Technology, Tax, and Domestic Trade: Evidence from Rwanda's Electronic Invoicing Expansion

QMUL Applied Micro Internal Seminar

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Digital technology informs enforcement and shapes firm-to-firm trade

Digital technology is spreading fast across firms in Africa (World Bank 2023)

- **State-firm:** Business visibility (Okunogbe & Tourek 2024), information for enforcement (Pomeranz 2015)
- **Firm-firm:** Complementarity in adoption (Buera et al. 2021), interfirm trade (Gadenne et al. 2022)

Today, a regulatory technology: e-invoicing

How does e-invoicing exposure affect firm formalization and domestic interfirm trade?

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Today, a regulatory technology: e-invoicing

How does e-invoicing exposure affect firm formalization and domestic interfirm trade?

African countries with **e-invoicing requirements**

We estimate the impacts of a reform which creates incentives for small firm e-invoicing adoption in Rwanda

We combine firm administrative microdata on the universe of formal transactions with a matched nationwide firm survey

- Measure both firm and sector-level supply chains

The reform we study uses income tax reporting requirements to generate demand for e-invoices among large firms

- Document substantial aggregate adoption of e-invoicing by small firms on reform implementation

We trace e-invoicing demand upstream through pre-existing supply chains and find:

1. ↗ small firm adoption of e-invoicing
2. ↗ formalization
3. ↗ self-reported measures of firm scale & third-party-reported formal connections

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Contribution to literature

Propagation of supply chain incentives for formalization (Gadenne et al. 2022, Garriga & Tortarolo 2024)

- **This paper:** Supply chain incentives (beyond the VAT), in at-scale policy reform context

Technology adoption by SMEs in developing countries (Verhoogen 2021, Manelici et al. 2023)

- **This paper:** Policy promotes firm-to-firm linkages and (self-reported) firm scale

Regulatory technology compliance (Okunogbe & Pouliquen 2022, Okunogbe & Tourek 2024) and formalization (de Andrade et al. 2016, Piza 2018)

- **This paper:** Supply chain generated incentives have a high impact compared to other formalization interventions

Context and Data

Firm taxation in Rwanda depends on firm scale

Corporate Income Tax (CIT) with an annual 20 M Rwf turnover threshold

- **Large firms** above threshold file CIT w/ expenses (i.e., a profit-tax regime)
- **Small firms** below threshold file turnover only: 'simplified' regime

Pre-reform:

- **Large firms** mandated to use e-invoicing for VAT
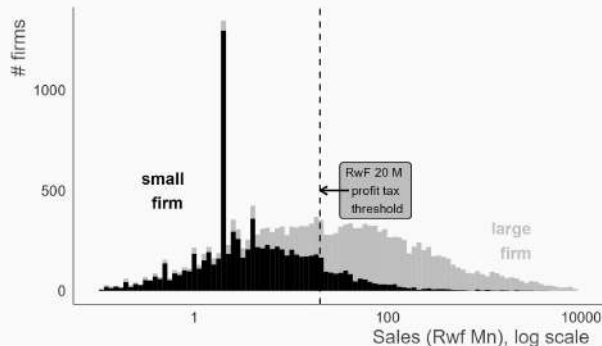- **Small firms** are not

Figure 1: The firm size distribution in Rwanda

A Regulatory Technology: EBM and E-invoicing

Electronic Billing Machines (EBMs) are teller systems that record digitally signed, itemized and time-stamped receipts

- Transmitted via internet to the Rwanda Revenue Authority (RRA)

Introduced in 2013 for large firms (Eissa et al. 2015)

- 2018-2021: Hardware EBM v1 replaced by software EBM v2, suite of mobile, tablet and 'plug-in' EBM released as EBM v2.1

Benefits include stock management & bookkeeping

Costs of operation comprise internet, electricity and a requisite digital platform

2020 reform increases the cost of 'informal' trade

In 2019, policy decrees *de jure* EBM use for all firms (small & large)

Beginning in 2021 ruling mandates *de-facto* EBM use for large firm expense validation (file profit-based CIT)

- *Expenses not supported by electronic invoices or customs declarations will not be supported as deductible expenses*
- Extends issuance requirements in the firm (i.e., to small firms) and product space (i.e., to non-VAT products)
- Minimum of 73% of input expenses supported by invoices

In 2023, RRA allows some validation requirements to be fulfilled via ledger (e.x., loss on asset disposal)

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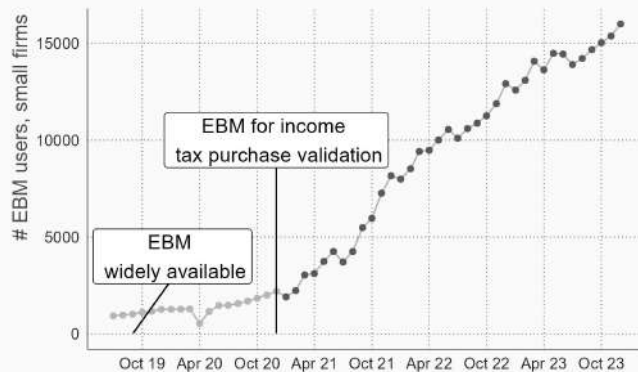# 5x more firms start issuing receipts over two years

Figure 2: EBM use among small firms

Microdata from the universe of formal firms in Rwanda

1. Annual Corporate Income Tax (CIT) declarations (2017-2023)
   - Sales and taxes declared for all firms
   - Expenses for large firms (by category $+$ imports)

2. EBM transaction data (2017-2023)
   - Seller & buyer identified by (anonymized) taxpayer identification number

3. Domestic production network, observed prior to EBM expansion
   - **Sectoral:** 2017 sectoral input-output tables from NISR
   - **Firm:** Pre-adoption value-added purchases annex

4. We conduct a matched survey of 1k firms in April 2023
   - Stratified by predicted receipt requests and baseline formality
   - Realized costs and perceived benefits of EBM use
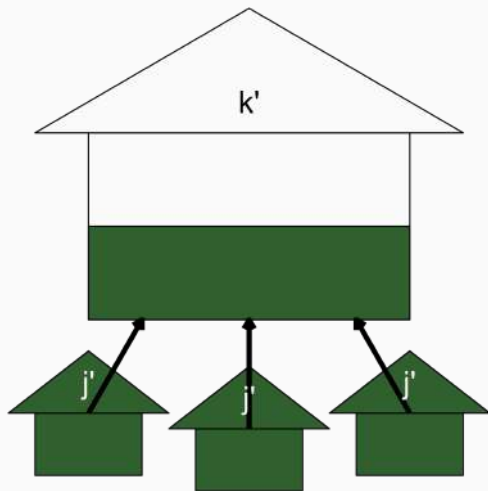
Empirical Strategy

Policy generates heterogeneous demand for receipts across suppliers
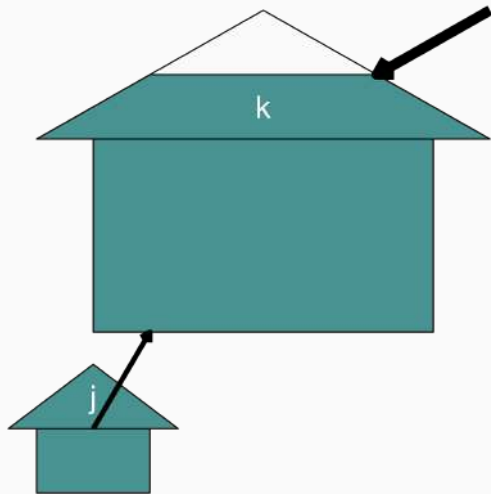
Large firm k may already have many receipts at baseline, such that demand for receipts is low

- Demand transmitted to small firm j is low

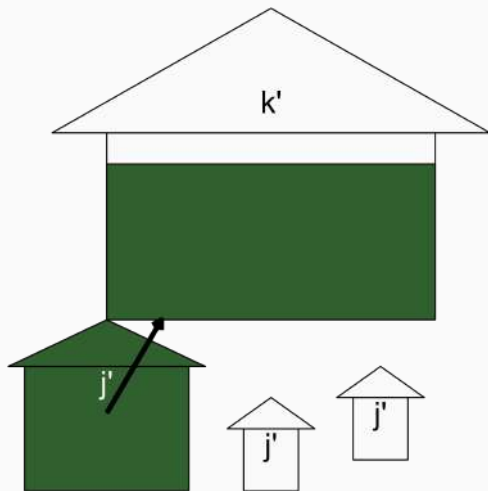# Policy generates heterogeneous demand for receipts across suppliers

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Large firm k' may have few receipts at baseline, such that demand for receipts is high

- Absent a receipt, firm k' cannot deduct the expense from income tax sales

- Demand for receipts among firms j' is high

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Adopting firm j' can gain additional demand by issuing receipts

Theory motivates a shift-share-like empirical design

Measure receipt demand using
pre-reform *unvalidated expenses*

- Valid expenses are those
  supported by EBM or import
  declarations
- Total expenses are those declared
  in Corporate Income Tax (CIT)
  filings

Measure firm-firm connections using
pre-reform VAT annexes and sectoral
input-output tables

Summed over all downstream buyers k

$$\text{exposure}_j$$

$$= \sum_k j\text{'s sale share to } k \times k\text{'s receipt demand}$$

$$= \sum_k \underbrace{\frac{x_{jk,t<2020}^{\text{VAT}}}{\sum_k x_{jk,t<2020}^{\text{VAT}}}}_{\text{domestic trade data}} \times \underbrace{\left(1 - \frac{\sum_j x_{jk,t=2020}^{\text{EBM}} + x_{k,t=2020}^{\text{Import}}}{x_{k,t=2020}^{\text{CIT}}} \right)}_{\text{administrative data on expenses}}$$

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Event study compares changes in firms facing high vs low receipt demand

$$y_{jt} = \alpha_j + \gamma_{l(j)t} + \gamma_{o(j)t} + \delta_{v(j)t} + \sum_{t=2017, t \neq 2020}^{2022} \beta_t \text{exposure}_j + \epsilon_{jt}$$

- Outcome y_{jt} for firm j in year t
- FE for firm (α_j), district-year ($\gamma_{l(j)t}$), sector-year ($\gamma_{o(j)t}$) and baseline VAT-year ($\delta_{v(j)t}$)
- 2020 is our reference period
  - The year prior to validation requirement by large firms
- **Identification assumption:** Firm j's sale share to firms of type k or k' is uncorrelated with unobserved factors affecting y_{jt}, conditional on FE
  - i.e., identification from exogeneity of shares (Goldsmith-Pinkham et al. 2020)

(► Firm and sector samples)

Our estimates of the policy's causal impact is unbiased if our *j*'s sale shares are independent of unobserved factors affecting y_{jt}

Three tests of these assumptions (Goldsmith-Pinkham et al. 2020)

1. **Generic shares:** buyer k shares across sellers j often unpredictive of seller j characteristics
   (▸ share correlates)

2. **Heterogeneity:** confirm distribution of β_k reflects the β point estimate (▸ Rottemburg Weights)

3. **Balance + pretrends:** baseline firm characteristics broadly uncorrelated with measure of receipt demand
   (▸ balance)

Results

Firms faced with (more) receipt demand are more likely to use EBM

Between 2021 and 2023, 15,000 firms begin issuing receipts

We explain 7-13% of aggregate increase **firm** and **sector** samples

- EBM use increases 3-10 pp (13-25%) at average exposure

(▸ Adoption means)   (▸ First-stage table)

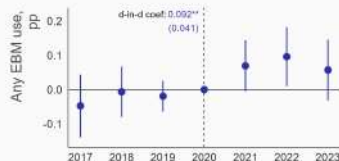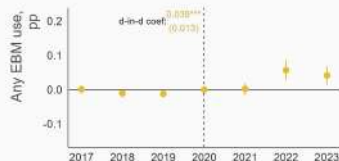Exposure shifts firms to issue EBM to firm clients, not consumers   (▸ EBM to whom?)

Figure 3: sector and firm EBM use impacts

More exposed firms formalize

Probability of reporting positive tax liability
increases 3-4pp (6-22%)

- Large effects relative to formalization
  interventions   (▸ Compliance means)

Demonstrates potential of demand-side
incentives (Naritomi 2019, Garriga &
Tortarolo 2024)   (▸ mechanisms)

- Formalization impacts attenuate on
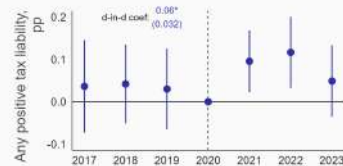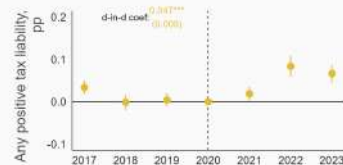 incentive loosening   (▸ 2023 impacts)

Figure 4: sector and firm formalization
impacts

Exposed firms report more sales

Exposed firms report 5-10% more taxable sales following the reform

Many small firms do not report costs in the simplified regime

- Adopters may face higher costs on demands from large clients
- Potential bound on (unobserved) profit impacts for small firms: among surveyed firms, exposed firms report more suppliers (▸ Firm survey measures)
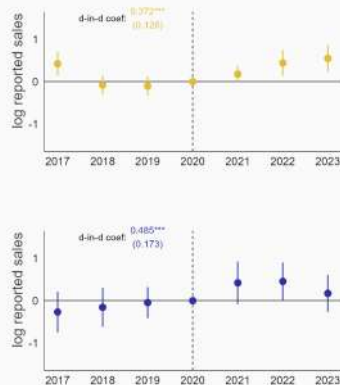

Figure 5: sector and firm scale impacts

These firms develop more formalized supply chains

More exposed suppliers develop more connections to large clients

- At median exposure, suppliers gain 1.1 to 1.2 new buyers
- Extensive margin buyer relationships account for a meaningful proportion of the variation in sales (Huneeus 2020)

Consistent with qualitative evidence from survey

- Absent a receipt, the majority of firms fear losing a client (transaction)
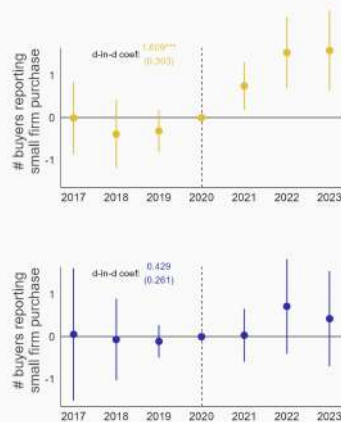
(▸ Results table)

Figure 6: sector and **firm** supply chain impacts

We find that exposure to e-invoicing demand increases formalization of formal trade with small firms

A reform in which small firm EBM adoption incentives are created by large firm expense validation requirements causes:

- EBM use among small firms increases between 13 and 25%, meaningful proportion of aggregate adoption
- Small firms formalize, declare tax liabilities
- Report more sales, formalize supply chains

Ahead: How do we trade off costs and benefits across firms?

- Survey data to measure costs on small firms
- Model allows us to aggregate impacts across adopting and non-adopting small firms

Thank you for listening!

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de Andrade, G. H., Bruhn, M., & McKenzie, D. (2016). A helping hand or the long arm of the law? Experimental evidence on what governments can do to formalize firms. *World Bank Economic Review*.

Eissa, N., Zeitlin, A., Karpe, S., & Murray, S. (2015). Incidence and Impact of Electronic Billing Machines for VAT in Rwanda. *International Growth Centre*, (pp. 1–16).

Gadenne, L., Nandi, T. K., & Rathelot, R. (2022). Taxation and Supplier Networks: Evidence from India. *SSRN*.

Garriga, P. & Tortarolo, D. (2024). Firms as tax collectors. *Journal of Public Economics*.

Goldsmith-Pinkham, P., Sorkin, I., & Swift, H. (2020). Bartik instruments: What, when, why, and how. *American Economic Review*.

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Naritomi, J. (2019). Consumers as tax auditors†. *American Economic Review*.

Okunogbe, O. & Pouliquen, V. (2022). Technology, Taxation, and Corruption: Evidence from the Introduction of Electronic Tax Filing. *American Economic Journal: Economic Policy*, 14(1), 341–372.

Okunogbe, O. & Tourek, G. (2024). How Can Lower-Income Countries Collect More Taxes? The Role of Technology, Tax Agents, and Politics. *Journal of Economic Perspectives*, 38(1), 81–106.

Piza, C. (2018). Out of the Shadows? Revisiting the impact of the Brazilian SIMPLES program on firms' formalization rates. *Journal of Development Economics*.

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Potential survey/mechanisms section

We interpret formalization impacts as arising from a thickening of the paper trail

We show that exposure jointly shifts EBM use and formalization

- EBM adoption creates a digital paper trail on firm activities
- For *small, non-VAT* firms declaring income tax rather than large VAT firms (Pomeranz 2015)

‣ EBM and compliance

In particular, large firm demand increases the cost of informality relative to the cost of the paper trail

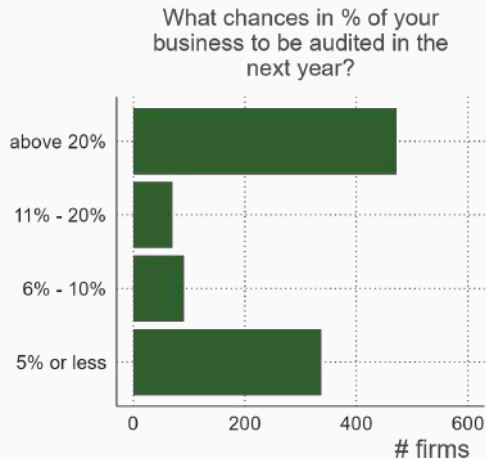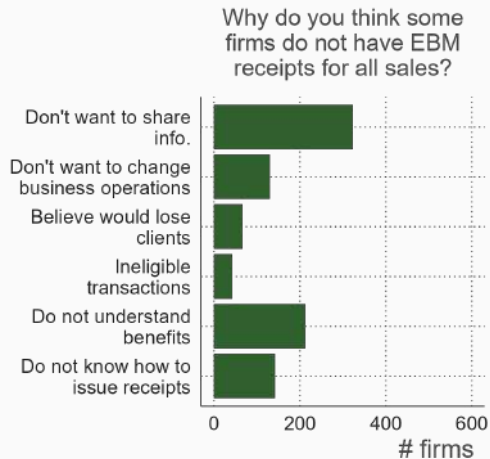- 1/3 of firms avoid using EBM to minimize information sharing with RRA

‣ barriers to EBM use

We infer that exposure shifts costs for firms from whom audits are less salient

‣ audit and adoption

‣ Event study results

Many reasons for non-compliance, despite high perception of audit risk

Exposed firms have more suppliers

1. Ask firms in changes over last 2 years (e.x., *how have your input prices changes in the last two years?*)

2. Estimate a first difference specification with survey responses in changes:

$$\Delta y_i = \beta z_l + X'_{i0}\gamma + \epsilon_i$$

	Dependent variable:							
	More clients		More suppliers		Higher input prices		Higher output prices	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sector exposure	−0.098	−0.067	0.178**	0.139	0.028	0.037	−0.021	−0.002
	(0.102)	(0.112)	(0.091)	(0.102)	(0.067)	(0.081)	(0.108)	(0.117)
Controls		X		X		X		X
# obs.	654	654	667	667	697	697	685	685

cost moments for back of envelopes

Table 1: Cost moments for EBM use

	Cost of EBM adoption				
	Printer	Device	Electricity	Airtime	Maintenance
survey mean	175886.96	298643.44	1054.91	2286.38	0.73
unit	monthly	one-off	monthly	monthly	annual
factor	12.00	0.25	12.00	12.00	125000.00
total	2110643.48	74660.86	12658.91	27436.56	91541.82

complementary infrastructure important

	(1)	(2)	books acc. (3)	internet (4)	laptop. conf. (5)	smrt. conf. (6)	costs (7)
				Dependent Variable: Any EBM Use			
Post x Exposure	0.029**	0.056	0.126	−0.212*	0.191	−0.125	0.164**
	(0.013)	(0.081)	(0.110)	(0.125)	(0.169)	(0.227)	(0.079)
Var x Post			0.150**	0.097	0.095	−0.079	0.252***
			(0.060)	(0.067)	(0.081)	(0.112)	(0.053)
Var x Exposure x Post			−0.132	0.268**	−0.166	0.202	−0.141
			(0.125)	(0.136)	(0.174)	(0.227)	(0.116)
Surveyed firms only		X	X	X	X	X	X
# obs.	437,228	5,691	5,355	5,355	5,691	5,691	5,558

exposure and audit risk substitutable?

| | | | Dependent Variable: Any EBM Use | | |
| | | | audit imp. | acc. imp | info imp. |
	(1)	(2)	(3)	(4)	(5)
Post x Exposure	0.029**	0.056	0.240*	0.059	0.054
	(0.013)	(0.081)	(0.124)	(0.104)	(0.155)
Var x Post			0.136*	0.190***	0.019
			(0.071)	(0.053)	(0.087)
Var x Exposure x Post			−0.253*	−0.020	0.008
			(0.152)	(0.126)	(0.183)
Surveyed firms only		X	X	X	X
# obs.	437,228	5,691	5,558	5,558	5,558

Exposed firms gain formal firm clients, not consumers
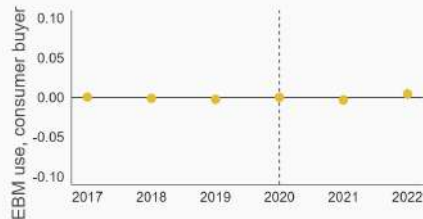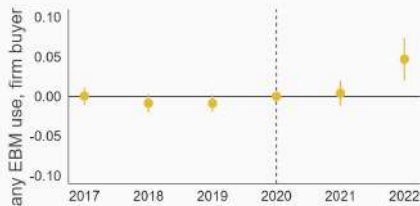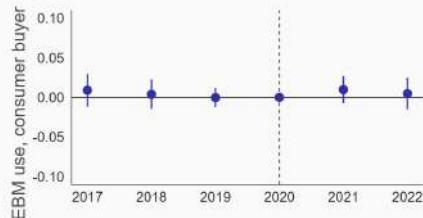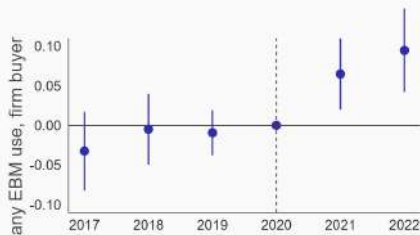
acceleration or catch-up?

Exposure promotes adoption. Of firms who would have adopted anyway, faster? Of firms who would not have adopted? i.e., is the impact of exposure larger for firms will smaller predicted adoption $X_j'\hat{\beta}$?

1. estimate $\hat{\beta}$ for each firm by regressing pre-period adoption y_{jo} on X_j

   - $X_j \in$
     {baseline VAT, any employment, any EBM purchase, any positive declaration}
   - $y_{jo} = X_j\hat{\beta} + \epsilon_j$

2. use $\hat{\beta}$ to predict post-period adoption for each firm $X_j'\hat{\beta}$

3. Estimate main specification for high and low values of $X_j'\hat{\beta}$

# Firms with high predicted baseline adoption are more likely to adopt

Model:		Any use		
	(1)	(2)	(3)	(4)
Variables				
$z_j \times$ post	0.009	0.09**		
	(0.01)	(0.04)		
post $\times$ Above median predicted adoption	0.50***	0.54***	0.54***	0.51***
	(0.05)	(0.07)	(0.06)	(0.03)
$z_j \times$ post $\times$ Above median predicted adoption	0.12***	-0.06		
	(0.04)	(0.08)		
$z_o \times$ post			-0.005	0.03*
			(0.01)	(0.02)
$z_o \times$ post $\times$ Above median predicted adoption			0.22**	0.15***
			(0.10)	(0.04)
Fit statistics				
# obs.	16,308	7,950	336,150	167,844
sample	All firms	Test	All firms	Test

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

(◄ Event study results)

Appendix

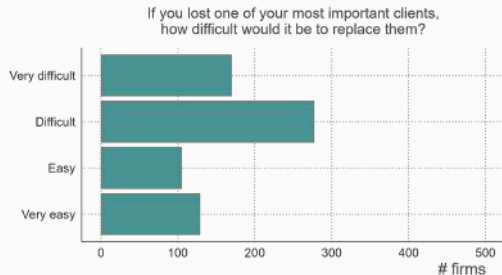# Large firms: Share of declared purchases with receipts increases 13 pp pre to post reform

EBM purchases and imports
_____
Income tax purchases
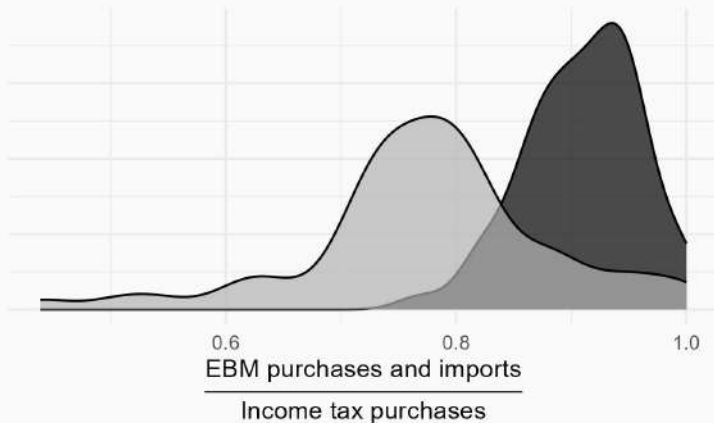
Caveat: EBM requirement imposes costs along the supply chain

$$y_{kt} = \alpha_k + \mu_t + \sum_{t=2017}^{2022} \beta_t \text{receipt demand}_{k,2020} + \epsilon_{kt}$$
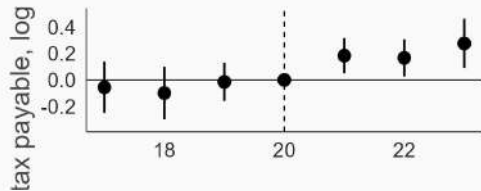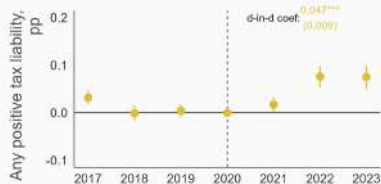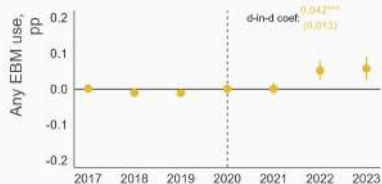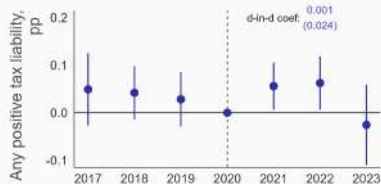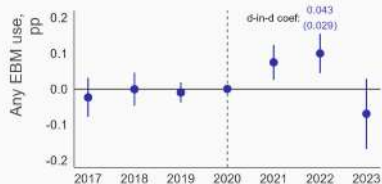

- **Large firms:** expenses without receipts increase tax liability

If you lost one of your most important clients, how difficult would it be to replace them?

- **Small firms:** costly to replace clients who need receipts

Do incentives wane in 2023?

Established versus new trading relationships? New links require signals? More information in pre-existing trading partnerships? (Hjort et al. 2020)

▸ Event study results

Small firms in the VAT annex

- VAT annexes are a rich source of data on firm-to-firm transactions
  - The purchases annex also identifies several thousand non-VAT purchases

- Before 2017, this includes sales by non-VAT firms
  - After 2017, validation using EBM sales imposed VAT to VAT trade only in the purchase annex
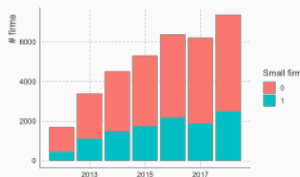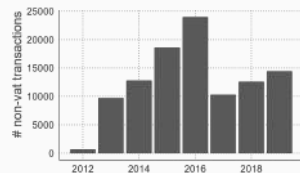
(◄ Instrument construction)

alternative suppliers for products often supplied by small firms

Number of within-district product suppliers

◀ Instrument construction
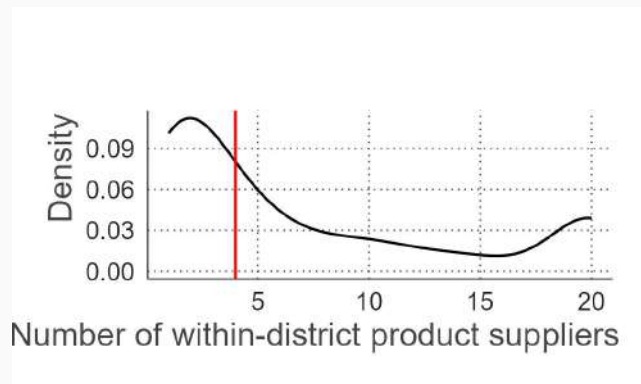
Impact estimates on large firms suggest significant costs

Using Poisson pseudo maximum likelihood (PPML), estimate:

$$y_{kt} = \alpha_k + \mu_t + \sum_{t=2017, t \neq 2020}^{2022} \beta_t \left(1 - \text{Validation share}_{k,2020}\right) + \epsilon_{kt}$$

- declared turnover falls markedly in response to the policy
- given insufficient supply of validated receipts, tax increases

  $\rightarrow$3 policy cost on large firms

- balance sheet variables are unchanged: responses likely reporting rather than real
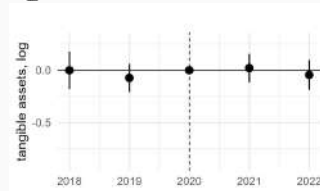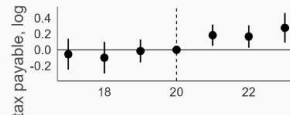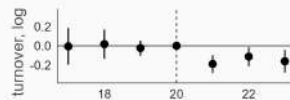
Adoption outcomes

- Point estimates suggest that exposure to electronic invoicing exposure is associated with an increase in adoption of approximately 13-25% relative to the baseline

	Any adoption		Any use	
Model:	(1)	(2)	(3)	(4)
Variables				
exposure$_o$ × post	0.03***		0.03***	
	(0.01)		(0.01)	
exposure$_j$ × post		0.08***		0.10***
		(0.02)		(0.03)
Fit statistics				
# obs.	336,150	16,308	336,150	16,308
# clu.	56	2,718	56	2,718
baseline dep. var.	0.09	0.28	0.06	0.14
exposure mean	0.34	0.25	0.34	0.25
firm FE		X		X
district-year FE	X	X	X	X
sector FE	X		X	

Clustered (loc_sec) standard-errors in parentheses
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Adoption means

Sector
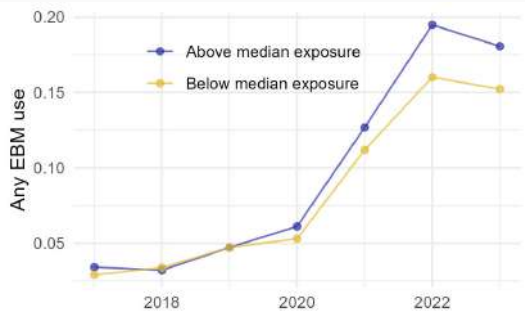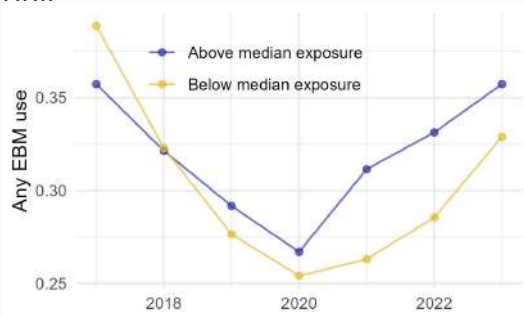
Firm

Formalization means

Sector
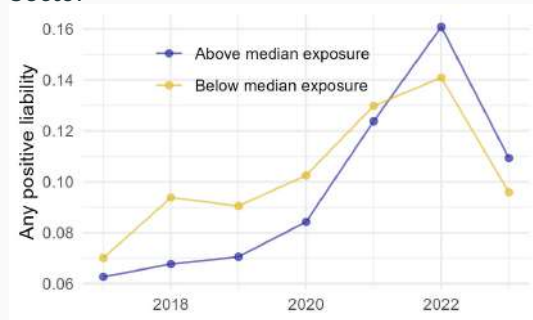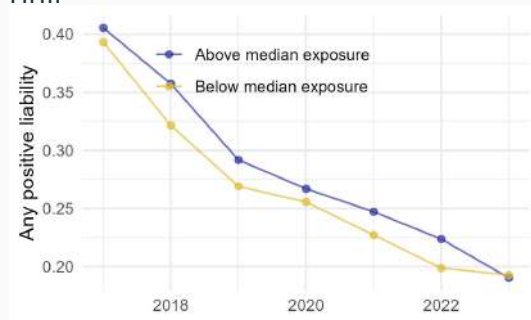
Firm

Purchase shares of top buyers over suppliers mostly uncorrelated with small firm characteristics

Dependent variable	Firm 1	Firm 2	Firm 3	Firm 4	Firm 5
Turnover	0.000	-0.012	-0.002	-0.006	-0.005
	(0.000)	(0.040)	(0.006)	(0.013)	(0.008)
EBM purchases	-0.000	0.001***	0.000*	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Any EBM buyer	0.031	0.253	-0.002	0.268	0.098
	(0.058)	(0.143)	(0.117)	(0.288)	(0.174)
Age	0.006	-0.008	0.001	-0.061	-0.011
	(0.004)	(0.016)	(0.011)	(0.066)	(0.022)
Kigali	0.109	0.120	0.183	0.341	0.223
	(0.100)	(0.302)	(0.412)	(0.728)	(0.243)
VAT taxpayer	0.008	0.127	0.018	0.281	0.114
	(0.059)	(0.141)	(0.120)	(0.291)	(0.176)
firms	78	50	49	45	44

‹ Instrument construction

Estimates for each buying firm k distributed around aggregate estimate
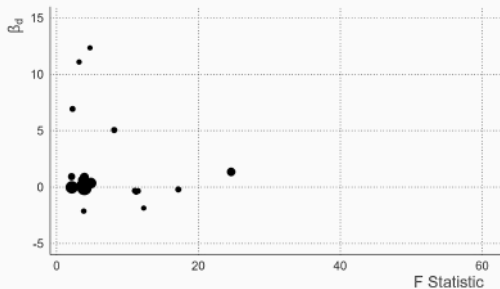
Industry-level instrument
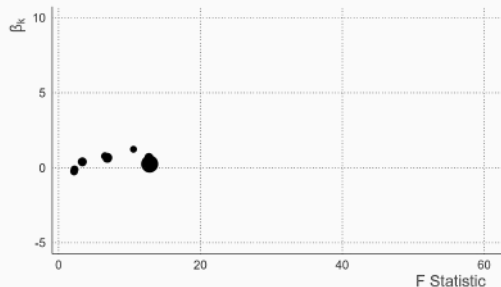
Firm instrument

Assert exogeneity conditional on covariate imbalances

|						
	Dependent variable:					
	Exposure					
	(1)	(2)	(3)	(4)	(5)	(6)
Turnover	1.247	0.192	−0.009	1.247	1.455	1.000
	(0.084)	(0.426)	(0.430)	(0.084)	(2.002)	(2.704)
	[0.000]	[0.654]	[0.984]	[0.000]	[0.468]	[0.712]
Purchases from EBM	2.258	−0.754	−1.067	2.258	−20.483	−16.704
	(0.084)	(1.235)	(1.107)	(0.084)	(9.621)	(9.728)
	[0.000]	[0.542]	[0.336]	[0.000]	[0.034]	[0.086]
EBM buyer	0.162	−0.068	−0.084	0.162	0.079	0.059
	(0.084)	(0.025)	(0.025)	(0.084)	(0.043)	(0.046)
	[0.056]	[0.007]	[0.001]	[0.056]	[0.065]	[0.201]
Firm age (years)	2.439	−0.638	−0.759	2.439	1.510	0.872
	(0.104)	(0.393)	(0.379)	(0.104)	(0.616)	(0.646)
	[0.000]	[0.106]	[0.046]	[0.000]	[0.015]	[0.178]
Kigali	0.680	0.213	−0.000	0.680	−0.115	−0.000
	(0.084)	(0.078)	(0.000)	(0.084)	(0.041)	(0.000)
	[0.000]	[0.007]	[1.000]	[0.000]	[0.005]	[1.000]
VAT registered	0.123	0.042	0.020	0.123	−0.009	−0.019
	(0.084)	(0.043)	(0.040)	(0.084)	(0.037)	(0.039)
	[0.147]	[0.335]	[0.617]	[0.147]	[0.804]	[0.637]
Retail	0.017	−0.017	−0.022	0.017	−0.076	−0.061
	(0.084)	(0.018)	(0.020)	(0.084)	(0.074)	(0.066)
	[0.842]	[0.333]	[0.277]	[0.842]	[0.303]	[0.353]
Sub-District FE			X			X
# firms	49,518	49,518	49,518	1,842	1,842	1,842
# clusters		56	56		1,842	1,842
Omnibus F		4.454	3.703		4.454	1.731
		[0.000]	[0.000]		[0.000]	[0.103]

- Columns 1 & 4 display means, 2-3 and 5-6, differences

- Balance improved on inclusion of sub-district FE
  - motivates inclusion in main specification

◀ Instrument construction

Exposure shifts adoption and compliance incentives in the same direction

- Estimate interacted outcomes:
  $y_{jt} = \text{adoption}_{jt} \times \text{compliance}_{jt}$
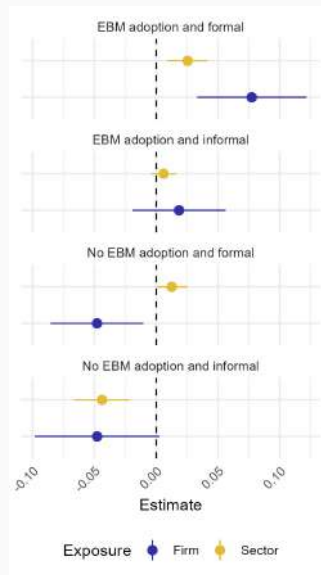
We measure exposure using both firm and sector domestic supply chains

	'Shift' + 'share'				
	Receipt demand	Trade shares	# firms	# clusters	considerations
Firm, j	CIT + EBM + Customs	VAT annex	$\approx$ 1.5 k	$\approx$ 1.5 k	no entry
Sector, $o(j)$	CIT + EBM + Customs	IO table	$\approx$ 50 k	$\approx$ 50	natn'l stats data

Downstream outcomes

Model:	Any tax liab.		Any formal empl.		# large buyers	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	Poisson	Poisson
Variables						
post $\times$ exposure$_o$	0.05***		0.003		1.1***	
	(0.01)		(0.007)		(0.32)	
post $\times$ exposure$_j$		0.05*		0.04**		0.36
		(0.03)		(0.02)		(0.24)
Fit statistics						
# obs.	297,108	11,052	297,108	11,052	259,771	3,467
# clu.	56	1,842	56	1,842	54	626
baseline dep. var.	0.19	0.43	0.08	0.18	0.28	3.9
exposure mean	0.34	0.25	0.34	0.25	0.34	0.25
firm FE		X		X		X
sector FE	X		X		X	
sub-District-year FE	X	X	X	X	X	X

Clustered (loc_sec) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Model

Model of trade between small and large firms (Gadenne et al. 2022)

- Large firm k
    - Buys from small firms
    - Sells to final consumers
- Demand function:

$$q_{kF} = Q_F \Big(\frac{P_F}{p_{kF}}\Big)^{\sigma}$$

- Final demand Q_F, Price index P_F, $\sigma > 1$
- Optimal price:

$$p_{kF} = \frac{P_k}{(1-\tau)z_k}\frac{\sigma}{\sigma-1}$$

- Tax rate τ, productivity z_k
- Cost index $P_k = (\sum_j p_{jk}^{1-\rho})^{\frac{1}{1-\rho}}$, $\rho > \sigma$

- Small firm j
    - Uses labor
    - Sells to large firms
- Demand from client k:

$$q_{jk} = \frac{q_{kF}}{z_k}\Big(\frac{P_k}{p_{jk}}\Big)^{\rho}$$

- Optimal price for client k:

$$p_{jk} = c_j\frac{\rho}{\rho-1}$$

- Marginal cost $c_j = \frac{W}{z_j}$, wage W

We introduce electronic invoicing in supply chains

- Reform increases relative cost of transactions with receipts

$$p_{jk} = c_j \frac{\rho}{\rho - 1} \omega_{jk}$$

$$\omega_{jk} = \begin{cases} (1 + \delta) > 1 & j \text{ invoices to } k \\ 1 & \text{otherwise} \end{cases}$$

- $\omega = $ *compliance cost* of adoption

- Reform reduces relative demand of transactions *without* receipts

$$q_{jk} = \frac{q_{kF}}{z_k} \left(\frac{P_k}{p_{jk}/\gamma_{jk}} \right)^{\rho}$$

$$\gamma_{jk} = \begin{cases} 1 & j \text{ invoices to } k \\ (1 - \tau) < 1 & \text{otherwise} \end{cases}$$

- $\gamma = $ *demand loss* from non-adoption

Firms trade off compliance cost and demand loss

- Approximate difference in profits from adopting EBM after the reform:

$$\Delta\Pi_j = \hat{\Pi}_j \times \left[1 + (\rho - \sigma)\tau \sum_k (1 - s_{Ek})\lambda_{jk}\right] \times \left[\rho\tau - (\rho - 1)\delta\right]$$

- $\hat{\Pi}_j$ are profits before the reform
- $\rho\tau - (\rho - 1)\delta$ is the net benefit of adoption
    - Firms adopt if demand loss τ is large relative to compliance cost δ
- $(1 - s_{Ek}) = \frac{\sum_{j \in N} x_{jk}}{\sum_j x_{jk}}$ is k's share of unvalidated expenses
    - Captures receipt demand of k
- $\lambda_{jk} = \frac{x_{jk}}{\sum_k x_{jk}}$ is the share of j's sales going to k
    - Captures importance of k to j