INTERNATIONAL MONETARY FUND

Leveraging Digital Technologies in Boosting Tax Collection

Manabu Nose, Nicola Pierri, and Jiro Honda

WP/25/89

2025
MAY

WORKING PAPER

 WP/25/89

IMF Working Paper
Fiscal Affairs Department

Leveraging Digital Technologies in Boosting Tax Collection

Prepared by Manabu Nose, Nicola Pierri, and Jiro Honda*

Authorized for distribution by Nikolay Gueorguiev
May 2025

ABSTRACT: This paper explores how digitalization in the corporate sector can boost tax revenue collection,. finding that stronger firm digitalization is associated with higher tax revenues across countries and also higher tax paid across firms. The cross-country estimates illustrate that a one-standard-deviation increase in firm digitalization is associated with an increase in tax revenues-to-GDP by up to 3 percentage points, conditional upon the level of digitalization of tax administration (GovTech). A firm-level analsis reveals that firm digitalization significantly improves tax compliance among high-risk taxpayers, such as small and informal enterprises, particularly in the service sector. This indicates that digitalization not only broadens the corporate tax base but also plays a crucial role in improving tax compliance. Moreover, both country and firm-level analyses reveal a significant synergy between firm digitalization and GovTech, undescoring the importance of promoting both to enhance tax collection. These analyses also suggest that, in developing countries, it is essential to create enabling environments for firm digitalization and GovTech and address any constraints to achieve their synergy effects.

RECOMMENDED CITATION: M. Nose, N. Pierri, and J. Honda (2025), “Leveraging Digital Technologies in Boosting Tax Collection.” IMF Working Paper 25/89.

JEL Classification Numbers:	H20, H21, H25, H32, H83, O10
Keywords:	Tax compliance; Public-Private digitalization; GovTech
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* We thank Vitor Gaspar, Juan Toro, Nikolay Gueorguiev, Shafik Hebous, Jean-Marc Atsebi, Aiko Mineshima, Kerstin Gerling, Naima Smaini, Liz Gavin, Serge Mani, Stoyan Markov, Patricio Barra, Shan Zhong, Enrique Rojas, Seydou Coulibaly, Faycal Sawadogo, Herve Tourpe, Solomon Frankosiligi, Emmanuel Crown, and IMF Fiscal Affairs Department seminar participants for their insightful comments. We benefited from excellent research assistance from Dhruv Gandhi at the initial stage of this project.

WORKING PAPERS

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I. Introduction

1. **The benefits of government digitalization (GovTech) for tax collection have been well acknowledged in recent studies.** The IMF Staff Discussion Note (IMF, 2023) highlights that adoption of new Information and Communication Technology (ICT) in tax administration can significantly enhance revenue collection. Empirical studies provide supportive evidence, showing that digitalizing the public sector, especially tax administration, can lead to substantial efficiency gains by improving taxpayer identification, detecting tax evasion, and enhancing tax collection (Okunogbe and Tourek, 2024; Okunogbe and Santoro, 2023a). Additionally, a recent study emphasizes that the revenue yields from digitalizing revenue administration could be further strengthened by expanding reliable digital connectivity, scaling up ICT expenditure by tax administrations, ensuring adequate staffing and expertise among tax officials (Nose and Mengistu, 2023).

2. **There is a scarcity of empirical studies examining the role of firm digitalization for tax revenues, which is ex-ante ambiguous.** Boosting digital business transformation has proven critical for firm performance, wage growth, and resilience to economic shocks, as highlighted in extensive literature. However, the relationship between firm digitalization and tax revenues remains largely unexplored. To fully leverage the potential of digitalization for tax collection, a fuller understanding of the role of firm digitalization is essential. Firm digitalization could either facilitate or harm tax collection. On the one hand, the digitalization of business transactions – spanning from product order and delivery to billing and payments – facilitates systematic recording of these transactions, which could enhance the efficiency of corporate and value-added tax collection or raise firms' awareness on the risks of being detected. On the other hand, digital capabilities could facilitate tax evasion: for example, in developing countries to roll up two different accounting files to hide income - an internal (confidential) file and a public (for tax purposes) file. Shifting profits to avoid taxes may be easier for high-tech firms, such as multinationals digital platform, than for more traditional firms. Therefore, novel empirical research advancing our knowledge in this area is vital for refining domestic revenue mobilization strategies, especially as the frontier of digitalization expands with artificial intelligence technologies, such as large language models.

3. **Against this background, the paper investigates the role of firm digitalization through both country-level and firm-level analyses.** By utilizing a comprehensive cross-country database that encompasses business and government digitalization, as well as corporate tax payments at the country and firm level, this paper fills the gap in the literature by investigating the relationship between firm digitalization, GovTech, and tax revenue collection. Specifically we aim to address three questions: (a) does the progress in firm digitalization contribute to tax collection?; (b) through which channels do firm digitalization enhance tax collection?; and (c) are there synergies between firm digitalization and GovTech[1] that facilitate tax collection?

4. **The key findings of the paper are as the following:**

- **There is a positive relationship between firm digitalization and domestic tax revenues.** Countries with higher level of business digital adoption have larger tax-to-GDP ratios. A two-way fixed effect regression at firm-level reveals that firms using more ICT as inputs for their intermediate production are

[1] This paper treats GovTech and E-Government as broad and interchangeable concepts, encompassing the overall digitalization of the public sector as well as the digital investments made by specific entities, such as revenue administrations. The term "firm digitalization" is also employed in a broad sense, referring to the general supply-side aspects of corporate digitalization, as captured by the World Bank's Digital Adoption Index (see Section III.1), while also including the utilization of IT inputs (see Section III.2).

also more likely to pay taxes, pay more taxes when they do pay taxes, and pay a larger share of their operating revenues in taxes. A causal interpretation of this relationship, however, cannot be established with certitude.

- **The impact of firm digitalization on tax revenues is potentially significant, conditional on the level of GovTech.** The cross-country estimates illustrate potentially large impact. A one-standard-deviation increase in firm digitalization is associated with an increase in tax revenues-to-GDP by up to 3 percentage points (based on country-level estimates) and with an increase in the ratio of tax payments to corporate turnover by up to 0.12-0.32 percentage points (firm-level estimates).[2] When the impact is scaled by the sample mean of respective outcome variables, the magnitudes of the effect are broadly comparable – an increase by about a fifth of average tax revenues-to-GDP ratio (country-level) and by 6-20 percent of firms' average tax payment over turnover ratio (firm-level).
- **The mechanism by which firm digitalization enhances domestic revenue mobilization primarily operates through improved compliance.** The firm-level analysis highlights the importance of the compliance channel, revealing that the relationship between firm digitalization and taxes paid is stronger for firms deemed riskier in terms of compliance – specifically, smaller firms and firms operating in countries with higher levels of informality. The Oaxaca-Blinder decomposition further indicates that unexplained components including the compliance cost channel account for about 40-70 percent of the observed relationship between digitalization and tax payments in the service sector.
- **As a government matures in its use of digital technologies for tax administration, the impact of firm digitalization on tax revenues is estimated to be significantly stronger.** This finding confirms the existence of significant positive synergies between the digitalization of private and public sectors.

5. **This paper's findings call for a dual approach with promoting both GovTech and firm digitalization (to enhance tax revenues), highlighting that investing in digitalization will pay off by increasing future tax revenues.** This dual approach not only modernizes government tax systems but also encourages businesses' adoption of digital practices, thus leveraging the synergies documented in this study. Additionally, the fiscal costs of digital investments are likely to be offset by future tax revenue increases, making coordinated digital improvements highly beneficial. Investing in digitalization, supported by policies for universal broadband and ICT investments, can yield high returns and should be considered in cost-benefit analyses, especially for countries with limited fiscal space.

6. **The rest of the paper is structured as follows.** Section II provides literature review. Sections III estimates the relationship between firm digitalization and tax revenues at country-level and firm-level respectively. Section IV concludes.

II. Literature Review

7. **A long-standing literature has documented a wide range of benefits from firm digitalization, including higher firm growth, higher wages, and stronger resilience to shocks.** Seminal papers, including Bloom et al. (2012), Beaudry et al. (2010), Bresnahan et al. (2002), Brynjolfsson and Hitt (2003), have documented that the use of digital and information technology by firms is an engine of productivity and wage

[2] The dependent variables are tax revenues normalized by GDP for the country-level regressions and tax payments normalized by operating revenues (turnovers) for the firm-level regressions.

growth both at the firm and at the local labor markets level. Recent studies have highlighted that technology adoption also enhances firms' resilience to economic, financial, and other shocks. See, for instance, Pierri and Timmer (2022), Nose and Honda (2023), Copestake, Estefania-Flores, Furceri (2022), OECD (2024).

8. **In light of these benefits, a number of studies also explore policies to foster firm digitalization.** Firm digital adoption can be fostered, for instance, by upgrading internet infrastructures (Augereau and Greenstein 2001, Hjort and Poulsen 2019), promoting IT skills (Babina and others 2024) and cashless payments (Chen, 2024), providing tailored support to the IT sector (Manelici and Pantea, 2021), or addressing any other context-specific constraint hindering digitalization. Drawing on India's experience, the G20 Digital Ministers recognized Digital Public Infrastructure (DPI) as an accelerator of the economy-wide adoption of digital tax services (so-called "Digital Inclusion") (Eaves et al., 2024). Policies fostering both public and firm digitalization require fiscal support for providing universal broadband connectivity and/or incentivizing taxpayers to accelerate ICT investments (Amaglobeli et al., 2023). Further, some scholars credit the robust E-government in Denmark and Estonia as key to their growing digital economies (Andersen and others 2003, Espinosa and Pino 2025). A more specific example is provided by Bellon, Dabla-Norris, and Khalid (2021), who study Peru's electronic invoicing reforms and find evidence of technology spillovers among firms.[3]

9. **A growing literature highlights the importance of digitalization of public administrations for domestic revenue mobilizations.** Studies relying on cross-country data, such as Amaglobeli and others (2023) and Nose and Mengistu (2023), document a strong association between the digitalization of revenue administration and tax revenues while also highlighting the importance of accompanying factors, such as legislative and administrative reforms. Country-specific studies point to significant tax revenue gains from the adoption of digital tools such as e-filing (Santoro, Amine, and Magongo, 2022), e-invoicing (Bellon and others, 2022, Fan and others, 2020), or electronic fiscal devices (Mascagni, Mengistu, and Woldeyes, 2021) in developing economies. The growing adoption of cashless payment methods, for instance within the Indian demonetization episode, also appears to enhance tax compliance (e.g., Das, Gadenne and others, 2023).

10. **There is scant evidence on the role of firm digitalization for tax collection.** To the best of our knowledge, the relationship of firm digitalization with tax revenues has not been explored, while several studies point at the lack of advancement in firm digitalization as a constraint to fully utilize the potential of GovTech to enhance tax compliance. A take-up of e-tax services, for instance, may remain partial due to barriers and digital divides among taxpayers in adopting digital tax services (Okunogbe and Santoro, 2023b). Based on special surveys of samples of taxpayers, several studies from Africa highlight key barriers (such as lack of taxpayer awareness, training, use of computerized accounting system) that limit the use of e-filing and e-payment by firms (Masud, 2019; Obert et al., 2018; Efobi et al., 2019).

III. Empirical Analyses

11. **We employ two complementary analyses at both the country and firm levels.** The country-level analysis compares nations based on their levels of digital adoption by businesses and governments. Meanwhile, the firm-level analysis utilizes detailed panel data on firms and sectors. This approach not only refines and confirms the patterns observed at the country level but also provides insights into the underlying

[3]Bird and Hanedar (2023) provide six examples of the role of digital technology in improving Social Safety Nets in low income countries and emerging markets.

mechanisms. Together, these analyses offer a comprehensive understanding of digital adoption's impact across different contexts.

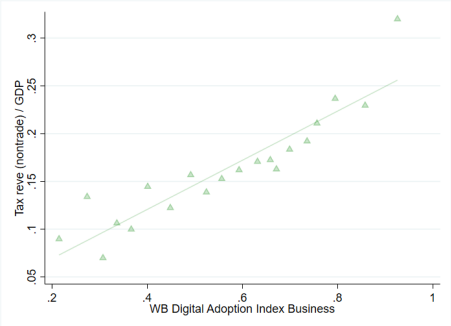
1. Country-level Evidence

12. **A cross-country analysis is conducted relying on the World Bank Digital Adoption Index (DAI).** The DAI was constructed from a set of cross-countries surveys to capture differences in the adoption of digital technologies for the 2016 Digital Dividends report (World Bank, 2016). To measure firm digitalization, the analysis in this paper focuses on the sub-index capturing adoption of digital technologies by businesses,[4] which is available for years 2014 and 2016. In the section III.1, the business digitalization sub-index is referred to as firm digitalization. Households' digital adoption is measured by the DAI sub-index on "people" digitalization. The government's digitalization is captured by the United Nations E-Governance index. A set of additional country-level control variables is taken from standard sources, such a macroeconomic data from International Financial Statistics (IFS), institutional quality variables from World Bank's Worldwide Governance Indicators, education data from the UNESCO Institute for Statistics, and revenue-related data from the IMF World Revenues Longitudinal Database (WoRLD).

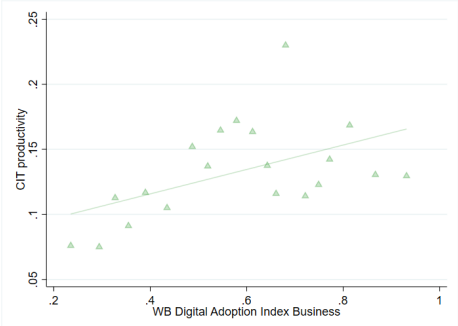
13. **Countries with stronger firm digitalization have higher tax revenues (Figure 1).** Figure 1 panel 1 plots the binned scatter plot (e.g., Chetty and others 2020) of the ratio of non-trade tax revenues—normalized

Figure 1. Country-level Data Descriptive Patterns

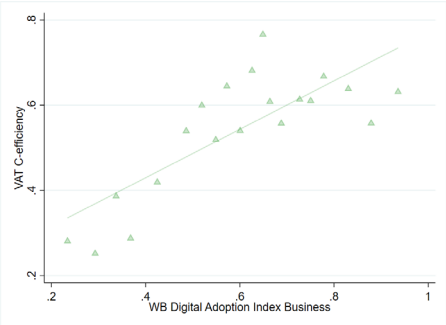
Panel 1: DAI Business and tax revenues



Panel 2: DAI Business and CIT productivity



Panel 3: DAI Business and VAT efficiency



Panel 4: Correlations of Digitalization and tax revenues

	Business Digitalization	E-Government	Households Digitalization
Business Digitalization	100%		
E-Government	90%	100%	
Households Digitalization	90%	93%	100%
Non-trade tax / GDP	61%	59%	57%

Sources: WBG and IMF

[4] The index is the average of four normalized indicators: the percentage of businesses with websites, the number of secure servers, the speed of download, and 3G (third generation) coverage in the country (World Bank 2016).

by GDP—on the y-axis against the DAI firm digitalization index, showing a strong positive correlation.[5] This pattern suggests the existence of gains for the fiscal sector stemming from firm technology adoption. The following two panels also show a positive correlation of firm digitalization with VAT C-efficiency and CIT productivity,[6] indicating digitalization gains may occur through different taxes paid by corporations. The last panel shows the pairwise correlation of four variables, that are the non-trade tax revenues and three different digitalization measures. It shows firm digitalization has a slightly higher correlation (61 percent) than household or government digitalization, although all digitalization measures are highly correlated with each other. All correlations are different than zero at 1 percent significance level.

14. **In light of the linear relationship above between firm digitalization and tax revenues, a regression analysis is employed to further investigate whether this relationship holds after controlling for important confounding factors.** The correlations illustrated by Figure 1 could be driven by richer countries having more digitalized businesses and better tax collection. Better institutions could promote both adoption of new technology and tax compliance. The structural transformation from agriculture-based to service or manufacturing based economies, or the availability of human capital may also impact business technological adoption and the government's ability to collect taxes. Therefore, a simple regression framework is employed to test whether the correlations illustrated in Figure 1 are robust to controlling for other country-level characteristics which may impact both digitalization and tax revenues. The regression equation is the following:

$$R_{c,y} = \delta_y + \beta \cdot DAIBusiness_{c,y} + \gamma \cdot X_{c,y} + \varepsilon_{c,y}$$

where $R_{c,y}$ is the ratio of non-trade tax revenues over GDP for country c in year y, $X_{c,y}$ is a set of controls, and δ_y are the year fixed effects. The following set of controls are considered:[7] structural macroeconomic variables (log of GDP per capita and its square, share of agriculture in GDP, oil exporters status), cyclical macroeconomic variables (inflation and GDP growth), quality of institution (rule of law, accountability, control of corruption, regulatory quality), human capital (average years of schooling), and two measures of tax policy reforms from Chang, Gueorguiev, Gavin, and Honda (2020).[8] As the sample includes both 2014 and 2016 DAI survey waves, year fixed effects are also included.

[5] This measure of tax revenues includes all tax revenues except for those collected on imports, such as import duties. It thus includes VAT, CIT, and PIT (indeed, firms often play a role in PIT collection of their employees).

[6] The VAT C-efficiency is the ratio between VAT revenues over the theoretical VAT revenues—consumption multiplied by the standard VAT rate—and it is commonly used as a measure of efficiency and lack of leakages of VAT collection (OECD 2016, Ueda 2017). CIT productivity captures the efficiency of corporate income tax collection in an analogous way (Hutton, 2023).

[7] Considering the high correlation between the different country-level variables (e.g., Figure 1), coupled with the relatively small sample size, the set of controls is chosen (i) so that the controls are available for most of the sample and (ii) to strike a balance between the aim to proxy for the most important sources of omitted variable biases and the need of not over-saturating the model.

[8] These measures are: (i) the difference between the tax revenues projected in a budget for year and the actual tax revenues of the preceding year and (ii) the difference between the budgeted revenues in a year versus the previous one, expressed as share of GDP. Results are robust to use alternative tax policy controls built directly from statutory rates, see Appendix Table AI.4.

15. **The regression analysis confirms a positive relationship between tax revenues and firm digitalization (Table 1).** The columns (1) to (4) of Table 1 report the results of the cross-sectional regressions. Business digitalization is found to be statistically significantly associated with higher tax revenues over GDP while controlling for macroeconomic (structural, cyclical, and human capital variables described in the previous paragraph) factors, institutional quality, and tax policy. Business digitalization has a stronger predictive power for tax revenues than E-government and household digitalization, highlighting the importance of this study.

Table 1. Country-level Tax Revenues and Digitalization

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Tax revenues (nontrade) / GDP							
Business Digitalization	0.257***	0.199***	0.158**	0.164*				
	(0.031)	(0.070)	(0.073)	(0.090)				
E-Government Index		0.0109	0.0251	0.0184				
		(0.060)	(0.056)	(0.065)				
Household Digitalization		0.0862	0.0881	0.0919	-0.0313	0.0802	0.0750	0.101
		(0.075)	(0.071)	(0.079)	(0.072)	(0.075)	(0.072)	(0.085)
Business Digitalization X High E-Government					0.195**	0.202***	0.162**	0.166*
					(0.075)	(0.070)	(0.072)	(0.084)
Business Digitalization X Low E-Government					0.194**	0.181**	0.125	0.130
					(0.076)	(0.073)	(0.080)	(0.096)
High E-Government					0.0942	-0.00205	0.00248	0.0698
					(0.063)	(0.066)	(0.061)	(0.072)
Macro Controls		X	X	X		X	X	X
Institutional Quality			X	X			X	X
Tax Policy				X				X
R2	0.381	0.492	0.521	0.539	0.388	0.493	0.525	0.633
Observations	290	281	281	262	290	281	281	262
Mean of dependent variable	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16

Source: WBG, UN, WEO, and staff calculations.

16. **The magnitude of this relationship appears to belarge.** The magnitude of the estimated coefficient in the most saturated specification (Table 1, column 4) is economically significant: a one-standard deviation increase in the firm digitalization index (0.19) is associated with an increase of tax revenues-to-GDP of 3 percentage point, which is about a fifth of the average tax revenues to GDP ratio in the sample (16 percent). In 2016, the average non-trade tax-to-GDP ratio was 11 percent in low-income countries and 25 percent in advanced economies, while the average firm digitalization index was, respectively, 0.39 and 0.83.[9] The coefficient in column (4) implies that if low-income countries had the same firm digitalization as advanced economies, then the expected tax-to-GDP ratio would increase by about 7 percentage point (reaching 18 percent of GDP), thus diminishing difference between the two groups of economies by about half. The back-of-the-envelope calculation based on cross-country estimates are illustrative which will be refined later with the firm-level analysis.[10]

17. **Several robustness tests support this analysis, although important caveats apply**. An important caveat of this analysis is that while the rich set of controls mitigates the concern that the results are driven by confounding factors, it is not possible to control all the potential sources of difference between countries. The estimated relationship between tax revenues and digitalization is robust to several alternative empirical specifications, such as including only one sample, including lagged controls to allow for lagged impact of business cycle fluctuations on tax collection, and including lagged tax revenues as controls (Table AI.2). Results are also broadly robust to the inclusion of forgone revenues due to tax expenditures as an alternative measure of tax policy, although the sample size shrinks significantly. However, the correlation of firm digitalization with VAT C-efficiency and CIT-productivity is positive but not statistically significant when all

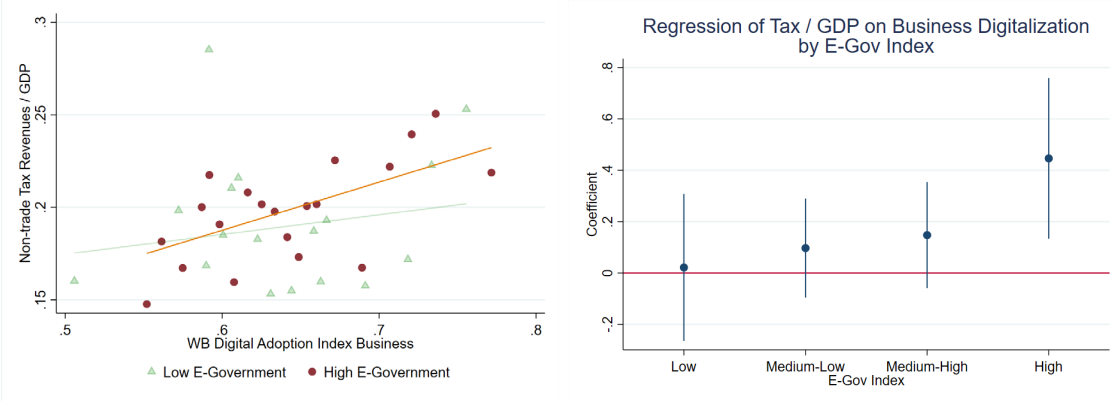
[9] Emerging markets had 15 percent non-trade tax-to-GDP ratio and 0.6 firm digitalization index.

[10] Obviously, such a large change in digitalization would deeply impact the structure of the economy beyond what the simple econometric framework can capture. For this reason, this back-of-the-envelope calculation aims only at providing an illustration of the magnitude of the coefficients and should not be misconstrued for a policy counterfactual.

controls are included (Table AI.1).[11] Moreover, adding country fixed effects would not produce meaningful results as the variation is mainly cross-sectional (the firm digitalization measure is available only for two years close to each other). Because of these limitations, to establish a robust relationship between digitalization and tax revenues, the second part of this section presents complementary analysis with more granular firm-level data, which allows the inclusion of country fixed effects to control for all the factors that could potentially confound the country-level results.

18. **The relationship between firm digitalization and tax revenues is stronger when E-Government is high (Table 1 and Figure 2), suggesting the presence of complementarities between business and GovTech.** Columns (5) to (8) of Table 1 present the result of a regression where the coefficient of firm digitalization is allowed to be different according to whether the country has an E-governance index above or below the median. Once macro and institutional controls are included, the firm digitalization coefficient appears to be significantly different from zero only within the high E-governance sample, while it is smaller within the low E-governance sample. The left panel of Figure 2 also represents this pattern graphically by plotting tax revenues against firm digitalization for the two samples separately, while controlling for the macro and institutional quality variables. The right panel, instead, reports the coefficient of the regression of tax revenues on firm digitalization by quartile of E-government index: the relationship appears to be large and positive only for countries in the top quartile of E-government.

Figure 2. Tax Revenues and Business Digitalization by Level of E-Government



Source: WBG, UN, IMF, and staff calculations

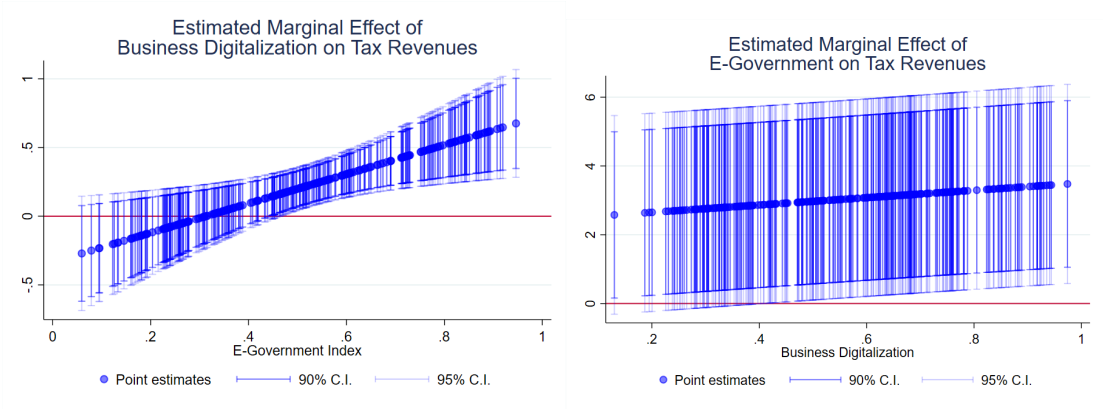
19. **To further investigate the importance of synergies between digitalization of businesses and public administration, country-specific marginal "effects" are estimated through a linear-interaction specification (Figure 3).** The following specification, including firm digitalization, E-government, and their interaction, together with the full list of controls, is estimated:

[11] This is partly due to the high correlation between some of the controls, as illustrated in Figure 1, which lead to large robust standard errors.

$$R_{c,y} = \delta_y + \boldsymbol{\beta} \cdot DAIBusiness_{c,y} + \boldsymbol{\alpha} \cdot Egov_{c,y} + \boldsymbol{\theta} \cdot DAIBusiness_{c,y} \cdot Egov_{c,y} + \gamma \cdot X_{c,y} + \varepsilon_{c,y} \quad (1)$$

The specification provides country-year specific marginal "effects"[12] of firm digitalization as $\boldsymbol{\beta} + \boldsymbol{\theta} \cdot Egov_{c,y}$ and of E-government as $\boldsymbol{\alpha} + \boldsymbol{\theta} \cdot DAIBusiness_{c,y}$. The estimated parameters from this equation are presented in Table AI.3: importantly, the coefficient $\boldsymbol{\theta}$ is positive and statistically significant, indicating the presence of synergies. The left panel of Figure 3 illustrates the relationship between the maginal "effects" of firm digitalization and the country's E-governance index highlighting a positive relationship and significant hetereogeneity across countries. In fact, the maginal effects are statistically different from zero only when the E-governance index is above 0.5, which is only about half of the sample. The right panel, instead, illustrates the relationship between the maginal "effects" of E-governance and the country's firm digitalization, highlighting a positive relationship, although less steep than the one presented in the left panel.

Figure 3. Estimated Marginal Effects



Source: WBG, UN, IMF, and staff calculations. Note: The Y-axes represent the estimated marginal effects, which are expressed as percent of GDP.

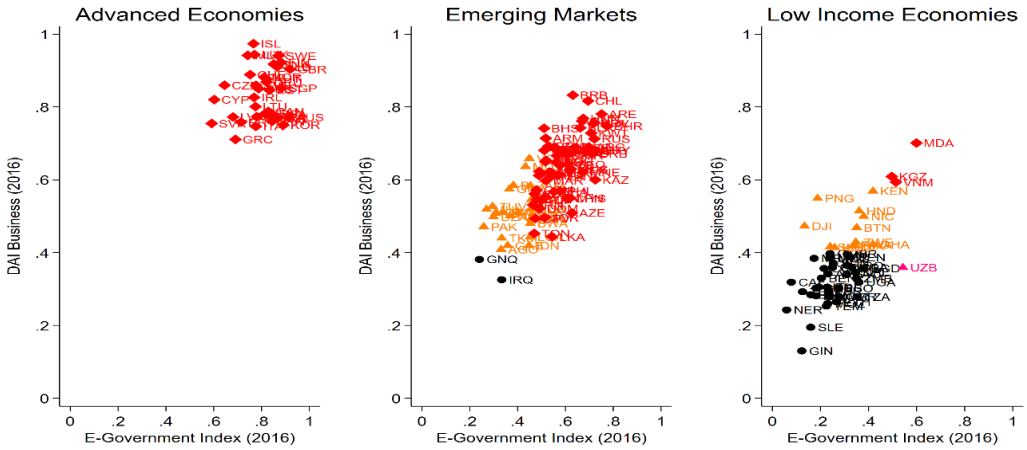
20. **The results on the importance of synergies are robust to the use of many different proxies to measure the digital adoption of government.** While the results presented above rely on the United Nations E-Governance index, they are broadly consistent if, instead, digitalization in the public sector is measured by any of the following: GovTech maturity index from WB, digital connectivity (from Alper and Miktus, 2019), DAI Government subindex from WB (that is, the government-side counterpart of the DAI firm digitalization subindex), or digitalization of revenue administration measures from the International Survey on Revenue Administration (ISORA, see https://www.imf.org/en/Capacity-Development/Training/ICDTC/Courses/ISORA). These results are illustrated in a graphical form in Annex Figure AI.1.

21. **Some countries—especially low-income countries—may not gain much without efforts on both GovTech and firm digitalization.** Figure 4 plots the countries in the sample according to their E-Government and firm digitalization index, separately for advanced economies, emerging markets, and low-income economies. The **red diamonds** indicate countries for which both the e-government and firm digitalization marginal "effects" are positive and statistically significant at 95 percent confidence. The **orange (pink)**

[12] The term "marginal effect" is enclosed in quotes because the causal interpretation of the relationship between digitalization and tax cannot be warranted without a reliable instrument.

triangles indicate countries for which only the e-government (firm digitalization) marginal effect is positive and statistically significant at 95 percent confidence. The **black dots** indicate countries for which neither of the two marginal effects are statistically different than zero. The patterns illustrated by Figure 4 indicate that, because digitalization in business and e-government tend to be positively correlated, countries with low levels of business and government digitalization may fail to reap the full fiscal benefits of digitalization unless they improve together on the two fronts. Unfortunately, low-income countries collect, on average, a small share of GDP in taxes and also have non-significant marginal effects of both business and GovTech, further highlighting the need for a dual approach.[13]

Figure 4. Estimated Marginal Effects of Business Digitalization and E-Government



Source: WBG, UN, IMF, and staff calculations

2. Firm-level Evidence

22. **A firm-level analysis is implemented to test for the digitalization-tax revenues relationship with more granular data.** Orbis is the main source of firm-level information, while digitalization is measured at sector-level based on the share of intermediate inputs sourced from ICT sectors.[14] The Orbis dataset (Bureau van Djik) is the most comprehensive global dataset reporting information from financial statements of private and public firms (e.g., Bloom and others 2012). The paper's sample includes about 36 million non-financial firms, headquartered in 56 countries (31 AEs & 25 EMDEs), over the 2011-2020 period. Firm digitalization ("Digital Intensity" in Table 2) is measured, following Honda and Nose (2023), by the share of intermediate inputs coming from three ICT intensive sectors (manufacturing of computer, electronic and optical equipment; telecommunication; and IT and other information services). This share is calculated from OECD's harmonized Input-Output Tables (2021 edition) reporting inter-sectoral flows of intermediate goods and services across 45

13 Figure AI.2 plots the median value of firm digitalization and E-Government for countries within macro-regions defined by geographical areas and stage of economic development. Groups of countries with similar level of income are clustered together, more than groups of countries from the same geographical areas—with the partial exception of European countries—suggesting the role of economic development is paramount with respect to geographical closeness.

14 ICT sector is defined according to OECD's ICT sector classification (OECD, 2007). It is made up of manufacturing and service industries whose main activity is linked to development, production, commercialization, and intensive use of new technology. The ICT manufacturing includes manufacturing of electronic parts, computers, communication equipment, consumer electronics, and magnetic and optical media. The ICT service includes wholesale of computers, computer equipment and software, telecommunications, and computer and related services.

sectors. We map Orbis's NACE (Nomenclature of Economic Activities) code to OECD's industry classification at 2-digit level.

23. **Table 2 reports descriptive characteristics of profit-making firms in Advanced Economies (AEs) and Emerging Market and Developing Economies (EMDEs).** About 26 percent of firms in the sample did not report tax payments in EMDEs, while nearly all firms pay some amount of taxes in AEs. On average, firms pay approximately 2 percent (1.6 percent) of their turnovers in taxes in AEs (EMDEs). Regarding digital intensity variable, the average share of ICT inputs used for production ranges from 2.4 to 2.6 percent in AEs and EMDEs, with significant variations across sectors, and a standard deviation of 3.2 to 4 percent. In AEs, there is a higher prevalence of established firms, running the business for longer years with the median firm age being 14 in AEs compared to 8 years in EMDEs. The median employment size is 5, with a relatively larger number of employees in AEs.

Table 2. Descriptive Statistics: Orbis

	N	Mean	Std. Dev	P10	P25	P50	P75	P90
Panel A: Advanced Economies								
Tax paid	15,323,618	0.930	0.256	1	1	1	1	1
Log (real tax payments)	16,163,919	8.970	2.300	6.330	7.410	8.857	10.34	11.93
Tax payments/Turnovers	15,842,290	0.021	0.027	0.001	0.004	0.011	0.026	0.053
Digital intensity	19,404,315	0.024	0.032	0.007	0.010	0.017	0.025	0.039
Firm age	19,395,973	18.19	15.30	4	7	14	25	38
Number of employees	19,404,653	25.41	78.05	1	2	5	14	45
Panel B: Emerging Market and Developing Economies								
Tax paid	13,339,673	0.741	0.438	0	0	1	1	1
Log(real tax payments)	11,794,137	7.088	2.166	4.515	5.742	6.935	8.295	9.725
Tax payments/Turnovers	11,565,269	0.016	0.018	0.001	0.003	0.010	0.024	0.037
Digital intensity	17,349,182	0.026	0.040	0.004	0.007	0.015	0.029	0.056
Firm age	17,271,671	10.14	7.894	2	4	8	14	21
Number of employees	17,349,214	21.24	60.71	1	2	5	15	39

Source: Orbis, OECD harmonized input-output table, World Economic Outlook, and staff calculations.

24. **A two-way fixed effect regression at the firm-level investigates the relationship between firm digitalization and tax payments on extensive and intensive margins.** The following estimating equation is considered:

$$y_{icst} = \alpha + \beta \cdot D_{cst} + \gamma \cdot X_{icst} + \mu_c + \tau_t + \mu_c \cdot \tau_t + \varepsilon_{icst} \quad (2)$$

where a unit of observation is a firm i in country c and sector s (NACE 2) and year t. y_{icst} is either (i) a binary variable equal to one if and only if the firm records positive tax payments, to capture the extensive margin, (ii) equal to the log of tax payments , or (iii) the tax payment normalized by operating revenues (turnovers), to capture the intensive margins.[15] At extensive margins, we exclude firms operating at loss (with negative Earnings Before Interest and Taxes (EBIT)) to capture firms compliance in corporate tax payment obligations. D_{cst} is our digital intensity measure for the sector firm belongs to; X_{icst} is a set of controls including firm

[15] The Orbis data do not report separate payments for different taxes, e.g., CIT versus VAT. When firms report negative tax payments, we treat such cases as nonpayment of taxes. Although such cases may include tax refunds, we are unable to identify which firms get how much tax refunds for a year. With these caveats in measurement, our estimates at the extensive margin should be interpreted with caution.

characteristics (firm age, the number of employments, total assets) and macroeconomic conditions (real GDP growth, inflation); and μ_c, τ_t are country and year fixed effects. A country-specific linear trend $\mu_c \cdot \tau_t$ controls for the effect of time-varying country-specific policy factors, such as the change in tax policy. β is our parameter of interest, disciplining the digitalization-tax relationship.

25. **Firm digitalization is associated with a higher probability of paying taxes and larger tax payments on the intensive margin.** Table 3 presents the regression results for firms in AEs (in columns 1-3) and EMDEs (in columns 4-6) separately. With basic firm and macro controls, an increase in the digital intensity index is associated with a higher probability of paying taxes at an extensive margin. Given larger tax non-compliance by firms in EMDEs as shown in Table 2, the marginal impact of firm digitalization contributes more meaningfully to widening tax nets in EMDEs. At the intensive margin, firm digitalization is associated with significantly higher tax payments in both income groups. In columns 3 and 6, we use the ratio of tax payments over firms' turnovers to control firms' ability to pay taxes, narrowing our focus on the impact through tax compliance. The result indicates a significant positive impact on tax compliance with a relatively larger impact in EMDEs. The results are robust to the inclusion of country-specific linear trends.[16]

26. **A comparison between the country- and firm-level results reveals that the estimated impact of digitalization on tax payments is somehow smaller when estimated with firm-level data—highlighting the benefits of more granular data**. A simple calculation—based on the predicted effect of a one-standard-deviation increase in digitalization—provides a transparent comparison between the results of the two analyses.[17] According to the results of Table 1 (column 3), a one-standard-deviation increase in firm digitalization is associated with an increase in tax revenues over GDP by 3 percentage points, in countries with high GovTech, while the impact is not statistically significant in countries with low GovTech. According to the results of Table 3, a one-standard-deviation increase in digital intensity is associated with an increase in tax payments over operating revenue ratio of 0.12 percentage points in AEs and 0.32 percentage points in EMDEs, which are equal to, respectively 6 and 20 percent of firms' average tax payment over turnover ratio in the sample. The normalization of these estimated effects by the mean value of dependent variables allows to compare the results across different approaches. This comparison reveals that both approaches result in estimates of the same order of magnitude, although the firm-level estimates are smaller, suggesting more granular data are useful to controls for potential country-level confounding factors.

[16] At the intensive margin, the effect of firm digitalization on tax payments may be underestimated as high-tech multinationals (e.g., digital platform companies) may be shifting profits to avoid taxes.

[17] Estimating the impact of a one-standard-deviation change to illustrate the magnitude of an empirical estimate is common in the economic and financial literature—e.g., Chodorow-Reich 2014—as one standard deviation covers almost 70 percent of the sample under normality assumption, thus excluding extreme values.

Table 3. Impact of ICT Adoption on Firm Tax Payments

	(1)	(2)	(3)	(4)	(5)	(6)
	Advanced Economies			**Emerging Market and Developing Economics**		
	Tax paid	Log(real tax payment)	Tax payment/ Turnovers	Tax paid	Log(real tax payment)	Tax payment/ Turnovers
Digital intensity	0.408***	2.702***	0.036***	0.075***	3.490***	0.081***
	(0.053)	(0.186)	(0.004)	(0.019)	(0.214)	(0.006)
Observations	13,282,566	11,519,808	11,519,808	15,316,855	15,836,281	15,836,281
Adj. R2	0.147	0.598	0.138	0.0992	0.625	0.119
Number of countries	23	23	23	31	31	31
Firm controls	YES	YES	YES	YES	YES	YES
Macro controls	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Country-specific trends	YES	YES	YES	YES	YES	YES

Standard errors are clustered at country and year level.
* p< 0.1, ** p< 0.05, *** p< 0.01

A. Mechanisms: Heterogeneous Effect of Firm Digitalization

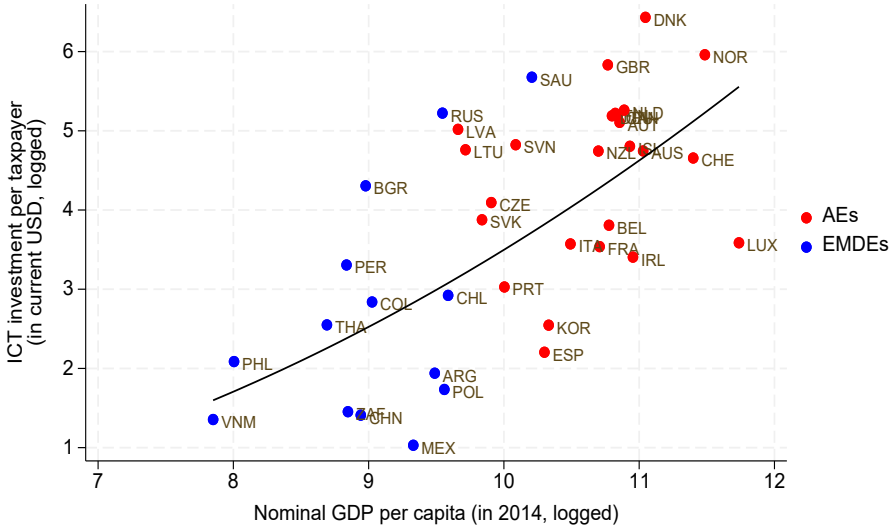
27. **We explore heterogeneity in the digitalization-tax relationship to shed some light on the channels through enhanced tax compliance and the complementarities between government and firm digitalization**. We additionally estimate the interaction term β_3 between business ICT and three aspects of heterogeneity (a variable H): (i) firm size, (ii) level of informality, and (iii) digitalization of tax administration.

$$y_{icst} = \alpha + \beta_1 \cdot D_{cst} + \beta_2 \cdot H_{ict} + \beta_3 \cdot D_{cst} \cdot H_{ict} + \gamma \cdot X_{icst} + \mu_c + \tau_t + \mu_c \cdot \tau_t + \varepsilon_{icst} \quad (3)$$

First, firm digitalization may improve compliance differentially more on smaller firms by simplifying tax filing and reducing their compliance costs, as similarly found in the literature (e.g., Bellon et al. (2022) on e-invoicing). We use the median size of firms in the sample (less than five employees) to define small firms. Second, regarding informality, we measure business informality using cross-country data on informal business and employment (Elgin et al., 2021). High informality is defined as the country where the business informality index is above the global average. Third, on government digitalization (GovTech), the analysis in this section measures the level of ICT capacity in the tax administrative operations or services using the ISORA data that provides information on annual ICT expenditure by each country's revenue agency per corporate taxpayers.[18] As revenue agency's digital spending increases, countries are deemed more ready to provide digital registration and online services to taxpayers. Figure 5 shows large cross-country variations in the level of ICT expenditure in tax administration, with a positive correlation with a country's income level.

[18] Nose and Mengistu (2023) found that the adoption of e-filing could have a positive impact on domestic tax collection only when the revenue agency made large investments in ICT infrastructure.

Figure 5. Revenue Administration ICT Expenditure Per Taxpayers: Cross-country Variations by Income Level



Source: ISORA, WEO, and staff calculations.

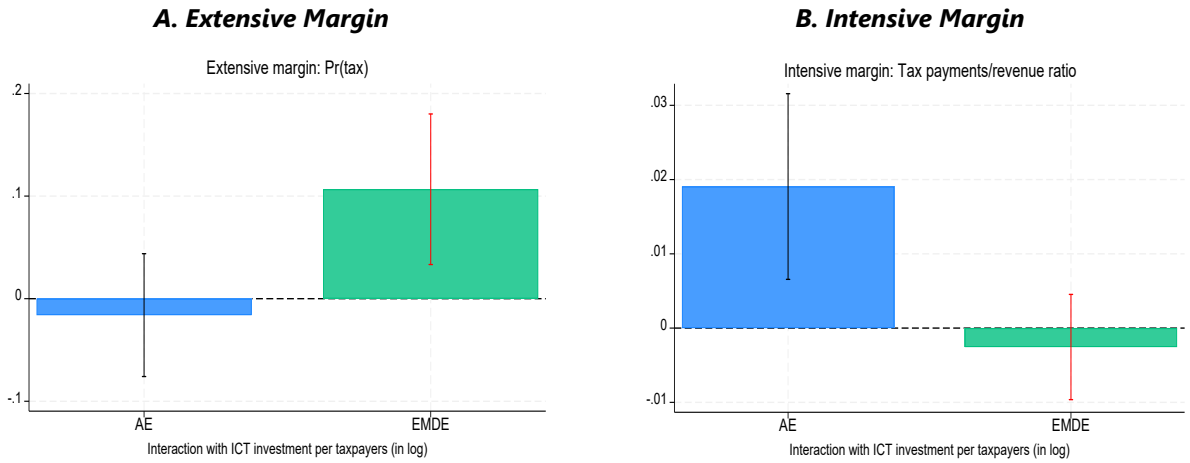
28. **The result confirms the positive synergy between GovTech and firm digitalization.** Figure 6 plots the estimated interaction term between firm digitalization and GovTech (ICT expenditure per taxpayers) (see Annex II for the regression tables).

- At the extensive margin (Panel A), the results suggest its strong complementarity with tax agency's ICT expenditure in digitalizing tax administrations in EMDEs. This reflects the importance of digital tax management and taxpayer registration within the government/tax agency to enhance corporate tax compliance through firm digitalization. Among EMDEs, as ICT expenditure per taxpayers transitions from the 25th to 75th percentile of its distribution (y-axis of Figure 5), one-standard deviation increase in digital intensity leads to a sizable increase in the probability of firms' tax payments by about 11 percent.[19]
- At the intensive margin (Panel B), across countries in AEs, as ICT expenditure per taxpayers transitions from the 25th to the 75th percentile of its distribution, a one-standard deviation increase in digital intensity leads to an increase in tax payments (relative to the operating revenues) by about 1.5 percent from the current level of tax payments in AEs.[20] The impact appears insignificant in EMDEs, underscoring lack of sound institutional foundations in underpinning revenue yields from digitalization (e.g., digital public infrastructure, digital ID) in developing countries. This is consistent with the findings in recent literature (Amaglobeli et al., 2023).

[19] For the sample of EMDEs, the estimated effect is calculated as 2.79 (75th-to-25th range in ICT expenditure per taxpayers (in log) for EMDEs) x 0.04 (one standard-deviation of digital intensity) x 100 = 11.2 percent.

[20] For the sample of AEs, the estimated effect is calculated as 0.48 (75th-to-25th range in ICT expenditure per taxpayers (in log) for AEs) x 0.032 (one standard-deviation of digital intensity) x 100 = 1.5 percent.

Figure 6. Synergy Between GovTech and Firm Digitalization
Coefficient of Interactive Effect by Income Groups

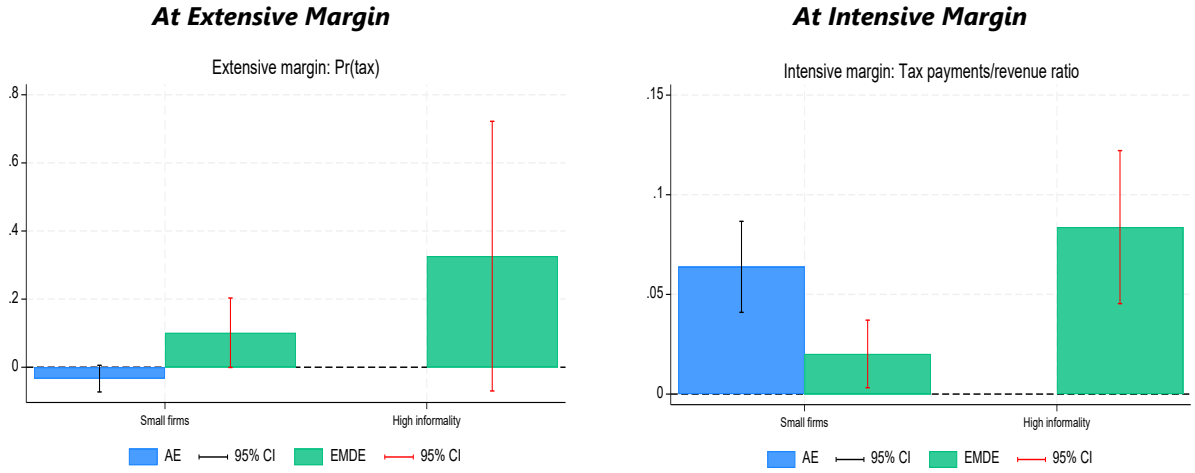


Source: Orbis, ISORA, WEO, OECD, and staff calculations.

Note: Error bars indicate 95% confidence intervals.

29. **The effect of firm digitalization on tax payments is larger for small firms or in countries with high levels of business informality, pointing to compliance as a primary channel of revenue yields (Figure 7).** At the extensive margin (Panel A), we find limited impact overall. At most, firm digitalization has a marginally stronger impact in raising tax payments for smaller firms in EMDEs. At the intensive margin (Panel B), we find stronger efficiency gains in tax collection from smaller firms in AEs. In EMDEs, the magnitude of the effect is relatively smaller than AEs, but still positive and significant gains were found from smaller firms. The level of business informality also affects the magnitude of corporate tax collections in EMDEs. In EMDEs with high level of informality, firm digitalization helps detect tax liabilities and reduce the cost of tax compliance, thereby contributing more significantly to enhanced tax payments.

Figure 7. Compliance Channel: Heterogeneous Effect of Firm Digitalization: Coefficient of Interactive Effect by Income Groups



Source: Orbis, WEO, OECD, Elgin et al (2021), and staff calculations.

Note: Error bars indicate 95% confidence intervals. Small firms and high informality are dummy variables, showing the differential effect relative to the reference group. The interaction with informality is only estimated for EMDEs where business informality is relevant for the analysis.

B. Decomposition of Mean Tax Payments Differentials

30. **We further employ the Oaxaca-Blinder (OB) decomposition to quantify the magnitude of the compliance effect of firm digitalization.** Firms that use ICT inputs more intensively in production may pay more taxes for two potential reasons: (a) **productivity channel** (digital technologies enhance firm productivity, thereby raising their profits) and (b) **compliance cost channel** (compliance costs decrease due to digital tax filing and payments). It is challenging to estimate CIT and VAT compliance gaps as non-compliance behaviors are deliberately concealed and not directly observable in a survey. The RA-GAP methodology has been applied to specific country cases (Ueda, 2018), which however requires granular tax declaration data for compliance gap estimation.

31. **Our approach is similar to the RA-GAP's approach.** Instead of using national account data, we use Earnings Before Interest and Tax (EBIT) and other firm characteristics available from the Orbis data to estimate CIT tax liability to calculate the gap between actual and potential tax payments. We employ a classic linearly separable OB decomposition model (Fortin, Lemieux, and Firpo, 2011) where tax payments are determined by corporate's observable and unobservable characteristics. We include comprehensive observable variables ($\mathbf{X}$) that are primary determinants of firms' tax capacity, including firm age, employment size, profitability, sector difference (manufacturing vs. service), as well as country-level fixed effects ("**explained component**"). Inclusion of country fixed effect controls for the cross-country difference in the level of tax administration capacity, compliance risk management, informality, and other institutional differences. The residual variations in tax payments ("**unexplained component**") are our proxy measure of compliance effect.

$$T_{icsg} = \beta_g \cdot \mathbf{X}_{icsg} + v_{icsg}, \quad \text{for } g = D,\ ND$$

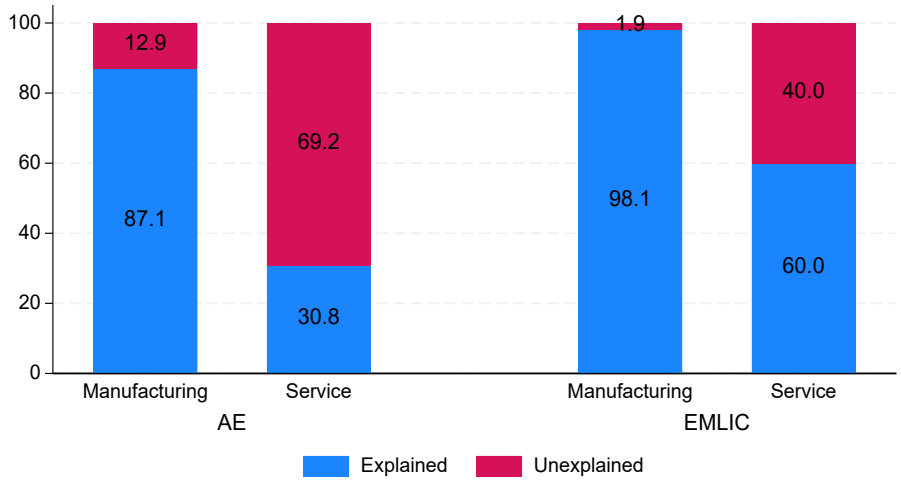
where D (ND) indicates a group of digitalized (less-digitalized) firms. Assuming mean independence and adding/subtracting the average counterfactual taxes that group D would have paid under group ND's

compliance structure, the mean tax payments differential Δ_T can be decomposed into two components as follows:

$$\begin{aligned}\Delta_T &= E[E(T_D|\mathbf{X}_D)|g=D] - E[E(T_{ND}|\mathbf{X}_{ND})|g=ND] \\ &= E(\mathbf{X}_D)\beta_D - E(\mathbf{X}_D)\beta_{ND} + E(\mathbf{X}_D)\beta_{ND} - E(\mathbf{X}_{ND})\beta_{ND} \\ &= \underbrace{\Delta\beta E(\mathbf{X}_D)}_{unexplained} + \underbrace{(E(\mathbf{X}_D) - E(\mathbf{X}_{ND}))\beta_{ND}}_{explained}\end{aligned}$$

The first term is "unexplained component" due to the difference in tax compliance structure between digital and less-digital group (slope difference), while the second term is "explained component" due to the differences in observable characteristics between two groups under the compliance structure of the reference (less-digitalized) group.

Figure 8. Oaxaca-Blinder Decomposition:
Mean Difference in Tax Payments Between Digitalized and Less-Digitalized Firms



Source: Orbis, WEO, OECD, and staff calculations.

Note: Firm age, number of employees, Earnings Before Interest and Tax (EBIT), and country fixed effects are included as observables.

32. **The OB decomposition result suggests that unexplained components including the compliance cost channel explain 40-70 percent of larger tax payments for digital firms compared to non-digital firms in the service sector (Figure 8).** In the manufacturing industry, the positive impact of firm digitalization on tax payments is mostly explained by the observable differences between digital and less-digital firms. In contrast, unexplained components (including the compliance cost channel) explain about 40-70 percent of larger tax payments for digital firms compared to non-digital firms in the service industry. The contribution of unexplained component to mean tax payment differences is pronounced for service industry where tax compliance is generally weaker than manufacturing industry.

IV. Conclusions

33. **Using a combination of country-level and firm-level analyses, the paper demonstrates a positive relationship between firm digitalization and tax revenues.** Countries with higher level of business digital adoption have larger tax-to-GDP ratios, and this relationship remains robust even when controlling for a rich set of structural, cyclical macroeconomic, institutional quality, and tax policy factors, suggesting a potential causal link. Firm-level analysis shows that firms using more ICT in their production processes are more likely to pay taxes, pay higher taxes, and contribute a larger share of their operating revenues in taxes compared to other firms in the same country and year. An important caveat of these analyses is that, while results are robust to controlling for several relevant confounding factors, no highly credible instrumental variable (or natural experiment) for firm digitalization across different countries could be found. Thus, a causal interpretation of this relationship is likely but cannot be established with certitude.

34. **The magnitude of the relationship is significant, conditional on the level of GovTech**. The paper provides estimates for illustrative purposes, showing that a one-standard-deviation increase in firm digitalization is associated with an increase in tax revenues-to-GDP by up to 3 percentage points (based on country-level estimates) and with an increase in the ratio of tax payments to corporate turnover by up to 0.12-0.32 percentage points (firm-level estimates). When we scale the impact by the sample mean of respective outcome variables, the magnitudes of the effect are broadly comparable – an increase by about a fifth of average tax revenues-to-GDP ratio (country-level) and by 6-20 percent of firms' average tax payment over turnover ratio (firm-level). These estimates suggest that if low-income countries could achieve the level of firm digitalization seen in advanced economies, the gap in the tax-to-GDP ratio between these groups would be nearly halved. However, these benefits of firm digitalization are contingent on having a high level of GovTech. In other words, if the level of GovTech is low, our results suggest that such benefits may not materialize.

35. **This paper highlights the significant role of enhanced compliance with firm digitalization.** The firm-level analysis underscores the importance of the compliance channel, showing a stronger relationship between digitalization and tax payments for smaller firms and those in countries with higher informality. The OB decomposition exercise further indicates that unexplained components including the compliance cost channel account for approximately 40 to 70 percent of the observed relationship between digitalization and tax payments in the service sector.

36. **There is evidence of significant synergy effects between digitalization efforts at businesses and public administrations.** Country- and firm-level analyses both reveal some synergy effects of firm digitalization and GovTech. That is, the estimated tax gains from firm digitalization are larger in countries with higher GovTech maturity (and vice versa). The relationship between firm digitalization and tax revenues is stronger when governments are also more digitalized, revealing significant synergies. The country-level relationship between firm digitalization and tax revenues is significantly positive only among countries that have an above the median level of E-government. Similarly, the positive relationship between GovTech and tax revenues is stronger when firms are also more digital. The firm-level analysis also confirms that the relationship between the use of ICT inputs and tax payments is stronger in countries where revenue administrations actively invest and adopt digital technologies.

37. **The results of this paper call for a *dual approach* to digitalization: To maximize the benefits of tax collection, it is essential to promote both GovTech and firm digitalization**. A policy mix that modernizes tax systems and promotes firm digitalization has a greater impact on tax collection because of the

synergies between public and private digitalization. Policies supporting the digitalization of public administration can encourage similar advancements in private firms, leading to greater overall gains. Additionally, the fiscal costs of investments in digitalization may be offset by future tax revenue increases, suggesting that coordinated digital improvements yield higher returns and potentially alter cost-benefit analyses for public investments, especially in constrained fiscal environments.

38. **The paper underscores another policy implication: investing in digitalization will pay off by boosting future tax revenues**. Policies fostering both public and firm digitalization require fiscal support for providing universal broadband connectivity and/or incentivizing taxpayers to accelerate ICT investments (Amaglobeli et al., 2023). However, given the relatively modest costs estimated for achieving universal broadband access (SDG 9) in the literature (Oughton et al, 2023),[21] the initial digital investment costs would be well offset by the expected high returns through enhanced tax collection in the medium-term. Because of the synergic impact of public-private digitalization on revenues, the fiscal "net" cost of investments would be significantly low when the investments to enhance digitalization at both firms and public administration are done together. This provides an important policy implication as these future additional tax revenues should be reflected in considering the cost-benefit analysis of digital-enhancing public investments, especially for countries with limited fiscal space.

39. **The analyses reveal significant differences between advanced economies and developing countries.** In AEs, firm digitalization has a greater impact on tax payments, suggesting the importance of supportive environments to maximize the benefits of digitalization. In developing countries, it is essential to create enabling environments for firm digitalization and GovTech, and to address any constraints to achieve their synergy effects. In this regard, identifying and addressing any constraints that might hinder the synergy between firm digitalization and GovTech are essential for reaping revenue yields from digitalization. However, an important caveat is that, while investing in IT equipment for public administration, in digital literacy, or in digital infrastructure can have a beneficial impact, the institutional and legal frameworks as well as organization strength and staff competency at the tax administration —which are more difficult to improve—need to be updated in parallel for the adoption of technology (Acemoglu 2025).

[21] According to Oughton et al. (2023), the provision of universal 4G cellular broadband access is estimated to cost at most $418 billion (about 0.45 percent of global GDP) across the globe.

Annex I. Country-level Analysis: Additional Tables and Figures

Table AI.1. Digitalization, CIT Productivity, and VAT C-efficiency

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	CIT productivity				VAT C-efficiency			
Business Digitalization	0.0939***	0.0176	0.0661	0.0546	0.569***	0.396	0.470*	0.123
	(0.033)	(0.115)	(0.101)	(0.086)	(0.081)	(0.253)	(0.277)	(0.326)
E-Government Index		-0.207	-0.262	-0.273**		-0.454	-0.193	-0.0898
		(0.147)	(0.175)	(0.106)		(0.380)	(0.314)	(0.330)
Household Digitalization		-0.0319	-0.0330	0.00243		0.577	0.594	0.786*
		(0.155)	(0.154)	(0.159)		(0.354)	(0.361)	(0.431)
Macro Controls		X	X	X		X	X	X
Institutional Quality			X	X			X	X
Tax Policy				X				X
R2	0.0333	0.216	0.262	0.379	0.168	0.296	0.413	0.450
Observations	281	269	269	212	249	238	238	189
Mean Dependent Var	.13	.13	.18	.13	.54	.54	.54	.54

Source: WBG, UN, IMF, and staff calculations

Table AI.2. Business Digitalization and Tax Revenues – 2016 only or Controlling for Lagged Tax Revenues

	2016 data only				Include lagged tax revenues			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Tax revenues (nontrade) / GDP							
Business Digitalization	0.262***	0.208***	0.180***	0.215***	0.0387***	0.0293*	0.0252*	0.0314**
	(0.030)	(0.059)	(0.058)	(0.061)	(0.012)	(0.015)	(0.015)	(0.014)
E-Government Index		0.0689	0.0982*	0.0505		0.00506	0.0183	0.0203
		(0.063)	(0.058)	(0.068)		(0.016)	(0.016)	(0.014)
Household Digitalization		0.0695	0.0578	0.0965		0.0378*	0.0412**	0.0309*
		(0.069)	(0.068)	(0.069)		(0.021)	(0.020)	(0.018)
Lag of Tax revenues (nontrade) / GDP					0.880***	0.842***	0.835***	0.864***
					(0.035)	(0.026)	(0.024)	(0.026)
Macro Controls		X	X	X		X	X	X
Institutional Quality			X	X			X	X
Tax Policy				X				X
R2	0.411	0.572	0.613	0.653	0.932	0.954	0.957	0.965
Observations	145	140	140	133	290	281	281	262
Mean Dependent Var	.16	.16	.16	.16	.16	.16	.16	.16

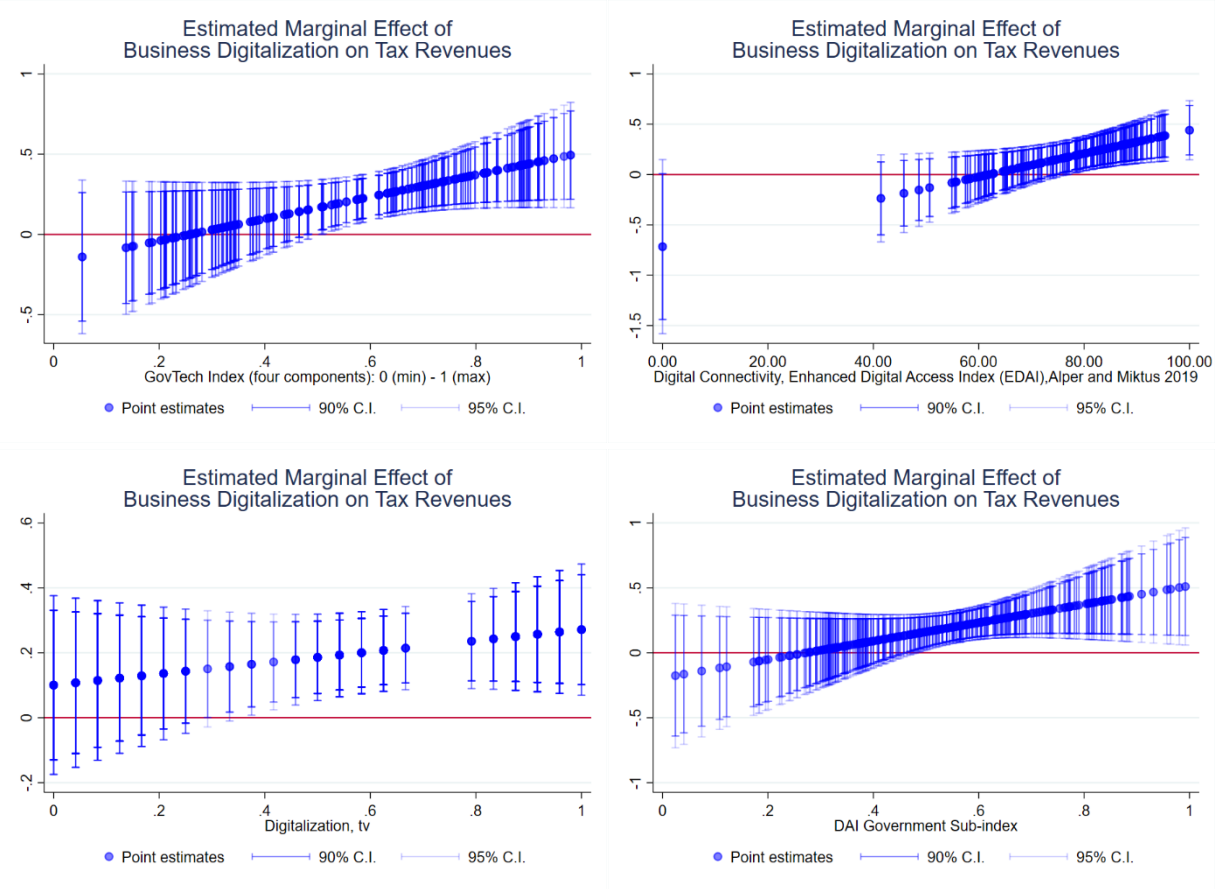
Source: WBG, UN, IMF, and staff calculations

Table AI.3. Parameter Estimates from Linear Interaction Model.

	(1) **Tax revenues (nontrade) / GDP**
β	-0.334 (0.236)
α	2.438 (1.481)
θ	1.067** (0.430)
Macro Controls	**X**
Institutional Quality	**X**
Tax Policy	**X**
R2	0.659
Observations	262

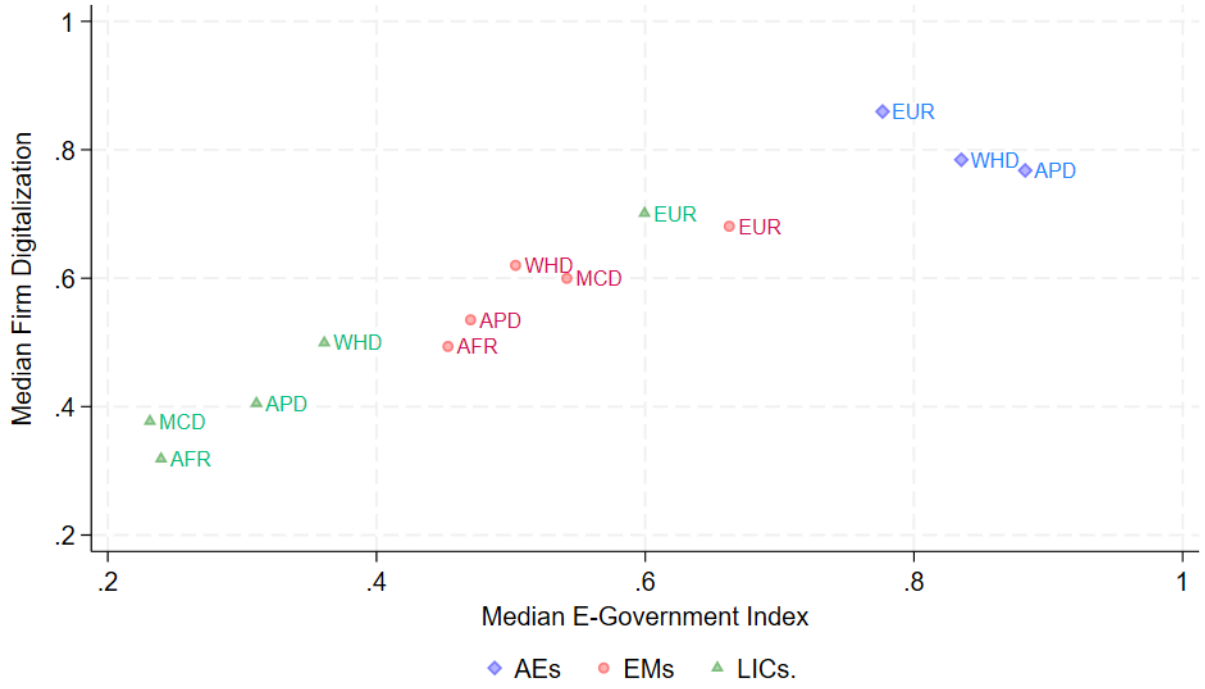
Source: WBG, UN, IMF, and staff calculations.
Note: parameters estimate from the following equation (1) in the main text.

Figure AI.1. Marginal "Effects" of Business Digitalization on Tax Revenues: Robustness to the use of Different Measures of Government Digital Adoption



Source: WBG, UN, IMF, and staff calculations

Figure AI.2. Business Digitalization and E-Government by Macro-regions



Source: WBG, UN, IMF, and staff calculations

Table AI.4. Business Digitalization and Tax Revenues – Alternative Tax Policy Controls

	(1)	(2)
	Tax revenues (nontrade) / GDP	
Business Digitalization	0.254***	0.138*
	(0.031)	(0.072)
E-Government Index		0.0171
		(0.057)
Household Digitalization		0.106
		(0.069)
Macro Controls		X
Institutional Quality		X
Tax Policy	X	X
R2	0.476	0.579
Observations	290	281

Note: tax policy controls are the top PIT, CIT, and VAT rates. For countries with missing data, the rate of each tax is assumed to be the average than those in other countries at the same level of economic development. Source: WBG, UN, IMF, and staff calculations.

Annex II. Heterogeneous Impact of Firm Digitalization: Regression Tables

Table AII.1. Heterogeneity: Firm Tax Payments and Digital Intensity

Panel A. Advance Economies

	(1) Tax paid	(2) Tax payment/ Revenue	(3) Tax paid	(4) Tax payment/ Revenue	(5) Tax paid	(6) Tax payment/ Revenue	(7) Tax paid	(8) Tax payment/ Revenue
Digital intensity	0.144	-0.006	0.096***	0.044***	0.082***	0.103***	0.026	0.051***
	(0.126)	(0.023)	(0.027)	(0.004)	(0.024)	(0.011)	(0.046)	(0.003)
Digital x ICT investment/taxpayers	-0.016	0.019***						
	(0.031)	(0.006)						
Digital x Small firm			-0.033*	0.064***				
			(0.020)	(0.012)				
Digital x High informality					-0.180*	-0.041***		
					(0.104)	(0.011)		
Digital x Service sector							0.045	0.031***
							(0.037)	(0.007)
Observations	8064843	8025253	15316855	15836281	2672091	2812446	15316855	15836281
Adj. R2	0.104	0.0922	0.0979	0.120	0.125	0.142	0.0980	0.119
Number of countries	29	29	31	31	17	17	31	31
Firm controls	YES	YES	YES	YES	YES	YES	YES	YES
Macro controls	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Country-specific trend	YES	YES	YES	YES	YES	YES	YES	YES

Standard errors are clustered at country and year level.
∗ p< 0.1, ∗∗ p< 0.05, ∗∗∗ p< 0.01

Panel B. Emerging Market and Developing Economies

	(1) Tax paid	(2) Tax payment/ Revenue	(3) Tax paid	(4) Tax payment/ Revenue	(5) Tax paid	(6) Tax payment/ Revenue	(7) Tax paid	(8) Tax payment/ Revenue
Digital intensity	0.068	0.056***	0.363***	0.027***	0.392***	0.028***	0.419***	0.019***
	(0.179)	(0.018)	(0.058)	(0.003)	(0.044)	(0.003)	(0.105)	(0.002)
Digital x ICT investment/taxpayers	0.107***	-0.003						
	(0.037)	(0.004)						
Digital x Small firm			0.101*	0.020**				
			(0.052)	(0.009)				
Digital x High informality					0.326	0.084***		
					(0.202)	(0.020)		
Digital x Service sector							-0.029	0.021***
							(0.136)	(0.005)
Observations	6164644	4394066	13282576	11519818	12528443	10748683	13282576	11519818
Adj. R2	0.0648	0.147	0.140	0.135	0.135	0.139	0.141	0.134
Number of countries	16	16	25	25	24	24	25	25
Firm controls	YES	YES	YES	YES	YES	YES	YES	YES
Macro controls	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Country-specific trend	YES	YES	YES	YES	YES	YES	YES	YES

Standard errors are clustered at country and year level.
* p< 0.1, ** p< 0.05, *** p< 0.01

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Leveraging Digital Technologies in Boosting Tax Collection
Working Paper No. WP/2025/089