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Technology and Tax: Adoption and Impacts of E-services in Rwanda

Fabrizio Santoro, Adrienne Lees, Marco Carreras, Theonille Mukamana, Naphtal Hakizimana, Yves Nsengiyumva

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Summary

Many low-income countries are increasingly digitising various tax services, usually motivated by efforts to increase efficiency and transparency and reduce the burden of compliance for taxpayers. However, where awareness and adoption are suboptimal, tax e-services may produce only partial benefits. In this paper, we examine the adoption of tax e-services in Rwanda, a low-income country which has invested significant resources in digitalising government service delivery and made tax e-services mandatory from 2015. Using a combination of panel survey and tax administrative data, we study the drivers and impacts of e-services awareness and adoption. We find evidence that, before the pandemic, female and less educated taxpayers, with less sophisticated businesses, were left behind in technology adoption, even where e-services were the only option for taxpayers. Exploiting the outbreak of COVID-19 during our data collection, we also study shifts precipitated by a shock that normalised digital transactions. Take-up of e-services is remarkable two years after the pandemic, but still not universal. For those not using the e-services the same challenges in access persist – indicating the potential for more targeted policy interventions. Interestingly, technology adoption is not strongly related with filing behaviour, and we study the reasons why non-filers report using the tools and, on the contrary, why active filers report they do not. Also, we do not find any significant impact of e-services adoption on perceived fairness of the tax system and overall willingness to pay, which we hypothesised benefit from e-services. Finally, using evidence from qualitative interviews, we highlight practical challenges in using e-services, such as connectivity problems and slow systems, which undermine the potential benefits.

Keywords: technology, tax compliance, tax administration, digital financial services.

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Contents

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Acronyms

CIT	Corporate Income Tax
FGD	Focus group discussion
LMICs	Low and middle income countries
PIT	Personal Income Tax
RRA	Rwanda Revenue Authority
SSA	Sub-Saharan Africa
TIN	Taxpayer identification number

Introduction

Many aspects of life in low and middle income countries (LMICs) have been digitalised recently. Tax administration, including filing returns and making tax payments, has not escaped this trend (Arewa and Davenport 2022; World Bank 2016).[1] Across Africa, many countries – including Rwanda, the country under study – have adopted some form of electronic filing systems, often incorporating electronic payment of taxes through digital financial services (ATAF 2021).[2] The COVID-19 pandemic has added a new impetus to these digitalisation efforts, as governments seek to simultaneously improve tax collection by bolstering compliance and reduce in-person interactions (Okunogbe and Santoro 2021).[3]

It is believed that digitalising tax filing and payment can have a range of benefits. First, e-services might reduce the compliance burden on taxpayers, by reducing the effort required to file and pay taxes and minimising the need for time-consuming visits to tax offices. This is particularly relevant for small taxpayers in Sub-Saharan Africa (SSA), who typically face higher compliance costs (Mascagni, Santoro and Mukama 2019; Okunogbe and Pouliquen 2022; Aiko and Logan 2014; Yilmaz and Coolidge 2013). Relatedly, online facilities might improve taxpayers' experience, by enabling access to salient information, improving record-keeping and making it easier to monitor one's own tax compliance. Second, opportunities for corruption and rent-seeking can be reduced by minimising in-person interactions with tax officials. If officials are no longer required to verify submissions and receive payments, this can guard against obstruction and extortion, particularly in contexts, like SSA, where mistrust in tax officials is high (Chalendard, Duhaut, Fernandes, Mattoo, Raballand and Rijkers 2020; Ouedraogo and Sy 2020; Isbell 2017). Third, from the perspective of tax administrations, e-services can reduce staffing needs, lowering the cost of tax collection and increasing efficiency. Ultimately, these three factors might improve the perception of the fairness and reliability of the tax system, boosting tax morale and willingness to comply (Prichard et al 2019, Arewa and Davenport 2022).

However, realising these benefits depends on high levels of awareness, adoption, and active usage of e-services by taxpayers. Existing literature shows that, for instance, lack of information could be one of the key barriers to adopting new technologies (Foster and Rosenzweig 2010), and that actual usage requires a significant know-how component (Conley and Udry 2010; Janvry, Macours and Sadoulet 2017; Munshi 2004). If specific barriers hamper access to and usage of e-services, a digital divide can arise among users, with important consequences for fairness and equity. As a result, governments have adopted several strategies to boost awareness and usage, such as making e-filing and e-payment mandatory (Santoro, Amine and Magongo 2022), phasing out paper-based returns, and simplifying tax procedures, to enhance the ability of taxpayers to use these systems directly (Kochanova, Hasnain and Larson 2020).

Despite these efforts, tax e-services have not always delivered on their potential (Okunogbe and Santoro 2021). It is also unrealistic to believe that take-up of any technology could be

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1 As of 2015, 32 per cent of developing countries had introduced e-filing (World Bank 2016). For further detail on these systems in Rwanda, Kenya, Uganda, Nigeria, and Eswatini see Ndayisenga and Shukla (2016), Mayega, Ssuuna, Mubajje, Nalukwago and Muwonge (2021), Gwaro, Maina and Kwasira (2016), Mas'ud (2019), and Santoro, Amine and Magongo (2022).

2 Research by ATAF in 2016 found that 12 revenue administrations (RAs) had ICT systems allowing electronic registration, filing, and payment of taxes. By 2018, that number had increased to 23 in a sample of 26 African RAs. Seventeen of the RAs had modernised their tax collection processes with electronic filing and payment of taxes (ATAF 2021).

3 This is particularly relevant in sub-Saharan Africa where in-person interactions with tax officials were the norm before the pandemic. In African countries, 72 per cent of firms report being required to meet with tax officials, and for those affected, 3.2 meetings are held on average each year. In contrast, 37 per cent of firms in Europe and Central Asia are required to meet with firms and of those affected, 2.1 meetings are held on average (Okunogbe and Santoro 2021).

universal, especially in challenging contexts, and the adoption of any useful service is likely to be staggered over time, since it implies overcoming significant transition costs and information asymmetries. A growing literature from both high- and low-income countries shows that take-up of IT solutions outside of tax is far from being universal (Srinivasan and Burrell 2013; Casaburi and Reed 2014; Nakasone, Torero, and Minten 2014; World Bank 2016; Arewa and Davenport 2022). However, relatively little is known about the adoption of tax e-services in LMICs, especially Africa.

In this paper, we fill the gaps in the literature by focusing on Rwanda. Rwanda has established itself as a leader among LMICs in the deployment of administrative e-government systems.[4] Since 2015, online filing and online payment of taxes has been mandatory, facilitated by two e-services: *E-tax*, a free web-based platform designed to be used on computers and smartphones, and *M-declaration*, a feature phone-based application designed for taxpayers which enables mobile money payments and a simpler process for filing a return.[5] However, even when all filing is now done online, in practice, many taxpayers rely on assistance from tax officials or employ tax accountants, and therefore may remain unaware of e-services or unable to realise the time and cost-saving benefits.[6] Our research answers the following questions: (i) what drives the awareness and adoption of tax e-services; and (ii) how has the practical experience with tax e-services affected taxpayers' perceptions of the fairness of the tax system and their broader willingness to comply? We also exploit the unanticipated COVID-19 shock, which normalised digital transactions and shifted people away from in-person interactions, and test whether this had an impact on the adoption of e-services. This was a salient shock in Rwanda, where the government response to the crisis was especially swift and severe (Mascagni and Santoro 2021), with a rapid corresponding shift to digital solutions – as shown in our paper, more than 90 per cent of the sample under study started to use any e-services two years after the pandemic started.[7]

We apply a mixed methods approach, using administrative data from the tax register and returns, a nationally representative panel survey of 2,000 income taxpayers with baseline information collected pre-COVID-19 and four follow-up rounds after the pandemic hit, and focus group discussions (FGDs) with 24 e-services users. This data is merged using taxpayer identification numbers from the RRA database. At the baseline, before the outbreak of COVID-19, we explain awareness and adoption by a mix of variables drawn from survey and administrative data. Due to the panel nature of our survey, we can also measure shifts in e-services adoption precipitated by the COVID-19 shock. Throughout our analysis, we distinguish between incorporated businesses and sole traders, and between different filing behaviours – those who are registered but fail to submit declarations (non-filers), those who submit entirely empty returns, with zeroes reported in all fields (nil-filers) and those who submit non-zero returns (active filers), in line with recent literature (Mascagni and Santoro 2021; Santoro 2021).

We present four key findings. First, we explore determinants of awareness at baseline (January 2020). Female, less educated taxpayers, with less sophisticated businesses, are significantly less aware of the e-services, even when these are the only way to comply. We

[4] The latest World Bank GovTech Maturity Index, an indicator of public sector digital transformation, ranked Rwanda above the average for low-income countries (Dener, Nii-Aponsah, Ghunney and Johns 2021). The *Irembo* e-government portal is especially notable. This system facilitates citizens in submitting applications and making payments for a large number of government services.

[5] M-declaration is typically used by presumptive taxpayers, who, by virtue of lower earnings, are subject to a simplified tax regime. E-tax, in contrast, covers all tax types. This is discussed in more detail in section 1.

[6] In this paper, we use the language of 'users' and 'non-users', but the reader should bear in mind that non-users are taxpayers whose filing is processed online by another agent (a tax accountant, a Rwanda Revenue Authority (RRA) official), as all tax returns have to be filed online.

[7] For instance, *The New Times*, a leading daily newspaper, reported that the weekly value of mobile money payments at merchants increased by 700 per cent between mid-February and mid-April 2020. https://www.newtimes.co.rw/news/mobile-money-transactions-grow-450-3-months

also find that interactions with the RRA show a strong positive correlation with awareness, suggesting that the RRA plays a role in sensitising taxpayers. Second, similar evidence emerges when studying actual adoption before the pandemic. Again, female taxpayers, and the less knowledgeable and sophisticated taxpayers, have lower rates of adoption. Social media use is an important correlate for sole traders, which suggests that the RRA could employ more targeted communication strategies through social media channels. Third, we find that, two years after COVID-19, the take-up of any e-service rose substantially (Figure A1a), and also show that the widespread usage of mobile money during the pandemic strikingly correlates with the probability of starting using the e-services. Interestingly, filing behaviour is not correlated with technology adoption at baseline, and only weakly correlated after the pandemic. Fourth, we do not find any strong impact of e-services on perceived fairness, an outcome which e-services is thought to improve. Relatedly, we do not see any significant effects on intrinsic motivations to comply with taxes. The FGDs highlighted a multitude of practical challenges in using e-services, such as connectivity problems and a slow system, which might illustrate why tax perceptions do not improve. Such challenges might also explain why non-filers report using the e-services to about the same extent as other filing categories (Figure A1b), yet fail to comply.

Our results add to the small, but growing, literature on the adoption of tax e-services in LMICs showing important disparities in adoption, as well as a hiatus between policy intentions and actual practice. Research from Nigeria indicates that taxpayer education, age, technology readiness, and the use of an external auditor can constrain take-up of e-filing, especially for small taxpayers (Efobi, Beecroft, Belmondo, and Katan 2019; Mas'ud 2019). Sifile, Rodgers, Tendai and Desderio (2018) find that connectivity, as well as a lack of technical knowledge and training, are major barriers to take-up in Zimbabwe. Using an experimental design in Tajikistan, Okunogbe and Pouliquen (2022) confirm that providing training and information, something that Rwandan users call for as well, significantly increases e-filing adoption. Using cross-country data, Kochanova *et al*. (2020) show that implementing complementary online services, such as e-payments, enhances the potential of e-filing – a positive relationship that we also find. Regarding the impacts of e-services, Okunogbe and Pouliquen (2022) find that e-filing reduces compliance costs for adopters and increases payments from taxpayers who were more likely to evade before the intervention, by reducing the potential for collusion.[8] Similarly, Kochanova *et al*. (2020) find that e-filing significantly reduced the likelihood of inspection by tax officials in the Central Asian region. A recent study in Uganda found positive and significant impacts of two complementary interventions – a taxpayer registration and education campaign, and an e-filing mandate for taxpayers in the simpler presumptive tax regime – on the number of taxpayers filing returns and on tax revenue (Jouste, Nalukwago and Waiswa 2021). Finally, data from the World Bank Doing Business indicates that the introduction of e-services in Ethiopia reduces the time taken to file and pay taxes by an average of 25 per cent after five years (World Bank 2015).[9]

We make several contributions to this literature. First, we add new knowledge by separately studying companies and sole traders, as well as different taxpayer types (non-filers, nil-filers, and active taxpayers). Second, we compare patterns for two distinct e-services, targeted at taxpayers with different levels of sophistication. Mobile phone and mobile money solutions, like M-declaration, are particularly relevant given the dramatic growth of phone ownership and digital financial services in Africa (Arewa and Davenport 2022). In this way, we also link to the abundant literature on the beneficial impacts of mobile money services (Jack and Suri 2014; Lee, Morduch, Ravindran, Shonchoy and Zaman 2021; Suri and Jack 2016; Riley

[8] Interestingly, for taxpayers who were less likely to evade, tax payments reduced, suggesting that e-services also reduced the potential for coercion.

[9] Exceptionally positive examples come from Belarus (from 987 hours to 183 hours), Costa Rica (from 402 hours to 163 hours), and Kenya (from 432 hours to 202 hours).

2018). Third, we aim to present a more comprehensive picture through a mixed methods approach, which is rarely used in this literature, with the exception of Mascagni, Santoro, Mukama, Karangwa and Hakizimana (2022). Fourth, we connect take-up of IT tools and the recent COVID-19 crisis, similar to Santoro, Amine and Magongo (2022).[10]

More broadly, we contribute to the literature on the potential for new technologies to improve tax administration in low and middle income countries (LMICs) (Arewa and Davenport 2022; Okunogbe and Santoro 2021; World Bank 2016; Bird and Zolt 2008). Alongside e-filing and e-payment facilities, recent research has particularly focused on the potential of electronic fiscal devices. These are growing in popularity and can yield large revenue gains (Mascagni, Mengistu and Woldeyes 2021; Bellon, Matthieu, Dabla-Norris, Khalid, Lima, Rojas and Villena 2019; Ali, Shifa, Shimeles and Woldeyes 2015; Eissa and Zeitlin 2014). However, they suffer from similar barriers to adoption, including poor connectivity, inadequate infrastructure, limited knowledge, and low technological readiness (Mascagni, Dom and Santoro 2021; Eilu 2018). Our results also echo those in the wider literature on e-government projects (Banerjee, Duflo, Imbert, Mathew and Pande 2020; Lewis-Faupel, Neggers, Olken and Pande 2016; Callen, Gibson, Jung and Long 2016), pointing to major challenges in accessibility and usability (Aker and Cariolle 2020) and the lack of digitally enabled citizen feedback (World Bank 2016).

Finally, this paper has significant policy relevance. Rwanda has been identified as a leader in the digitalisation of government (Schreiber 2018), and the tax administration has made significant investments in strengthening data management systems and designing e-services for taxpayers. Our findings suggest that discrepancies between government mandates and actual practices still persist, and that more can be done to increase the awareness and adoption of tax e-services. Specific categories of taxpayers remain unaware of these tools and rely on tax officials or accountants to file their returns online. This has dampened the potential of e-services to streamline the tax filing and payment experience and improve taxpayer sentiment. Without realising these practical effects, digital government projects, such as e-services, risk failing to provide their full intended benefits.

In what follows, we start by presenting the context in section 1. In section 2, we describe in detail the research design. Results on drivers of uptake are presented in section 3, which also includes evidence around shifts in usage after COVID-19. Impacts on perceptions are discussed in section 4. Section 5 concludes.

1 Context: Rwanda, e-services and the COVID-19 crisis

1.1 Tax system

Rwanda shares many of the challenges common to tax administrations in LMICs, from limited resources to high levels of informality.[11] Despite these challenges, prior to the COVID-19 pandemic, the Rwandan tax-to-GDP ratio had seen steady growth, rising to 16.7 per cent in 2019, slightly above the average of 16.3 per cent for sub-Saharan African countries, and

[10] We also connect with Mascagni and Santoro (2021) who explore the broader COVID-19 impacts on taxpayers' attitudes, perceptions and behaviour, but do not focus on tax digital tools.

[11] According to Schneider and Williams (2018), informality amounts to 36 per cent of national income over the period 2008–2017, compared to 42 per cent in East Africa.

outperforming the average for low-income countries by over 4 percentage points (Appendix Figure A2).[12]

In this paper, we focus on the two main income taxes – Corporate (CIT) and Personal Income Tax (PIT) – which accounted for approximately 20 per cent of total revenues in 2019 (RRA 2020). Both taxes apply to businesses: PIT on non-incorporated businesses with a single owner and CIT on corporations.[13] These are both filed annually, by no later than 31 March of the following tax period. While the tax rate for CIT is a uniform rate of 30 per cent on the profit, the tax rate for PIT follows a progressive schedule (RRA 2017). Income taxpayers can also either file under the 'real regime', a full reporting regime where detailed books of accounts are required, or under the presumptive, simplified, regimes (the 'lump sum' and 'flat amount' regimes) if earnings fall below a certain threshold (RRA 2017). As we will see in section 2.2, CIT payers are typically larger and more sophisticated than PIT ones and are often too large to qualify for the presumptive regime.

The compliance gap for income taxes is particularly concerning in Rwanda, as in other similar contexts. Three distinct filing behaviours have been identified. The first are non-filers, or those who fail to submit a declaration when liable to do so. Non-filers tend to be the norm in Rwanda, despite the high penalties for failure to file,[14] and more common among PIT rather than CIT payers.[15] This pattern has been found in other LMICs, such as Uganda (Kangave, Waiswa and Sebaggala 2021) and Eswatini (Santoro 2021). Secondly, some taxpayers file, but report zero on all fields of their return (zero income, zero tax due, etc), thus providing no information, and no tax revenue, to the RRA. Nil-filing is widespread in Rwanda and more common within CIT than PIT payers.[16] This is also common in other contexts (Mascagni *et al*. 2022; Santoro and Mdluli 2019; Mascagni and Mengistu 2016). Non-filers and nil-filers both result in zero tax payments and are thus unproductive in revenue terms (Moore 2020). Third, active taxpayers file a non-zero return, although they may still under-report their income and tax liability. In Rwanda, from 2011-2019, about 48 per cent of CIT and 81 per cent of PIT filing populations were active taxpayers. To account for this multifaceted compliance challenge, we consider all three categories in our study.

1.2 E-services

The RRA has implemented a number of digital reforms in recent years – from digitising customs and domestic tax management, to introducing technological solutions for taxpayers, including electronic fiscal devices and e-filing and e-payment systems (Appendix Table A1; Schreiber 2018). E-services became mandatory for all taxpayers in 2015, with the aim of replacing paper returns and cash-based tax payments, reducing the need for in-person interactions with tax officials and reducing the time taken to settle tax liabilities.[17] E-tax is a free tax web-platform which works on computers, tablets, and smartphones and requires

[12] ICTD/UNU-WIDER GRD – Government Revenue Dataset (2021). https://www.wider.unu.edu/project/grd-%E2%80%93-government-revenue-dataset Figures refer to total tax revenues, excluding non-tax revenue.

[13] All businesses are immediately registered for Income Tax during business registration. This is either Personal Income Tax (PIT) or Corporate Income Tax (CIT) depending upon the number of shareholders that are registered. If there is only one shareholder, the taxpayer is registered for Personal Income Tax (PIT). If there is more than one shareholder, the taxpayer is registered for Corporate Income Tax (CIT).

[14] A non-filer is subject to a fine for late payment, depending on the period: 20 per cent of the tax due if the time limit for declaration and payment has not been exceeded by 30 days; 40 per cent of the tax due if the time limit for declaration and payment has been exceeded by thirty (30) days but has not been exceeded by 60 days; 60 per cent of due taxes if the time limit for declaration and payment has been exceeded by 60 days.

[15] In the period 2011-2019, they amount to 74 per cent and 39 per cent of PIT and CIT taxpayer populations, respectively.

[16] About 52 per cent of filing CIT payers report nil returns, compared to 19 per cent of PIT ones. This behaviour may suggest that CIT businesses engage in strategic filing decisions, aiming to avoid severe fines for non-filing but limiting their tax liability through nil-filing, a pattern documented elsewhere in Africa (Santoro and Mdluli 2019; Santoro, Groening, Mdluli and Shongwe 2020).

[17] Qualitative evidence indicates that RRA's mandating of e-filing and e-payments reduced the time it took businesses to prepare, file, and pay taxes from 119 hours in 2015 to 109 hours in 2016 (Fichers and Naji 2020).

internet connection. Launched in 2011, it is intended to centralise all tax processes, such as filing and paying of taxes and claiming refunds. It covers all tax types, from income tax to VAT, except for local taxes (Appendix Figure A3). In contrast, M-declaration functions on feature phones through USSD technology and can be used offline. It has more basic functionality and a less sophisticated interface than E-tax (Appendix Figure A4). This application, launched in 2013, is an alternative for less sophisticated taxpayers, and can only be used for a limited set of tax types.

The differences in design follow a clear policy intent. E-tax is meant to be used by income taxpayers filing in the real regime, as they need to share more detailed information on their activity and are required to remit multiple taxes (income tax and VAT at minimum). M-declaration, instead, is targeted at presumptive taxpayers (in the flat amount or lump sum regimes) and those paying motor vehicle or transport income taxes (mostly moto-taxi drivers). M-declaration users have to indicate their overall annual turnover and their flat amount or lump sum income tax is automatically determined in the app. Some exceptions exist, by which presumptive taxpayers can also use E-tax if they want to. Both services enable tax payments through digital financial services. E-tax allows taxpayers to use internet banking (a mobile wallet), while M-declaration facilitates mobile money payments, which can be made offline.

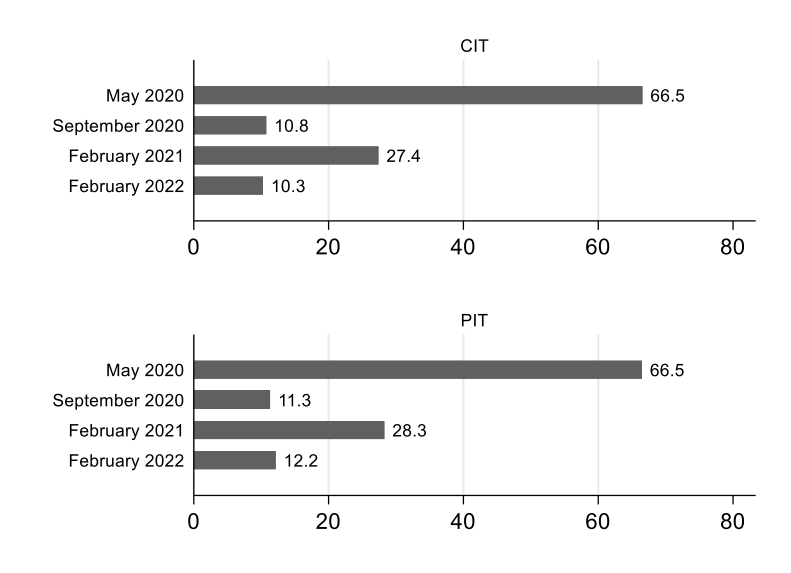
1.3 The COVID-19 crisis

Rwanda's experience with COVID-19 has been similar to that of other low-income African countries, where case numbers have remained relatively low, but government measures have been quite strict (Mascagni and Lees 2022). As shown in Appendix Figure A5, the first COVID-19 case was reported in Rwanda on 14 March 2020, more than a month after the completion of the baseline survey data collection (more details in section 2.1). Restrictions on movement, including school closures and a ban on public gatherings, were introduced on the same day. On 21 March, lockdown measures were intensified, with the suspension of international and domestic travel, a dusk to dawn curfew and all but essential workers being required to work-from-home. These restrictions were in place until early May, after which restrictions generally remained more relaxed and case numbers below 1.5 per million people. Although the number of cases in 2020 remained relatively low, the stringency of Rwanda's lockdown is comparable to countries with much higher incidences of COVID-19 and many more deaths (Appendix Figure A6). The situation worsened in early 2021, when the country experienced an unprecedented spike in infections. A second lockdown was imposed only in the capital Kigali, while the rest of the country was subjected to softer restrictions.

A recent study of the impact of the pandemic in Rwanda, based on data from VAT declarations, shows that economic activity contracted by 10 per cent in 2020, with the largest drop corresponding to the strictest lockdown regulations in April 2020 (Mascagni and Lees 2022). Our survey data, which is restricted to small and medium firms, who do not necessarily pay VAT, shows similar patterns. Both CIT and PIT businesses in Rwanda were hit by the pandemic in May 2020, when more than two-thirds of the businesses reported being closed for reasons related to COVID-19 (Figure 1). The share of closed businesses significantly drops in the next survey round (September 2020), in line with more relaxed measures and a lower case count. The share of impacted businesses increases again in early 2021, consistent with the renewed incidence of the pandemic from January 2021, especially in Kigali.[18] In early 2022, the share of impacted businesses falls again in line with the less concerning pandemic situation, getting back to the level of September 2020 (Figure 1). In the analysis below, we exploit the business closure as a measure of the exposure to COVID-related shocks, to understand the role played by the pandemic in promoting or hampering the adoption of e-services (sections 2.3 and 4).

[18] Such a pattern is confirmed in another survey-based study on Rwandan firms (Tourek 2018).

Figure 2 Share of businesses closed due to COVID-19 pandemic



Source: Authors' own calculations using ICTD survey data, multiple rounds.

2 Research design

2.1 Data sources

We use three data sources: a nationally representative taxpayer survey, administrative tax data from RRA, and FGDs. The survey captures taxpayer profiles in detail, with information on business practices, tax attitudes and perceptions. We use this data to study the drivers of awareness and adoption, before and during the pandemic, and the impacts on perceived fairness and willingness to comply. Administrative data provides more information on taxpayers and their filing behaviour. Finally, with FGDs, we uncover underlying mechanisms behind the main findings. The novel combination of these datasets allows us to gain a more complete picture of a taxpayer's profile and produce more precise results.[19] Taxpayer identification numbers allow us to unambiguously connect the three data sources.

2.1.1 Rwanda National Taxpayer Survey

The survey covered approximately 2,000 taxpayers registered for income tax, nationally representative of the population of taxpayers in Rwanda (section 2.2). We hired a Kigali-based survey company, with abundant experience in running similar surveys in Rwanda, to perform the exercise.[20] It was originally planned as a one-off exercise, through in-person interviews in January–February 2020. After the COVID-19 outbreak in March 2020, we expanded the number of rounds to study the impacts of the pandemic. These later interviews were performed over the phone, with aspects of attrition discussed in section 2.2. The initial interviews became the baseline, with the same sample targeted in May 2020 (round 1), September 2020 (round 2), February 2021 (round 3), and February 2022 (round 4). The timing of follow-up rounds corresponds to some key stages of the pandemic in Rwanda: round 1 is implemented soon after the first national lockdown; round 2 takes place during substantial reopening; round 3 is run at the height of a second wave of infections

[19] A similar example of the combination of such data sources in the tax and development literature, also in Rwanda, is provided by Mascagni, Dom and Santoro (2021).

[20] We received ethical approval from the National Institute of Statistics of Rwanda in January 2020.

corresponding with a second lockdown, localised in the capital city; and round 4 is in a relatively stable situation two years into the pandemic.

For the sake of this study, we mostly make use of baseline and rounds 3-4 surveys as they include key data on e-services adoption (section 2.2 below). Thus, we first look at adoption in a context essentially free of COVID-19 in early 2020 and compare this to data collected one and two years later, when the effects of COVID-19 on business activity and the economy are very much established. Rounds 1 to 4 are used to keep track of COVID-related shocks to business activity throughout the year (section 1.3), as this is likely to be a key correlate with shifts in e-services usage.

The baseline survey includes the following key modules: (i) demographics, (ii) business characteristics, (iii) risk aversion, (iv) tax knowledge quiz with eight questions from which a knowledge index is built, (v) satisfaction with public services, (vi) interactions with RRA, (vii) overall tax burden, (viii) tax compliance attitudes and perceptions. Importantly, we included questions about awareness and adoption of e-services (with information about obstacles and issues faced by users), the key outcomes of our analysis. The (shorter) survey rounds 3 and 4 replicates the questions on e-services. Among the limitations of our approach, the questionnaire was not intended to capture compliance costs in detail, an aspect which involves a large number of specific questions around the practical experience of complying. Due to constraints in the length of the survey, we could not implement a specific module on compliance costs, while we rely on adequately measured tax attitudes and perceptions from module (viii). We leave the study of the impacts of e-services on compliance costs to future research.

2.1.2 Administrative data

We have access to the tax registry, which contains information on the universe of taxpayers registered with the RRA, and the CIT-PIT returns and payments data for 2019, which provides information on the filing and payment behaviour before the survey began. Each taxpayer is assigned a taxpayer identification number (TIN), which is consistent across all RRA datasets and is used to merge administrative and survey data.

The administrative data serves three main purposes. Firstly, it was used to identify and locate the surveyed taxpayers (section 2.2). Secondly, it assists in identifying active taxpayers, nil-filers, and non-filers in the most recent tax year (2019), which informed our sampling strategy. Finally, administrative data provides additional information which we use in our model: for instance, whether the taxpayer is registered as a company or sole proprietor, the tax regime under which they are registered, and whether they also pay VAT (section 2.3).

2.1.3 Focus group discussions

In September 2021, we ran four FGDs in Kigali with 24 participants.[21] The first two FGDs, which we label FGD1 and FGD2, involved 13 E-tax users. The second two groups, FGD3 and FGD4, took place with 11 M-declaration users. Taxpayers were randomly drawn from RRA administrative data, as with the survey sample. Inclusion restrictions required that the participants be based in Kigali, for logistical feasibility, and actively filing returns through the e-services.

[21] The FGDs were held on the premises of a private research company in Kigali. Each FGD was led by one ICTD author, with assistance from the Rwandan research company. Each session lasted for about two hours and was conducted in a combination of English, French and Kinyarwanda. The audio recordings of the FGDs and accompanying notes were analysed ex-post using a coding framework organised around a list of key thematic areas. Portions of text were allocated systematically into each theme to identify common patterns and findings across the four focus groups.

The discussions followed a pre-designed structure, consisting of three sections. Part 1 dealt with the e-services in general, to capture taxpayers' broader considerations about what works and what does not. Part 2 sought explanations for the surprisingly muted evidence of impacts on tax attitudes and perceptions. Participants were provided with a hypothetical scenario – the story of a user who is unable to file through the e-service, due to flaws in the tool – and asked to explain what the solution could be based on their experience. Part 3 focused instead on the pandemic and how relevant e-services had become for taxpayers since COVID-19 broke out.

We made sure to extract truthful and honest opinions, especially on sensitive aspects. A local research company was hired to build trust with participants and the local language was often used for the more sensitive issues. Participants were assured that no information would be shared with the RRA and no official from the RRA participated in the recruitment or discussion phases. We encouraged honest opinions by emphasising the policy relevance of the FGDs and the fact they were aimed at helping RRA to improve their e-services.

2.2 Survey sample characteristics

The survey sample consists of 1,968 small and medium taxpayers.[22] The sample was randomly extracted from the RRA taxpayer registry through a stratified randomisation algorithm.[23] The majority (62 per cent) of the sample is based in the capital city, with the remaining 38 per cent located more rurally (Appendix Figure A7).[24] Roughly a quarter of the sample are incorporated businesses, while the rest are sole proprietors, registered for CIT or PIT respectively (see section 1). Although all firms are registered with the RRA, we see the same patterns in filing behaviour discussed above: (i) 6 per cent of CIT and 28 per cent of PIT businesses do not file declarations (non-filers); (ii) 31 per cent of CIT and 23 per cent of the PIT businesses file nil declarations (nil-filers); and (iii) the remaining 63 per cent of CIT and 51 per cent of PIT businesses are active taxpayers. In 82 per cent of the cases, we interviewed the owner of the business, while in 6 per cent of the cases, mostly with incorporated businesses, we spoke to the general manager.[25]

In Table 1, we present more details on the sample characteristics. On average, CIT payers have a lower share of female ownership, have higher education, and more engagement with social media in their everyday life – not specifically on tax.[26] All business characteristics are statistically different between the tax categories, with CIT payers being more established (older), registered in Kigali, and having employees. They are also more sophisticated businesses, with a higher share of book-keeping (74 per cent against just 37 per cent of PIT payers), bank accounts (74 per cent versus 18 per cent), and email usage (49 per cent versus 7 per cent). As expected, CIT payers are also larger – they report seven times the sales of PIT payers, on average.[27]

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22 In order to successfully reach the final sample, enumerators attempted to contact a total of 3,200 taxpayers by phone, to set up appointments for in-person interviews. 474 (15 per cent) of such calls were unsuccessful, as the enumerator did not manage to speak to the respondent on the phone – while of the remaining 2,726, (3,200-474) 758 denied consent, leaving 1,968 participants. The main reason for unsuccessful calls is not picking up after many attempts. Only a small share of unsuccessful calls is due to invalid phone numbers, thus supporting the validity of contact information in RRA's database.

23 Strata variables used are (i) an indicator for being a CIT taxpayer, (ii) an indicator for being registered for VAT, (iii) taxpayer size (micro, small, medium).

24 We included firms registered in 20 out of 30 districts in Rwanda. We dropped the ten smallest districts to facilitate the logistics of data collection, while maintaining the national representativeness of all provinces. The surveyed districts are: Bugesera, Gasabo, Gatsibo, Gicumbi, Huye, Kamonyi, Karongi, Kayonza, Kicukiro, Muhanga, Musanze, Nyagatare, Nyamasheke, Nyanza, Nyarugenge, Rubavu, Ruhango, Rusizi, Rwamagana, and Nyamagabe.

25 Residual categories are business partner (4.6 per cent) and internal accountant (3.6 per cent).

26 We group different social media in one main category. The most common ones are Whatsapp (74 per cent), Facebook (42 per cent), Instagram (22 per cent) and Twitter (15 per cent).

27 Appendix Table A2 gives further details on the sectoral classifications of businesses in the sample.

Importantly, businesses also differ in terms of tax features. CIT payers are almost all registered for the full reporting real regime, as opposed to a third of PIT businesses. Only a small minority of PIT payers use the services of a tax accountant, while almost half of companies do, or are registered for VAT.[28] CIT payers are also much more likely than PIT ones to receive tax-related information from and interact with RRA.[29] Consistent with their size, CIT businesses report higher tax liabilities and payments than PIT ones, although only a third of CIT businesses made a tax payment in 2019, while for PIT businesses this falls to 12 per cent. Finally, as expected, CIT businesses report a higher share of E-tax usage while PIT businesses are more likely to use M-declaration.

Table 1 Main business characteristics

	CIT	PIT	Difference	P-value
Individual characteristics				
Female	24.8%	37.7%	-12.9%	0.000
Age group[30]	3.31 (1.01)	3.29 (1.01)	-0.02	0.655
Higher education	66.9%	26.1%	40.8%	0.000
Using social media	93.2%	70.6%	22.6%	0.000
Business characteristics				
Age of the company	5.7 (3.2)	3.3 (2.7)	2.3	0.000
Kigali	77.2%	57.2%	20.0%	0.000
No employees	23.0%	64.0%	-41.0%	0.000
Keeping books	74.1%	36.8%	37.3%	0.000
Knowledge index	4.2 (1.8)	3.3 (1.7)	0.9	0.000
Bank account	73.9%	18.0%	55.9%	0.000
Uses email for business	48.7%	6.7%	42.0%	0.000
Sales (USD, thousands)	15.5 (65.1)	2.9 (36.1)	12.6	0.000
Tax features				
Real regime	91.1%	36.1%	55.0%	0.000
Tax accountant	46.0%	9.4%	36.6%	0.000
Total formal taxes	3.2 (2.1)	2.0 (1.3)	1.1	0.000
VAT registration	60.7%	7.0%	53.7%	0.000
Get info from RRA	69.6%	47.6%	22.0%	0.000
Interacted with RRA	42.9%	28.4%	14.5%	0.000
Audited	24.0%	25.7%	-1.7%	0.449
Fined	49.5%	44.2%	5.2%	0.045
Nil-filers 2019	31.3%	22.8%	8.5%	0.000
Non-filers 2019	6.0%	28.4%	-22.4%	0.000
Made tax payments in 2019	34.8%	12.2%	22.5%	0.000
Tax payments in 2019 (USD, thousands)	9.9 (26.6)	0.7 (5.1)	9.2	0.000
Aware of any e-service	81.0%	60.2%	20.8%	0.000
Using any e-service	77.4%	55.3%	22.1%	0.000
Using E-Tax	60.9%	36.4%	24.5%	0.000
Using M-Declaration	17.6%	29.8%	-12.2%	0.000
N	**1,485**	**483**		

Source: Authors' own calculations using ICTD baseline survey data and RRA tax admin data.

A final note is due on attrition. Despite our efforts to minimise attrition, inevitably some respondents dropped out during the course of our data period. On round 3, we managed to reach 1,612, or 82 per cent of the initial sample – meaning that we have information on e-services usage after COVID-19 for them only (section 3.3).[31] On round 4 in February 2022,

[28] This is not surprising as companies are more likely to file in the real regime, thus reporting much more information to the authority – hence, the higher need for a tax accountant.

[29] Interestingly, no differences emerge with respect to the history of audits and fines. This may suggest that companies, despite being more likely to interact with RRA, are better equipped to avoid penalties and fines, probably due to their greater use of tax accountants.

[30] Age group categories: 1: 19 or younger; 2: 20-30; 3: 31-40; 4: 41-50; 5: 51-60; 6: 61-70; 7: 71 or older.

[31] For differences across observations in the third wave and those that dropped out, please refer to Table A3 in the Appendix. We generally observed that taxpayers not participating in the third wave are, on average, younger, more educated, with a higher proportion of female compared to those that participated; in addition, the businesses of those

we collected information from 1,396 individuals, or 86 per cent of the sample interviewed in round 3 and 71 per cent of the initial sample. An attrition rate of 29 per cent is somewhat justifiable given the one-year span and the challenging times of data collection. However, all 1,968 taxpayers observed at baseline have been interviewed in at least one of the follow-up rounds, while for 92 per cent of the sample we have at least two follow-up observations. This means that we have information on COVID-related shocks at different points in time during the pandemic for a larger subset of respondents.

2.3 Theoretical framework

In this section, we briefly outline a framework for thinking about the decision to adopt a new tax e-service. The first stage of converting a largely analogue process (and population) into a digitally enabled one is awareness, followed by adoption and, ultimately, active use. From the perspective of a taxpayer (the potential adopter), these outcomes might depend on a number of factors:

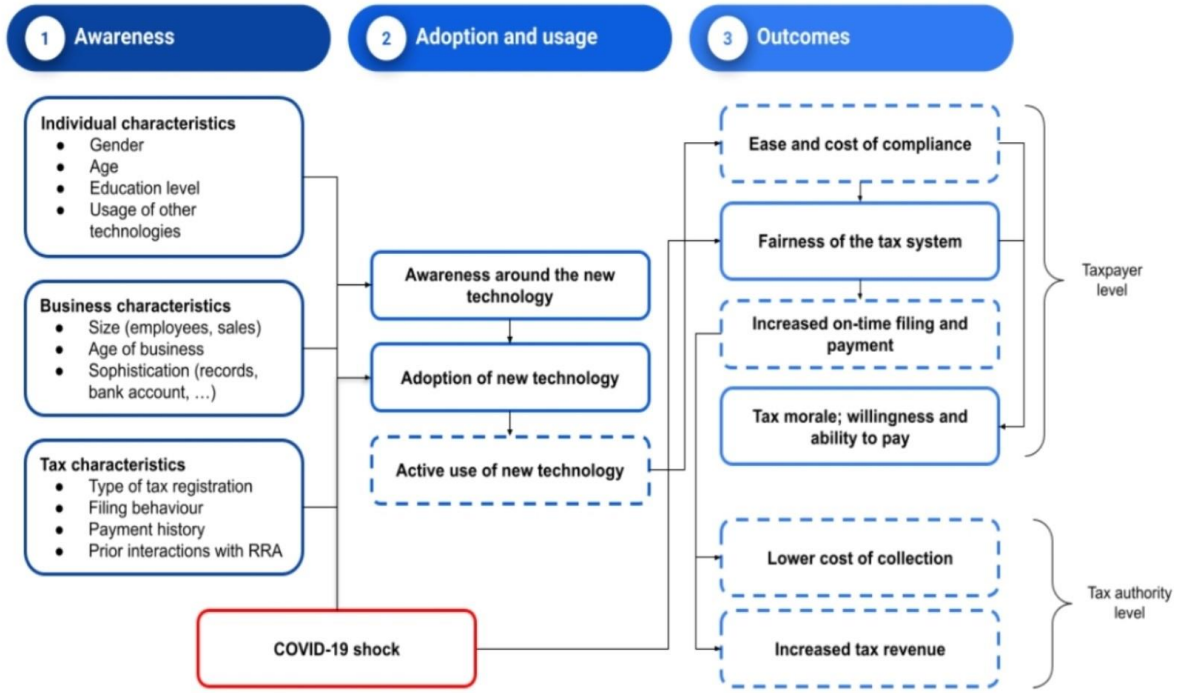
i. **Individual characteristics**: literature has shown that gender, age, and educational attainment can influence awareness of and readiness-to-adopt new technological interventions among taxpayers in Africa (Mas'ud 2019; Efobi *et al*. 2020). We also hypothesise that individuals who are already using other technologies (proxied by social media use) are more likely to be aware of, and ready to adopt, E-tax or M-declaration services.
ii. **Business characteristics**: we hypothesise that a larger, more established, and more sophisticated business is more likely to be aware of, and more likely to subsequently adopt, e-services. Due to the nature of their operations, these businesses are less able to 'hide' from the tax authority and are also more likely to be more familiar with new developments in e-services.
iii. **Tax characteristics**: awareness and usage are also likely to be influenced by the extent of the *existing* engagement with the tax authority. We hypothesise that our outcomes will increase for taxpayers who have registered in the real regime, as well as for VAT, with a history of filing non-zero declarations, paying their liability, and interacting with the tax authorities (whether 'punitively', through previous audits and fines, or just by being supplied with information).
iv. **COVID-19**: Finally, we allow for the COVID-19 shock to influence awareness and adoption of e-services. The presence of COVID-19 has raised the salience of contactless modes of operation and sensitised people towards transacting online, or on their mobile phones through mobile money.

Figure 2 shows this decision flow. In our data, we cannot identify whether a taxpayer is truly an active user of any e-service, or the intensity of their use (for instance, if they just log-in to view tax information, but still rely on visiting a tax office to file or pay taxes). Our analysis therefore concentrates on *awareness* and *adoption* of e-services, two necessary precursors to active use. We also hypothesise that adoption of new technologies (as a proxy for active use) will have various impacts, at the level of both the taxpayer and the tax authority (see Figure 2). Due to the sudden pandemic outbreak, exploding in the 2020 filing period after the baseline survey, we cannot precisely measure impacts on on-time filing and payment rates, tax revenue, or the administrative cost of tax collection (shown in Figure 2 by boxes with dashed lines). A separate study indicates significant COVID-related impacts on tax attitudes and behaviour (Mascagni and Santoro 2021). For a cleaner analysis, we then drop out 2021 filings, although we aim to analyse them more thoroughly in the future. However, we can test whether adoption does in fact improve the perceived fairness of the tax system, and, in turn, boost tax morale or the willingness to comply (represented by boxes with solid lines). Due to

taxpayers not participating in the third wave are more concentrated in Kigali and tend to be more formal businesses, filing CIT and registered in the real regime.

the data constraints discussed in 2.1.1, we cannot directly test whether adoption lowers compliance costs (represented as well by a box with dashed lines), which we leave to future research.

Figure 2 Awareness, adoption, and impacts of new tax technologies



Source: Authors' own construction.

2.4 Evaluation strategy

To test our hypotheses, we first investigate the factors correlated with taxpayers' awareness and adoption of e-services using the probit model in Equation (1) below,

$$Y_i = f(\beta' \, Individ;\ \gamma' \, Business\ ;\ \delta' \, Tax;\ v) \qquad (1)$$

where Y_i is the dependent variable (binary variables indicating awareness and adoption of digital tools), $Individ$ is a vector of individual taxpayer characteristics, $Business$ is a vector of business characteristics, and Tax is a vector of firms' tax features. 'Awareness' is measured through the survey question: '*Are you aware of online or mobile-based options/services provided by the RRA*?' and 'adoption' is measured through the survey question: '*Which of the following online or mobile-based options/services do you currently use?*'. Taxpayers could select E-tax, M-declaration, or both. The corresponding probit coefficients indicating the relevance of each factor are given by β', $\gamma'$and δ'. Sector fixed effects are captured in v. The full set of variables used are detailed in Table 2 below (refer to Table 1 for summary statistics).[32]

In a second step, we rerun our main probit model to explore the correlates with shifts in usage, after the start of the COVID-19 pandemic, according to Equation (2):

$$Y_i = f(\alpha' COVIDshock;\ \beta' \, Individ;\ \gamma' \, Business\ ;\ \delta' \, Tax;\ v) \qquad (2)$$

[32] We do not report here those factors which get omitted due to collinearity. They are variables No TV, Owner, Operative, Email use, EBM use. The summary statistics of these factors are reported in Table 1 for completeness.

The main difference is that now Y_i indicates whether the taxpayer *i* became a new adopter of, or, inversely, stopped using, the e-service one year later, where adoption is measured and defined in the same way as Equation (1).

Table 2 Variables used in the probit models

Individual characteristics	*Business characteristics*	*Tax characteristics*	
Female	Age of the business	Real Regime	Get information from RRA
Age group	Kigali	Tax accountant	Interacted
Higher education	Without employees	Non-filer 2019	Audited
Using social media	Keeping books	Nil-filer 2019	Fined
	(Ln) Sales (USD)	CIT	Knowledge Index
	Bank account	Total formal taxes	Tax payments 2019
		VAT registered	

To the three sets of predictors in Table 2, we add an indicator for whether the business closed due to COVID-related challenges or regulations ($COVIDshock$). As explained in section 1, many businesses were forced to close, especially during the first lockdown in spring 2020, while most reopened in summer. A non-negligible share closed again during the second, localised, lockdown in early 2021 – and then reopened two years into the pandemic (Figure 1). Given the specific context of Rwanda, where e-services have been significantly encouraged since COVID-19 to reduce in-person interactions, we particularly focus on the α' coefficients, to capture the influence of COVID-19 on awareness and adoption.

The first part of this analysis is descriptive – it helps to understand important correlates but does not allow us to claim any causality. The second part, looking at shifts in adoption due to the COVID-19 shock, may point to a more causal connection. The sudden and unexpected nature of the pandemic could be considered as an external random shock, as in Mascagni and Santoro (2021). Hence, we can interpret these results as the impact of COVID-19 on adoption patterns. Finally, the third part of the analysis investigates the relationship between e-services adoption and tax perceptions using information from the baseline survey. In detail, we will use a probit model using Equation (1) and covariates indicated in Table 2 to specifically look at whether digitalising tax services had any significant relationship with perceived fairness in the tax system and willingness to comply.

3 Awareness and adoption of e-services

3.1 What drives awareness of e-services?

Following the model discussed above, Table 3 below reports the results of the probit model with awareness of e-services as the outcome variable, measured at baseline (January 2020). The set of results in column 1 pools all observations, regardless of the category of the business.[33] We will focus our discussion on comparing the results for CIT (column 2) and PIT businesses (column 3).

[33] See Appendix Table A for results from a series of specifications in which the three groups of determinants are added to the regression equation sequentially.

Table 3 Awareness of any tax e-service at baseline, January 2020 (probit regression)

	(1) All	(2) CIT	(3) PIT
	Individual characteristics		
Female	**-0.213*** **	-0.405**	-0.174**
	(0.068)	(0.176)	(0.075)
Age	**-0.112*** **	-0.046	-0.116***
	(0.033)	(0.082)	(0.037)
Higher education	**0.253*** **	0.512***	0.196**
	(0.081)	(0.179)	(0.092)
Using social media	**0.231*** **	0.388	0.265***
	(0.079)	(0.294)	(0.085)
	Business characteristics		
Age of the company	**0.009**	0.041	0.008
	(0.017)	(0.041)	(0.019)
Kigali	**-0.047**	0.273	-0.123
	(0.072)	(0.175)	(0.079)
No employees	**0.056**	-0.107	0.077
	(0.074)	(0.201)	(0.081)
Keeping books	**0.230*** **	0.350*	0.219***
	(0.075)	(0.204)	(0.082)
Knowledge Index	**0.093*** **	0.142***	0.078***
	(0.021)	(0.054)	(0.023)
Bank account	**0.112**	-0.147	0.162
	(0.089)	(0.213)	(0.103)
Uses email address	**0.527*** **	0.413**	0.539***
	(0.126)	(0.187)	(0.186)
Ln sales (USD)	**0.020**	0.008	0.032**
	(0.013)	(0.026)	(0.016)
	Tax characteristics		
Real regime	**-0.333*** **	-0.341	-0.282***
	(0.095)	(0.491)	(0.099)
Tax accountant	**-0.240** **	-0.241	-0.206
	(0.107)	(0.189)	(0.144)
Non-filer 2019	**-0.001**	0.171	-0.032
	(0.088)	(0.215)	(0.099)
Nil-filer 2019	**-0.056**	0.375	-0.069
	(0.109)	(0.600)	(0.113)
CIT	**0.275** **	-	-
	(0.112)		
Total formal taxes	**0.094*** **	-0.001	0.135***
	(0.030)	(0.059)	(0.036)
VAT reg.	**-0.175**	0.193	-0.391**
	(0.117)	(0.199)	(0.159)
Get info from RRA	**0.159** **	0.435**	0.107
	(0.066)	(0.177)	(0.072)
Interacted	**0.335*** **	0.455***	0.306***
	(0.072)	(0.174)	(0.082)
Audited	**0.003**	0.164	-0.025
	(0.075)	(0.186)	(0.083)
Fined	**-0.099**	0.076	-0.131*
	(0.065)	(0.160)	(0.072)
Ln Tax payments 2019	**0.012**	0.006	0.011
	(0.009)	(0.018)	(0.011)
Observations	**1,963**	473	1,485
Sector Fixed Effects	**Yes**	Yes	Yes
Pseudo R-sq.	**0.146**	0.280	0.110

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Coefficients are marginal effects from a probit model. Variables are described in detail in section 2.4.

Source: Authors' own calculations using ICTD baseline data.

Before discussing the probit results, it is worth stressing that, before COVID, awareness of RRA e-services is not universal, despite these services being mandatory for tax filing and payment. Survey data shows that as many as 19 per cent and 40 per cent of CIT and PIT payers, respectively, are not familiar with either E-tax or M-declaration (Table 1). This further

motivates the need to understand the drivers of awareness in more detail, especially for policymakers.

From Table 3, we extract three key findings. Firstly, individual characteristics play a significant role in explaining awareness. There is a clear gender dimension – being female reduces the probability that CIT and PIT payers are aware of e-services by 40 and 17 percentage points, respectively. Having a higher education significantly increases awareness, with stronger effects for CIT businesses (a 51 percentage point increase versus 20 percentage points for PIT). Interestingly, age and social media use are only relevant for e-services awareness in PIT businesses. This might indicate younger, more socially connected taxpayers, with small businesses, find e-services, particularly M-declaration, suitable for their needs.

Secondly, in terms of business characteristics, a higher score on the tax knowledge quiz is significantly correlated with increased awareness of e-services, as is having a business email address. These variables both reflect a higher degree of taxpayer education and digital readiness. We also find that book-keeping and having higher monthly sales are significant predictors of awareness for PIT payers, which could indicate that awareness increases as these small businesses grow and adopt better business management practices.

Finally, tax characteristics are more important for PIT businesses than CIT. The negative effects of being in the real regime or registered for VAT are surprising, albeit this may indicate that larger businesses are more likely to delegate tax matters to accountants instead of dealing with filing by themselves, hence less likely to know about the e-services. Awareness increases as PIT businesses become more engaged, through paying more in formal taxes or interacting with the RRA. Interestingly, non-filers and nil-filers were not significantly less (or more) aware of e-services than active taxpayers – a lack of correlation which will come up when studying adoption as well.

Evidence from the FGDs largely confirms the patterns above. Firstly, taxpayers learned about e-services through a combination of informal channels, such as word-of-mouth or through friends,[34] and more formal interactions with the government (RRA staff, local representatives, *Irembo*).[35] RRA marketing campaigns on social media, television, and radio were also key channels of information.[36] However, some participants noted that the current communication channels, particularly social media, exclude certain parts of the population, such as those in rural areas.[37] It would seem that digital marketing campaigns are not yet a full substitute for tax education delivered by officials or other government representatives in person. Importantly, interviews with the RRA indicate that taxpayers may be actually using

[34] P1 from FGD1: 'I got to know it through my friends; they taught me how to file and submit.' P5 from FGD1: 'I got to know about E-tax through my husband who is an accountant.' P5 from FGD2: 'I think I just stumbled on the information back then from people who were talking about it then they had to check to know what it was in detail.' P1 from FGD3: 'When I became a taxpayer, I asked people who are used to tax how they did and they told me all about it.'

[35] P4 from FGD2: 'I got the training from RRA in 2013.' The same happened to P6 from FGD1. P2 from FGD4: 'When we started using this system, Ngali people (local authorities) passed by every venue telling us how to use it.' P3 from FGD4: 'I mostly got information from RRA.'

[36] P6 from FGD2: 'I heard about it at RRA when they start introducing it then on TV and radio, so I started looking about it how it works.' P2 from FGD3, also linking to previous note, 'knew it from radio adverts but also when we went to declare at RRA they told us that there is a new way to declare which is M-declaration and they guided us on how to do it'. P5: 'I got to know about it through radio and TV adverts.' P4 from FGD3: 'I used to go to *Irembo* and they declared for me but afterwards they told me that there is a new way (M-declaration) and they taught me how to use it.'

[37] P2 from FGD2: 'You know these things of going on TV, radios, etc… there is another bad thing that happens when it comes to communication from Revenue, most information is on Twitter but who goes on Twitter you get it? Like 10 per cent of the entire population knows Twitter…'. P3 from FGD4: 'The way RRA advertises is still poor compared to other companies. For example, MTN and Airtel advertise to the extent that they even put billboards on street lights but because RRA is the government they don't care because if you are late they will charge you penalties.' P2 from FGD4: 'RRA should have one way that is known to all, a way in which it passes all the information that it wants to communicate to the population. So, I think they should find a way either on billboards, TV adverts, SMS, radio adverts, etc.'

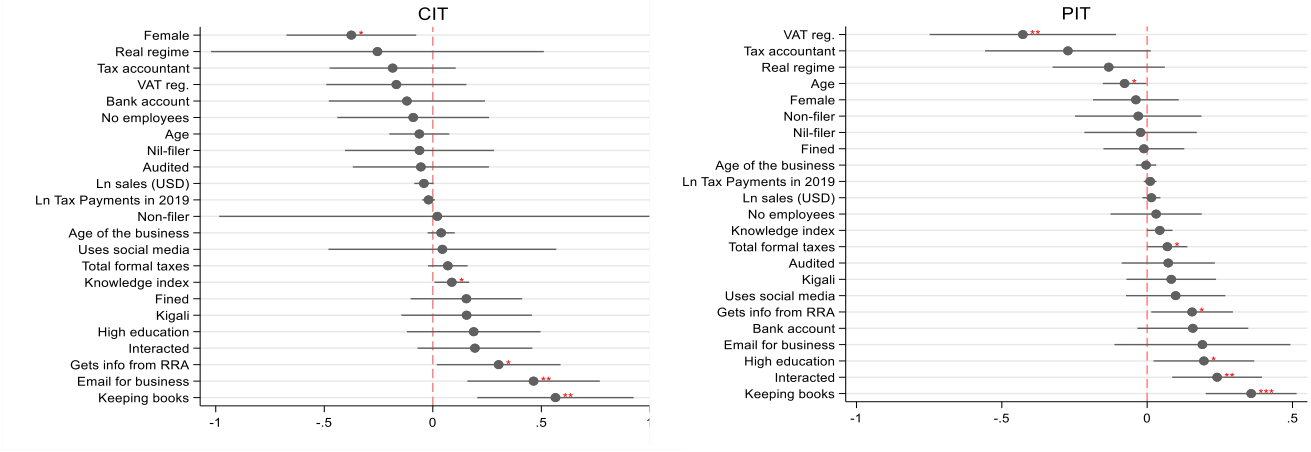
the tools, but not be aware of their specific name, again stressing the importance of sensitisation and marketing campaigns.

3.2 What drives adoption of e-services? The pre-COVID-19 situation

We now turn to the adoption of e-services at baseline (January 2020), considering the factors affecting adoption for E-tax and M-declaration separately. To appreciate the results visually, we present coefficient plots for CIT and PIT businesses in the figures below (Appendix Table A5 shows the full probit results). Firstly, we explore the factors related with E-tax adoption. Table 1 shows that 61 per cent of CIT and 36 per cent of PIT payers report that they are using this service. For CIT businesses, the gender gap persists. Female owned businesses are 37.5 percentage points less likely to adopt e-services. Unsurprisingly, improved tax knowledge, having a business email address, and keeping books are significantly and positively correlated with adoption. These variables all point to more sophisticated businesses which have already adopted digital business practices.

For PIT businesses, patterns on adoption are in line with those on awareness (Table 3). The VAT registration of the business and the age of the business owner are negatively correlated with E-tax adoption, by -7.7pp (-3 per cent) and -43pp (-16 per cent) respectively. In contrast, knowledge of the tax system, the number of formal taxes paid, receiving information or having an interaction with RRA, level of education, and book-keeping all positively affect the probability of adopting E-tax. The positive influence of these factors again indicates that better equipped taxpayers, with more interactions with the RRA, are more likely to adopt e-services.

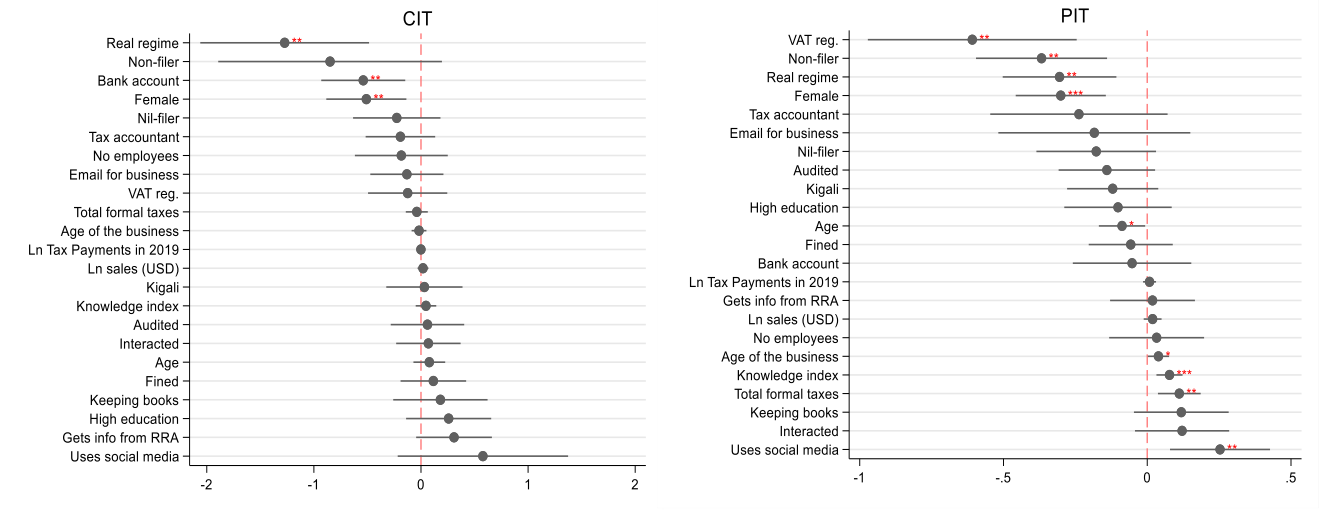
Figure 3 Factors affecting the adoption of E-tax at baseline, January 2020



Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients are marginal effects from a probit model. Variables are described in detail in section 2.4.
Source: Authors' own calculations using ICTD baseline data

Secondly, we look at the correlates of adopting M-declaration, which 17 per cent of CIT and 30 per cent of PIT payers report using (see Table 1). For CIT businesses, the registration in the real regime (127 pp) and having a bank account (54 pp) are negatively related with the adoption of M-declaration. This evidence seems to be in line with the fact that larger and more sophisticated companies opt for the E-tax service which is more suited to their needs (see section 1.2). The negative correlation between adoption and female owned businesses follows previous results, suggesting that gender is playing a key role in fostering IT adoption.

Figure 4 Factors affecting the adoption of M-declaration at baseline, January 2020



Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients are marginal effects from a probit model. Variables are described in detail in section 2.4. Source: Authors' own calculations using ICTD baseline data.

For PIT businesses, VAT registration, being a non-filer in 2019 (19 pp), having a female owner (34 pp), registration in the real regime (40 pp) and, to a lesser extent, taxpayer age (6 pp) are all factors negatively related with the adoption of M-declaration. Interestingly, this is the only case in which taxpayer filing behaviour plays a role in explaining adoption.[38] Being a PIT non-filer decreases M-declaration adoption, which is consistent with the non-compliant behaviour of these taxpayers. We also find that tax knowledge (7 pp), total formal taxes paid (6 pp) and the use of social media (24 pp) positively affect the likelihood of adopting M-declaration. Interestingly, being connected on social networks, which was already explaining PIT payers' awareness (Table 2), is the strongest covariate of M-declaration adoption.

In sum, we find that increased business size and sophistication positively correlates with adopting E-tax over M-declaration, in line with the design of the platforms. The negative correlation with female ownership is somewhat concerning and might call for some targeted tax education from the RRA. The FGDs confirmed that many taxpayers simply do not have sufficient knowledge about taxes broadly, and low adoption of e-services is linked to this lack of information.[39] Participants also highlighted the use of intermediaries (tax accountants) to file and pay taxes on behalf of taxpayers, despite the tools being designed to facilitate taxpayers themselves. This suggests that some taxpayers do not have the confidence that they are capable of filing and paying their taxes for themselves.[40] Relatedly, there is a certain resistance to change, particularly among older, more rural taxpayers, who prefer the security of paper-based records and statements, which M-declaration does not generate. This might

[38] The fact that non-filing does not correlate with usage might be due to a number of reasons. Non-filers, as emerged from interviews with the RRA, may be using the tool for other purposes, such as looking for information, communicating with the RRA, or even paying taxes other than income taxes, as with local government fees. They might also be using the tool but then fail to file due to limited familiarity and IT-savvyness.

[39] P1 from FGD1: 'There are many business owners that don't know how to read or even write so they won't know how to comply with the government's rules and regulations sometimes.' P4 from FGD1: 'And the reason why many taxpayers are not familiar is because they are ignorant about that, they don't have much information about the E-tax.' P4 from FGD3: 'There are some people in rural areas that don't even know how to use phones, family of many people that use only one phone thus they can't have time to learn how to declare.'

[40] P5 from FGD1: 'The reason why many people aren't aware of the E-tax I think is because they think it's a job reserved to accountants and only, so they prefer hiring someone to do it rather than learn and do it themselves even later on. They don't think of themselves capable of doing it.' P6 from FGD1: 'Secondly many people give the job to others to do it so they never learn.'

indicate that taxpayers who are less comfortable with technology do not fully trust these services.[41]

3.3 COVID-19 and changes in the adoption of e-services

Rwanda's economy has struggled significantly with the effects of COVID-19. Many businesses have been forced to close, sometimes just temporarily, due to government mandates or reduced economic opportunities (Figure 1 and section 1.3). These shocks might be important in understanding shifts in adoption and usage of e-services. Taxpayers might stop using e-services to trade 'out-of-sight' of the tax authority or to reduce the costs associated with tax compliance, when business resources are scarce. On the other hand, the RRA has campaigned intensively for 'going fully digital', promoting the usage of e-services for taxpayers to avoid physical interactions with RRA officials, many of whom are working remotely.[42]

To understand these patterns, we exploit the panel nature of the survey data and rely on the four follow-up survey rounds collected in between May 2020 and February 2022 (section 2.1). During the last two rounds of the survey in February 2021 and 2022 we asked respondents whether, since the last interview, they have used either E-tax or M-declaration. Comparing the answers with those given at the baseline, we can map shifts in usage over time. Overall, e-services uptake has been remarkable over the last two years (Figure A1a). Interestingly, even nil- and non-filers increasingly report using the e-services (Figure A1b) – thus suggesting only a weak correlation between technology adoption and compliance behaviour (see footnote 39). Studying the patterns of shifts in usage in more detail, Table 4a and 4b report these changes, by February 2021 and 2022 respectively, in terms of the number of taxpayers and the percentage of total taxpayers in each category.

Table 4a Adoption of tax e-services after COVID-19 – by February 2021

		E-Tax	M-Declaration
Stopped using in 2021		*12.3%*	*14.9%*
		199	240
No change	*Never used*	*24.3%*	*60.5%*
		393	976
	Always used	*28.9%*	*12.6%*
		466	203
Started using in 2021		*34.4%*	*12.5%*
		554	203
Total		**1,612**	**1,612**

Source: Authors' own calculations using ICTD baseline and third survey round data

[41] P4 from FGD3: 'They have mindsets that are not easy to change so that they can learn, they believe they can't do it themselves.' P3 from FGD4: 'I think it is due to routine, people have routines that they don't want to let go.' P3 from FGD3: 'Especially older people that are used to keeping records of papers, they want to continue that way, that's why they choose *Irembo* over M-declaration so that they can keep every record.'

[42] Interview with RRA, 8 July 2021.

Table 4b Adoption of tax e-services after COVID-19 – by February 2022

		E-Tax	M-Declaration
	Stopped using in 2022	*2.8%*	*15.9%*
		39	222
No change	*Never used*	*7.0%*	*62.3%*
		97	871
	Always used	*38.2%*	*11.1%*
		534	156
	Started using in 2022	*52.0%*	*10.5%*
		726	147
	Total	**1,396**	**1,396**

Source: Authors' own calculations using ICTD baseline and fourth survey round data

Focusing first on E-tax, we see that, one year into the pandemic, most business owners did not change their usage habits regarding the tool, with a roughly equal split between those that never (24 per cent) and always (29 per cent) used it. Interestingly, more than one-third (34 per cent) of the sample had started using E-tax in the last year. Two years later, in contrast, uptake of new users had risen substantially (52 per cent), while very few stopped using the e-service (3 per cent) With M-declaration, we see, both one year and two years after the start of the pandemic, that 60 per cent of the sample has never used the e-service, with a lower share (12.5 and 10 per cent) of new users than E-tax.

To understand the factors associated with changes in e-service adoption, we return to the model in Equation (1) and add information on business closure due to COVID-19. We focus on usage two years later, in round 4, for simplicity. We also add an indicator for whether the taxpayer increased their usage of mobile money since the advent of COVID-19.[43] The pandemic has increased reliance on mobile money services, which were already ubiquitous in Rwanda.[44] This might play a role in the decision to use E-tax or M-declaration, both of which encourage tax payments to be made using mobile money. The Rwandan government also strongly encouraged the usage of mobile money for person-to-business and person-to-government transactions so to reduce in-person interactions. Unsurprisingly, most taxpayers reported increased usage of mobile money since COVID-19 (Appendix Figure A9).

The analysis below uses a restricted sample: those who had started and those who had stopped using e-services by February 2022. For the first group, we only include new users of e-services, that is, taxpayers who did not use e-services at the baseline but subsequently adopted at least one of the tools. For the second group, we only consider those who reported using e-services at the baseline but had stopped by round 3.

The probit model results are shown in Table 5 below. We identify three key findings. Firstly, business closure in the first year of the pandemic does not significantly shape adoption. However, being closed by two years after the start of the pandemic significantly and sizeably curbs adoption likelihood for M-declaration. These results might suggest that COVID-related business shock is not a key determinant for adoption, at least in the first year. When the crisis persisted, businesses affected by year two might have found it more difficult to comply, and hence are less likely to adopt the technology. The FGDs indicated that while the

[43] The survey question reads: *'How has your usage of mobile money changed after COVID-19?'* Respondents were given three options relative to the change in usage – increased, decreased and stayed the same.

[44] Survey data confirms that almost everyone (98.2 per cent) has a mobile money account, with most of them having used it for many years in the past and only a small share (7 per cent) opened a bank account in 2020, in the year of COVID-19. For 85 per cent of the latter, COVID-19 was the main reason for opening an account.

government encouraged the use of e-services,[45] expecting taxes to be remitted while businesses were closed was seen as unfair.[46]

Secondly, we do find a strong and significant relationship between increased mobile money usage and adoption of the e-services, both for E-tax (col. 1) and M-declaration (col. 2). This is quite indicative of the potential of digital financial services to spur adoption of e-services. In the case of M-declaration, for instance, the rise in popularity came together with the general rise in mobile money usage during the pandemic.

Finally, we see that, for E-tax, keeping books of account is negatively associated with becoming a new user – in line with what found at baseline (sec. 3.2), while being located in Kigali and having higher education positively affects such a shift. Likewise, nil-filers are much less likely to start using the tool – as it could be that they delegate other actors (tax accountants, RRA officials) to file nil on their behalf. Such a finding improves our understanding on the relationship between technology and compliance, mostly hidden when considering usage trends at the aggregate level (Figure A1b). For M-declaration, rural taxpayers are more likely to become new users, and those more active on social media are less likely to stop (in line with previous findings). Interestingly, being more sophisticated in terms of tax regime and bank account ownership correlates with stopping using the app – as the taxpayer probably switches over to the more complete E-tax option.

Overall, these results partially confirm those in the previous section, showing that challenges in adoption have persisted two years into the pandemic. On the positive side, it is telling to see that the two e-services pick up in different geographical areas – E-tax in Kigali and M-declaration in provinces – as intended by their design, as well as that there are signs of businesses growing and abandoning the simpler M-declaration app for the fully-fledged E-tax option. Likewise, the fact that gender is no more a key determinant of adoption, as it was at baseline, may suggest that female taxpayers are taking up the technology – the same applies for tax knowledge. Nevertheless, the FGDs highlighted that the COVID-19 crisis forced some taxpayers to adapt to e-services,[47] but that those who were less equipped for this change (less educated and less tax-aware businesses) still failed to keep up with the changes.

[45] P3 from FGD3: ‘I went to RRA and they told me that I couldn’t enter so they gave me the USSD code and guided [me] through all the application until I paid.’ P3 from FGD2: ‘The government was encouraging people to work from home; once you’re working from home you have to work online so on those tax must be paid online using E-tax.’

[46] P4 from FGD1: ‘I think COVID-19 had a negative impact on people's lives because there are some people who had to pay taxes while they weren’t working and it was unfair.’

[47] P4 from FGD1: ‘It forced people to learn how to use technology: even when you needed help RRA tells you to go write an email so you have no other choice than to file on time by yourself because otherwise you will be caught with a penalty.’ P4 from FGD3: ‘People had to stay home so we had to learn how to do it ourselves.’ P2 from FGD3: ‘Yes, because we weren’t allowed to move from home many people learned to use the system.’

Table 5 Factors associated with a change in usage of digital tax tool systems two years after COVID-19, February 2022 (probit model)

	E-Tax		M-declaration	
	(1)	(2)	(3)	(4)
	Stopped Individual + Business + Tax	**Started** Individual + Business + Tax	**Stopped** Individual + Business + Tax	**Started** Individual + Business + Tax
Closed in May '20	**-0.043**	**0.071**	**-0.215**	**0.054**
	(0.189)	**(0.148)**	**(0.174)**	**(0.121)**
Closed in September '20	**-0.344**	**0.188**	**-0.011**	**-0.109**
	(0.330)	**(0.253)**	**(0.255)**	**(0.206)**
Closed in February '21	**-0.039**	**0.146**	**0.326**	**0.011**
	(0.218)	**(0.170)**	**(0.211)**	**(0.141)**
Closed in February '22	**0.258**	**0.317**	**0.245**	**-0.540****
	(0.281)	**(0.233)**	**(0.263)**	**(0.219)**
Increased use Mobile Money	**-0.459****	**0.208**	**0.085**	**0.379*****
	(0.202)	**(0.142)**	**(0.177)**	**(0.131)**
Female	-0.032	-0.063	0.195	-0.103
	(0.211)	(0.146)	(0.188)	(0.125)
Age	0.051	0.056	0.094	-0.000
	(0.098)	(0.072)	(0.082)	(0.056)
Higher education	-0.409*	0.199	0.202	-0.120
	(0.224)	(0.190)	(0.208)	(0.145)
Using social media	0.021	0.043	-0.400**	-0.219
	(0.234)	(0.159)	(0.184)	(0.135)
Age of the company	-0.059	0.028	-0.052	-0.049
	(0.038)	(0.038)	(0.042)	(0.030)
Kigali	0.090	0.381**	0.360*	-0.344***
	(0.197)	(0.153)	(0.185)	(0.126)
No employees	-0.330	0.035	0.034	0.142
	(0.208)	(0.149)	(0.176)	(0.130)
Keeping books	-0.538***	0.292*	0.217	-0.199
	(0.202)	(0.172)	(0.175)	(0.136)
Knowledge index	-0.074	-0.017	0.019	0.038
	(0.069)	(0.041)	(0.052)	(0.035)
Bank account	0.181	0.048	0.679***	0.021
	(0.223)	(0.204)	(0.231)	(0.162)
With email address	0.047	-0.129	-0.103	0.285
	(0.295)	(0.364)	(0.341)	(0.204)
Ln sales (USD)	0.041	0.025	0.001	0.009
	(0.040)	(0.031)	(0.037)	(0.024)
Real regime	0.068	-0.122	0.439*	-0.252
	(0.282)	(0.209)	(0.242)	(0.162)
Tax accountant	0.210	0.411	-0.144	-0.210
	(0.345)	(0.264)	(0.334)	(0.181)
Non-filer 2019	-0.016	-0.117	-0.317	0.144
	(0.258)	(0.211)	(0.260)	(0.157)
Nil-filer 2019	0.350	-0.398*	0.446*	-0.113
	(0.303)	(0.210)	(0.251)	(0.179)
CIT	-0.120	-0.214	0.017	0.329*
	(0.329)	(0.268)	(0.314)	(0.199)
Total formal taxes	-0.211**	0.102	0.033	0.014
	(0.090)	(0.069)	(0.074)	(0.051)
VAT reg.	0.292	-0.456	-0.320	-0.212
	(0.368)	(0.320)	(0.393)	(0.203)
Get info from RRA	0.470**	0.199	0.198	-0.056
	(0.201)	(0.145)	(0.167)	(0.117)
Interacted	0.282	-0.067	-0.023	-0.115
	(0.197)	(0.164)	(0.172)	(0.127)
Audited	-0.033	0.108	0.319*	0.205
	(0.222)	(0.164)	(0.185)	(0.125)
Fined	0.015	0.153	0.018	-0.097
	(0.190)	(0.139)	(0.159)	(0.111)
Ln Tax payments 2019	0.016	0.010	0.002	-0.013
	(0.024)	(0.021)	(0.021)	(0.017)
Observations	468	677	339	865
Sector fixed effects	Yes	Yes	Yes	Yes
Pseudo R-sq.	0.151	0.139	0.147	0.114

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Source: Authors' own calculations using ICTD baseline and round 4 survey data.

4 E-services, perceived fairness, and willingness to pay

In this final part of the paper, we look at the relationship between e-services adoption and tax perceptions. We consider the perceived fairness in the tax system and the intrinsic willingness to comply, based on evidence from the baseline survey (January 2020) and FGDs, since such outcomes are thought to be influenced by technological interventions (Okunogbe and Santoro 2021).

We first look at taxpayers' perception of the fairness of the tax system. Responses to the survey question are shown in Appendix Table A6.[48] Descriptively, there is no sizeable difference between the perceptions of users and non-users. Consistently, investigating factors correlated with fairness perceptions using a probit model, we do not find any positive relationship between using e-services and improved perceptions, as seen in the coefficient plots below (full results in Appendix Table A7).[49]

In turn, it is not surprising that e-services adoption showed no positive correlation with the intrinsic motivation to comply (measured by whether respondents felt that tax evasion is never justifiable), as shown in Appendix Figure A10. In the case of PIT payers, using M-declaration seems to significantly depress intrinsic motivations. Whether e-service usage has a positive effect on filing behaviour, and in turn on tax collection, remains an open question worthy of further research.

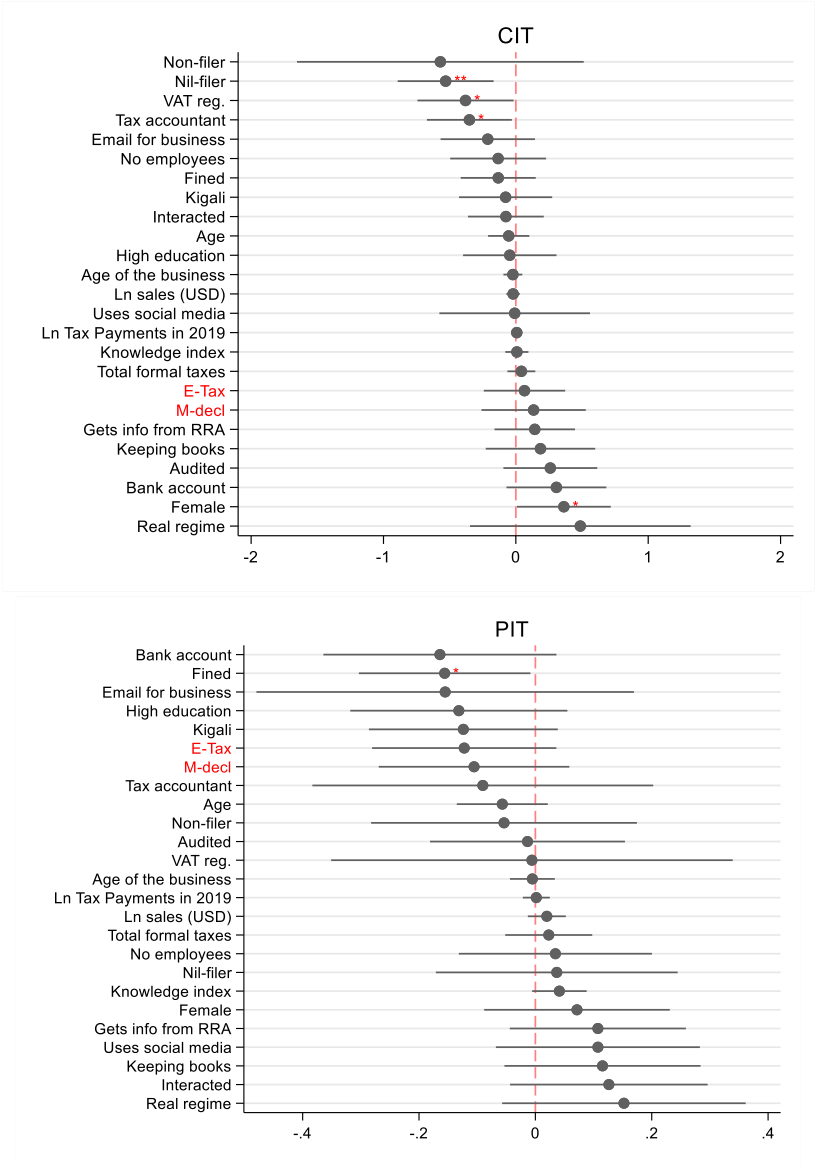
Trying to disentangle such muted evidence, we consider taxpayers' practical experience with the e-services and document important challenges. Users were asked specific questions about issues encountered while using either the E-tax or M-declaration systems – specifically, whether they experienced: (i) a slow system, (ii) a busy system, (iii) not-validated annexures, or (iv) rejected declarations. In Figure 6, we show the share of E-tax (top) and M-declaration (bottom) users, for CIT (left) and PIT (right) businesses, who experience these issues. For both E-tax and M-declaration, a slow system is the most common issue, with more than two-thirds of users across each tax category facing this. Technical issues related to the software seem to be a recurrent problem faced by Rwandan taxpayers – a pattern common to other African countries as well (ATAF 2021).[50]

[48] We asked respondents the following question: '*On a scale from 1, very unfair, to 5, very fair, how fair and equitable do you believe that businesses like yours generally perceive the general tax system to be?'* For the purpose of this analysis, we have only selected respondents considering the system as very fair.

[49] For CIT businesses, the perception of a fair tax system is negatively associated with VAT registration (38pp or 10 per cent), using a tax accountant (35pp or 10 per cent) and for being a nil-filer in the 2018 fiscal year (53pp or 15 per cent), while we observe a significant and positive relationship with female taxpayers (36pp or 10 per cent). For PIT businesses, the only statistically significant (and negative) relationship is related to having previously received a fine from RRA (16pp or 5 per cent) – which was also affecting compliance costs (Figure 4).

[50] Taxpayers who engaged in the 2020 ATAF ICT survey pronounced the lack of stability as the main barrier to using the RA e-system.

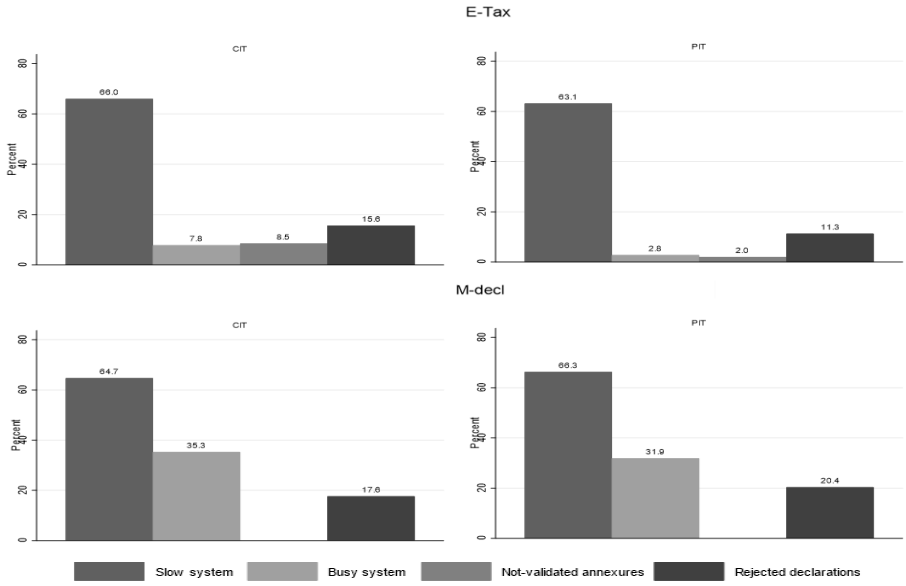
Figure 5 E-service usage and taxpayers' perception about fairness of the tax system, coefficient plot



Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients are marginal effects from a probit model. Ease of complying is a 0-1 indicator variable derived from the survey question 'On a scale from 1, very unfair, to 5, very fair, how fair and equitable do you believe that business like yours generally perceive the general tax system to be?' and indicates whether taxpayers answer 'Very fair'. Usage is derived from the following survey question: 'Which of the following online or mobile-based services do you currently use?' The independent variables are described in detail in section 2.4.

Source: Authors' own elaboration using ICTD baseline data.

Figure 6 Issues experienced with e-services



Source: Authors' own calculations using ICTD baseline data.

Interviews with the RRA and FGDs help to unpack these issues. Firstly, using the E-tax system to file declarations and send attachments to RRA requires data, which can be expensive to purchase.[51] This challenge of keeping positive airtime and data balances on SIM cards was also a practical constraint in using electronic billing machines (EBMs) in Rwanda, as described in Mascagni, Dom and Santoro (2021). Cost issues are often coupled with connectivity issues experienced by the mobile network provider,[52] which the RRA cannot directly address, but point to a wider challenge in accessing digital services in a context where the necessary infrastructure is not universal. Crucially, when connectivity issues arise close to the deadline, taxpayers are automatically punished with penalties, a fairness-related aspect discussed in more detail below.[53]

Secondly, when using E-tax many VAT declarations are rejected when the system automatically cross-checks the validity of those reports. For instance, if a VAT buyer reports through E-tax a purchase from a given seller, to claim input VAT credit, the RRA will reject that purchase claim if a corresponding report from the seller is not found. In most cases, buyers would then have to ask the seller to accurately report the transaction, so that their claim could be approved by the system. The aim of these verification checks is to improve the accuracy of reporting – as well as enhancing revenue by saving audit costs. However, many taxpayers, without further assistance or information to understand why their claim was rejected, are left feeling frustrated.[54]

51 P5 from FGD3: 'In order to declare you got to have airtime on your phone otherwise you can't. If you have an MTN unpaid debt then you can't declare, so I think that is a big issue because you may want to declare but you don't have airtime.'

52 P1 from FGD3: 'The first thing that they should correct is the network system, it shouldn't always be about the network that fails and we face penalty charges because of that. They should improve their system.' P2 from FGD3: 'MTN or Airtel should strengthen their network because I think that the problem comes from them not RRA. There are many areas which are not captive of the network thus it becomes harder for people living there to pay taxes on time.' P6 from FGD2: 'There are many districts or areas where you go and you lose total network, you can't even call so I think the network issue is to be really taken into consideration.'

53 P2 from FGD3: 'But also, there are times where network can disappoint and you will be late and get caught with the deadline and it drives you into a loss you had not imagined.'

54 P4 from FGD2: 'Yes, that it has an error but you find it has all the required information. You ask yourself I've like ten invoices which are supposed to reduce my VAT, we meet this problem and it is one of the challenges.'

Finally, both e-services are less reliable during peak usage periods, especially closer to the filing deadlines, when close to 10,000 users are online.[55] Almost all FGD participants found themselves in such a situation, either declaring late at night when the system is less busy or failing to declare last-minute thus incurring automatic penalties.[56] Such evidence relates to the level of e-services adoption of non-filers, in line with that of actives and nil-filers, as shown in Figure A1b. Non-filers may be genuinely using the e-services but failing to comply due to the technical challenges documented with the FGDs.

Further evidence from FGDs hint at a number of constraints which seem to balance out the immediate benefits. On the one hand, taxpayers were aware of the potential benefits of e-services, such as the ease of filing anywhere[57] and the time and costs saved by not needing to queue or travel to pay taxes.[58] E-tax also seemed to positively affect record-keeping practices,[59] and facilitates better access to tax information.[60] In addition, e-service users might file more accurate returns and enjoy higher transparency, on-time assistance and ease in spotting errors.[61] As P2 from FGD2 puts it, 'the system guides you' when filing. On average, such benefits are much more present among E-tax rather than M-declaration users.

However, there are important limitations to e-services, which often outweigh the benefits. They range from suboptimal synchronisation of RRA tax management systems, such as those of customs, national and local taxes,[62] to the lack of physical documentation and proof of payment in M-declaration, which only sends an automated SMS after filing. When the SMSs do not come through, M-declaration users have to physically go to local government offices to obtain official proof of their filing and payment records. Taxpayers also report taking screenshots of the SMSs received to have a safe copy in case of lost or theft of their

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55 Such a pattern is observed in other contexts as well, as in Kenya (Maisiba and Atambo 2016).

56 P2 from FGD1: 'For most clients that declare on the last day, the system isn't friendly at all. It crashes a lot and sometimes people are caught in penalty charges like that. And the penalty charges are very high.' P1 from FGD1: 'At the end of the month due to many declarations being made the system runs slow or even sometimes crashes. For example you can put your TIN number and the system tells you that it is not correct but after a while when you put it again the system accepts it because the jam has been reduced in the system. Most businesses declare taxes during the night because many people have already declared during the day and there is no jam.' P5: 'Sometimes it can get bad when you're trying to declare on the last day and the system gets really maybe overwhelmed by the requests that are coming in so it normally shuts down so people end up paying penalties.'

57 P4 from FGD1: 'It is easier because even if you don't have transport means you can still declare/file while you are at home. So the work is simplified. Even when banks are closed you can still declare through mobile banking.' P6 from FGD1: 'For people who are caught with deadlines while outside the country they can easily pay through online banking and thus can avoid penalties, not like before when you were in foreign countries you knew you will be charged because you had no other choice as you didn't have means to pay.' P6 from FGD2: 'Another thing it is not necessary to be here in Rwanda to do the declaration and payments: I can do it while I'm abroad without being here.'

58 P4 from FGD2: 'Another thing is that the system helped us; we use to go to RRA and their staff would leave around 5pm but today you can declare at 11pm in the evening so the system really helps.' P6 from FGD1: 'E-tax is good because it reduces some costs like transport, it now saves time that we used while at the RRA offices.' P3 from FGD3: 'Yes, this system has helped a lot because we used to go far to branches which were not crowded and it took time and transport money so that we can pay on time but now we no longer have to do that.' P4 from FGD4: 'Before, we used to go to RRA and spend more than two/three days declaring but now it is only seconds/minutes so it saves time.'

59 P6 from FGD2: 'Monitoring the stock, when you buy a thing it is an example you sell it and reduces the stock, you can know the items you have sold per day without have to ask your accountant, you will know your stock.'

60 P5 from FGD1: 'While declaring, as the system stores data it is easy for you to check from previous records and use that information you want while declaring, without going back into papers.' P3 from FGD1 shared the same experience.

61 P1 from FGD1: 'You perceive errors whereas before I could go the RRA waiting to declare without knowing that I will [have] to go back and correct errors.' P3 from FGD1: 'It is best because there is basic help while declaring, when you need assistance you can immediately text them and they reply back and help you. There is also security provision like when you forget your password they immediately send it to your phone number or email.' P5 from FGD2: 'You can easily spot the errors when you're trying to declare but back then even the Revenue they wouldn't spot the errors but now these days the system can give you the error report of anything that is not correct.' P3 from FGD4: 'The system tells us how much we have to pay.' P2 from FGD1: 'When declaring you can't miss steps or skip those that you don't want to answer or fill, you have to fill every thing that the system has. So the system guides you.'

62 P5 from FGD3: 'Yes, property tax, local taxes, they are managed by Revenue but at different platforms so this should be synchronised so there is one dashboard where all the taxes are supposed to be.' P5 from FGD1: 'Another thing is about import: when you want to declare VAT on products that you have imported sometimes the system tells you that it doesn't exist in the area you have placed it, it doesn't appear in the system easily, while in customs at the port they have recorded it before you make the products enter the country. Maybe it's because its different [between] RRA and in customs so maybe they could work together in synchronisation.'

device.[63] Relatedly, M-declaration users – in contrast with E-tax users – felt that their record-keeping practices did not improve,[64] or even worsened after the introduction of the app.[65] For instance, P1 of FGD4, said that 'record-keeping has gone down because we had paper proof of our payments but now we don't always keep record of the messages they send us'. When such issues arise, online assistance is not always effective, and taxpayers need to visit RRA or other government offices anyway, as in a traditional, manual system.[66]

Importantly, evidence from the FGDs indicates how negative repercussions from practical experience affect the broader perception of fairness and intrinsic motivation to comply. Certain e-service users, when faced with the practical problems described above, experience frustration with the high automatic penalties and a sense that the tax system works against them.[67] However, some positive impacts were acknowledged. Taxpayers acknowledged increased transparency with respect to tax obligations,[68] reduced scope for capricious and arbitrary audits and fraud, and a strengthened perception of horizontal equality.[69] This is especially true for M-declaration users, who due to their smaller nature were 'taken for granted' (P3 of FGD3) in the manual system and experienced discrimination and a lack of professionalism. Overall, however, these positive and negative impacts seem to balance out.

5 Conclusions and policy recommendations

Online tax filing and payment services are thought to bring a range of benefits, from reduced compliance costs and improved record-keeping, to limiting opportunities for corruption and increasing fairness in the tax system. However, their success depends, on, among other things, the level of awareness and adoption among taxpayers. Our results indicate that awareness and adoption of e-services in Rwanda have considerably increased during the

63 P2 from FGD4: 'Now that we use our phones, sometimes we do not receive messages telling us we have paid so some of us prefer to go to *Irembo* and get a paper proof that we have paid.' P3 from FGD3: 'On my behalf after paying I take a screenshot and then save it on my email or any other application so that in case I need it then I will use it. So, I wonder what will happen to other people when they face problems while they don't have any proof that they have paid?' P4 from FGD4: 'Phones can be damaged, stolen and etc. because am an aware man I can screenshot them and save them in my email.'

64 P1 from FGD4: 'When you declare you write it somewhere like an agenda because phones can be stolen or damaged.'

65 P2 from FGD4: 'Would it be easy for me to find all the payment messages? I don't think so. I don't know if there is a way they can change that or do something else to help people keep record'. P1 from FGD3: 'The only issue is lack of trust because people don't have tangible records. Before, you used to keep every record for more than five years that even your child could use them in case of need. But now you only have a message on your phone and you may lose it or even messages can disappear.'

66 P1 from FGD3: 'That person can go [to] the nearest RRA branch to ask for help because leaving it isn't the best solution because the consequences will be on you not RRA.' P1 from FGD4: 'If I do it once, twice and it doesn't work then the third time I will go to *Irembo*.' P1 from FGD1: 'The first option is to go to an RRA officer to ask for help but before the deadline days knock on.'

67 P5 from FGD4: 'I didn't pay penalty charges as such because we declared and then the next day we received a message saying that we haven't paid and that we were charged with a 100 thousand, but we claimed and I went back to where I had the payment at to get the receipt. RRA checked well and they realised that I had paid thus they removed the penalty.' P2 from FGD4: 'Those charges are high because if someone can be declaring 6k and they charge me a penalty of 100k, do you think it's fair? Couldn't they put it in percentages according to what someone is due to pay?' P1 from FGD3: 'The problem that bothers us the most is that when you declare and it fails they still take your money, and the more you try and it fails those charges keep on being removed while you haven't even got the service you wanted.' P4 from FGD1: 'Sometimes you pay and the system shows you that you haven't paid and sometimes you can get charged a penalty if you don't go to RRA on time to check.'

68 P2 from FGD1: 'But today while using E-tax you know exactly how much you will be charged in case you are late to declare your taxes, and you know that at the beginning when you are registering your business in the system.' P1 from FG1: 'If a mistake is made then we are all charged the same amount as penalty so it positively makes every business support others because they know they will be paying the same if they are doing the same business: there will be no difference.' P3 from FGD2: 'Every tax is set on percentages that are common to everyone.'

69 P3 from FGD1: 'It has reduced the loopholes for corruption. I consider it as Sophias (speed checking cameras) that we see in the streets. So before if you had a friend from RRA he/she could help and remove some of the taxes you had to pay and you paid less and you could pay him/her for charges, but now there is no way you can do it because it is in the system.'

pandemic, albeit starting from low levels pre-COVID-19 (January 2020). It is unrealistic to expect universal take-up of an IT solution in any context, especially in a low-income country. We particularly focused our study on issues related to partial adoption, focusing on the pre-COVID-19 situation. Our results point to the fact that female, less educated taxpayers with less sophisticated businesses are much less likely to be aware of, and using, e-services. The fact that such e-services are mandatory suggest that taxpayers reporting not using them might actually recur to intermediaries for assistance, persisting in manual practices and not fully benefitting from a full digital solution. Despite that, uptake remarkably improved two years into the COVID-19 pandemic. We show that business shock may play a role in fostering usage and that, strikingly enough, uptake of e-services strongly correlates with the increased use of mobile money payments during the pandemic. By 2022, gender gaps in usage seem to be closed, while we observe that the two e-services are taken up in different geographical locations, as intended by design.

In terms of impacts, we do not find support for the hypothesis that e-services benefit taxpayers by improving perceived fairness and boosting willingness to pay. We argue that negative user experiences, such as congestion during peak times, limited internet coverage, and the automatic triggering of penalties after deadlines, outweigh the perceived benefits, in terms of improved record-keeping, reduced transport and queuing costs, and higher horizontal equality. Such operational issues in the practical experience seem to have a negative effect on perceived fairness. Unsurprisingly, the intrinsic motivation to comply is not affected by e-services when transition costs and other practical constraints imply that their functioning is not optimal. Such challenges may also explain why, quite puzzlingly, non-filers still report using the e-services. They may genuinely do so, but eventually fail to comply due to such technical difficulties.

Our study suffers some limitations. First, it was not designed to measure the e-services' impacts on actual compliance, due to the sudden pandemic outbreak just after the baseline survey (March 2020), which impacted reporting behaviour for that year, as shown in Mascagni and Santoro (2021). However, we use pre-COVID-19 filing and payment history to predict awareness and usage. A future study will try to address this gap in the analysis and understand how the muted impacts on tax perceptions translate into actual behaviour. Second, the survey tool is not designed to carefully capture compliance costs, hence we cannot directly test whether e-services alleviate such costs – although we fill such gaps with original evidence from FGDs. Third, we do not address important questions on how digitised data and IT boost the core functions of tax administration (Arewa and Davenport 2022; Okunogbe and Santoro 2021). While we document negligible impacts on taxpayers' attitudes and perceptions, there could be large revenue gains from sustained digitisation in the revenue authority, as well as gains in better data usage for monitoring, planning, and statistical analysis. We plan on exploring such topics in the future.

Despite such limitations, our results have three main implications for policymakers. The revenue authority and other public institutions in Rwanda are increasingly digitising their functions, often outperforming their peers in other African countries. Yet, this study points to areas with scope for improvement. First, the RRA could invest more in advertising and marketing the tools, filling gaps in awareness. Our analysis indicates that certain categories of taxpayers, such as female and less educated business owners, might benefit from targeted information campaigns. In addition, the FGDs highlighted a strong desire to see improvements in the way the RRA communicates, reaching broader segments of the population,[70] and using innovative marketing techniques.[71] Similar evidence is emerging from

[70] P2 from FGD4: 'So, if RRA can pass through SMS then we can all be aware of what's new because whenever a message pops up, I read, and if I find it interesting then I read for further information.' P1 from FGD4: 'RRA can give information through SMS and give us newsfeed and even give us flyers about what's new and what they have improved.' P3 from FDG4: 'What I think would be best is: they should have another branch dedicated to marketing and advertisement only.' P5 from FGD2: 'Changing the model of communication: broaden it, it shouldn't be on Twitter and

other African countries as well (ATAF 2021).[72] Relatedly, the tax administration should better understand the practical experience of e-services, especially in those cases in which taxpayers report that they are not using them. These taxpayers may recur to suboptimal, semi-manual, filing practices, asking for support from intermediaries, thus not fully unlocking the potential of technology. The RRA should better identify such cases and provide adequate support.

Second and related, taxpayer assistance and training should be intensified. Many taxpayers found that the response of the RRA to their reports of IT problems was ineffective[73] and there is strong demand for a better functioning feedback mechanism.[74] Importantly, our analysis indicates that having more interactions with the RRA increases levels of adoption. These conclusions are consistent with other research findings on high levels of taxpayer confusion in Rwanda and the benefits of taxpayer training and education (Tourek 2018; Mascagni *et al.* 2019; Mascagni, Dom, and Santoro 2021). The RRA could specifically consider users of e-services who end up not filing, as they might be experiencing important barriers severely limiting their compliance.

Finally, we can reflect on the broader preconditions for successful technological interventions, including those relating to infrastructure, staff, and regulation (Okunogbe and Santoro 2021). There seems to be scope to expand the number of functions and overall capacity of the RRA's IT systems, to reduce downtime and system failures and to ensure that the system can handle peak traffic.[75] Even the best-designed e-services live within a broader technological infrastructure which also needs to be boosted, for instance to ensure that all taxpayers have an affordable, reliable internet connection. Secondly, human resources and staff training could be increased, to improve service delivery and the level of assistance available for taxpayers.[76] Finally, certain compliance challenges stem from convoluted aspects of the tax code – as already documented in Mascagni, Dom and Santoro (2021) – rather than from the practicalities of filing and paying. In these circumstances, simplification rather than technology is the best way of improving compliance.

What are the implications of this research for other low-income countries? Rwanda is clearly an outlier in the extent to which it is digitising and automating government processes. This research suggests that the problems we identified are likely to be even bigger when other governments with a less-developed IT infrastructure attempt similar reforms. Their

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other things, but it should be on TV, radios, phone calls if possible, text messages; I mean it will increase the tax base – that would be also good for taxpayers.'

71 P2 from FGD3: 'So, that's why in order to communicate to people RRA should have one way that is known to all, a way in which it passes all the information that it wants to communicate to the population. So, I think they should find a way either on billboards, TV adverts, SMS, radio adverts, etc.' P3 from FGD4: 'I agree with him because the way RRA advertises is still poor compared to other companies. For example, MTN and Airtel advertise to the extent that they even put billboards on street lights.'

72 Where these platforms exist, there are reports of non-responsiveness by staff, poor quality of issue resolution, task backlog, and some platforms only serve between 8 am and 5 pm yet tax activities go on 24/7 (ATAF 2021).

73 P2 from FGD3: 'You would write an email and they would not respond; they take like a week.' P5 from FGD1: 'They should respond quickly to emails, letters and any inquiries given by taxpayers.' P3 from FGD2: 'Maybe RRA can put someone to answer the phone and if it happens on the day of the deadline they can record your information so they don't penalise you.'

74 P2 from FGD1: 'They should put a 'chat with us' direct box so that people can chat and directly get responses and get help quickly. And also for things you haven't filed well they can also send a direct message so that we can easily correct and spare time... P1 and P5 from FGD3: 'I would tell them to assist more their clients who are us taxpayers. In case we need assistance and help they should be quick to assist, because at the end of the day it is both our profit.' P3 from FGD4: 'They shouldn't only bring officers to look for faults while they have not even taken time to teach us how to use it.'

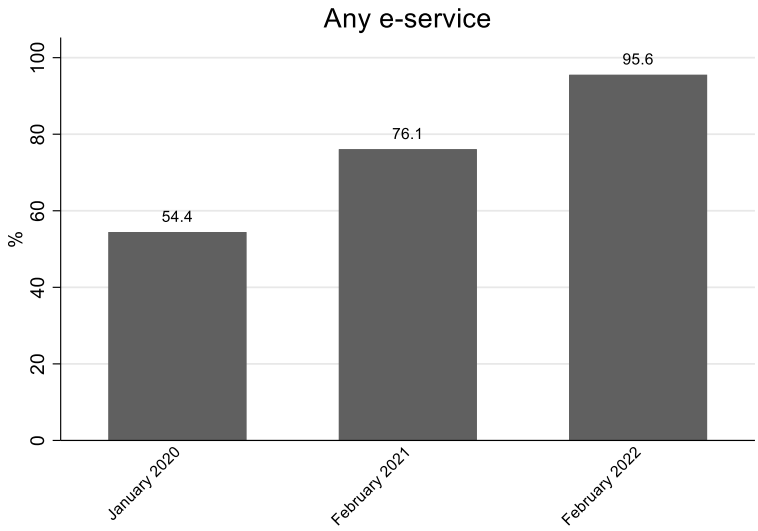
75 P3 from FGD1: 'The system should be strengthened so that it can accept many people at the same time, then we can not get caught with the deadline. Or they can make fibre optics available for everyone to afford easily.' P6 from FG2: 'No, if they have a server which is busy why can't they make it strong so that it can facilitate everyone who wants to access it?'

76 P1 from FGD3: 'They should add more offices in every area with employees that can assist everyone efficiently.' P3 from FGD4: 'Field officers should be increased. In every sector they should be more than two officers.'

policymakers need to devote even more attention to the broader circumstances likely to affect the success of any specific new IT solution, and to the actual constraints on user awareness and adoption (see, for instance, Santoro *et al*. 2022). More research is needed to evaluate the impacts of tax e-services in these lower capacity contexts.

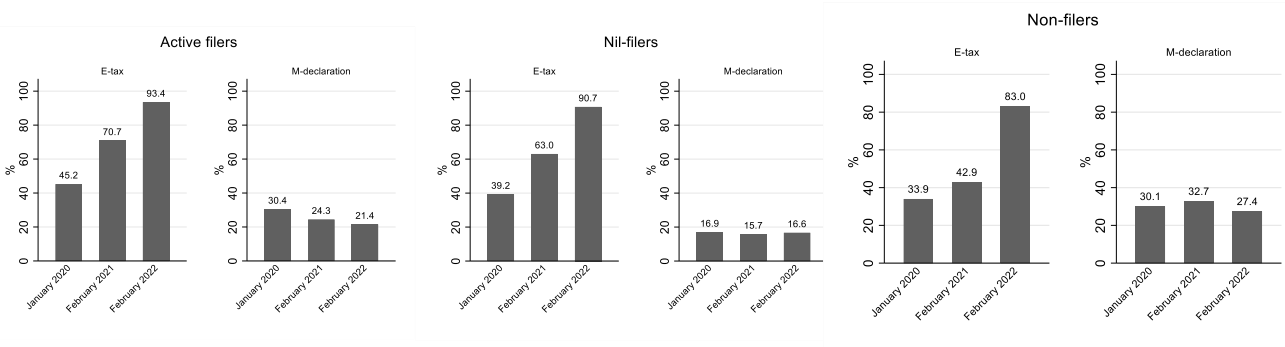
Appendix

Figure A1a Usage of any tax e-service over time



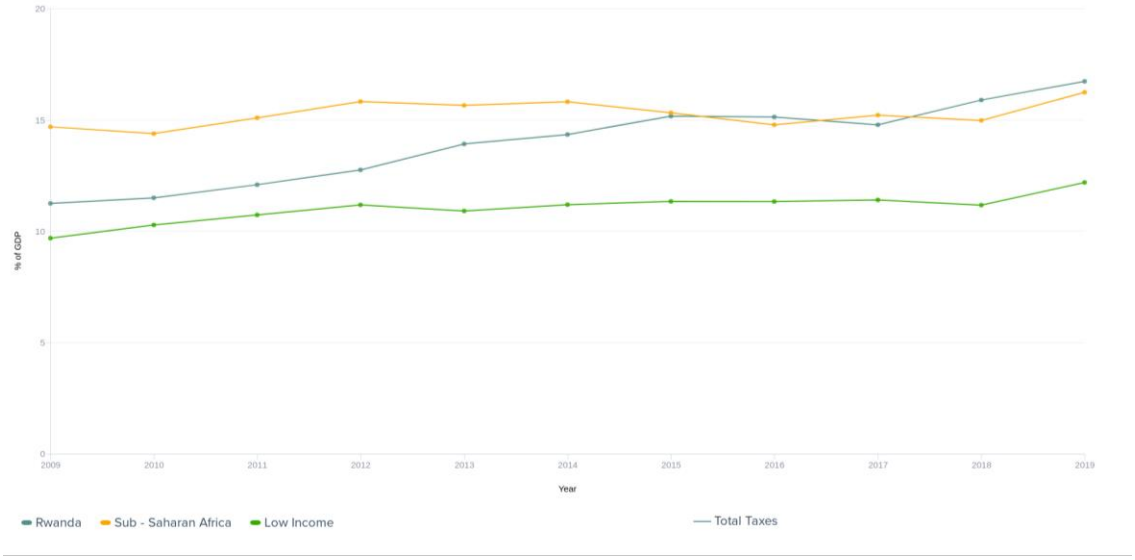
Source: Authors' own calculations using ICTD survey data.

Figure A1b Usage of tax e-services over time, by filing category



Source: Authors' own calculations using ICTD survey data.

Figure A2 Tax-to-GDP ratio, 2009 to 2019



Source: Government Revenue Dataset (2021).

Table A1 Digital reforms undertaken by RRA, 2004–2021

Year	IT solution
2004	Introduction of an Automated System for Customs Data (*ASYCUDA*). *ASYCUDA* is a computerised system which covers foreign trade procedures
2005	Introduction of the Standard Integrated Government Tax Administration System (*SIGTAS*)
2011	Introduced e-filing and e-payment
2012	Issued the Electronic Single Window, a system that allows firms to provide import and export information online
2013	Created a mobile application for filing and payment with feature phones
2013	Mandated the use of electronic billing machines (EBMs) for formal businesses with revenues above a minimum threshold (RWF 20 million annually)
2014	*E-Tax* enhancement replaced previous e-filing and e-payment systems
2019	Launched *e-suggestion*, a web-based chat function to support taxpayers
2021	Launched the 'EBM for all' policy, mandating the use of EBMs for taxpayers of any size

Figure A3 Types of income tax declared using E-tax or M-declaration

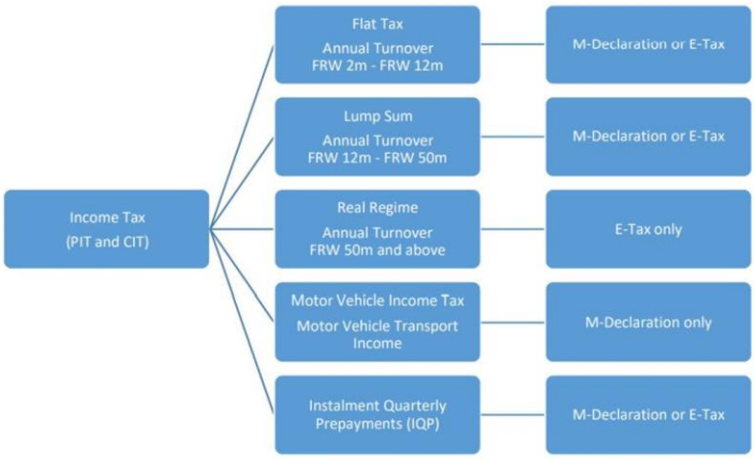
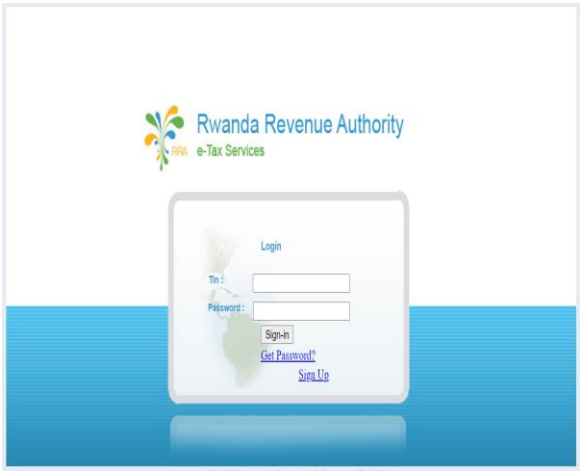


Figure A4 E-tax and M-declaration interfaces



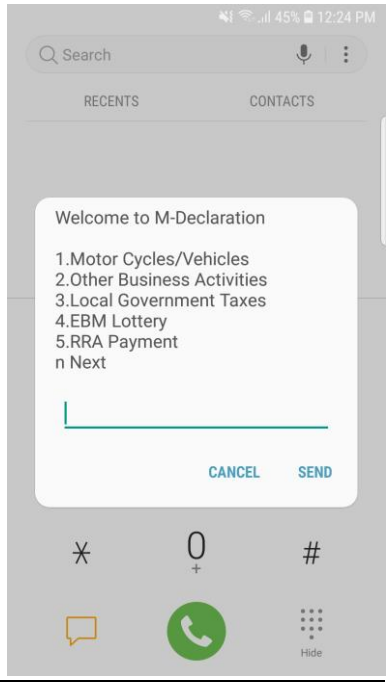
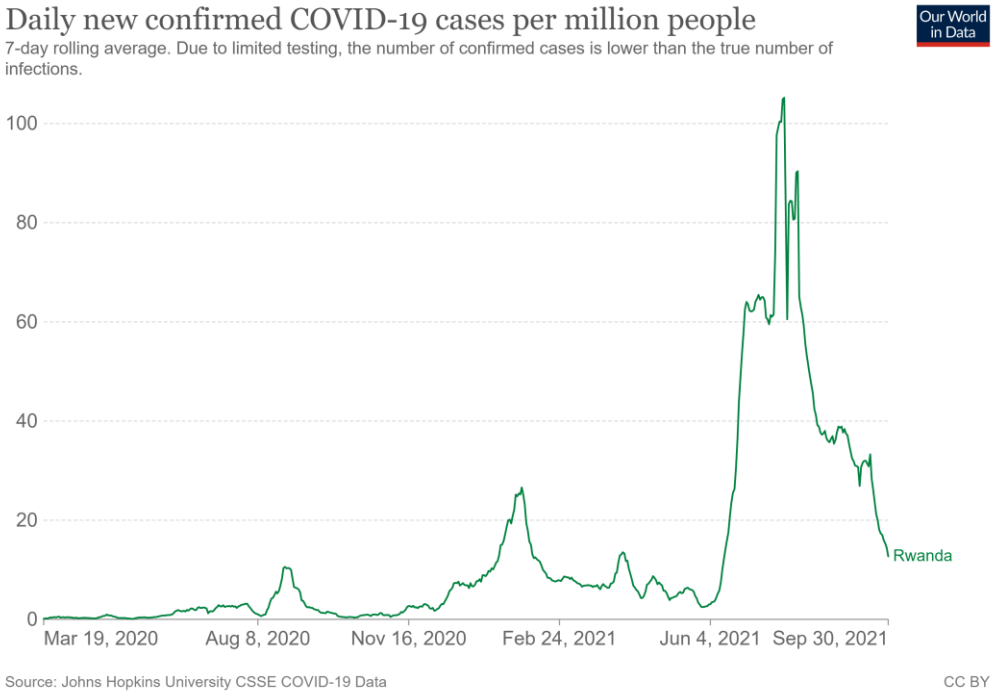


Figure 4a E-tax

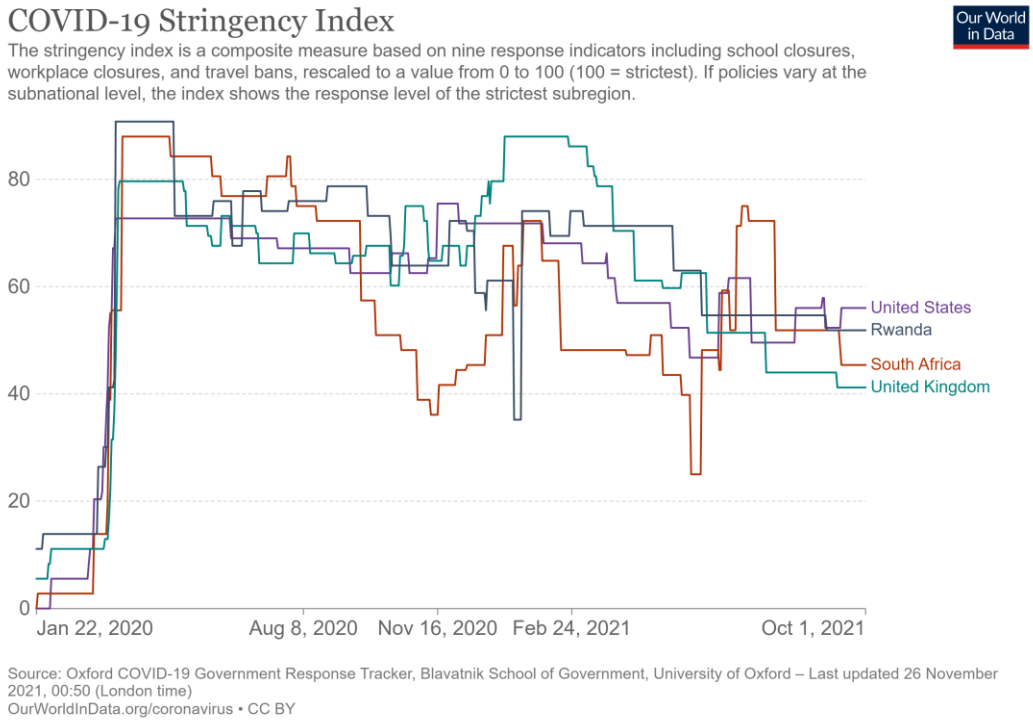
Figure 4b M-declaration

Figure A5 Confirmed cases of COVID-19 per million in Rwanda



Source: Our World in Data (2021).

Figure A6 Stringency Index in Rwanda



Source: Our World in Data (2021).

Figure A7 Sample location

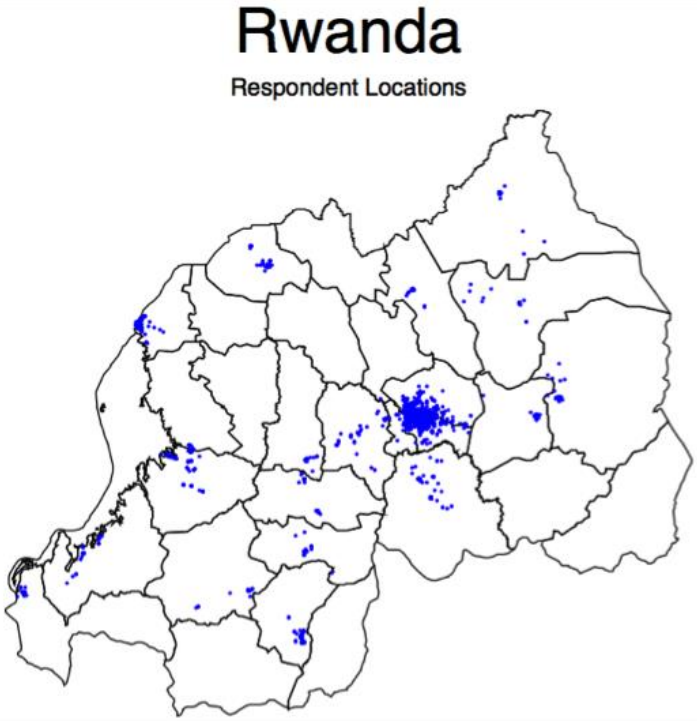


Table A2 Number of observations by industrial sector classification

	N	%
Agriculture, forestry and fishing	40	2.03
Construction	49	2.49
Financial and insurance activities	26	1.32
Information and communication	70	3.56
Manufacturing, mining and quarrying	39	1.98
Other service activities	114	5.79
Professional, scientific, and technical activities	162	8.23
Public administration and defence; education	22	1.12
Real estate activities	20	1.02
Wholesale and retail trade; transportation	1,336	67.89
Mobile money agent	11	0.56
Insurance agent	14	0.71
Saloon services	24	1.22
Tailor (sewing)	10	0.51
Lawyer	12	0.61
Bar Resto/Boutique	14	0.71
Cleaning services	5	0.25
Total	**1,968**	**100**

Table A3 Attrition on the third wave of data collection

	In third wave	Not in third wave	Difference	P-value
Individual characteristics				
Female	33.4%	39.9%	-6.5%	0.019
Age group[77]	3.33 (1.05)	3.14 (0.98)	0.193	0.002
Higher education	33.7%	46.6%	-12.9%	0.000
Using social media	74.5%	83.4%	-8.9%	0.000
Business characteristics				
Age of the company	3.9 (3.0)	3.8 (2.8)	0.1	0.703
Kigali	58.8%	77.2%	-18.4%	0.000
No employees	54.2%	52.8%	1.3%	0.645
Keeping books	44.8%	51.4%	-6.6%	0.024
Knowledge index	3.493 1.785	3.652 1.764	-0.159	0.125
Bank account	30.8%	36.2%	-5.5%	0.045
Uses email for business	15.9%	21.9%	-6.0%	0.006
Sales (USD, thousands)	5.72 (46.13)	7.21 (40.11)	-1.49	0.589
Tax features				
Real regime	47.9%	57.3%	-9.4%	0.001
Tax accountant	17.5%	22.2%	-4.7%	0.038
Total formal taxes	2.41 (1.55)	1.74 (1.79)	0.669	0.000
VAT registration	19.0%	25.6%	-6.6%	0.005
Get info from RRA	51.9%	57.9%	-5.9%	0.042
Interacted with RRA	31.8%	32.6%	-0.8%	0.765
Audited	26.1%	21.9%	4.1%	0.104
Fined	45.7%	44.7%	1.1%	0.717
Nil-filers 2018	23.9%	28.9%	-5.0%	0.049
Non-filers 2018	23.3%	21.3%	1.9%	0.428
Positive tax payments in 2019	18.2%	16.0%	2.2%	0.334
CIT	22.5%	33.7%	-11.2%	0.000
Aware of any e-service	65.5%	64.3%	1.2%	0.673
Using any e-service	60.7%	61.0%	-0.3%	0.921
Using E-Tax	41.3%	47.5%	-6.2%	0.032
Using M-Declaration	27.5%	23.6%	3.9%	0.134
N	**1,612**	**356**		

[77] Age group categories: 1: 19 or younger; 2: 20-30; 3: 31-40; 4: 41-50; 5: 51-60; 6: 61-70; 7: 71 or older.

Table A4 Awareness of e-services (probit models)

	(A1)	(A1b)	(A1c)	(A2)	(A2b)	(A2c)	(A3)	(A3b)	(A3c)
	All	**CIT**	**PIT**	**All**	**CIT**	**PIT**	**All**	**CIT**	**PIT**
	Individual	Individual	Individual	Individual + Business	Individual + Business	Individual + Business	Individual + Business + Tax	Individual + Business + Tax	Individual + Business + Tax
Female	**-0.310*** **	-0.497***	-0.250***	**-0.209*** **	-0.453***	-0.177**	**-0.213*** **	-0.405**	-0.174**
	(0.064)	(0.163)	(0.070)	**(0.067)**	(0.173)	(0.074)	**(0.068)**	(0.176)	(0.075)
Age	**-0.052***	-0.068	-0.050	**-0.072** **	-0.049	-0.059	**-0.112*** **	-0.046	-0.116***
	(0.030)	(0.068)	(0.034)	**(0.032)**	(0.075)	(0.036)	**(0.033)**	(0.082)	(0.037)
Higher education	**0.534*** **	0.790***	0.330***	**0.291*** **	0.544***	0.213**	**0.253*** **	0.512***	0.196**
	(0.071)	(0.153)	(0.085)	**(0.079)**	(0.170)	(0.090)	**(0.081)**	(0.179)	(0.092)
Using social media	**0.300*** **	0.587**	0.254***	**0.205*** **	0.461*	0.229***	**0.231*** **	0.388	0.265***
	(0.074)	(0.258)	(0.079)	**(0.077)**	(0.273)	(0.082)	**(0.079)**	(0.294)	(0.085)
Age of the company				**0.019**	0.040	0.009	**0.009**	0.041	0.008
				(0.013)	(0.029)	(0.016)	**(0.017)**	(0.041)	(0.019)
Kigali				**-0.180*** **	0.137	-0.259***	**-0.047**	0.273	-0.123
				(0.066)	(0.162)	(0.071)	**(0.072)**	(0.175)	(0.079)
No employees				**0.057**	-0.054	0.082	**0.056**	-0.107	0.077
				(0.071)	(0.192)	(0.078)	**(0.074)**	(0.201)	(0.081)
Keeping books				**0.285*** **	0.453**	0.256***	**0.230*** **	0.350*	0.219***
				(0.072)	(0.196)	(0.079)	**(0.075)**	(0.204)	(0.082)
Knowledge Index				**0.109*** **	0.151***	0.097***	**0.093*** **	0.142***	0.078***
				(0.019)	(0.048)	(0.021)	**(0.021)**	(0.054)	(0.023)
Bank account				**0.114**	-0.174	0.150	**0.112**	-0.147	0.162
				(0.085)	(0.202)	(0.100)	**(0.089)**	(0.213)	(0.103)
With email address				**0.562*** **	0.461***	0.547***	**0.527*** **	0.413**	0.539***
				(0.121)	(0.179)	(0.181)	**(0.126)**	(0.187)	(0.186)
Ln sales (USD)				**0.024***	0.004	0.033**	**0.020**	0.008	0.032**
				(0.013)	(0.024)	(0.015)	**(0.013)**	(0.026)	(0.016)
Real regime							**-0.333*** **	-0.341	-0.282***
							(0.095)	(0.491)	(0.099)
Tax accountant							**-0.240** **	-0.241	-0.206
							(0.107)	(0.189)	(0.144)
Non-filer 2018							**-0.001**	0.171	-0.032
							(0.088)	(0.215)	(0.099)
Nil-filer 2018							**-0.056**	0.375	-0.069
							(0.109)	(0.600)	(0.113)
CIT							**0.275** **	-	-
							(0.112)		
Total formal taxes							**0.094*** **	-0.001	0.135***
							(0.030)	(0.059)	(0.036)
VAT reg.							**-0.175**	0.193	-0.391**
							(0.117)	(0.199)	(0.159)
Get info from RRA							**0.159** **	0.435**	0.107
							(0.066)	(0.177)	(0.072)
Interacted							**0.335*** **	0.455***	0.306***
							(0.072)	(0.174)	(0.082)
Audited							**0.003**	0.164	-0.025
							(0.075)	(0.186)	(0.083)
Fined							**-0.099**	0.076	-0.131*
							(0.065)	(0.160)	(0.072)
Ln Tax Payments 2019							**0.012**	0.006	0.011

							(0.009)	(0.018)	(0.011)
Observations	**1,963**	473	1,485	**1,963**	473	1,485	**1,963**	473	1,485
Sector Fixed Effects	**Yes**	Yes	Yes	**Yes**	Yes	Yes	**Yes**	Yes	Yes
Pseudo R-sq.	**0.058**	0.139	0.035	**0.115**	0.232	0.078	**0.146**	0.280	0.110

Robust standard errors in parentheses - *** p<0.01, ** p<0.05, * p<0.1

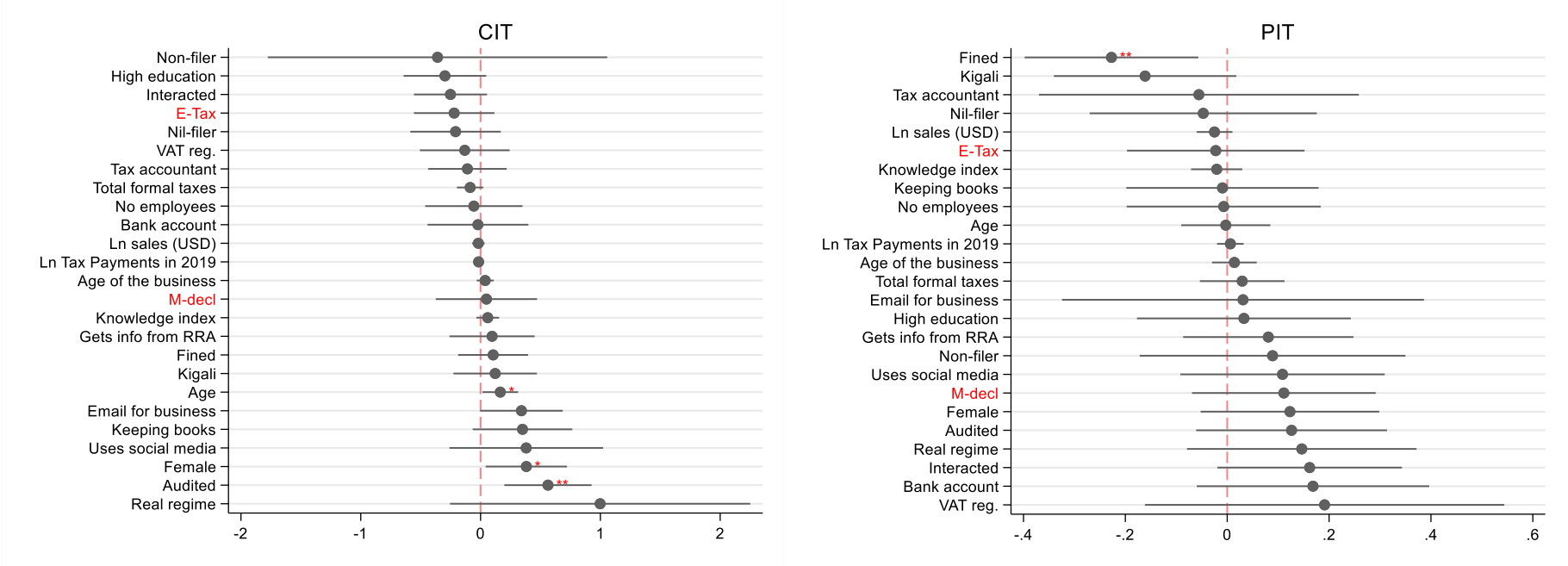
Table A5 Adoption of e-services (probit models)

	E-Tax			M-declaration		
	(A4)	(A4b)	(A4c)	(A5)	(A5b)	(A5c)
	All	**CIT**	**PIT**	**All**	**CIT**	**PIT**
	Individual + Business + Tax	Individual + Business + Tax	Individual + Business + Tax	Individual + Business + Tax	Individual + Business + Tax	Individual + Business + Tax
Female	**-0.100**	-0.375**	-0.039	**-0.340*** **	-0.510***	-0.301***
	(0.067)	(0.153)	(0.075)	**(0.072)**	(0.191)	(0.080)
Age	**-0.076** **	-0.062	-0.078**	**-0.060***	0.078	-0.088**
	(0.033)	(0.071)	(0.038)	**(0.035)**	(0.076)	(0.041)
Higher education	**0.174** **	0.188	0.195**	**-0.040**	0.258	-0.102
	(0.075)	(0.157)	(0.088)	**(0.081)**	(0.203)	(0.095)
Using social media	**0.085**	0.044	0.098	**0.245*** **	0.578	0.253***
	(0.081)	(0.268)	(0.087)	**(0.084)**	(0.406)	(0.089)
Age of the company	**0.004**	0.039	-0.004	**0.022**	-0.018	0.039**
	(0.015)	(0.032)	(0.018)	**(0.016)**	(0.035)	(0.019)
Kigali	**0.102**	0.156	0.083	**-0.071**	0.032	-0.120
	(0.069)	(0.153)	(0.079)	**(0.071)**	(0.182)	(0.081)
No employees	**0.010**	-0.090	0.031	**0.003**	-0.183	0.033
	(0.072)	(0.178)	(0.080)	**(0.076)**	(0.221)	(0.084)
Keeping books	**0.365*** **	0.565***	0.358***	**0.103**	0.181	0.119
	(0.072)	(0.184)	(0.080)	**(0.077)**	(0.225)	(0.084)
Knowledge index	**0.060*** **	0.088**	0.043*	**0.067*** **	0.047	0.077***
	(0.019)	(0.041)	(0.022)	**(0.020)**	(0.049)	(0.023)
Bank account	**0.093**	-0.119	0.157	**-0.134**	-0.539***	-0.053
	(0.084)	(0.184)	(0.097)	**(0.093)**	(0.200)	(0.105)
With email address	**0.361*** **	0.464***	0.190	**-0.166**	-0.132	-0.184
	(0.104)	(0.156)	(0.154)	**(0.115)**	(0.174)	(0.170)
Ln sales (USD)	**-0.005**	-0.041*	0.015	**0.010**	0.019	0.019
	(0.013)	(0.023)	(0.016)	**(0.013)**	(0.026)	(0.016)
Real regime	**-0.161***	-0.255	-0.132	**-0.396*** **	-1.273***	-0.305***
	(0.092)	(0.391)	(0.098)	**(0.095)**	(0.402)	(0.101)
Tax accountant	**-0.257*** **	-0.185	-0.273*	**-0.208***	-0.192	-0.238
	(0.098)	(0.148)	(0.145)	**(0.108)**	(0.166)	(0.157)
Non-filer 2018	**-0.018**	-0.061	-0.023	**-0.186** **	-0.226	-0.177*
	(0.084)	(0.175)	(0.099)	**(0.093)**	(0.208)	(0.106)
Nil-filer 2018	**-0.019**	0.021	-0.031	**-0.377*** **	-0.849	-0.368***
	(0.106)	(0.513)	(0.111)	**(0.110)**	(0.533)	(0.116)
CIT	**0.300*** **	-	-	**-0.088**	-	-
	(0.101)			**(0.113)**		
Total formal taxes	**0.060** **	0.069	0.069**	**0.062** **	-0.039	0.112***
	(0.027)	(0.047)	(0.035)	**(0.030)**	(0.052)	(0.038)
VAT reg.	**-0.253** **	-0.168	-0.428***	**-0.397*** **	-0.124	-0.609***
	(0.108)	(0.165)	(0.164)	**(0.123)**	(0.189)	(0.185)
Get info from RRA	**0.187*** **	0.303**	0.155**	**0.064**	0.309*	0.018
	(0.063)	(0.145)	(0.072)	**(0.067)**	(0.180)	(0.075)
Interacted	**0.244*** **	0.194	0.241***	**0.102**	0.069	0.121
	(0.067)	(0.135)	(0.079)	**(0.072)**	(0.153)	(0.084)
Audited	**0.045**	-0.055	0.073	**-0.082**	0.061	-0.140
	(0.072)	(0.160)	(0.082)	**(0.076)**	(0.175)	(0.086)
Fined	**0.017**	0.155	-0.011	**-0.012**	0.116	-0.057
	(0.062)	(0.131)	(0.071)	**(0.065)**	(0.156)	(0.075)
Ln Tax Payments 2019	**0.000**	-0.019	0.010	**0.004**	-0.001	0.008

	(0.008)	(0.015)	(0.011)	**(0.009)**	(0.018)	(0.012)
Observations	**1,963**	476	1,485	**1,968**	471	1,450
Sector fixed effects	**Yes**	Yes	Yes	**Yes**	Yes	Yes
Pseudo R-sq.	**0.113**	0.167	0.077	**0.097**	0.147	0.097

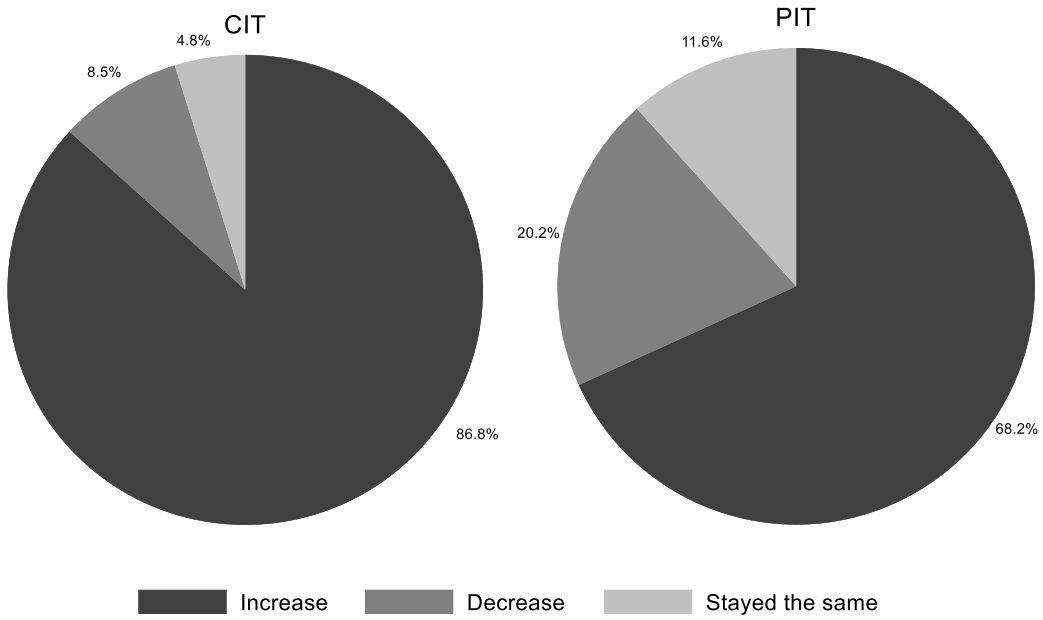
Robust standard errors in parentheses - *** p<0.01, ** p<0.05, * p<0.1

Figure A8 E-service usage and taxpayers' perception about ease of compliance, coefficient plot



Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients are marginal effects from a probit model. Ease of complying is a 0-1 indicator variable derived from the survey question 'What do you think about the general difficulty you have in complying with formal taxes?' and indicates whether taxpayers answer 'Very easy'. Usage is derived from the following survey question: 'Which of the following online or mobile-based services do you currently use?' The independent variables are described in detail in section 2.4.
Source: Authors' own calculations using ICTD baseline data.

Figure A9 Change in usage of mobile money after COVID-19



Source: Authors' own elaboration using ICTD data from the second round.

Table A6 Share of taxpayers perceiving the tax system as 'very fair'

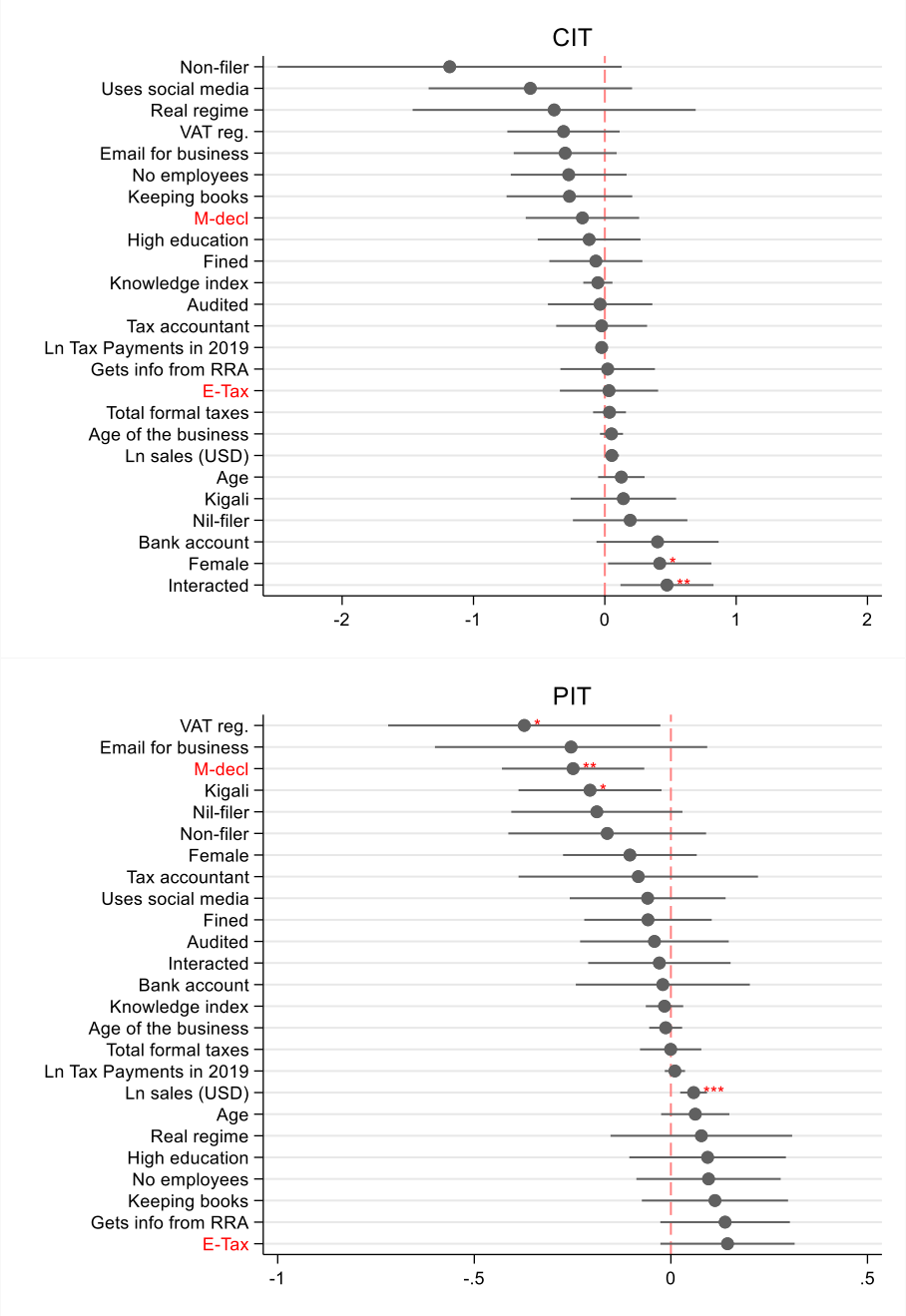
	CIT		PIT	
	Users	**Non-users**	**Users**	**Non-users**
E-Tax	79.6%	75.3%	71.4%	74.0%
M-Decl	80.5%	77.4%	71.0%	74.0%

Source: Authors' own calculations using ICTD baseline data.

Table A7 Impacts of adoption of e-services (probit models)

	Fairness of the tax system		
	(A6a)	(A6b)	(A6c)
	All	**CIT**	**PIT**
	Individual + Business + Tax	Individual + Business + Tax	Individual + Business + Tax
E-Tax	**-0.084**	0.065	-0.122
	(0.072)	(0.157)	(0.081)
M-decl	**-0.084**	0.134	-0.105
	(0.076)	(0.201)	(0.084)
Female	**0.117**	0.363**	0.072
	(0.072)	(0.181)	(0.081)
Age	**-0.062***	-0.054	-0.057
	(0.034)	(0.080)	(0.040)
Higher education	**-0.070**	-0.046	-0.132
	(0.082)	(0.180)	(0.095)
Using social media	**0.064**	-0.008	0.107
	(0.083)	(0.290)	(0.089)
Age of the company	**-0.001**	-0.022	-0.005
	(0.017)	(0.036)	(0.020)
Kigali	**-0.131***	-0.077	-0.124
	(0.074)	(0.179)	(0.083)
No employees	**0.007**	-0.134	0.034
	(0.077)	(0.185)	(0.085)
Keeping books	**0.090**	0.186	0.115
	(0.078)	(0.211)	(0.086)
Knowledge index	**0.033**	0.008	0.041*
	(0.020)	(0.045)	(0.024)
Bank account	**-0.021**	0.307	-0.164
	(0.092)	(0.192)	(0.102)
With email address	**-0.117**	-0.212	-0.155
	(0.113)	(0.182)	(0.166)
Ln sales (USD)	**0.010**	-0.021	0.020
	(0.014)	(0.026)	(0.017)
Real regime	**0.207****	0.487	0.152
	(0.100)	(0.425)	(0.107)
Tax accountant	**-0.184***	-0.351**	-0.090
	(0.103)	(0.164)	(0.149)
Non-filer 2018	**-0.111**	-0.530***	0.037
	(0.090)	(0.185)	(0.106)
Nil-filer 2018	**-0.102**	-0.570	-0.054
	(0.111)	(0.553)	(0.117)
CIT	**0.067**	-	-
	(0.113)		
Total formal taxes	**0.034**	0.042	0.023
	(0.030)	(0.054)	(0.038)
VAT reg.	**-0.049**	-0.380**	-0.006
	(0.118)	(0.185)	(0.176)
Get info from RRA	**0.120***	0.143	0.107
	(0.068)	(0.155)	(0.077)
Interacted	**0.076**	-0.075	0.126
	(0.073)	(0.146)	(0.087)
Audited	**0.008**	0.260	-0.014
	(0.075)	(0.181)	(0.085)
Fined	**-0.125***	-0.133	-0.156**
	(0.065)	(0.145)	(0.075)
Ln Tax Payments 2019	**0.004**	0.007	0.002
	(0.009)	(0.017)	(0.012)
Observations	1,847	457	1,388
Sector fixed effects	**Yes**	Yes	Yes
Pseudo R-sq.	**0.031**	**0.122**	**0.033**

Figure A10 E-service usage and taxpayers' perception about never justifying tax evasion, coefficient plot



Note: *** p<0.01, ** p<0.05, * p<0.1. Coefficients are marginal effects from a probit model. Never justify evasion is a 0-1 indicator variable derived from the survey question 'Please tell me for the following statement whether you think it can always be justified, never be justified, or something in between. The range goes from 1 (never justified) to 5 (always justified): some people not paying taxes on their income' and indicates whether taxpayers answer 'Very fair'. Usage is derived from the following survey question: 'Which of the following online or mobile-based services do you currently use?' The independent variables are described in detail in section 2.4.
Source: Authors' own elaboration using ICTD baseline data.

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