**Do Taxes Hold Back Technology and Innovation? Evidence From Firms In Emerging Economies**


## Abstract

With rapid technological advancement and digitalization, how the tax environment shapes firms' technology adoption remains largely unaddressed. Using three waves of the World Bank Enterprise Surveys for India, Pakistan, and Vietnam over 36,000 firm-year observations, we relate two measures of perceived tax burden, tax rates and tax administration, to two adoption outcomes: whether a firm maintains a website or social media presence, and whether it uses foreign-licensed technology. Same-period regressions show both tax measures positively associated with website adoption, the opposite of what a simple compliance-cost story predicts. Once we replace contemporaneous tax burden with its lagged value, the tax-administration coefficient flips negative, consistent with a reverse mechanism: firms that adopt digital tools become more visible to tax authorities and subsequently report a heavier burden, rather than tax burden discouraging adoption. Firm fixed-effects and India-exclusion checks confirm the pattern is not an artifact of cross-firm heterogeneity or the sample's large Indian share. The results point to a formalization channel linking digitalization and taxation that has been under-examined in the technology-adoption literature, and set up some extensions for the full paper.


## 1. Research Question

Firms in developing economies adopt digital and foreign-sourced technology at markedly different rates, and taxation is one of the most frequently cited business-environment obstacles in these same economies (Mohammed & Bunyaminu, 2021). The standard prior is straightforward: heavier tax burdens and more onerous tax administration absorb resources and managerial time that would otherwise go toward technology investment, so adoption should fall as tax burden rises (Gadzo et al., 2013; Coles et al., 2021; Wang et al., 2025). Recent work on tax-administration digitalization also conveyed the idea that firms that adopt digital tools have higher visibility to tax authorities and this increases measured tax burden (Eaves et al., 2024; Nose et al., 2025). We cannot use a single cross-sectional regression to separate these two theories. Both predict a relationship between tax burden and adoption, just with opposite signs and timing. This paper asks a narrow, testable version of the broader question: does tax burden predict technology adoption and innovation distinctly in a way that survives an explicit check for reverse causation, and does the answer differ between tax rates and tax administration as distinct dimensions of the tax environment?

## 2. Literature Review

Taxation is not just a transaction between firm and government officials, but the whole process of taxation, along with its rate and administration, influences the firm’s investment and innovation decisions. The resources that could be available to firms for innovation may go to paying tax. Taxes may reduce retained earnings and hinder investments in digitalization. This idea is more relevant to low-income economies, where firms face financial constraints (Gao & Liu, 2021).

Corporate taxation can affect the firm-level product innovation or process innovation (Shao & Xiao, 2019). Fiscal policy can affect firms' incentives to undertake technology-related investment. Much of the literature on tax and tech adoption focuses on R&D, patents, and physical investment, whereas the technology adoption or digital presence of firms does not need to conduct R&D. Having a website, licensed technology from other firms, or foreign level can be a measure of technology adoption or digitalization.

Developing economy firms face significant technology gaps influenced by factors such as financing, management capacity, and market orientation (Cusolito et al., 2020; Cirera et al., 2022). Research

regarding firm resilience and AI adoption suggests high tax burdens act as an additional, under-recognized barrier to technology adoption (Aga & Francis, 2015).

Complex procedures and weak administrative capacity consume managerial time (Bird and Zolt, 2008), but digital tools can increase tax payments, which, while correlated, does not necessarily mean causation (Nose et al., 2025), and is complicated by exposure to inspection scrutiny (WBES). Heavy tax burdens can also hinder digital value-chain participation (Wang, Xuanyuan, and Peng, 2025), presenting an endogenous relationship that requires instrumental variable approaches to solve (Xie, 2023).

In all three strands, there is one area of gap that was overlooked: while much has been written on how technology is shaping firm taxation, little has been written on how the tax environment is changing the adoption of technology, and little of it has examined the questions of adoption separate from questions of R&D, export, or compliance results. This paper asks that question directly: does the tax environment influence firms' decisions to adopt technology? Using harmonized WBES data for India, Pakistan, and Vietnam, distinguishing tax burden from tax administration, and absorbing country, wave, and sector effects throughout.

**Table 1. Variable Description**

| Role | Variable | Survey Question | Survey code | Original coding | Our coding |
|---|---|---|---|---|---|
| **Tax** | Tax rates | How Much of An Obstacle: Tax Rates | j30a | 0–4 | 0–4 |
| | Tax administration | How Much of An Obstacle: Tax Administrations | j30b | | 0–4 |
| **Technology** | Digital presences | Establishment Has Its Own Website | c22b | 1 Yes, 2 No, -9 DK | 1/0 |
| | Foreign-licensed technology | Do You Use Technology Licensed From A Foreign-Owned Company? | e6 | | 1/0 |
| **Innovation** | Product innovation | New Products/Services Introduced Over Last 3 Years | h1 | | 1/0 |
| | Processes innovation | New Products/Services Also New For The Establishment's Main Market | h5 | | 1/0 |
| | R&D expenditure | During Last Fiscal Year, Establishment Spent On R&D (Excl. Market Research)? | h8 | | 1/0 |
| **Firm control** | Firm Size | Permanent, Full-Time Employees At End of Last Fiscal Year | l1 | Num. | log |
| | Firm age | Year Establishment Began Operations | b5 | Calculated[1] | |
| | Export status | % of Sales: Direct Exports | d3c | Percentage | 1/0[2] |
| | Finance constraint | How Much of An Obstacle: Access To Finance | k30 | 0-4 | 0-4 |
| | Sector | Module (Retail or Service) | a0 | | |

## 3. Data and Variables

The sample pools three waves of the World Bank Enterprise Surveys for India, Pakistan, and Vietnam, yielding 36,097 firm-year observations, unbalanced across firms: about 51 percent of firms are observed once, 31 percent twice, and 18 percent in all three waves. India accounts for roughly four-fifths of the pooled sample, a composition issue we address directly in a robustness check. The choice of sample is due to some underlying reasons. India, Pakistan, and Vietnam, being unique populous Asian emerging economies, present an ideal case for empirically examining how the tax environment influences firms' digital technology adoption. All are actively undergoing digital transformation, and their tax systems are almost common, with high tax rates and tax compliance burdens (Binh & Lien, 2019; Metreau et al., 2026).

## 4. Empirical Models

The study employs a linear probability model, given its suitability for large firm-level panels with multiple fixed effects (Site & Parmar, 2024), where coefficients retain a direct percentage-point

[1] Firm age = Survey Wave Year - Establishment Year

[2] Firms reporting an export share greater than 0% are coded as 1 (exporter), while firms reporting no exports are coded as 0 (non-exporter).

interpretation (Wooldridge, 2010). The boundary limitations (Horrace & Oaxaca, 2005) of the technique are acknowledged and addressed through clustered standard errors and diagnostic checks confirming minimal distortion in our sample. For all equations, standard errors are clustered at the firm level.

$$Y_{ict} = \beta_0 + \beta_1 TaxRate_{ict} + \beta_2 TaxAdmin_{ict} + \gamma X_{ict} + \mu_c + \lambda_t + \delta_s + \epsilon_{ict} \ldots\ldots (1)$$

$$Y_{ict} = \beta_0 + \beta_1 TaxRate_{ict-1} + \beta_2 TaxAdmin_{ict-1} + \gamma X_{ict} + \mu_c + \lambda_t + \delta_s + \epsilon_{ict}. (2)$$

$$Y_{ict} = \beta_0 + \beta_1 TaxRate_{ict} + \beta_2 TaxAdmin_{ict} + \gamma X_{ict} + \alpha_i + \lambda_t + \epsilon_{ict} \ldots\ldots\ldots\ldots (3)$$

$$Y'_{ic't} = \beta_0 + \beta_1 TaxRate_{ic't} + \beta_2 TaxAdmin_{ic't} + \gamma X_{ic't} + \lambda_t + \delta_s + \epsilon_{ic't} \ldots\ldots\ldots (4)$$

$$Y'_{ic't} = \beta_0 + \beta_1 TaxRate_{ic't} + \beta_2 TaxAdmin_{ic't} + \gamma X_{ic't} + \alpha_i + \lambda_t + \epsilon_{ic't} \ldots\ldots\ldots (5)$$

Equation 1 shows our baseline model, which examines the impact of taxation burden on technology adoption, with digital presence, Foreign-licensed technology, Product innovation, process innovation, and R&D expenditure as dependent variables in their respective equations. In this baseline model $Y_{ict}$ include both innovation and technology variables, whereas in$Y'_{ict}$ only include the technology variables. $X_{ict}$ defines the firm-level controls with details in Table 1 and $\mu_c$ shows country fixed effects, $\lambda_t$ wave fixed effects, and $\delta_s$ sector fixed effects, $\alpha_i$ shows firm fixed effects and $\epsilon_{ict}$ shows the error term. $i, c, t$ and $s$ are used to represent firm, country, and survey wave, and sector in the equations, respectively, with $t-1$ representing the lag value and $c'$accounting for subsamples of Pakistan and Vietnam only.

**5. Results**

Rigorous diagnostic evaluations including multi-way clustering for heteroskedasticity and a leave-one-out instrumental variable approach for endogeneity confirm the dataset is free from biasing anomalies. The baseline high-dimensional fixed effects specification is statistically verified as the most efficient, unbiased, and valid estimation technique for this model.

The empirical results point to a clear distinction between tax burden and tax administration in shaping firms' technology and innovation decisions. Rather than affecting all forms of technology adoption in the same way, the two dimensions of the tax environment appear to operate through different channels. The results also become more informative when the analysis moves from pooled cross-firm comparisons to firm fixed effects, where the estimates rely on changes within the same firms over time.

In the baseline specification, which controls for country, survey-wave, and sector effects, tax rates are positively associated with website adoption. The results reported in Table 2 suggest that firms facing higher reported tax rates and tax administration obstacles are, on average, somewhat more likely to use a website by 0.68 and 1.71 percentage points, respectively. None of them supports our hypothesis that tax burden discourages adoption. The innovation outcomes show strong positive coefficients for tax variables. Tax rate is significant for all innovation variables, and tax administration is insignificant for product innovation. Foreign technology has no significant relationship with either tax variable.

Accounting for firm-level heterogeneity, tax administration shows distinct results. It stays positive for websites but turns negative for all innovation outcomes: product innovation at -0.0314, process innovation at -0.0188, R&D at -0.0150. This suggests tax administration burden doesn't stop a firm from putting up a website. It hinders the resource-intensive projects that innovation requires (Mukherjee et al., 2017).

Lagged tax administration turns negative for website adoption (-0.0210), a sign flip from the same-period result. That flip matters. It's consistent with reverse causation: firms that go digital become more

visible to tax authorities, and that visibility shows up as a higher reported tax burden in the same period it happens. Once we look at last period's burden instead, predicting today's decision, the relationship reverses toward what theory would expect. Lagged tax rate, meanwhile, stays positive for websites and foreign technology, but turns negative for product and process innovation, evidence that whatever is driving the tax rate result differs by outcome, and isn't a single mechanism running through the whole table.

Table 3 gives the study another dimension. Many factors cannot be seen about the firm: how the firm is managed, the risk appetite, the technological aspirations, and many more; any of these can quietly determine both the tax rate of the firm and the technology it adopts. Firm fixed effects clean that up, and compare each firm to itself in the past. When we do this, the tax rate relationship with the website and foreign technology is gone, and both coefficients become insignificant. However, the relationship between tax rate and innovation is stronger, not weaker: 0.0484 for product innovation, 0.0391 for process innovation, and 0.0526 for R&D. That eliminates the simplest counterargument. It is not simply a fixed difference between firms that happens to look like a tax effect. Tax administration's split personality continues too: positive for websites (0.0363), negative for all three measures of innovation.

**Robustness Check**

A potential concern is the composition of the dataset. India accounts for the majority of observations, so the baseline results could potentially reflect patterns specific to the Indian sample. The analysis thus re-estimates the models using only Pakistan and Vietnam data.

The robustness results broadly support the main results. At the country level, tax administration is positive and significant for website adoption, foreign technology, and the tax-rate coefficient is small but statistically insignificant for website adoption and is weakly negative for foreign technology. More importantly, when the tax-rate coefficient is calculated for the Pakistan–Vietnam subsample, it is found to be negative for website adoption (−0.0250) and statistically insignificant for foreign technology (−0.0076). However, tax administration is positive and statistically significant for both of the above, with coefficients of 0.0365 for website adoption and 0.0273 for foreign technology.

The robustness exercise thus does not replicate each of the coefficients from the full sample, as is appropriate with fewer observations, as India is not included in the exercise. The results support the credibility of the main findings: the estimated relationships are not entirely generated by India's dominance in the dataset.

**6. Conclusion**

The study empirically examined the complex relation of tax burden and technology adoption at the firm-level sample from 3 emerging economies. The relationship between taxation and firm-level technology adoption is not a simple case where tax hinders technology adoption and innovation. The empirical relation differs depending on the perspective of tax rate and tax administration. The tax environment differently influences the technology and innovation factors. Short-term factors like having a website are positively influenced, and long-term investments and commitments like R&D projects are hindered by the tax burden. Tax rate burden tells a messier story. It stays positive across nearly every specification we ran, including firm fixed effects. Tax administration and tax rate are not interchangeable measures of burden; they behave differently in this data, and collapsing them into one variable would have hidden the paper's central finding. And the direction of causality between digitalization and taxation deserves more attention than it has received in a literature that has mostly studied the reverse; the extensions outlined above are aimed at turning this associational pattern into a causal one.

**Acknowledgement**

This research received no external or internal grant funding. The authors declare no financial relationships or other conflicts of interest related to this research.

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**Table:2 LPM Estimation Results**

| Variable | (1) Website | (2) Website Lagged | (3) Foreign Tech | (4) Foreign Tech Lagged | (5) Product Innov. | (6) Product Innov. Lagged | (7) Process Innov. | (8) Process Innov. Lagged | (9) R&D | (10) R&D Lagged |
|---|---|---|---|---|---|---|---|---|---|---|
| **Tax rate** | 0.0068*** | | -0.0012 | | 0.0189*** | | 0.0124*** | | 0.0236*** | |
| | (0.0025) | | (0.0017) | | (0.0022) | | (0.0020) | | (0.0021) | |
| **Tax rate$_{(-1)}$** | | 0.0159*** | | 0.0091*** | | -0.0059** | | -0.0049** | | 0.0026 |
| | | (0.0050) | | (0.0032) | | (0.0029) | | (0.0022) | | (0.0027) |
| **Tax admin** | 0.0171*** | | 0.0006 | | 0.0001 | | 0.0098*** | | 0.0182*** | |
| | (0.0027) | | (0.0018) | | (0.0023) | | (0.0022) | | (0.0022) | |
| **Tax admin$_{(-1)}$** | | -0.0210*** | | 0.0003 | | 0.0065** | | 0.0070*** | | 0.0005 |
| | | (0.0053) | | (0.0033) | | (0.0032) | | (0.0025) | | (0.0027) |
| **Firm age** | 0.0011*** | 0.0010*** | -0.0004*** | -0.0006*** | 0.0002 | 0.0003 | -0.0007*** | 0.0000 | -0.0002 | 0.0004** |
| | (0.0002) | (0.0003) | (0.0001) | (0.0002) | (0.0001) | (0.0002) | (0.0001) | (0.0001) | (0.0001) | (0.0002) |
| **Firm Size** | 0.1374*** | 0.1305*** | 0.0352*** | 0.0354*** | 0.0159*** | 0.0045* | 0.0159*** | 0.0070*** | 0.0229*** | 0.0219*** |
| | (0.0020) | (0.0040) | (0.0015) | (0.0029) | (0.0018) | (0.0026) | (0.0017) | (0.0022) | (0.0018) | (0.0023) |
| **Export Status** | 0.2016*** | 0.1712*** | 0.0813*** | 0.1248*** | 0.1119*** | 0.0660*** | 0.0999*** | 0.0416*** | 0.1257*** | 0.0556*** |
| | (0.0073) | (0.0129) | (0.0071) | (0.0143) | (0.0077) | (0.0111) | (0.0075) | (0.0092) | (0.0078) | (0.0103) |
| **Finance constraint** | -0.0153*** | 0.0061 | -0.0073*** | -0.0011 | -0.0004 | 0.0136*** | 0.0153*** | 0.0101*** | 0.0054** | 0.0129*** |
| | (0.0024) | (0.0042) | (0.0015) | (0.0027) | (0.0022) | (0.0028) | (0.0021) | (0.0024) | (0.0021) | (0.0026) |
| **Constant** | -0.0620*** | 0.0236 | -0.0442*** | -0.0632*** | 0.0691*** | 0.0361*** | 0.0485*** | 0.0038 | 0.0049 | -0.0617*** |
| | (0.0085) | (0.0184) | (0.0059) | (0.0119) | (0.0070) | (0.0111) | (0.0067) | (0.0091) | (0.0068) | (0.0092) |
| **Country FE** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Wave FE** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Sector FE** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Obs** | 35,015 | 9,598 | 27,949 | 8,242 | 33,993 | 9,593 | 32,900 | 9,591 | 32,857 | 9,588 |
| **R-squared** | 0.184 | 0.162 | 0.061 | 0.068 | 0.066 | 0.057 | 0.074 | 0.052 | 0.095 | 0.079 |

Significance: *** p<0.01, ** p<0.05, * p<0.10 Standard errors in parentheses
Country, wave, and sector FE included in all models. SEs clustered at firm level.

**Table:3 Firm Fixed-Effects Estimation**

| Variable | (1) Website | (2) Foreign Tech | (3) Product Innov. | (4) Process Innov. | (5) R&D |
|---|---|---|---|---|---|
| **Tax rate** | -0.0047 (0.0045) | -0.0047 (0.0041) | 0.0484*** (0.0040) | 0.0391*** (0.0037) | 0.0526*** (0.0037) |
| **Tax admin** | 0.0363*** (0.0048) | -0.0038 (0.0044) | -0.0314*** (0.0043) | -0.0188*** (0.0040) | -0.0150*** (0.0040) |
| **Firm age** | 0.0011*** (0.0004) | -0.0001 (0.0003) | -0.0005 (0.0003) | -0.0011*** (0.0003) | -0.0004 (0.0003) |
| **Firm size** | 0.0803*** (0.0076) | 0.0253*** (0.0069) | 0.0354*** (0.0072) | 0.0283*** (0.0068) | 0.0369*** (0.0068) |
| **Export Status** | 0.1536*** (0.0141) | 0.0489*** (0.0155) | 0.0812*** (0.0145) | 0.0455*** (0.0132) | 0.0679*** (0.0139) |
| **Finance constraint** | -0.0109** (0.0043) | -0.0170*** (0.0036) | 0.0120*** (0.0038) | 0.0296*** (0.0037) | 0.0241*** (0.0038) |
| **Constant** | 0.1948*** (0.0307) | 0.0291 (0.0289) | -0.0112 (0.0288) | -0.0088 (0.0274) | -0.0596** (0.0273) |
| **Firm FE** | Yes | Yes | Yes | Yes | Yes |
| **Wave FE** | Yes | Yes | Yes | Yes | Yes |
| **Obs** | 16,715 | 11,060 | 16,244 | 15,689 | 15,652 |
| **R-squared** | 0.598 | 0.476 | 0.496 | 0.526 | 0.562 |

*** p<0.01, ** p<0.05, * p<0.10

Standard errors in parentheses, clustered at firm level.

Firm FE absorbs country, sector, and all other time-invariant firm characteristics automatically. SEs .

Note: Sample restricted to firms observed in 2+ waves  single-wave firms are automatically dropped ("singleton observations") since firm FE requires within-firm variation to identify effects.

**Table:4 Robustness Check (Pakistan & Vietnam Only)**

| Variable | (1)<br>Website | (2)<br>Foreign Tech | (3)<br>Website | (4)<br>Foreign Tech |
|---|---|---|---|---|
| **Tax rate** | -0.0001<br>(0.0054) | -0.0066*<br>(0.0035) | -0.0250**<br>(0.0115) | -0.0076<br>(0.0085) |
| **Tax admin** | 0.0241***<br>(0.0059) | 0.0098**<br>(0.0040) | 0.0365***<br>(0.0113) | 0.0273***<br>(0.0093) |
| **Firm age** | 0.0022***<br>(0.0005) | 0.0006*<br>(0.0003) | 0.0009<br>(0.0009) | 0.0002<br>(0.0009) |
| **Firm size** | 0.1193***<br>(0.0045) | 0.0529***<br>(0.0039) | 0.0941***<br>(0.0160) | 0.0509***<br>(0.0136) |
| **Export Status** | 0.1572***<br>(0.0173) | 0.0676***<br>(0.0140) | 0.1605***<br>(0.0435) | 0.0298<br>(0.0362) |
| **Finance constraint** | 0.0007<br>(0.0053) | -0.0041<br>(0.0036) | -0.0023<br>(0.0102) | -0.0032<br>(0.0089) |
| **Constant** | -0.0793***<br>(0.0187) | -0.1125***<br>(0.0143) | 0.0687<br>(0.0635) | -0.1041*<br>(0.0560) |
| **Firm FE** | - | - | Yes | Yes |
| **Wave FE** | Yes | Yes | Yes | Yes |
| **Sector FE** | Yes | Yes | - | - |
| **Observations** | 6,118 | 5,273 | 2,229 | 1,756 |
| **R-squared** | 0.182 | 0.114 | 0.671 | 0.558 |

Significance: *** p<0.01, ** p<0.05, * p<0.10
Sample: Pakistan and Vietnam firms only (India excluded)