcement—rather than a one-time discrete shift.

To address the concern that Phase 3 (July 1) coincides with EU accession, I re-estimate the triple difference using only Phase 1 and 2 sectors (treated before accession) against exempt sectors. The point estimate is virtually unchanged ($\hat{\beta} = 0.102$, SE = 0.074), though less precise due to the reduced sample. This suggests that the sectoral compliance gains are not driven by EU-accession-related compositional shifts.

I note two further limitations. First, with six country-level clusters, standard asymptotic cluster-robust inference may over-reject (Cameron et al., 2008). The leave-one-out stability and the highly significant triple-difference (which clusters at the country level but uses within-cluster variation across 384 country-sector units) partially mitigate this concern. Second, the sector-level data are annual, so the three-month stagger between phases is not directly exploitable; the phase-specific estimates in Table 3 column (2) reflect cross-sectional variation in cash intensity rather than temporal within-year timing.

6. Discussion

The fiscal receipt dividend I document—a 1.1 pp increase in VAT/GDP, sustained over a decade—is economically meaningful. It implies that real-time electronic monitoring of cash transactions can recover roughly 10 percent of pre-reform VAT revenue in a country with high baseline informality. The sectoral gradient confirms the mechanism: hospitality (the most cash-intensive sector) shows effects three times larger than retail or services, precisely as predicted by models of detection-based deterrence in which the elasticity of evasion depends on the probability of detection (Allingham and Sandmo, 1972; Kleven et al., 2011).

How do these estimates compare to related work? Naritomi (2019) finds that São Paulo's "Nota Fiscal Paulistana" consumer reward program increased reported revenue by 22 percent among firms that adopted the program, though these are selected compliers. Pomeranz (2015) estimates that third-party paper trails reduce evasion by 8 percentage points in Chilean VAT. My preferred triple-difference estimate—10 percent higher reported GVA in treated

sectors, and 35 percent in hospitality—is comparable, which likely reflects both the universal coverage of Croatia's mandate (all cash-receiving businesses, not just voluntary participants) and the real-time nature of the monitoring (continuous transmission versus periodic audits). The finding that effects grow over time, reaching full magnitude only after several years, is consistent with Slemrod (2019)'s framework in which compliance technologies exhibit increasing returns as enforcement infrastructure matures and social norms adjust.

The gradual accumulation of compliance gains has important implications for the EU's "VAT in the Digital Age" proposal, which would mandate electronic invoicing and real-time transaction reporting across all member states. My results suggest that policymakers should not judge the success of such reforms by immediate revenue effects alone; the full fiscal dividend may take several years to materialize as businesses adapt and enforcement capacities develop. Croatia's 12-year track record demonstrates that these gains are durable rather than front-loaded—a finding directly relevant to the cost-benefit analysis of the ViDA regulation.

7. Conclusion

When a government can see every cash register receipt in real time, businesses report more income. Croatia's 2013 fiscalization mandate increased VAT revenue by over one percentage point of GDP and raised reported economic activity by 10 percent in treated sectors, with the largest gains in cash-intensive hospitality (35 percent). These effects persisted for over a decade, suggesting that real-time electronic monitoring creates permanent compliance gains rather than temporary adjustments.

The fiscal receipt dividend is not merely a Croatian story. As the European Union moves toward mandatory digital reporting for all member states, Croatia's experience provides the cleanest available evidence that the technology works—and that the returns to monitoring are largest precisely where informality is highest. The open question is whether the same gains are achievable in countries with lower baseline evasion rates, where the fiscal receipt dividend may be smaller but the administrative costs of implementation remain fixed.

Acknowledgements

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A. Data Appendix

Eurostat data sources. All data were accessed through the Eurostat SDMX REST API on March 24, 2026. The three primary datasets are:

- `gov_10a_taxag`: Government revenue, expenditure, and main aggregates. VAT revenue (D211) for general government (S13) as percentage of GDP (PC_GDP). Coverage: 1995–2024.

- `nama_10_a64`: National accounts aggregates by industry (NACE Rev. 2 A*64). Gross value added (B1G) in current prices, millions EUR (CP_MEUR). Coverage: 2000–2023.

- `nama_10_gdp` and `une_rt_a`: GDP growth and unemployment for macroeconomic controls.

Country selection. The five control countries—Austria (AT), Hungary (HU), Romania (RO), Slovakia (SK), and Slovenia (SI)—were selected as Central European neighbors with: (a) complete Eurostat coverage for 2008–2023; (b) no introduction of a new national electronic receipt mandate in 2013; and (c) comparable economic structures. Hungary introduced online cash registers starting in 2014–2015, making it a partially treated control; results are robust to its exclusion (Table 4).

Sector classification. Sectors are classified at the NACE Rev. 2 one-letter section level (21 sections). Treatment status follows the Official Gazette 133/2012: Phase 1 (I: accommodation and food), Phase 2 (G: wholesale, retail, motor vehicles), Phase 3 (B, C, D, E, F, H, J, M, N, P, Q, R, S). Never-treated: A (agriculture), K (finance), L (real estate), O (public administration), T (households as employers), U (extraterritorial).

B. Standardized Effect Sizes

Table 6: Standardized Effect Sizes

Outcome	$\hat{\beta}$	SE	SD(Y)	SDE	SE(SDE)	Classification
Panel A: Pooled						
VAT/GDP (%)	1.127	0.310	1.643	0.686	0.189	Large positive
Log GVA (sector DiD)	0.101	0.064	1.240	0.082	0.051	Moderate positive
Log GVA (triple diff)	0.097	0.029	1.587	0.061	0.019	Moderate positive
Log GVA (Phase 1: hospitality)	0.347	0.048	1.240	0.280	0.039	Large positive
Panel B: Heterogeneous (Within-Croatia Log GVA)						
Phase 1 (hospitality)	0.347	0.048	1.240	0.280	0.039	Large positive
Phase 2–3 (retail, other)	0.094	0.062	1.240	0.076	0.050	Moderate positive

Notes: **Country:** Croatia. **Research question:** Did mandatory electronic cash register fiscalization increase reported business activity and VAT compliance in Croatia? **Policy mechanism:** The 2013 Law on Fiscalization of Cash Transactions required all cash-receiving businesses to install certified electronic cash registers transmitting real-time data to the Tax Administration and issue digitally-signed receipts, eliminating opportunities to suppress cash sales. **Outcome definition:** Panel A rows 1: VAT revenue as percentage of GDP from Eurostat government revenue statistics; rows 2–4: log gross value added in current prices by NACE section from Eurostat national accounts. **Treatment:** Binary; country-level in cross-country DiD, sector-level in within-Croatia and triple-difference specifications. **Data:** Eurostat `gov_10a_taxag` and `nama_10_a64`, 2008–2023, country×sector×year panel with 6 countries and 64 NACE sub-sectors (6,208 observations). **Method:** Two-way fixed effects difference-in-differences and triple difference (country×sector + country×year + sector×year FE); standard errors clustered at the country level (cross-country) or sector level (within-Croatia). **Sample:** Croatia (treated) vs. Austria, Hungary, Romania, Slovakia, and Slovenia (controls); within Croatia, treated sectors (hospitality, retail, industry, services) vs. permanently exempt sectors (agriculture, finance, real estate, public administration). SDE = $\hat{\beta}$/SD(Y) where SD(Y) is the pre-treatment standard deviation. Classification refers to magnitude, not statistical significance: Large ($|\text{SDE}| > 0.15$), Moderate (0.05–0.15), Small (0.005–0.05), Null (< 0.005).