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Digital Merchant Payments as a Medium of Tax Compliance

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Summary

Consumers in Africa increasingly pay for their purchases through mobile money, especially since the pandemic. These transactions are known as *digital merchant payments*. Rwandan consumers can choose between using standard mobile money services or a specific service only for digital merchant payments – MoMo Pay. Digital payments of any kind have the potential to improve tax compliance, because they imply digital data trails and better record-keeping. How far is this potential being realised in Rwanda? In collaboration with the Rwanda Revenue Authority, we collected survey data from 1,100 merchants country-wide and were able to correlate this with tax administrative data, i.e. the tax records of the interviewees held by the revenue authority. We also conducted focus group discussions with 15 merchants. We found that the great majority of payments are still made in cash. Larger, more knowledgeable and financially included merchants opt for MoMo Pay as opposed to standard mobile money, the latter being preferred by female and less educated and equipped merchants. At the start of the pandemic, in March 2020, for a period of 18 months, all fees on MoMo Pay transactions were waived to foster digital payments through the service. In September 2021, fees were then reintroduced. The waiver led to a significant rise in the use of MoMo Pay relative to cash. When the MoMo Pay fee was reintroduced, there was a significant shift back to cash from both MoMo Pay and standard mobile money services, even if the latter were not affected by the fee. Lastly, we measure whether the adoption of digital payments correlates with merchants' tax perceptions and compliance behaviour. First, we show that merchants using MoMo Pay tend to disagree with the obligation of paying taxes in order to receive public services, a measure of fiscal reciprocity. Such negative correlation is probably due to the fee imposed on MoMo Pay. Furthermore, standard mobile money usage improves the perceived ease of complying with taxes, while that is not the case for MoMo Pay. Again, the fact that fees on MoMo Pay are not clearly identifiable in MoMo Pay statements complicates merchants' reporting and reconciliation of their activity for tax purposes. When it comes to compliance behaviour with VAT, the adoption of digital payments by merchants only improves their reported VAT sales and inputs, and only in the short term, while final VAT liability does not change. This hints at perverse compensating strategies to avoid taxes. We recommend that the tax administration better understand the adoption patterns of digital payments and incentivise usage among less equipped categories of taxpayers. The tax administration would also benefit from getting access to mobile money data to better monitor and enforce merchants' compliance.

Keywords: digital payments, technology adoption, tax compliance.

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Acknowledgements

Acronyms

AFR	Access to Finance Rwanda
BTCA	Better than Cash Alliance
CIT	Corporate income tax
DFS	Digital financial services
DID	Difference in differences
EBM	Electronic billing machine
FE	Fiscal exchange
FGD	Focus group discussions
KII	Key informant interviews
LIC	Low-income country
PIT	Personal income tax
PSM	Propensity score matching
RNPS	Rwanda National Payment Strategy
RRA	Rwanda Revenue Authority
RIPPS	Rwanda Integrated Payments Processing System
SACCO	Savings and Credit Cooperative

Introduction

Digital merchant payments that is, transactions between traders, or between traders and customers performed with digital means of payment and without cash, hold great promise in terms of fostering tax compliance (Santoro, Munoz, Prichard and Mascagni 2022). First off, digital merchant payments, often without the fees and bureaucratic steps existing in the banking sector, provide access to safer, quicker, formal payments for consumers, thus promoting business growth coupled with formally traceable transactions (UN Capital Development Fund 2019). Second and related, digital merchant payments leave a digital trail of data on sales which, at least in theory, can be accessed and exploited by tax administration to monitor and enforce compliance (Okunogbe and Santoro 2022). When that is possible, tax administration could use such information to check whether a firm's tax declarations are consistent with the payments recorded digitally for the same firm (Santoro *et al.* 2022). Taking these two elements together, such technology could both improve users' perceptions around the tax system and their actual compliance. As a last point, the exemption of digital merchant payments from tax designs taxing mobile money transactions has indeed recently been used by African governments to foster the formalisation and digitalisation of businesses. In this sense, digital merchant payments are particularly interesting to study as they belong to the broader technological shift taking place in African tax administrations, where governments are investing in solutions such as electronic sales registers or electronic fiscal devices, as well as online services to file and pay taxes, as a strategy to improve monitoring and compliance (Casey and Castro 2015).

Rwanda is an exciting context in which to study digital merchant payments. In the country, retail payments are following the global trend of increasingly becoming digital, and digital payments are expected to reach 80 per cent of the gross domestic product by 2024 (UN Capital Development Fund 2019: 4). Of the digital payment instruments available in Rwanda, mobile money is the leading one.[1] While still overwhelmingly used for remittances, mobile money is increasingly used for a diverse range of purposes (money transfers, bill payments, airtime, etc.) (Access to Finance Rwanda 2020), which, since 2020, increasingly include digital merchant payments. Such retail payments, typically made via a person-to-business payment option called MoMo Pay, have seen a surge in uptake by Rwandan consumers, mostly attributable to the government efforts to channel payments to mobile money as a response to the pandemic (Mwai 2020a). In 2020 alone, retail merchants accepting MoMo Pay nearly tripled, while consumers using MoMo Pay sextupled (Mwai 2021a). These cashless payments have indicated the potential for continued growth of digital financial services (DFS) in Rwanda.

As a second point of motivation, digital financial services, including digital merchant payments, have been increasingly targeted as a potential source of tax revenue by resource-constrained governments in Africa (Munoz, Mascagni, Prichard and Santoro 2022). Many African countries introduced new taxes and levies on mobile money with the goal of raising extra revenue to fund development. It is still unclear, however, what the impacts of such taxes are on mobile money usage and financial inclusion. The Rwandan context is particularly interesting in this sense. While there is no specific tax on mobile money, digital financial services in Rwanda are subject to a range of fees and commissions, imposed by mobile network operators, which eventually increase the cost of usage. Importantly, fees on MoMo Pay were waived at the onset of the pandemic, and later reintroduced. While such fees are not taxes per se and not imposed by the government, it is equally informative to

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[1]   Mobile money users in Rwanda increased twofold between 2016 and 2020, from just over 2.3 million users in 2016 to 4.3 million users in 2020, reaching a penetration rate of 60 per cent amongst Rwanda's 7.1 million adults in 2020 (Access to Finance Rwanda 2020). As many as 99 per cent of urban Rwandan adults and 30 per cent of rural Rwandan adults can reach a mobile money agent in less than 30 minutes, delivering the quickest points of financial access in both urban and rural settings (Access to Finance Rwanda 2020).

understand their impacts on merchants as important lessons can be learned on the potential effects of actual taxes on digital financial services.

Against this context, we aim at answering the following question: how is mobile money usage for retail payments shaping merchants' tax perceptions and, ultimately, tax compliance behaviour? We have access to a wealth of tax administrative data, kindly shared by the Rwanda Revenue Authority (RRA), which we originally combine with a survey of 1,135 merchants in Rwanda, as well as with focus group discussions (FGDs) with merchants and in-depth interviews with key industry players. With such data, we are able to document (a) the drivers of DFS adoption, (b) the role fees have on DFS adoption as well as continued DFS use, and (c) the impact that DFS use or non-use has on tax perceptions and behaviour. Importantly, we are able to compare the person-to-business payment option MoMo Pay with the mobile money traditional service, used through personal accounts.

We present four sets of findings. First, in terms of descriptive mapping of usage, we uncover that DFS are largely used in parallel with cash, which remains king. Traders, also, tend to use MoMo Pay and mobile money on personal accounts to the same extent. Surprisingly, cash-based transactions are relatively large, thus hinting at a large share of informal trading taking place, with potentially negative repercussions for compliance. Linking to the role of fees, the main barriers for usage are indeed the levies on DFS and, to a smaller extent, know-how and awareness. External factors like clients' and suppliers' preferences – suggesting network externalities (Katz and Shapiro 1985; Bellon, Chang, Dabla-Norris, Khalid, Paliza and Villena 2022), and government encouragement – are behind adoption as well.

Second, we identify the drivers of DFS adoption in a regression setting. In line with the descriptive evidence, users of DFS are more sophisticated and profitable. When comparing the merchant-specific service MoMo Pay and mobile money via personal accounts, we understand that larger, more equipped and knowledgeable traders opt for MoMo Pay rather than via personal accounts. Interestingly, non- and nil-filing correlates with usage of mobile money via personal accounts, suggesting that potential tax avoiders self-select themselves into this tool, shying away from the better monitored and tracked business-specific option. Furthermore, the misperception around the RRA having access to MoMo data, which 18 per cent of the sample wrongfully believe to be the case, does not play any role in explaining adoption.

Third, when it comes to the role of fees in shaping usage, we document a clear pattern in which the fee waiver on MoMo Pay enhances usage of this option, and consistently reduces reliance on cash. Trading through the mobile money personal account increases as well, albeit the waiver did not affect it. At the same time, the fee reintroduction produces a concerning reversion to cash and a drop in usage of both the mobile money-based options, although the fee affected MoMo Pay only, hinting to broader negative repercussions spilling over mobile money services in general.

Lastly, when connecting DFS usage and compliance, evidence is rather mixed. On the one hand, hard pecuniary motivations, such as perceived enforcement, are unaffected by usage. On the other, using any DFS seems to improve the social norm of compliance, where taxpayers comply because their peers do so – hinting at a network effect consistent with the fact that adoption mainly results from the influence of suppliers and clients. Furthermore, when considering the two mobile money-based options, using MoMo Pay deteriorates fiscal reciprocity, probably due to the fact that merchants do not see the link between the fees on the service and the provision of public services. There is not supposed to be such a link, as the fee is not a tax, but it is telling of merchants' confusion around what fees are for, an aspect of poor knowledge of tax matters already documented in Rwanda (Mascagni, Santoro and Mukama 2019). On the more practical side, mobile money personal account usage

improves the perceived ease of complying with taxes, while that is not the case for MoMo Pay, due to a number of technical difficulties and complexities in using it that we capture through the FGDs.

When we consider actual behaviour, we document a short-term effect of DFS adoption on VAT declarations. We measure a positive impact on VAT sales and inputs in the year following adoption, with no actual change in tax liability. After the year, the effect is indistinguishable from zero. The fact that merchants adjust both sales and costs margins tells of a perverse response through which they do not end up paying more VAT, even though they are disclosing more sales. Even more concerning, the fact that the impact dissipates in the medium term suggests that merchants may be going back to their pre-adoption compliance behaviour, as they might not see any threat of audit or higher enforcement when using DFS, in line with the null impacts on the corresponding perceptions. Relatedly, the fact that very few (18 per cent) of merchants believe that the RRA has access to MoMo data can also explain this behavioural reversal to pre-adoption levels.

This study contributes to different strands of the public finance and development literature. First, we contribute to the thin evidence on digital merchant payments. To the best of our knowledge, no academic evidence has been produced on the potential of digital transactions to influence merchants' tax perceptions and behaviour. Two exceptions are worth mentioning. First, Jacolin, Massil and Noah (2021) find a negative relation between the expansion of digital financial services and informality by considering 101 emerging and developing countries over the period 2000–15. Despite providing interesting macroeconomic insights, the study of Jacolin *et al.* (2021) lacks – by its very macro, cross-country nature – in the depth of the evidence produced and is unable to shed more light on the repercussions on tax compliance and tax revenue brought about by the increase in formalisation. A second exception is given by the study of Ligon, Malick, Sheth and Trachtman (2019) in Jaipur, India. The authors show that supply-side barriers to obtaining necessary infrastructure or meeting prerequisite requirements to adopt digital payments explain the low level of adoption of DFS. What seems to matter for adoption are rather the merchants' perceptions of future increases in tax liability and the fear of being put under the agency's radar. We elaborate the tax angle in more depth, through a more tax-oriented questionnaire and the analysis of tax compliance behaviour through administrative data – a crucial aspect that Ligon *et al.* (2019), a study relying on survey data only, neglected.

Second, we contribute to the growing literature that examines the impact of digital technologies on tax compliance, as reviewed in Okunogbe and Santoro (2022). In contrast to most papers, our study focuses on a novel technology, digital merchant payments, largely neglected.[2] This is despite digital merchant payments being quite connected with other, more studied, technologies – for instance, some versions of electronic billing machines are linked with digital payment methods. Importantly, while most of the current studies indicate the positive impacts of such technology, the mixed results we find hint at users' perverse behavioural responses in much the same vein as found for electronic billing machines in Mascagni, Mengistu and Woldeyes (2021). Linked to that, we contribute by informing how IT adoption among taxpayers has been changing after the pandemic, an aspect still unexplored, at least at a micro level, in the literature, with the exception of Santoro, Amine and Magongo (2022).[3] Furthermore, we particularly connect with recent qualitative studies from Africa indicating important digital divides between users and non-users.[4] Lastly, we contribute by

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[2]   Most of the literature focusses on e-invoicing (see Fan, Liu, Qian and Wen 2020; Bellon, Chang, Dabla-Norris, Khalid, Lima, Rojas and Villena 2019; Bellon *et al.* 2022), the electronic submission of tax returns or e-filing (Jouste, Nalukwago and Waiswa 2020; Okunogbe and Pouliquen 2017; Yilmaz and Coolidge 2013), and the use of electronic sales registry machines (Mascagni *et al.* 2021).

[3]   In so doing, we also connect with recent work tracking the shifts in taxpayers' attitudes and behaviours after COVID-19 (Mascagni and Santoro 2021).

[4]   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

also considering impacts on perceptions, and not only on compliance, given the survey data available. More specifically, we connect technology adoption with changes in tax perception indicators which are likely to explain compliance. As derived from the public finance literature, we focus on pecuniary motivations connected to deterrence (Allingham and Sandmo 1972; Sandmo 2005); softer, non-pecuniary factors broadly falling under the umbrella term of tax morale (Luttmer and Singhal 2014; Prichard 2022); more practical perceptions around the ease of compliance and of getting information on the tax system (Dom, Custers, Davenport and Prichard 2022). Technology like digital merchant payments can potentially affect all such perceptions, as argued in recent work (Okunogbe and Santoro 2022; World Bank 2016), but so far very little evidence, if any, has been produced around this.

Lastly, at least tangentially, we speak to the nascent literature around taxation of digital financial services (Munoz *et al.* 2022). Although we do not evaluate formal taxes on DFS, we study the role of fees, as imposed by mobile network operators, on usage. Such evidence could potentially inform current debates around taxing mobile money, as it indicates immediate behavioural responses which could take place if a new tax is introduced. As a matter of fact, in recent years, many governments in Africa have increasingly turned to taxes on DFS, and particularly mobile money, as an easy means to raise revenues and fund development, especially in light of the growing fiscal deficits post-pandemic (Matheson and Petit 2021; Mullins, Gupta and Liu 2020).[5] Only a handful of studies try to evaluate the impacts of such taxes, with inconclusive results (Clifford 2020).

Our study speaks to policy as well. Digital merchant payments are gaining momentum in Rwanda.[6] We produce recommendations for the tax administration, in terms of carefully understanding the linkages between DFS adoption and compliance, as well as considering the negative effects of introducing fees on digital payments. Lastly, this work fits in the current government plan to widen its tax base and increase tax revenues by unlocking the potential of digital financial services data and the monitoring of financial movements.[7] At least in theory, linking payments to sales data from tax returns would allow the RRA to monitor tax compliance without having to carry out costly physical audits. Yet, it is particularly difficult for tax administration, in Rwanda and beyond, to gain access to mobile money transaction data and unlock its potential (Santoro *et al.* 2022). Unsurprisingly, a marginal portion of the sample believes that such data sharing is taking place.

In what follows, we start by describing the Rwandan context in section 1, while we present the research design in section 2. Section 3 discusses our key quantitative results and section 4 presents qualitative evidence from in-depth interviews. Section 4 concludes.

2019). Sifile, Rodgers, Tendai and Desderio (2018) find that connectivity, as well as a lack of technical knowledge and training, is a major barrier to take-up in Zimbabwe.

[5] This includes Tanzania, Ghana, Cameroon, Uganda, Zimbabwe, Côte d'Ivoire, Kenya, and the Congo Republic; Malawi introduced a mobile money tax proposal, but it was removed before being approved (Clifford 2020).

[6] Previous tax compliance studies in Rwanda (Mascagni, Monkam and Nell 2016; Mascagni, Santoro, Mukama. Karangwa and Hakizimana 2022) were completed when cash had a near-dominance of the retail payments sphere (UN Capital Development Fund 2019).

[7] Also for this reason, in the past three years alone, Rwanda has passed legislation and created strategic plans to promote digital payments as well as incriminate individuals and entities involved in money laundering (Mwai 2020b).

1 Context

1.1 Tax system

Rwanda's tax system is characterised by the typical challenges of many low-income countries (LICs), from limited fiscal capacity to high levels of informality.[8] Despite that, tax performance in the country has seen steady growth, rising to a tax/GDP ratio of 16.7 per cent in 2019, slightly above the average of 16.3 per cent for sub-Saharan African countries, and higher than LICs' average (Appendix Figure A1).

In this study, we focus on the two main income taxes – corporate (CIT) and personal income tax (PIT) – which represented about 20 per cent of total revenues in 2019 (Rwanda Revenue Authority 2020). Both taxes apply to businesses: PIT on non-incorporated businesses with a single owner and CIT on corporations.[9] Income taxes are filed annually, by no later than 31 March of the following tax period. The tax rate for CIT is a uniform rate of 30 per cent on the profit, while the tax rate for PIT follows a progressive schedule (Rwanda Revenue Authority 2017).[10]

As an indication of compliance behaviour, at least three distinct filing behaviours can be identified. The first refers to 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,[11] and more common among PIT rather than CIT payers.[12] This trend is observed in other LICs, 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.[13] Nil-filing is also prevalent in other countries (Mascagni *et al.* 2020; Santoro and Mdluli 2019; Almunia, Gerard, Hjort, Knebelmann, Nakyambadde, Raisaro and Tian 2017; Mascagni and Mengistu, 2016). 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. Correspondingly, in our study, we focus both on active taxpayers and 'inactive' or 'unproductive' taxpayers (Moore 2022), a group combining non- and nil-filers.

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[8] According to Williams and Schneider (2016), informality amounts to 36 per cent of national income over the period 2008–2017, compared to 42 per cent in East Africa.

[9] 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).

[10] 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).

[11] 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 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.

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

[13] 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 2022).

1.2 Road to cashless

Although COVID-19 did accelerate Rwanda's push for mass DFS adoption, the journey 'towards a cashless Rwanda' (Government of Rwanda 2018) has its roots in 2014, when Rwanda joined the Better than Cash Alliance (BTCA), thus committing to creating its roadmap to a cashless economy.[14] The policy development reflecting this commitment became evident in 2018, when the National Bank of Rwanda (BNR) published its six-year Rwanda National Payment Strategy (RNPS), summarised by the document's slogan – 'Towards a cashless Rwanda'. By 2018, Rwanda had implemented various layers of digital payment infrastructure, including but not limited to the Rwanda Integrated Payments Processing System (RIPPS), RSwitch, MTN MoMo, Tigo Cash, and Airtel Money. While RIPPS and RSwitch are platforms that allow interbank (RIPPS) and debit/credit card transactions (RSwitch) to take place (Government of Rwanda 2018), the remaining platforms were all platforms to allow mobile money payments to take place using existing mobile subscribers' accounts. In fact, Access to Finance Rwanda (AFR) indicated in a 2016 study (Finmark Trust 2016) that 89 per cent of Rwandan adults were already financially included, mainly thanks to mobile money accounts and Savings and Credit Cooperatives (SACCOs). This infrastructure, however, was not yet being leveraged to its full potential, as only 46 per cent of formally included users were using DFS when Finscope 2016 was published (Government of Rwanda 2018: 24).

By 2018, though, Rwanda faced a sluggish uptake of DFS, yet had the ability to quickly deploy DFS to the masses via mobile wallets. As such, three key action steps in RNPS 2018–2024 were formulated. First, to review taxation policies regarding e-payment transactions to encourage usage. Second, to incentivise merchants and consumers to adopt digital payments (lower merchant discount rates, tax credits, rebates). Third, to encourage low-cost business models and solutions that accelerate payment adoption (Government of Rwanda 2018: 10).

One of the aforementioned DFS that has had a considerable effect on Rwanda's journey to achieving a cashless economy has been MoMo Pay, a mobile money payment service for consumers paying merchants. From a retail sales perspective, mobile money payments, through the person-to-business payment option called MoMo Pay, allow safe and quick reconciliation of payments for merchants, and are more attractive to a wider range of clients and offer more enhanced competitiveness in the sector, as well as additional benefits in terms of record-keeping and accounting, as transactions are adequately stored in the platform.

The RNPS 2018–2024 strategy was influential in the continual growth of mobile money use in Rwanda, and one of the reasons why merchants were able to quickly transition to using MoMo Pay to receive payments from consumers at the beginning of the COVID-19 pandemic. The fact that this quick transition was able to take place is the underlying reason why we decided to study the effect digital payments in Rwanda have had on merchants' tax compliance. In the country, MoMo acceptance far exceeds any other DFS payment amongst merchants in Rwanda. This is not surprising due to various factors, including but not limited to 1) the lower fees of accepting MoMo vs. credit cards, 2) the prevalence of mobile phone lines in Rwanda, and 3) the ease of use of the platform for both consumers and merchants.

As far as the costs of mobile money transactions are concerned, represented by the fees, a number of considerations should be made. First, MoMo Pay charges are paid for by the merchants, and consumers do not pay any fee when paying a merchant via MoMo Pay.

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[14]   BTCA, a global partnership created in 2012 to accelerate the transition from cash to 'responsible digital payments', has the Bill & Melinda Gates Foundation as well as Visa Inc. as two of its founding members, and has striven to develop an influential role in onboarding various multinationals and countries to its alliance.

Second, push/pull charges are fees incurred by all users (merchants and consumers) when transferring MoMo to/from their bank accounts. Third, sending fees only apply to person-to-person payments. This became a noteworthy factor once MoMo Pay charges were reinstated in *COVID III*. Rwanda's accelerated effort to promote DFS use throughout the COVID-19 pandemic can be discerned by observing the rapid change of fee structures in the mobile money ecosystem from the time period preceding COVID-19 up until the present. As the pandemic progressed, direct and indirect charges for mobile money use also changed and heavily impacted adoption rates by consumers and merchants alike. The evolution of fee structures during this time period was thus recorded, and given the following labels: *Pre-COVID, COVID I, COVID II, and COVID III* (see Figure 1). Phase 1, or the baseline, refers to the pre-COVID-19 situation, before March 2020, when a 1 per cent fee was applied to MoMo Pay transactions, on top of standard pull/push charges and sending fees. Phase 2 covers the period of March to June 2020, or the first wave of the pandemic. In this period, all pre-existing fees were waived, and using both MoMo Pay and MoMo through a personal mobile money account, described hereafter as 'personal number', became essentially free. In the third phase, from July 2020 to August 2021, digital merchant payments through MoMo Pay were free, but push/pull and sending fees on MoMo through a personal number were reintroduced, albeit at a reduced rate. Lastly, phase 4 refers to the period from August 2021 to the present, where MoMo Pay is affected by a 0.5 per cent fee on transactions above 4,000 RWF.

Figure 1 The evolution of fees on digital payments in 2020–2022

KEY FACTORS	TIMELINE			
	PRE-COVID (Before Mar 2020)	COVID I (Mar 2020 – Jun 2020)	COVID II (Jul 2020 – Aug 2021)	COVID III (Sep 2021 – PRESENT)
MTN MoMo Pay Charges	1%	0%	0%	0.5% (Transactions ≥ 4000 RWF) 0% (Transactions < 4000 RWF)
Push/Pull Charges	Per MTN/Bank Agreement	0	Reinstated: Per MTN/Bank Agreement	0
Sending Fees (MoMo) – Non MoMo Pay Transactions	MTN Applicable Rates	0	Reinstated, yet Reduced: MTN Applicable Rates	MTN Applicable Rates (same as Jul 2020 – Aug 2021)

The astonishing outcome of the initial decision to waive all fees in *COVID I* was the surge effect it had in MoMo Pay adoption. During this time period alone, MTN, the leading mobile network operator in Rwanda and East Africa, increased the quantity of MoMo Pay merchants from 5,000 registered merchants to 65,000 (interview with MTN, 28 February 2022). The subsequent reinstatement of MoMo Pay fees would then cause a drop in registered merchants to 48,500 by the beginning of *COVID III*. While not directly linked, the reinstatement of MoMo Pay fees coincidentally came immediately after the prohibition of push/pull charges by the National Bank of Rwanda in August 2021 (Mwai 2021b).[15] As of May 2022, Rwandan merchants accepting MoMo Pay face a 0.5 per cent fee for carrying out a transaction above 4,000 RWF, as listed under *COVID III*. A noteworthy observation is that both MoMo Pay and non-MoMo Pay charges, although present once again, are currently lower today than they were in the time period preceding the COVID-19 pandemic. The changing fee structures and their effect on merchants accepting DFS during the March 2020–May 2022 period are explored in section 3.3.

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[15] Push/pull charges were a source of revenue for both mobile money operators and banks, while current MoMo Pay fees only benefit MTN.

2 Methodology

2.1 Data sources

In line with recent literature (Santoro 2021; Mascagni and Santoro 2021), we follow a multi-method approach, originally combining different data sources: administrative data from the RRA, allowing for quantitative analysis; more qualitative tools such as interviews with key informants (KIIs) and focus group discussions (FGDs); and a survey questionnaire on a sample of 1,135 merchants in Rwanda, collecting mostly quantitative information, and to a lesser extent qualitative evidence as well.

Administrative data. We gained access to a wealth of administrative tax data, kindly shared by the RRA. First, we consider the taxpayer registry, which contains relevant information on all taxpayers registered with the tax agency, such as contact details and location, type of business and registration year, type of tax regime the taxpayer falls into, whether the taxpayer is registered for use of an electronic billing machine (EBM) and for which type of machine, etc. The registry is updated as of February 2022. A nationally representative sample is extracted from the registry, restricted to the capital city Kigali and the five secondary cities of Musanze, Muhanga, Rubavu, Rwamagana and Kayonza, selected based on the highest levels of business activity in their respective provinces.

Importantly, we apply some restrictions to the broad population of taxpayers: we consider only taxpayers registered for income tax and registered before 2021 – so to have at least one filing period before the survey – as well as taxpayers for whom contact details are valid. We also drop what we call 'never filers', taxpayers brought into the registry but never actually submitting a return, hinting at possible issues with aggressive registration campaigns of inactive entities (Mascagni, Santoro, Mukama, Karangwa and Hakizimana 2022; Moore 2022). We remove 'never filers' as anecdotal evidence suggests that most of them are not operative and obtained taxpayer identification numbers (TINs) for ad-hoc purposes rather than for filing income taxes. We also acknowledge that never filers can be actively trading and using DFS with clients, thus being deliberately non-compliant for tax purposes. However, to secure enough statistical power and a more homogenous sample of traders to run our analysis on DFS usage and impacts, we opted to discard such taxpayers. The final number of taxpayers used for the sampling is about 60,000, out of a total population of 352,000 taxpayers present in the registry.

Second, we recur to datasets on filing and payment, for both VAT and income tax. We use such information to understand, first, whether previous filing behaviour affects adoption of DFS, and, at a later stage, whether DFS adoption consequently shapes filing and payment outcomes.

Survey data. We successfully interviewed a total of 1,135 merchants, randomly extracted from the RRA registry and nationally representative of the population in Kigali and key economic hubs in the provinces.[16] About half of the sample consists of incorporated businesses registered for CIT (52 per cent), two-thirds are active taxpayers (with the remaining third being either nil- or non-filers) and the vast majority is based in Kigali (68 per cent). A third of the sample is composed of women and almost half has higher education. The average sales by month amount to almost US$6,000.[17]

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[16] Appendix Table A1 reports key summary statistics on the full list of variables.

[17] Interestingly, most of the taxpayers in the sample report being in operation in the last year (95 per cent). That is despite the fact that a third are inactive when their filing behaviour is considered, suggesting that taxpayers tend to misreport and under-declare their business activity for tax purposes. This pattern is also observed elsewhere, as in Eswatini (Santoro 2021).

The data collection took place through face-to-face interviews implemented by a team of 21 thoroughly trained enumerators using tablets for digital inputting. The data collection period ranged from 17 March to 15 April 2022.

The questionnaire, carefully designed through repeated interactions with the RRA, consists of seven modules, and takes an average duration of 43 minutes. After getting informed consent from the respondent, we collect demographic information and business-related features. After that, we implement a more intensive module on DFS and payment methods, including a battery of questions on usage across different time periods, average amounts for each payment method, and a quiz on mobile money knowledge. This module constitutes the core of our survey data collection efforts. It consists of retrospective panel questions on modes of payments in 2020–2022, capturing important data on usage trends, which we exploit in our analysis on the role of fees. As we discuss in the conclusion, we are aware of possible recall bias threating the robustness of our analysis. It is also true, however, that such an approach is the only viable way when transaction data from mobile money providers, extremely difficult to get for confidentiality reasons, is unavailable. Further, we ran a quiz module on tax knowledge in general, as we expect it to be a key driver of adoption of DFS as well. A final module gathers information on taxpayer attitudes and perceptions, from unconditional compliance to the perceived fairness of the tax system, from perceived deterrence to social norms – all in line with recent survey-based studies on tax compliance in developing countries (Santoro 2021).

FGDs and KIIs. In addition to survey data, we gain additional insights from alternative modes of qualitative data collection, such as FGDs and KIIs. FGDs were performed before the survey, in February 2022, so to inform the design of the questionnaire. We ran three FGDs with a total of 15 traders attending, for an average duration of two hours each. As with the survey sample, participants were randomly drawn from the RRA taxpayer registry.[18] The discussions were conducted in a combination of English, French and Kinyarwanda. The audio recordings of the FGDs and accompanying notes have been analysed ex-post using a coding framework organised around a list of key thematic areas. Portions of text have been allocated systematically into each theme to identify common patterns and findings across the three focus groups.

Furthermore, we ran a total of four KIIs with key players in the ecosystem. We spoke to key figures at Airtel, Bank of Kigali, Equity Bank, and MTN. We focused mostly on Airtel and MTN as they are the only telecom operators in Rwanda providing mobile money services, and also interviewed Bank of Kigali and Equity Bank as they both have DFS strategies they are trying to deploy in Rwanda. Key insights from these interviews are summarised in section 5 and help in better understanding the context as well as interpreting the main findings of the study.

2.2 Estimation strategy

Drivers of adoption. In order to address our first research question, we implement a simple multivariate regression model by regressing our outcomes, adoption of digital merchant payments, on a range of explanatory variables. The following probit equation describes our approach:

$$Y_i = f(\beta' \ Background; \ \gamma' \ Tax \ ; \ \delta' \ DFS) \tag{1}$$

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[18] Inclusion restrictions required that the participants be based in Kigali, for logistical feasibility, and actively using DFS as a mode of payments from clients. While location was obtained from the RRA registry, information on active usage of DFS was captured through a battery of screening questions run on the phone during the recruitment of participants.

where Y_i is the dependent variable, a binary variable indicating adoption of digital merchant payments, as derived from the survey tool. We first pool together usage of any digital payment method, either mobile money-based or through bank transfers or credit cards. We then discriminate between usage of MoMo Pay, the payment method specific to merchants, and MoMo through a personal number, in order to uncover differences in drivers of adoption. In terms of explanatory factors, we group these in three groups. First, a set of background features of the respondent, both at the individual[19] and business level;[20] second, a set of tax-related characteristics;[21] and, third, more DFS-related features. The corresponding probit coefficients indicating the relevance of each factor are given by β', γ' and δ'.

The role of fees. To identify shifts in usage of digital merchant payments, we exploit the panel nature of the survey module on usage, and the fact that we collect usage data on periods both before and after the onset of the crisis (Figure 1) through retrospective survey questions. More precisely, we run a set of fixed effects regressions to evaluate the impact of different time periods on four outcomes of interest: the share of total sales performed in cash, with MoMo Pay, with MoMo through a personal number and, lastly, through credit card and POS.

The regressions we estimate are based on equation 2, where Y_{it} is one of the relevant outcomes listed above. The coefficients of interest are β_1, β_2, and β_3, which capture the effect of three dummy variables corresponding to each time period of interest: March to May 2020 (*COVID1*), July 2020 to August 2021 (*COVID2*) and September 2021 to March 2022, the time of the survey (*COVID3*). γ_i captures the fixed effects: all the observable and unobservable factors that remain fixed over time, within individual respondents, during our data period. They include factors such as gender, location, sector, and even other characteristics such as the level of education or business practices. While some of these variables may change over longer periods of time, we can reasonably expect very little or no variation over the time periods – especially as no other major event occurred in Rwanda in addition to the pandemic. ε_{it} is an error term.

$$Y_{it} = \beta_0 + \beta_1 COVID1 + \beta_2 COVID2 + \beta_3 COVID3 + \gamma_i + \varepsilon_{it} \tag{2}$$

Impacts on tax attitudes and behaviour. As far as the impact on attitudes and behaviours is concerned, we adopt a two-pronged approach. First, considering the survey-based measures on attitudes, we perform a simple multivariate regression framework, in the same fashion as equation 1:

$$Y_i = f(\beta' \ DFS; \ \gamma' \ Controls) \tag{3}$$

where the key explanatory variable is, first, whether the merchant makes use of any digital merchant payments and, in more detail, whether she or he is using MoMo Pay or MoMo through a personal number. The set of controls includes all the above variables used in equation 1, pooling background, tax- and DFS-related features. As outcomes, we create three specific sets of attitudes, namely: (i) a set of soft motivations to comply – all connected to tax morale (Luttmer and Singhal 2014), such as the perceived fairness of the tax system,[22]

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[19]   Such as gender, age, education, usage of social media and wealth status indicated by the ubudehe category. Ubudehe is one of four categories of socio-economic classification of Rwandan citizens, used for the provision of government funds and insurance.

[20]   Such as business location and the size of business premises, whether the business has been operative in the last year, number of employees, sector, monthly sales, official record-keeping, internet usage.

[21]   Such as the tax type registered for, whether the taxpayer is actively filing, registered for EBM, paying VAT in addition to income tax, whether she or he has a tax accountant, the level of tax knowledge as derived from a three-question quiz, the number of hours spent per month on tax matters, and whether the business has ever been audited, fined or trained.

[22]   The survey question reads: 'How fair or unfair do you think the tax system is?'

peer pressure to evade,[23] fiscal exchange or reciprocity mechanisms,[24] and unconditional willingness to comply;[25] (ii) a set of perceptions referring to deterrence and trust towards the tax agency, such as the perceived probability of getting audited,[26] feelings around the severity of the RRA's enforcement strategy,[27] trust regarding the RRA's assistance,[28] (iii) a final set of more practical considerations, such as the ease of complying and filing a tax return,[29] and the perceived transparency of the tax system.[30]

In the attempt to control for selection bias in adopting the technology, we strengthen our specification in (3) with a propensity score matching (PSM) design (Rosenbaum and Rubin 1983). PSM helps to create a more suitable comparison group by matching adopters with the most similar non-adopters as based on observable characteristics. In our case, we recur to the Kernel matching technique, as it arrives at a more accurate match due to its weighting function. Through this technique, every observation of the adopters group is then matched with a weighted average of units from the non-adopters group.[31] As shown in appendix figures A4 and A5, the PSM technique vastly reduces the imbalances in observables across the two groups after match and, correspondingly, makes them pretty much comparable in terms of the log-odds distribution, or probability to be adopting the technology.[32] Specification (3) is then run on the matched sample.

As far as impact on behaviour is concerned, we exploit the fact that, for users of DFS, information on the month and year of adoption is available. Although recall bias could make our analysis more challenging, we recur to this solution as the only feasible way of knowing when adoption took place.[33] We employ a difference-in-difference strategy estimating the impact of DFS adoption on VAT outcomes. In much the same vein as in Mascagni *et al.* (2021), we take into account the fact that adoption of DFS is clearly not randomised and attempt to build a suitable control group by testing whether the parallel trend assumption holds. First, we make sure to include only those merchants who eventually adopt the DFS, thus dropping never-adopters. Then we restrict the analysis only to those for whom at least one filing period before and after adoption can be observed in the administrative data. Further, we directly test for it through the equation below, including as many as 12 filing periods before adoption and 12 after adoption:

$$Y_{it} = \alpha + \sum_{-12}^{12} \beta_t DFS_{it+k} + Y_i + T_t + \varepsilon_{it}$$
(4)

where, Y_{it} stands for VAT returns and payments outcomes reported by taxpayer i at a given filing period t. The indicator variable DFS_{it+k} takes value 1 if the taxpayer is k periods before

[23]   The survey question reads: 'Please tell me if you totally agree, somewhat agree, somewhat disagree, or totally disagree with the following statement: If my neighbours do not pay taxes, it is fair for me not to pay them either.'

[24]   Agreement with the statement 'Taxpayers must pay their taxes to the government in order to receive better public services.'

[25]   The survey question reads: 'Please tell me for the following statement whether you think it can always be justified, never be justified, or something in between: Under-declare income so to pay less tax.'

[26]   The survey question reads: 'What do you think is the approximate likelihood that you will be selected for audit or review this year regarding your declarations, from 0 per cent to 100 per cent?'

[27]   Agreement with the statement: 'RRA enforcement strategy is too heavy in punishing taxpayers.'

[28]   The survey question reads: 'If you contact RRA for information, how much trust or mistrust do you have that the RRA acts in the interest of ordinary citizens like you?'

[29]   The survey question reads: 'How easy/difficult it is to file an income tax return?'

[30]   The survey question reads: 'Based on your experience, how easy is it to find out how the government uses the revenue from people's taxes and fees?'

[31]   We selected 0.06 as the bandwidth in the kernel matching algorithm, as is common practice in the literature.

[32]   We perform the matching considering the three scenarios we are analysisng: (i) adopting any DFS, (ii) adopting MoMo Pay, (iii) adopting MoMo through personal number.

[33]   The revenue authority does not collect such information, not even for merchants using the official MoMo Pay tool, and it proved highly unfeasible to gather it from mobile network operators.

(after) adoption in period t. Y_i and T_t are firm and month fixed effects respectively. After having shown that parallel trend holds (section 3), we then estimate our main specification through a standard difference in differences (DID) approach with staggered treatment – as described in equation 5 below. We include month and taxpayer fixed effect, while DFS switches to one in the month of adoption.

$$Y_{it} = \alpha + \beta_t DFS_t + Y_i + T_t + \varepsilon_{it} \tag{5}$$

The key results of our analysis are described in section 3 below.

3 Results

3.1 Usage patterns

As displayed in Figure 2, cash as a mode of retail payment is still king, accepted by 88 per cent of the sample. Just about an eighth of the sample do not accept cash in their trading. Mobile money is relatively accepted, with about half either accepting MoMo Pay or MoMo through their personal number. This finding indicates that, despite the fact that MTN provided a specific mobile money platform for traders, they still prefer to transact through their mobile money personal accounts – the latter being unaffected by the fee.[34] Furthermore, about a third accept bank transfers and a sixth accept cheques. Interestingly, the same pattern emerges when considering traders' payments to suppliers (Figure A2a), while, when looking at payments to employees, usage of mobile money drastically reduces, and cash remains by far the predominant payment method (Figure A2b).

Figure 2 Mapping of merchant payments mode
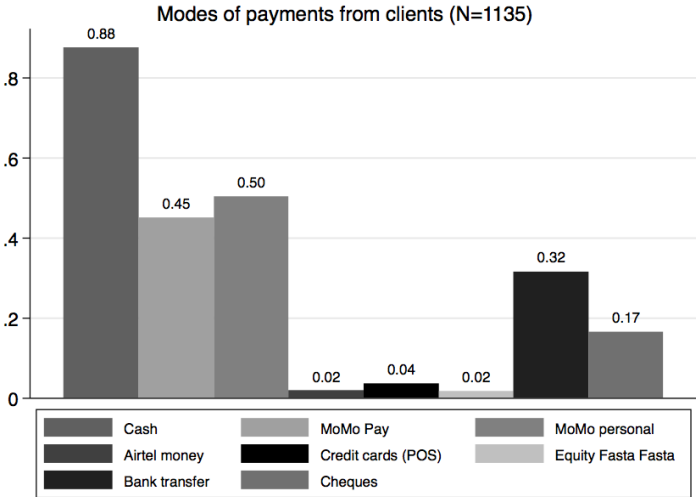
Note: data derived from survey question 'Which modes of payments from clients (P2B or B2B) are accepted here?'

When we take in consideration the daily amount transacted by mode of payment, cash-based transactions are surprisingly similar in size to sales made through MoMo Pay, as shown, for the three most common modes, in Figure 3. Cash, on top of being the most preferred option for traders, is also used for relatively large transactions, or transactions at least as large as those done through MoMo Pay. In contrast, sales made through a MoMo personal number are more concentrated along smaller amounts, indicating that smaller, and

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[34] The other mobile money provider, Airtel, is adopted by a tiny minority, indicating that MTN is the favourite option for users.

probably less sophisticated, businesses tend to adopt the standard mobile money service and not the platform specifically designed for them, MoMo Pay. This could also hint at the presence of daily limits MTN imposes on transactions on personal accounts, with the purposes of pushing larger transactions to MoMo Pay.

Figure 3 Average daily amounts by mode of payment
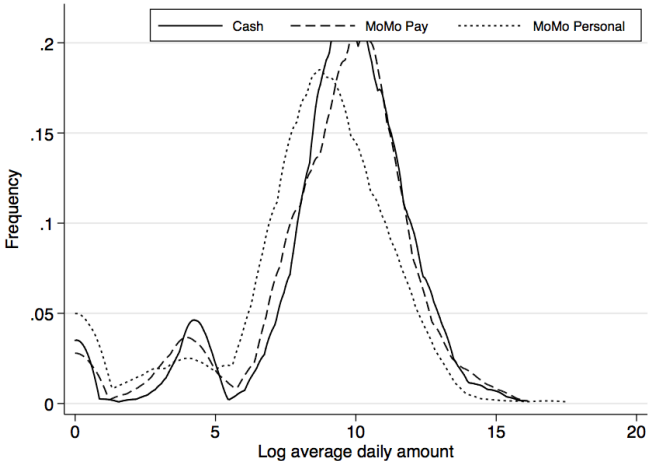
Note: data derived from survey question 'What is the average value of transaction – out of the total sales in a typical day? (RWF).' Amounts transformed in logs.

As displayed in Figure A3b, the most common reason for not using mobile money is the high charges and fees (47 per cent). The fact that this is stated as the first reason also for not using mobile money through a personal number is quite alarming, as transactions through the latter are essentially free for the receiving party (merchant). This evidence hints at broader unawareness and confusion among taxpayers around the fee structure and cost of mobile money – or to a wrong attribution of the fees on MoMo Pay to mobile money more generally. As a second key reason, clients' preference for cash is mentioned. Less frequently cited reasons refer to lack of knowledge and mobile money being difficult to use.

On the other hand, taxpayers seem to be pushed to use mobile money mostly by external forces (Figure A3a). Clients still remain important in traders' decisions about whether to adopt mobile money, and, secondly, the government's encouragement and broader national strategy play a key role as well, in line with what has been described in section 1. Other, more practical, factors like reduction of transaction time (34 per cent) and reduction of the transaction cost (25 per cent) also contributed, albeit to a lesser extent, to mobile money usage. Such factors are confirmed in the FGDs, with participants stressing the reduction in transaction cost thanks to enhanced security,[35] the ease of performing transactions[36] and, once again, the role played by clients' preferences, either for using mobile money[37] or reverting back to cash.[38]

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[35]   P1 of FGD1: 'We're now entering the world of cashless. It is not good to go with money in pocket. I think it is very important and it helps people to control their money: you don't get afraid that someone will come and rob you, they can even kill you if you have a lot of money in your pocket so it is a very good system.' P2 of FGD3: 'Everyone felt safe using it, even the fact that you can't be stolen your money when it is on your phone made it safer.' P1 of FGD4: 'So MoMo is good because it is safe to keep your money on MoMo rather than walking around with cash, let's say maybe 1 million. It can be stolen or you can lose it, but on MoMo no one can know that you have [it] and no one can steal on your MoMo if they don't know your pin.'

[36]   P1 of FGD2: 'In my business, which is hospitality, when someone is at their home they can order anything from us, sometimes through Vuba Vuba application and they can pay via MoMo.'

[37]   P3 of FGD1: 'Always clients are happy when you use MoMo pay code, even yourself when you are a client somewhere you would like to pay using MoMo pay code; sometimes when they don't have it, it becomes an issue.'

[38]   P6 of FGD4: 'Having cash is essential because you might have, like, to pay someone who doesn't want money on the phone; you will want cash, that is the only way they won't charge us as well.'

3.2 What drives adoption?

Figure 4 reports the OLS coefficient estimates on equation 1 over an indicator for using any DFS in trading. Of the positive correlates with adoption, DFS usage with suppliers is the most relevant one, hinting at significant IT transmission channels through the value chain, as well as large network externalities through which technology spreads across trading partners (Katz and Shapiro 1985). In this sense, the number of trading partners using digital merchant payments increases the value of such options for the merchants in our sample, in line with similar evidence around e-invoicing (Bellon *et al.* 2022). A second important group of factors refers to the business being in operation, and, relatedly, to its size (medium/large). While this evidence is only correlational, it could hint at the fact that technology adopters might be more likely to be productive, probably thanks to the ease of performing transactions and these merchants' higher attractiveness to clients. A third set of positive factors suggests that the IT-sophistication of traders also plays a role, as taxpayers using internet,[39] having a bank account (albeit marginally insignificant) and performing better in the quiz on mobile money are significantly more likely to use DFS. Lastly, interactions with the tax administration partially explain adoption. On the one hand, being audited positively correlates with adoption. On the other, having received training from RRA negatively covaries with adoption, somehow puzzlingly. The misperception around the RRA having access to MoMo data for tax purposes does not explain adoption and plays only an insignificant role.

Figure 4 OLS coefficients of correlates with any digital merchant payments
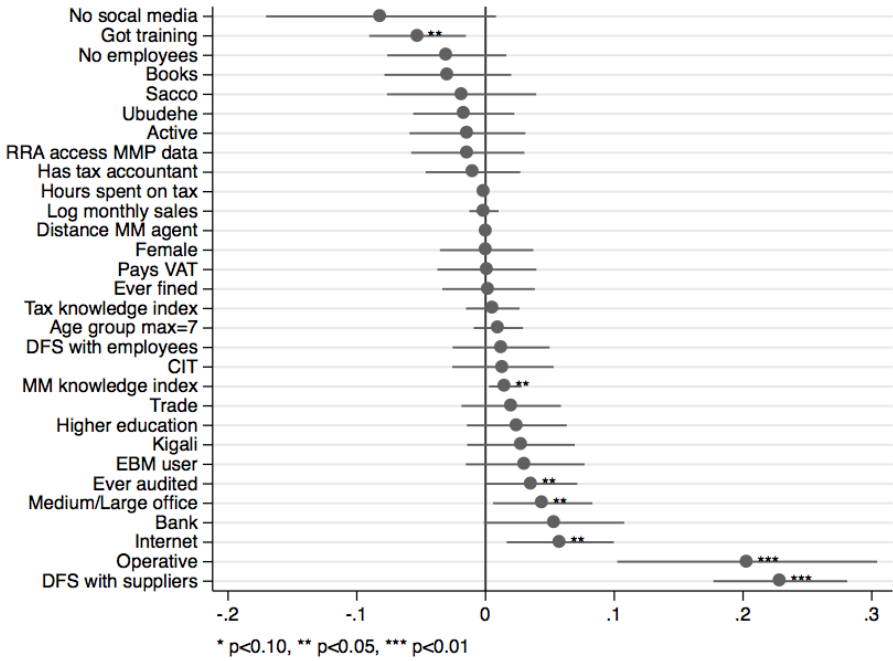
Note: data derived from survey question 'Which modes of payments from clients (P2B or B2B) are accepted here?' The outcome is a 0-1 indicator variable for accepting any DFS from clients.

The same analysis is performed in a disaggregated fashion on the two key mobile money-based services for trades, which are adopted by about half of the sample (Figure 2), with results reported in Table 1 below. Some statistically significant patterns emerge from the table. First, in terms of demographic features, female, younger, and less educated taxpayers are more likely to perform their transaction through the standard mobile money personal account, while that is not the case with MoMo Pay. This first piece of evidence illustrates that less knowledgeable and more marginalised groups would not take up the business-specific

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[39] While smartphone ownership and social media usage is very high, 36 per cent do not use a computer in their business and, correspondingly, 40 per cent do not use internet.

DFS service, probably due to practical barriers to usage. Through the lens of equity and fairness, it also suggests such marginalised groups would not be significantly impacted by a fee on a service they do not use.

Somewhat related to that, Table 1 also indicates that business-specific features explain the difference in adoption. On the one hand, larger businesses in the trading sector and with employees would take up MoMo Pay. On the other, less sophisticated and less equipped taxpayers, i.e. those without a bank account, a tax accountant, or those not keeping books of records, are much more likely to use their personal account rather than MoMo Pay.

Again relatedly, another key determinant of differential usage is taxpayers' knowledge around mobile money. More knowledgeable taxpayers are much more likely to adopt MoMo Pay, while those with poorer knowledge end up using their personal account. This mirrors the different patterns explained above, where female, less educated, less IT equipped taxpayers prefer their personal number; such profiles also show a poorer knowledge around mobile money. However, again the misperception and wrong assumption that the RRA has access to MoMo data is not a key discriminant factor for adoption.

Furthermore, some evidence from Table 1 seems to connect DFS adoption and compliance. While it is true that both types of adopters are much more likely to be operative, it is also concerning to see that actives and non-actives tend to more often use MoMo Pay and the personal account, respectively. The fact that being a nil- and non-filer positively correlates with using the personal account may suggest that these taxpayers would prefer this tool to partially transact informally – as business transactions done through such a means are not distinguishable from any other transaction type – and under-declare to the fiscus. It could be that nil- and non-filers shy away from MoMo Pay given their intent to remit less tax, as the business-specific service would track their transactions better, which these entities would rather keep informal. Interestingly, getting audited strongly correlates with using MoMo Pay, suggesting that the audit experience may have pushed taxpayers to adopt more formal and transparent merchant payment options.

Table 1 OLS coefficients of correlates with digital merchant payment modes

	(1) MoMo Pay	(2) MoMo Personal
CIT	-0.01	-0.01
	(0.03)	(0.04)
Active	0.06*	-0.09**
	(0.03)	(0.04)
Kigali	-0.04	-0.00
	(0.03)	(0.04)
Female	-0.01	0.07**
	(0.03)	(0.03)
Age group (max=7)	0.02	-0.04**
	(0.02)	(0.02)
Higher education	0.00	-0.10***
	(0.03)	(0.04)
Ubudehe	0.00	-0.02
	(0.03)	(0.03)
Operative	0.11**	0.12*
	(0.04)	(0.07)
Medium/large office	0.05*	0.03
	(0.03)	(0.04)
No employees	-0.12***	0.02
	(0.04)	(0.04)
Trade	0.12***	-0.00
	(0.03)	(0.03)
Log monthly sales	-0.01	-0.01
	(0.01)	(0.01)
Books	0.04	-0.12***
	(0.03)	(0.04)
Internet	0.02	0.02
	(0.03)	(0.04)
No social media	-0.02	-0.08
	(0.05)	(0.06)
EBM user	-0.06*	0.06
	(0.03)	(0.04)
Pays VAT	-0.10***	0.04
	(0.03)	(0.03)
Tax knowledge index (max=4)	-0.00	-0.03
	(0.02)	(0.02)
Has tax accountant	0.03	-0.09***
	(0.03)	(0.04)
Hours spent on tax	-0.00	-0.00
	(0.00)	(0.00)
Ever audited	0.08***	-0.01
	(0.03)	(0.03)
Ever fined	0.02	-0.03

	(0.03)	(0.03)
Got training	0.02	-0.05
	(0.03)	(0.04)
MoMo knowledge index (max=7)	0.11***	-0.06***
	(0.01)	(0.01)
RRA has access to MoMo Pay data	-0.02	0.05
	(0.04)	(0.05)
Distance MoMo agent min	-0.00**	0.00*
	(0.00)	(0.00)
Bank	0.10***	-0.08*
	(0.04)	(0.04)
SACCO	0.10*	-0.06
	(0.05)	(0.06)
DFS with suppliers	0.07**	0.17***
	(0.03)	(0.04)
DFS with employees	0.04	-0.05
	(0.05)	(0.05)
Mean of dep. variable	0.32	0.38
R-sq.	0.287	0.194
Observations	911	911

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. Outcome is an indicator variable for using the trader specific mobile money service, MoMo Pay, and the general mobile money personal account, in column 1 and 2 respectively. Data derived from survey question 'Which modes of payments from clients (P2B or B2B) are accepted here?'

3.3 The role of fees in shaping usage

After having described the drivers of adoption, we now study the role of fees in shaping digital merchant payments' usage. In this section, we exploit the fact that we have survey data on the composition of total sales across different payment methods and across the four phases under study (Figure 1).

With the available information on usage of payment methods across time, as captured in the survey (section 2.1), we can run a fixed effect regression to evaluate the impact of the different phases on the composition of sales by the different methods – as described in section 2. Fixed effect estimates are reported in Figure 5 below. The coefficients on the different phases are estimated based on equation 2 above (section 2), with the relevant confidence intervals. The dotted line represents the pre-COVID or Phase 1 value of each relevant variable. Since the pre-COVID value is the excluded category in equation 2, all other phases' coefficients are evaluated in comparison to it – hence indicating the relative change in usage as compared to pre-COVID times. Each individual graph in Figure 5 corresponds to a separate regression on the dependent variable indicated at the top of each one, i.e. the share of each payment method as part of the total sales.

These results point to significant shifts in usage in relation to the waiver and reintroduction of the fees. A first striking result is the significant fall of cash-basis sales over the total in phases 2 and 3, declining by more than 20 percentage points. Such a reduction corresponds to the waiver of fees on MoMo Pay and MoMo through personal number, indicating that merchants abundantly shifted to such digital means when it became more convenient – in line with the government's intention (section 1). The decline in cash is mirrored by a corresponding increase in MoMo Pay and MoMo through personal number. Importantly, MoMo Pay increases by a similar share (about 20 percentage points), while MoMo through personal number by a much smaller rate (about five percentage points). This shift is abundantly

confirmed in the FGDs. However, only a few participants link the COVID period with the reduction in charges,[40] while most somehow wrongly associate the overall pandemic experience and social distance requirements with the massive uptake of mobile money.[41] Again, this may suggest that the overall knowledge around mobile money fee structures and recent developments is relatively poor.

Second, the regressions indicate that in phase 4, when MoMo Pay is affected by a fee, the usage of this tool declines compared to phase 3 by few percentage points, while remaining substantially higher than pre-COVID levels, when MoMo Pay transactions had a fee of 1 per cent (Table 1). At the same time, cash usage in phase 4 rises as well, implying a concerning shift from digital to traditional modes of payments. The increment in cash-based transactions is substantial, about ten percentage points, with respect to phase 3, but the end result is that the prevalence of cash is still significantly lower than pre-COVID times. As a side note, it is worth mentioning that the share of transactions performed through MoMo personal number declines as well in phase 4, albeit they are not directly affected by the reintroduced fee on MoMo Pay. MoMo through personal number was already charged in phase 3, but it seems that merchants reduced its usage only in phase 4. This could be due to the wrong association of the MoMo Pay fee with this method as well, in line with the limited knowledge on the technicalities of the mobile money system mentioned above.

As a last result, and thus to enable comparisons across payment modes, we show that credit card transactions remain stable across the four phases, with no significant change compared to pre-COVID. This is expected as such transactions have not been affected by any fee changes during the study period.

These results, taken together, indicate that the fee waiver as a response to the pandemic significantly boosted the adoption of digital merchant payments and correspondingly curbed the prevalence of cash. Such a finding is particularly telling of the role of fees in spreading adoption of digital financial services and relates to the descriptive evidence on barriers to usage discussed in section 3.1. Also, this evidence suggests that reintroducing such fees, even at a very marginal rate, can have deleterious effects on usage and can quickly push merchants to revert to cash. What is worth stressing is that, when a fee on MoMo Pay is imposed, even the already 'taxed' MoMo through personal number drops in usage, indicating a radical shift towards cash. We will elaborate more on this point in the conclusion.

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[40]   P2 of FGD4: 'I knew about it but I didn't consider it. MTN agents used to go around teaching about it but the charges were a bit high so we didn't think of using it. But when COVID-19 knocked, the charges were dropped to no charges and people started using it. Even though the charges were again put on at least people had been familiar with using it.'

[41]   P2 of FGD1: 'I agree but if COVID-19 pandemic hadn't happened then people would be hard to convince for them to stop using cash. Because people were so convinced that they would infect themselves they even sanitised themselves before touching anything, even money, so they adopted MoMo as a way to not get infected.' P4 of FGD1: 'I think COVID-19 enhanced its use.' P4 of FGD4: 'Me too: I feel like if the pandemic hadn't happened we would not see as many people using MoMo as today.' P2 of FGD3: 'Nowadays because of Corona people are using MoMo to avoid contact. From my experience I saw that they liked using cash before Corona.' P1 of FGD3: 'I think MoMo pay code came during the COVID-19 pandemic, in order to stop the flow of money in hands of people; before, paying through mobile money was active but not that much. It became more active because of COVID-19.'

Figure 5 Shifts in usage, fixed effect regression
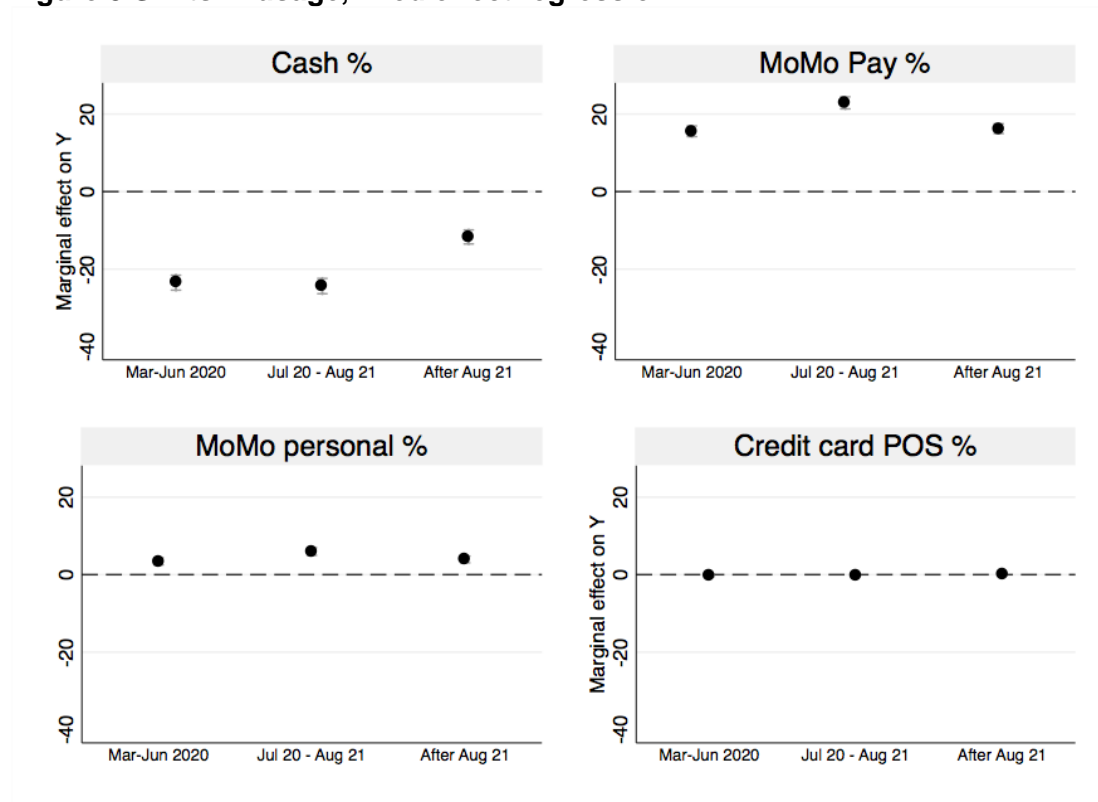
Note: results based on survey question 'For the following periods, please indicate the share of the following payment modes as a percentage of total sales.' Graphs show coefficients on round1, round2 and round3 (see equation 1) from fixed effects regressions on the relevant outcome, indicated at the top of each graph.

The qualitative evidence collected through FGDs helps us to better understand these findings. First, it shows that the recent fees on MoMo Pay are clear to everyone. Second, taxpayers are aware of the compensating behaviour put in place by traders, with an immediate reversion to cash-based transactions (which also avoid the fees on withdrawals),[42] or, at least partially, to trading through mobile money personal numbers.[43] Third, and interestingly, higher negotiation between traders and clients results, so that paying through mobile money is no more the default option and parties agree on the most convenient mode for each transaction.[44]

3.4 Digital merchant payments as a medium of tax compliance

At this stage, we attempt to answer our final question on whether the adoption of digital merchant payments has any effect on tax compliance. As described in section 2, we consider both the aspect of merchants' perceptions and attitudes, across four key outcomes, and the aspect of filing behaviour.

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[42] P5 of FGD4: 'It is going back to the original mode of paying with cash as people will getting away from mobile money.' P6 of FGD1: 'If you don't want to be charged you use the money to buy things or make other payments. If they pay you like 1000 you can use it to pay another thing; you don't have to withdraw, you can pay using the code because that is the only way they won't charge you.' P6 of FGD4: 'But that [traders' reversion to cash-based transactions to avoid fees] is happening after the introduction of charges.'

[43] P5 of FGD2: 'But you realise the moment MTN added the cost, people started using the MoMo personal number because they said OK, if clients are going to pay on the code, I will start losing a certain percentage, so you would rather pay on a personal number.' P2 of FGD1: 'When I need the full amount of money the client is paying me, I use my personal number so that I can send it to my bank and then I will get it fully as I wanted.'

[44] P1 of FGD3: 'From my experience, when I'm going to pay a bill, most of the time they will ask me: "Do you have cash or, if not, can you send it to my personal number?" And you will also add the charge.' P5 of FGD3: 'What he is saying is very true; most people nowadays they have started negotiating on the model of payments; if you're paying by card you have to add this because I have a charge to pay, so you would rather send it to my number or give me cash, so it's a matter of negotiation.'

In Table 2, we first look at 'soft' motivations, or non-pecuniary factors, behind tax compliance. We build indexes of the fairness of the tax systems (col. 1-2), peer pressure or social norms to comply (col. 3-4), fiscal exchange (FE) or reciprocity (col. 5-6), and a broader measure of willingness to comply or higher tax morale (col. 7-8). We first show results by pooling any DFS together (panel a), and by disentangling the effect of using MoMo Pay, on which a fee is imposed, and that of MoMo through personal number, which is fee-free (panel b). Regression results in panel a indicate that using any DFS has no tangible correlation with merchants' perceptions, apart from a significant relation with peer pressure. This finding is interesting as it suggests that DFS adopters are more likely to emulate neighbours in complying, and that social norm motivation could also explain why they adopted the technology – as a matter of fact, using DFS with suppliers was a key factor for adopting DFS with clients, as described above. The same social-behavioural drive could explain both DFS adoption and the role DFS have in improving perception.

In panel b, where we split by mode of payment, the main result is that using MoMo Pay has a deleterious effect on perception of reciprocity, while using MoMo through personal number has an opposite, positive, impact. We interpret this result as strong evidence around the detrimental role played by fees on MoMo Pay on merchants' soft motivations to comply. As a matter of fact, MoMo Pay users may not understand what this fee is used for, especially if interpreted as a general tax, and may extend their negative feelings on reciprocity to the broader set of taxes they remit. In contrast, DFS usage when a fee is not imposed, essentially free, improves the reciprocity feeling which, according to the literature, is thought to be a key driver of compliance (Prichard 2022). The other perceptions remain unaffected at any significant level.

After having considered soft perceptions, we consider mere pecuniary factors, such as a higher perceived audit likelihood level and perceptions around the severity of the enforcement strategy, and the trust towards the revenue authority. We do not find any significant correlation with such outcomes and report the results in Appendix Table A2. While the coefficient on perceived deterrence is positive for using any DFS (and using MoMo Pay specifically) it fails to be significant at any relevant level. The fact that soft perceptions covary with usage, but hard attitudes do not, could indicate that such technology is more effective in improving compliance through non-pecuniary mechanisms.

Lastly, we consider the correlations between using DFS and the ease of filing a tax return, as well as broader transparency perceptions around the tax system. Table 3 below hints at a positive relation with the ease of filing, albeit not significant. Relevantly, it shows that using MoMo through a personal number positively varies with the ease of filing, while that is not the case for MoMo Pay. There is some supporting evidence from FGDs around the positive impact on the ease of filing, especially for larger businesses[45] and notably in terms of providing an accurate record of transactions.[46] Improved record-keeping therefore has positive repercussions on the quality of tax filing, especially in the way mobile money helps in claiming deductions.[47] Yet some issues remain, particularly for merchants trying to obtain tax invoices for MoMo Pay fees charged by MTN MoMo to merchants using the MoMo Pay service.[48] The fact that such hidden fees are applied to MoMo Pay specifically generates

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[45]   P5 of FGD1: 'Also, for us it helps a lot in record-keeping because we have customers who pay a big amount of money, and they take medicines little by little until their money is finished. So you may forget to write it down somewhere, but with MoMo you have it in the system, and you know exactly when the client paid and how much.'

[46]   P6 of FGD3: 'The good thing with MoMo: with code and stuff it is easier to trace the money, it is traceable.' P1 of FGD1: 'It is good for business owners because they will be able to monitor the transactions on one device and they won't need to double check, and even save time because everything will be there. It will reduce theft from cashiers and other employees.'

[47]   P3 of FGD4: 'We are a big business so when going to pay taxes we also use MTN historic so as to see how many charges we also have to declare to RRA in order to deduct them.'

frustration and does not help much in tracking expenses and accurately reporting to the fiscus.[49] These issues with MoMo Pay seem to be in line with the null evidence around transparency and, more importantly, around the ease of filing through such a tool, as opposed to through a personal mobile money account.

Table 2 Impacts of DFS on tax morale perceptions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Fairness	Fairness	Peer pressure	Peer pressure	FE	FE	Never justify	Never justify
(a) Pooling together all DFS								
Any DFS	-0.02	0.00	0.07**	0.07**	-0.02	0.00	0.07	0.06
	(0.05)	(0.05)	(0.03)	(0.04)	(0.03)	(0.03)	(0.07)	(0.05)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Cash users Mean	0.535	0.535	0.246	0.246	0.910	0.910	0.504	0.504
R-sq.	0.002	0.185	0.012	0.184	0.002	0.273	0.005	0.319
N	688	688	722	722	722	722	697	697
(b) Splitting by MM modes								
MM Pay	0.04		-0.05		-0.13***		0.02	
	(0.05)		(0.03)		(0.03)		(0.05)	
MM personal number		0.00		0.02		0.10***		-0.01
		(0.04)		(0.03)		(0.02)		(0.04)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cash users Mean	0.574	0.589	0.197	0.153	0.938	0.851	0.523	0.555
R-sq.	0.047	0.066	0.105	0.089	0.220	0.164	0.105	0.091
N	739	810	777	854	777	854	745	822

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Results from a matched sample using Kernel matching algorithm. Fairness is a 0-1 indicator variable for believing that the tax system is fair, from the question 'How fair or unfair do you think the tax system is?' Peer pressure is a 0-1 indicator variable for agreeing to evade taxes if neighbours do that, from the question 'Please tell me if you totally agree, somewhat agree, somewhat disagree, or totally disagree with the following statement: "If my neighbours do not pay taxes, it is fair for me not to pay them either."' FE is a 0-1 indicator variable for agreeing with the statement 'Taxpayers must pay their taxes to the government in order to receive better public services.' Never justify is a 0-1 indicator variable for never justifying the following statement 'Under-declare income so to pay less tax.'

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48   P6 of FGD3: 'You just see the money you've received this amount and the new balance.' P5 of FGD4: 'No, they're added after, so [when] you look at the statement their charges are not appearing at the time when the transaction happened, and then when they send you the following statements you will see actually that they are adding the charges so it's never consistent. So, the reconciliation part of it becomes really complicated.'

49   P5 of FGD2: 'With reporting, because you always get a text message on the phone for every transaction, and also you can get a statement from MTN, and also their dashboard is a bit funny, accessing MoMo statements is not as easy as you would think; it is actually much easier to get a statement from the bank than an MTN statement. About the limit: even the bank has 90 days' limit for accessing past transactions if you want to access your account without having to pay, but for MTN you've to physically be there, then you line up, then you submit actually a letter for them to give you a statement. Online you can access like a few days in the past. So, it makes work more complicated, with small and small transactions that had happened over a period of time you find out that if you're using a bank people would actually decide to pay by bank or cash so you can easily make a deposit; with MoMo you find that in a day you have like thousands of transactions; if you're someone who is going to be sitting down to do the reconciliation and if you have thousands of transactions daily, it would be very complicated to do that.'

Table 3 Impacts of DFS on ease of filing and transparency perceptions

|	(1)	(2)	(3)	(4)
	Easy to file	**Easy to file**	**Transparency**	**Transparency**
(a) Pooling together all DFS				
Any DFS	0.07	0.07	-0.03	-0.02
	(0.05)	(0.05)	(0.05)	(0.04)
Controls	No	Yes	No	Yes
Cash users Mean	0.448	0.448	0.575	0.575
R-sq.	0.003	0.208	0.001	0.181
N	722	722	722	722
(b) Splitting by MM modes				
MM Pay	-0.01		0.02	
	(0.04)		(0.05)	
MM personal number		0.10[**]		-0.00
		(0.04)		(0.04)
Controls	Yes	Yes	Yes	Yes
Cash users Mean	0.527	0.520	0.593	0.602
R-sq.	0.161	0.156	0.089	0.087
N	777	854	777	854

Note: Standard errors in parentheses. [*] $p < 0.10$, [**] $p < 0.05$, [***] $p < 0.01$. Results from a matched sample using Kernel matching algorithm. Easy to file is a 0-1 indicator variable for believing that it is easy to file a return, from the question 'How easy/difficult it is to file an income tax return?' Transparency is a 0-1 indicator variable for believing that the tax system is transparent, from the question 'Based on your experience, how easy is it to find out how the government uses the revenue from people's taxes and fees?'

When looking at actual filing behaviour, we follow the fixed effect regression described in section 2. By considering the actual month and year of MoMo adoption, we can measure whether filing behaviour changes after that, holding constant all merchant-level characteristics. Figure 6 below indicates that the parallel trend assumption is respected, as pre-adoption periods do not show any effect significantly distinguishable for zero. The same figure documents a short-lived positive impact on turnover, VAT on taxable sales and VAT on inputs, while the VAT due does not change. Importantly, final VAT payment behaviour is also largely unaffected (Appendix Figure A7). The DID results are stored in the Appendix Table A3 and, overall, do not show any significant impact on VAT outcomes, given that the immediate positive responses quickly revert back to zero over time.[50]

Some considerations can be made around this evidence. First, it is worth mentioning that the positive impacts dissipate after a few filing periods after adoption, around three to four quarters. This suggest that MoMo adopters, after an initial increase in reporting probably due to the feeling of being more exposed to the tax agency, quickly revert back to pre-adoption levels. This reversion can be due to merchants finding strategies to avoid being detected, or just perceiving a less severe enforcement level. Second, it is telling to see how the final VAT due does not change, mostly because traders over-report both sales and purchases. Such a finding is quite in line with recent literature on the behavioural responses of taxpayers to tax e-services, as summarised in Okunogbe and Santoro (2022). Related to this, the fact that very few (18 per cent) of merchants in the sample perceive that the RRA might have access to MoMo data, which can be used to monitor compliance, can explain the limited impacts of adoption, in the form of a quick behavioural reversal to pre-adoption levels and cost overreporting.

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[50] We do not find any significant result even when restricting to merchants with at least six periods before and after adoption, for which the table on VAT filing is omitted for brevity. In Table A4 on VAT payments, we include the coefficients using such restriction, which turn out insignificant.

Figure 6 Impact of DFS adoption on VAT filing behaviour
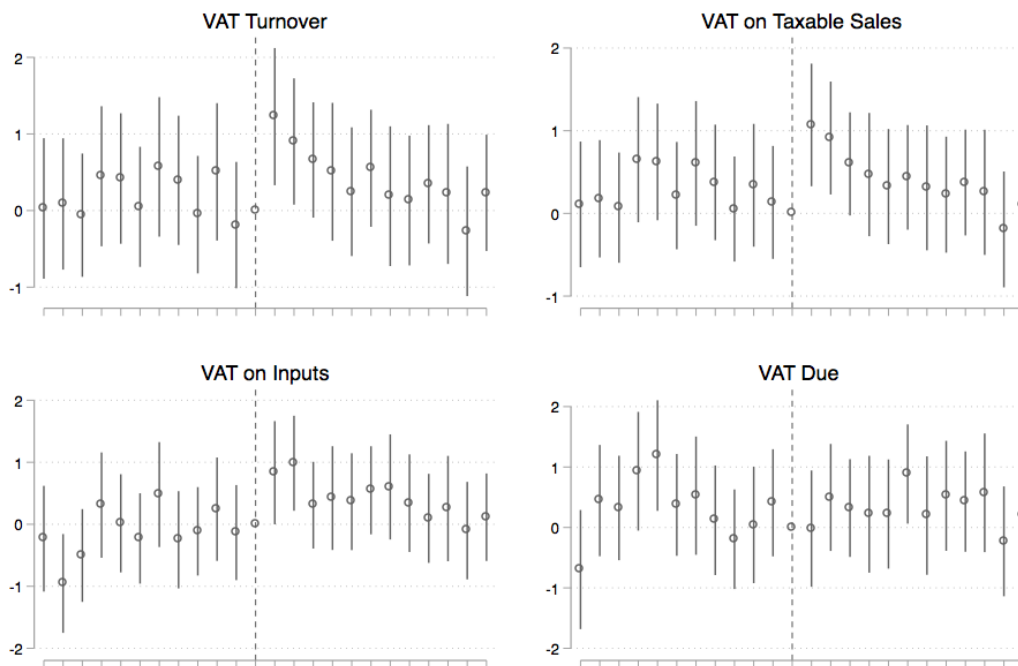
Note: The figures report coefficients on dummies capturing periods before and after adoption, estimated in a diff-in-diff setting. The vertical line indicates the month of adoption of mobile money as a means of merchant payments, as gathered from survey data. Outcomes are log transformed and extracted from RRA administrative data. We restrict to respondents for which at least one pre- and post-adoption period is observed.

We present interesting patterns around heterogeneity. While no significant differences are found across location and taxpayer types (CIT and PIT),[51] the results show that most of the effect is driven by taxpayers in the trading sector, as opposed to all the others (Appendix Figure A8). Also, EBM users drive most of the impact, while for non-users digital merchant payment adoption is not impactful. This may suggest possible complementarities among different technologies, where digital merchant payments perform much better when other key technologies, such as EBMs, are already in place (Appendix Figure A9). Furthermore, firms which were not audited in the last year are largely responsive when filing for VAT, and significantly so, as opposed to firms who had been audited already, hinting at the fact that digital merchant payments can substitute for traditional audits, probably due to the impression that they come with higher scrutiny (Appendix Figure A10). Lastly, male taxpayers react much more than female ones. While we cannot easily explain why, we leave the exploration of the gender dimension to future research.

4 Voices from the industry

In an effort to better understand the DFS trends in Rwanda, four KIIs were carried out with four institutions that currently provide digital financial services to Rwandan consumers. These companies are Bank of Kigali, Equity Bank, MTN, and Airtel. While Bank of Kigali and Equity Bank are traditional brick and mortar banks, MTN and Airtel are mobile telecommunications service providers that have forayed into the mobile payments business during the last decade. As expected, the different institutions vary in their approaches to the Rwandan DFS market.

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[51] We omit result figures for the sake of brevity.

In the case of Bank of Kigali, our interview led to understanding that Bank of Kigali is not looking to compete with market leader MTN on processing payments and is instead focused on maintaining MTN's trust accounts as well as handling deposits for Rwanda's larger investors and government institutions (28 January 2022). This position of comfort is the opposite of what Bank of Kigali's rival, Equity Bank, is trying to achieve. Equity Bank, on the other hand, launched Equity Fasta Fasta, a mobile payments platform similar to MTN's MoMo Pay, in September 2021. The platform, launched coincidentally at the same time that MTN reimposed merchant fees on MoMo Pay transactions, is fee-free and available to any person who has an Equity bank account. As of January 2022, 9,000 merchants have signed up for the platform (27 January 2022).

While Bank of Kigali and Equity Bank approach their DFS offering in different ways, MTN and Airtel have a similar vision. However, our interviews with Airtel Rwanda and MTN MoMo indicate two very different realities faced by each company. Our Airtel interviewee estimated that MTN dominated 90+ per cent of mobile money payments in Rwanda, leaving Airtel with less than 10 per cent of the share. As such, Airtel's focus is on finding any way possible to increase their share by deploying different strategies, notably fee-free services for consumers and merchants, as well as building branches that can hold larger amounts of cash at one time (4 February 2022).

MTN's focus contrasts to Airtel's not only in that they have to maintain and not lose their dominant market share, but also in that they can use their leading position to come up with key strategies for the future. For example, MTN indicated that a return to fee-free MoMo Pay transactions for merchants could be possible if MTN is able to generate revenue through different revenue streams that can help offset the cost of maintaining the MoMo network (28 February 2022). When we asked MTN what kind of products these could be, the prime focus was on MTN being able to issue their own loans.

As a last consideration, a debate is ongoing in the industry around the possibility of sharing merchant transactions on mobile money platforms with the tax administration. While on one side the RRA is quite proactive in engaging in conversations around a new sharing agreement for data on merchant transactions, on the other, it is encountering some resistance and concerns from the industry. If anything, discussions on data sharing seem to be rather ad hoc and specific to mobile network operators (MN0s), rather than more comprehensively embracing the whole industry. Yet a major cause of resistance is the fear that sharing mobile money data for tax purposes would slow down the efforts of developing the cashless ecosystem the industry put in place in the last decade. It is thought that sharing data with the RRA would drive clients back to cash-based transactions, as they would want to hide their business-related information from the tax collector. Related to that, the risk for MNOs of losing the trust of large portions of their client base also prevents any significant development in data sharing agreements with the RRA. Unsurprisingly, very few merchants in Rwanda believe that such sharing is actually taking place.

Representatives from both MTN and Airtel told us that they have been approached by the RRA for merchant transaction data, yet MTN refused to share at this time, while Airtel has complied with the requests. When we asked MTN why they refused, we were told that sharing with the RRA at this current moment would slow down the efforts of developing the cashless ecosystem. MTN's representative added that they want to ensure that sharing takes place only when merchants will feel compelled to keep using the MTN MoMo platform, regardless of whether or not RRA has access to merchants' transactional data.

5 Conclusion

With this study, we have produced novel evidence on the uptake and impacts of digital merchant payments in Rwanda. First, we document a clear (and expected) divide between users and non-users of digital merchant payments. Importantly for tax compliance, we find that adopters of the merchant-specific service MoMo Pay are more tax savvy and equipped, and also more likely to be reporting, to be operative and to submit positive income tax returns to RRA, as gathered from the administrative data. We then show how the fees imposed on MoMo Pay severely impact its usage, with concerning repercussions on using mobile money through personal account, which is fee-free. The mere fact that MoMo personal payments were negatively affected when MoMo Pay fees were reinstated, despite not sharing the same tariff structure, suggests that the MoMo ecosystem was stunted during its peak growth. Lastly, we causally connect usage with tax perception and behaviour, finding mixed evidence only. If anything, the fee on MoMo Pay curbs perceptions of fiscal reciprocity. Also, the merchant-specific service does not improve the perceived ease of complying with taxes, while the simpler MoMo through personal accounts does. On behaviour, we find only short-lived positive impacts on VAT sales and inputs from returns, which however do not translate into higher VAT liability.

It is worth acknowledging the limitations of this study. First and foremost, we do not have access to user-level transaction data from mobile money operators, who would have offered a more precise and objective measure of usage. Such data is, unfortunately, very difficult to access for researchers, as it is for most government bodies, including the revenue authority. In the absence of mobile money transaction data, we recur to survey data to build a panel of usage of DFS across time. While we are aware that recall bias is at play, we simplified our approach by asking about DFS usage as a share of the total business sales, mostly to get a reasonably reliable usage estimate. We also divided our recall period by considering rare events, such as the COVID outbreak and the reinstatement of fees and focus on four adequately large time sub-periods. Second, and relatedly, we also do not have information on the exact time when merchants started using DFS, but return to a survey question. Data constraints appeared to be insurmountable to reach our research purposes, and we therefore used a second-best solution relying on clearly understandable questions, sufficient time devoted to DFS usage in the questionnaire and a team of thoroughly trained enumerators and supervisors.

Despite these limitations, we are able to produce several policy recommendations. A first set of recommendations concerns the tax administration – and the government more broadly – and relates to the digitalisation journey public institutions in Rwanda are embarking on. The clear divide we document seems to suggest that more targeted policies incentivising the adoption of digital merchant payments are needed – focusing on less equipped and marginalised income taxpayers. Again, tax knowledge and awareness of DFS more broadly could be used as a lever to push taxpayers towards digitalisation. Such recommendations pertain to other technologies as well, as with electronic fiscal devices (Mascagni, Dom, Santoro and Mukama 2022). On a related note, more compliant taxpayers opt for the merchant-specific service, while the others (such as nil- and non-filers) transact on the personal mobile money account, probably to hide income-generating activities.

Furthermore, careful considerations should be made about how usage affects tax perceptions, and then compliance. The fact that reciprocity considerations are negatively correlated with MoMo Pay speaks to broader effects of mobile money fees on a range of attitudes likely to shape compliance. The same logic applies to perceptions of the ease of filing, again negatively correlated with MoMo Pay. In both cases, using mobile money through personal accounts improves such perceptions. Policy should then think about how to make sure merchants' digital payment services, like MoMo Pay, bring the same benefits that

simpler mobile money seems to do. In this case, the role played by fees on MoMo Pay seems to be relevant, as it deteriorates fiscal reciprocity and, arguably, willingness to contribute and actual behaviour.

Linked to the above, the tax administration should be carefully considering the extent of dubious filing practices and perverse behavioural response to technology adoption. In the analysis above, we show that VAT filings improved upon DFS adoption but reverted back to pre-DFS adoption levels as time passed. Also, while VAT on both sales and purchases increased, the final VAT liability remained unchanged. Such behavioural response has also been documented in other contexts as well (see Okunogbe and Santoro 2022) and requires further attention from the tax administration, as it hints at taxpayers' strategic responses. It could be advisable to enhance the monitoring and enforcement functions when introducing a new technology in the tax system, as such an innovation could be easily misused by taxpayers to avoid taxes. Adequate investment in enforcement is then necessary.

As a last point, mobile money data remains particularly difficult to access. This constraint refers to both the government, including the tax administration, and researchers as well. At least in theory, having access to transaction data could significantly improve the capacity of the tax administration to define the taxable base and identify non-compliance – as shown in the literature around the potential of third party reporting (Okunogbe and Santoro 2022).[52] Open questions, however, remain on whether the tax administration has the required analytical skills and IT systems to handle huge amounts of new data from MNOs (Okunogbe and Santoro 2022). Lack of regulation on data sharing is also at play, as well as unclear rules on how to ensure data privacy and confidentiality. In practice, data sharing agreements between MNOs and public institutions in LICs are often non-existent, or discussed and performed on an ad-hoc basis, as described in section 4. It is even more difficult and time-consuming for researchers to have access to mobile money data, thus limiting the possibility of running robust analysis on usage. Much more research is needed in this direction.

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[52]   The result that the merchants' wrong belief about the RRA having access to MoMo data does not impact adoption or shape compliance could be also explained by the fact that merchants do not see this as credible enforcement and do not believe the tax administration has the adequate skills and resources to use that data for monitoring purposes.

Appendices

Appendix 1: Tables

Table A1 Background features of taxpayers in the sample

Variable	Obs.	Mean	Std.Dev.	Min.	Max.
CIT	1086	0.52	0.50	0.00	1.00
Active	1086	0.66	0.47	0.00	1.00
Kigali	1135	0.68	0.46	0.00	1.00
Female	1135	0.33	0.47	0.00	1.00
Age group (max=7)	1134	3.40	0.98	2.00	7.00
Higher education	1117	0.46	0.50	0.00	1.00
Ubudehe category	998	2.81	0.49	1.00	4.00
Have smartphone	1135	0.92	0.27	0.00	1.00
Don't have computer	1135	0.36	0.48	0.00	1.00
Don't use social media	1135	0.08	0.27	0.00	1.00
Operative	1134	0.95	0.22	0.00	1.00
Medium/large office	1135	0.53	0.50	0.00	1.00
No employees	1133	0.48	0.50	0.00	1.00
Trade	1135	0.49	0.50	0.00	1.00
Monthly sales USD	625	5822.88	32438.94	0.00	414632.81
Hours spent on tax	1017	2.99	6.74	0.00	72.00
Book-keeping	1118	0.72	0.45	0.00	1.00
Internet	1128	0.60	0.49	0.00	1.00

Note: data derived from survey.

Table A2 Impacts of DFS on deterrence perceptions

	(1)	(2)	(3)	(4)	(5)	(6)
	High audit %	**High audit %**	**Heavy RRA enf.**	**Heavy RRA enf.**	**Trust RRA**	**Trust RRA**
(a) Pooling together all DFS						
Any DFS	0.07	0.04	0.02	0.02	-0.05	-0.06
	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
Controls	No	Yes	No	Yes	No	Yes
Cash users Mean	0.248	0.248	0.761	0.761	0.744	0.744
R-sq.	0.013	0.113	0.001	0.051	0.008	0.050
N	679	679	722	722	710	710
(b) Splitting by MM modes						
MM Pay	0.05		0.01		0.01	
	(0.05)		(0.04)		(0.04)	
MM personal number		-0.01		0.01		0.01
		(0.04)		(0.04)		(0.04)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Cash users Mean	0.356	0.393	0.734	0.769	0.777	0.794
R-sq.	0.082	0.066	0.037	0.028	0.067	0.044
N	740	813	777	854	771	844

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Results from a matched sample using Kernel matching algorithm. High audit is a 0-1 indicator variable for perceiving an above median probability of getting audited, from the question 'What do you think is the approximate likelihood that you will be selected for audit or review this year regarding your declarations, from 0% to 100%? (%).' Heavy RRA enf. is a 0-1 indicator variable for agreeing with the following statement 'RRA enforcement strategy is too heavy in punishing taxpayers.' Trust RRA is a 0-1 indicator variable for trusting that the RRA helps taxpayers, from the question 'If you contact RRA for information, how much trust or mistrust do you have that the RRA acts in the interest of ordinary citizens like you?'

Table A3 Impacts of DFS adoption on VAT filing behaviour

	(1)	(2)	(3)	(4)	(5)	(6)
	Turnover	**VAT input**	**VAT on sales**	**VAT due**	**Nil VAT Yes**	**Refund Yes**
DFS adoption	0.39	0.50	0.15	0.23	0.01	0.00
	(0.38)	(0.38)	(0.32)	(0.47)	(0.03)	(0.02)
Month fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
TIN	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	8577	8577	8577	8577	8577	8577
Number of firms	181	181	181	181	181	181
Adjusted R^2	0.03	0.02	0.04	0.04	0.04	0.04

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Results from the staggered DID framework summarised in equation 5 in section 2. Outcomes in columns 1-4 are transformed in logs, while outcomes in column 5 and 6 are 0-1 indicator variables. Information obtained from RRA administrative data.

Table A4 Impacts of DFS adoption on log VAT paid

	(1)	(2)
	1 month	**6 months**
MM treatment	0.12	0.13
	(0.25)	(0.29)
Month fixed effect	Yes	Yes
TIN	Yes	Yes
Number of observations	5384	4370
Number of firms	135	72
Adjusted R^2	0.05	0.07

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Results from the staggered DID framework summarised in equation 5 in section 2. Outcomes are transformed in logs. Information obtained from RRA administrative data.
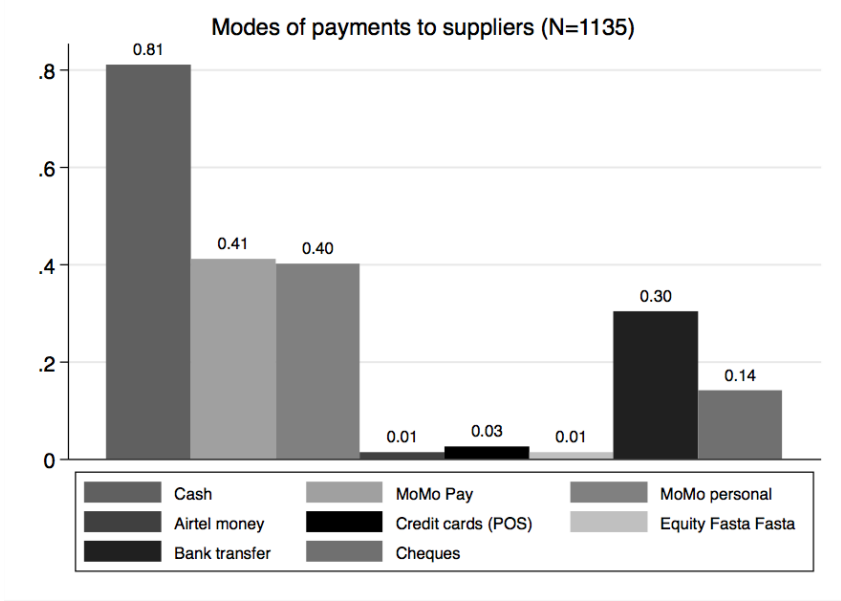
Appendix 2: Figures

### Figure A1 Tax-to-GDP ratio, 2009 to 2019
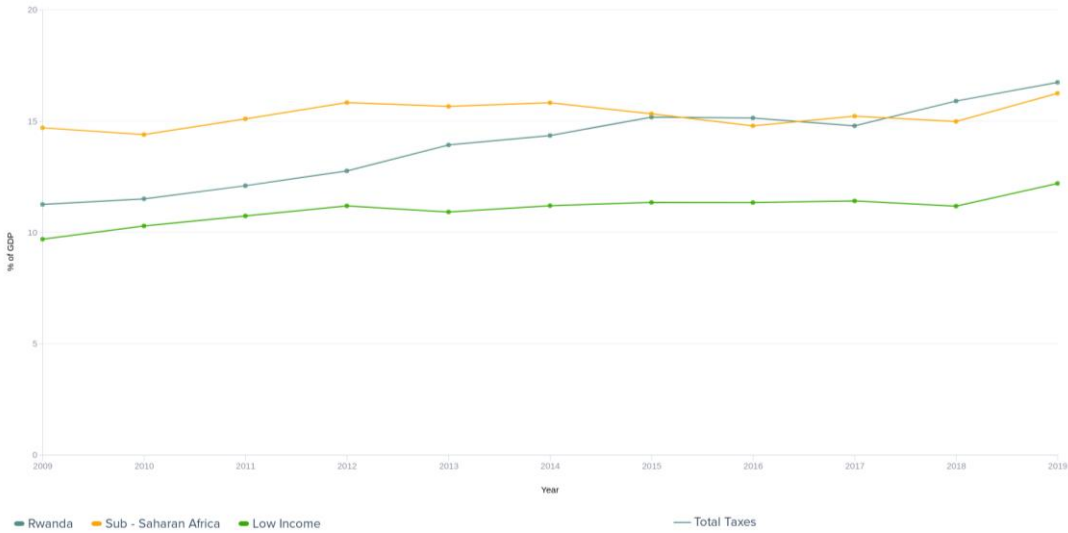
Source: ICTD/UNU-WIDER Government Revenue Dataset (2021). Figures refer to total tax revenues, excluding non-tax revenue.

### Figure A2a Mapping of merchants' modes of payment to suppliers

Note: data derived from survey question 'Which modes of payment do your suppliers (B2B) accept?'

## Figure A2b Mapping of merchants' modes of payment to employees

Modes of payments to employees (N=1135)
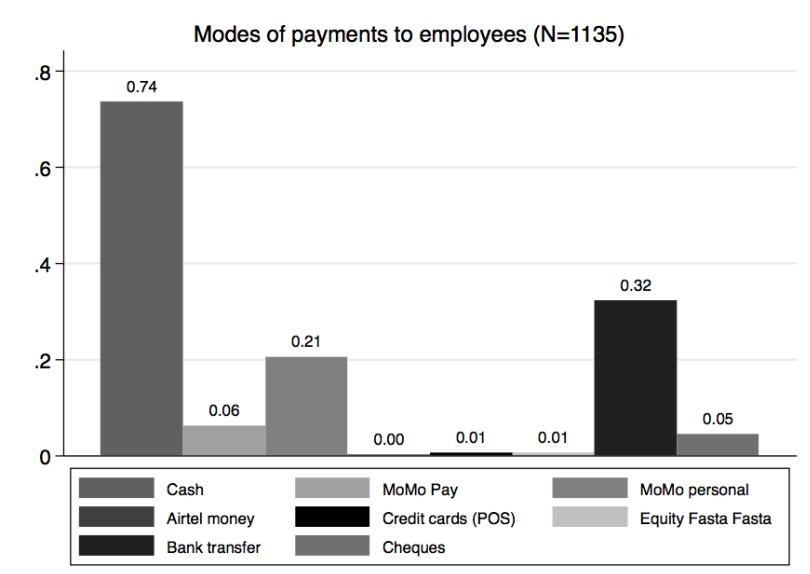
Note: data derived from survey question 'Which modes of payments does your business use to pay its employees?'

Figure A3a Reasons for using mobile money

Reasons for using MoMo (N=859)
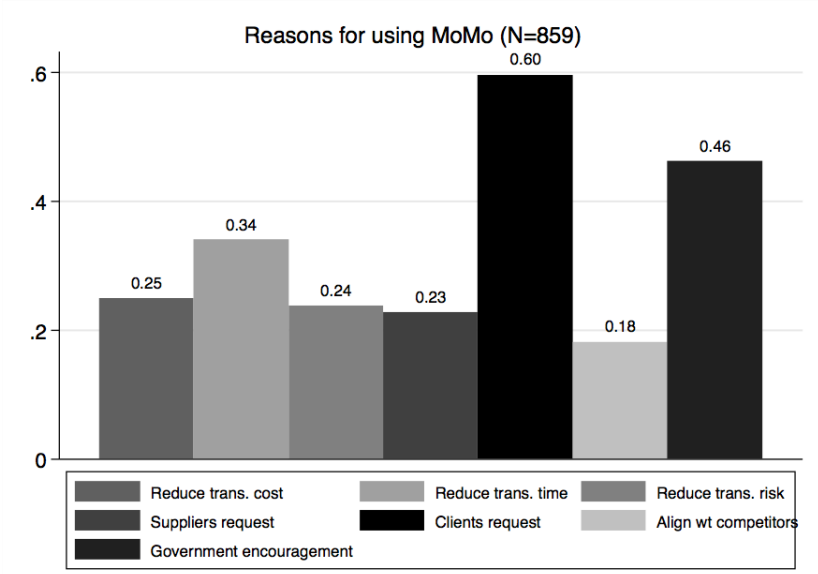
Note: data derived from survey question 'What are the reasons why your business started accepting MoMo in its financial transactions?'

Figure A3b Reasons for not using mobile money
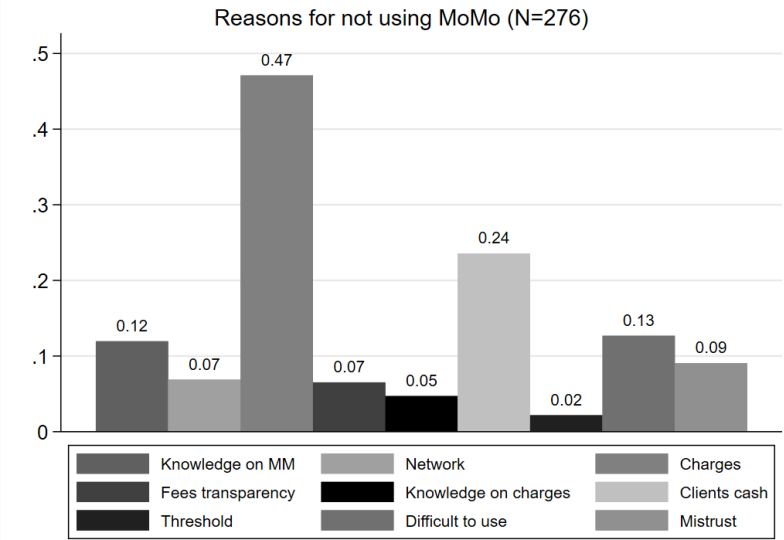
Note: data derived from survey question 'What are the reasons why your business does not accept MoMo in its financial transactions?'

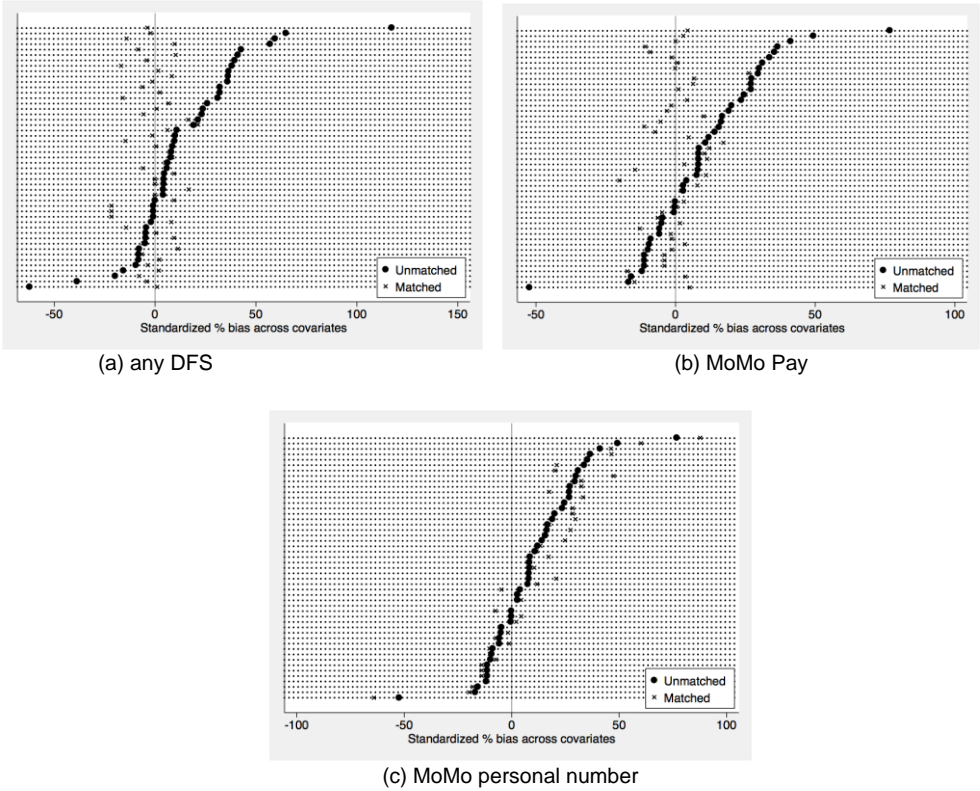## Figure A4 Balance across covariates, before and after PSM

(a) any DFS

(b) MoMo Pay

(c) MoMo personal number

Figure A5 Log-odds distribution, before and after PSM

(a) any DFS

(b) MoMo Pay

(c) MoMo personal number
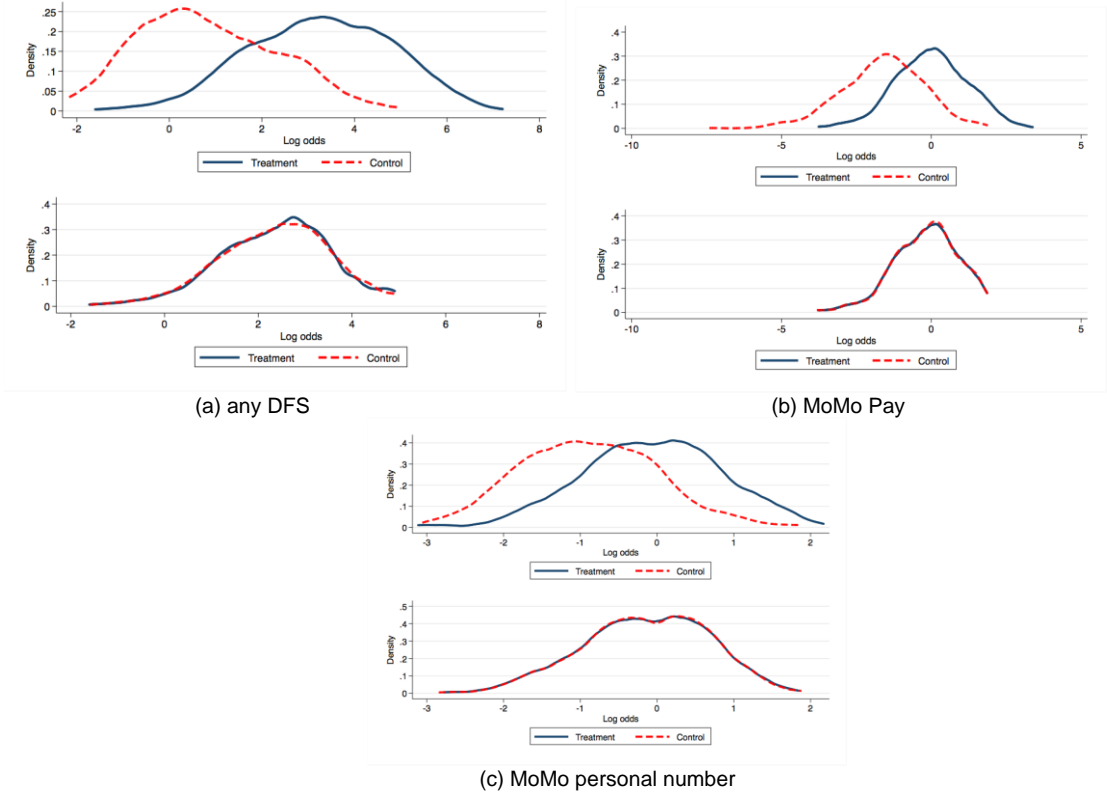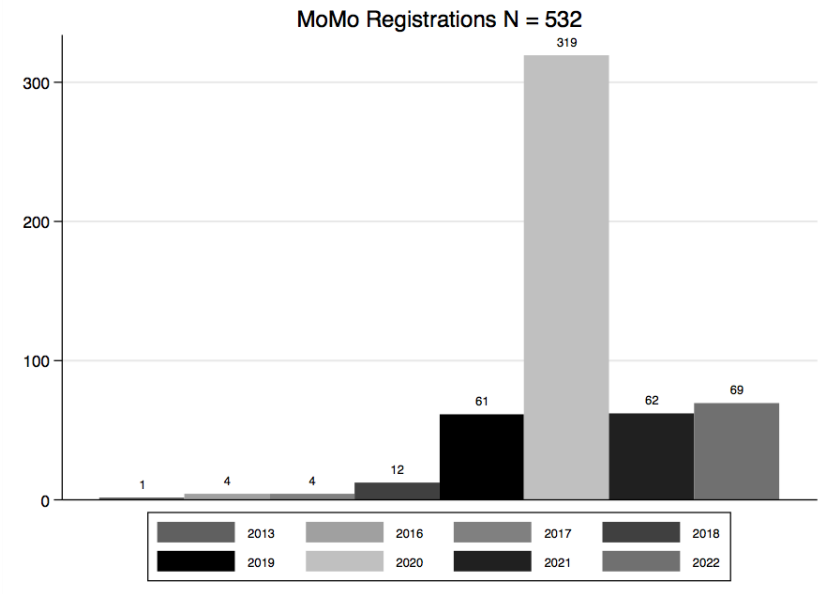
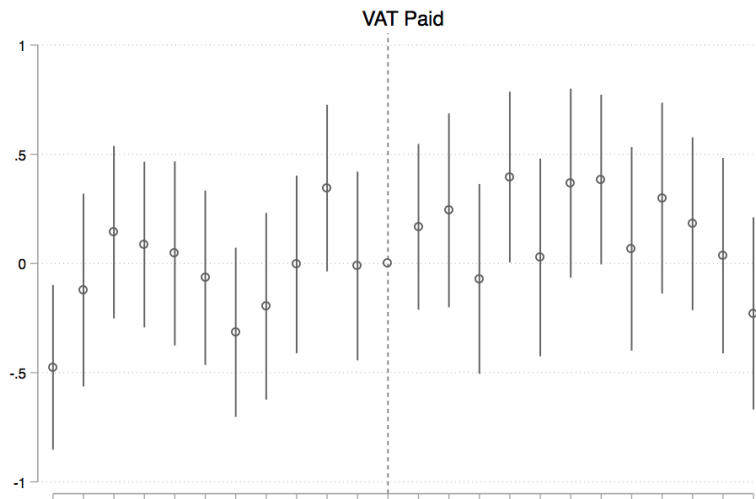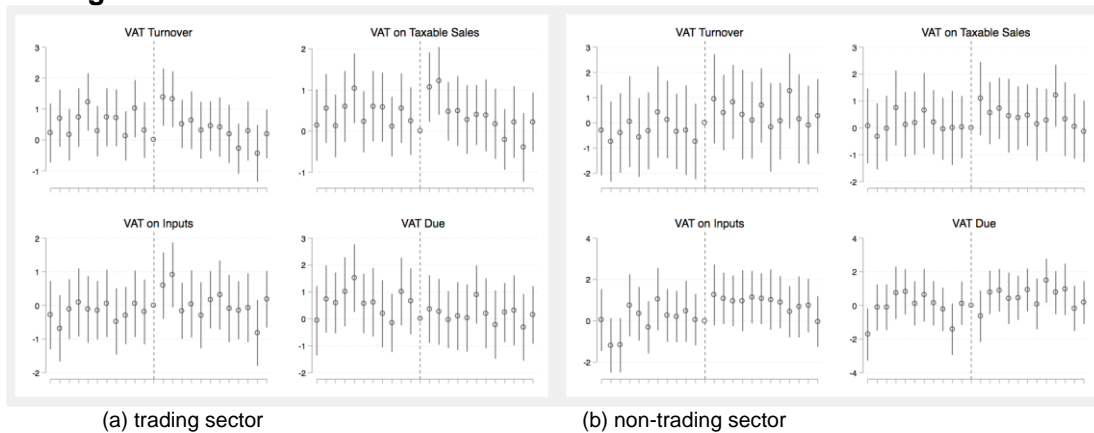# Figure A6 Year of registration to mobile money

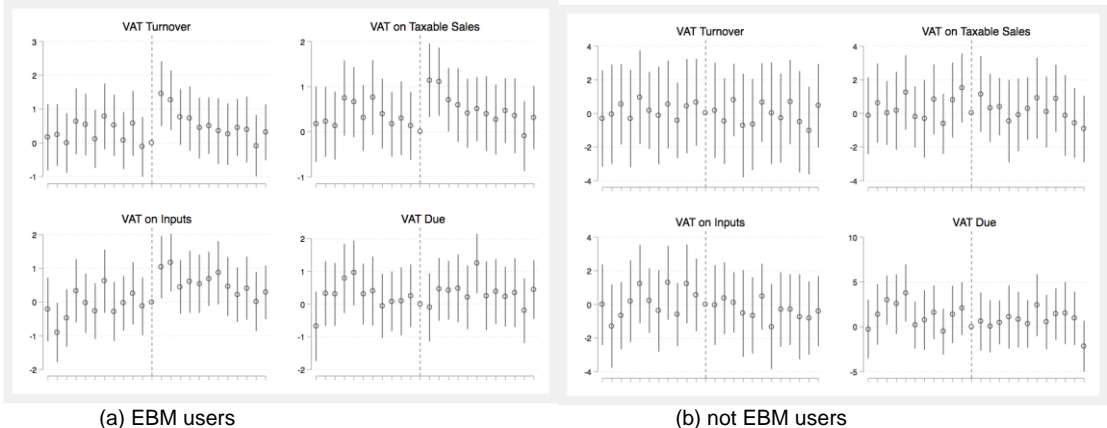## Figure A7 Impact of MoMo adoption on VAT payment behaviour

Note: The figure reports coefficients on dummies capturing periods before and after adoption, estimated in a diff-in-diff setting. The vertical line indicates the month of adoption of mobile money as a means of merchant payments, as gathered from survey data. VAT paid is log transformed and extracted from RRA administrative data. We restrict to respondents for which at least one pre- and post-adoption period is observed.

Figure A8 Impact of MoMo adoption on VAT filing behaviour: trading sector and non-trading sector

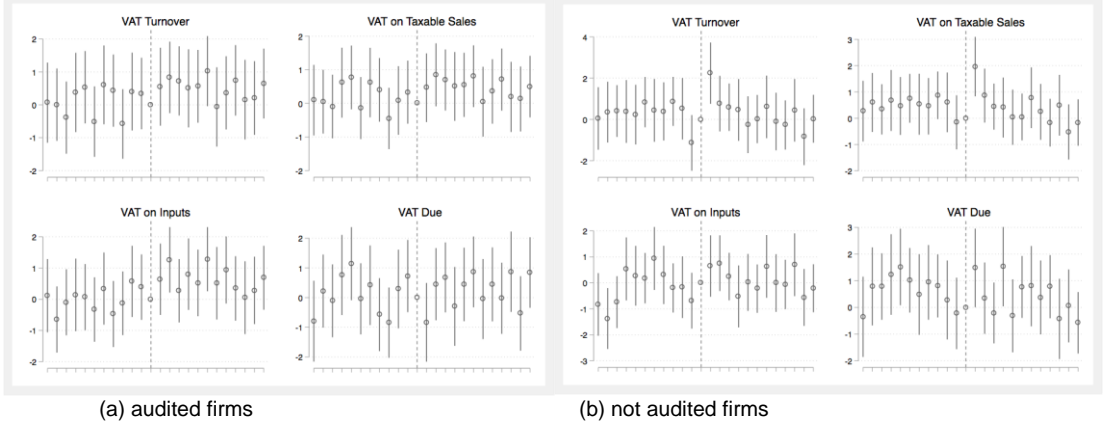(a) trading sector   (b) non-trading sector

Note: The figures report coefficients on dummies capturing periods before and after adoption, estimated in a diff-in-diff setting. The vertical line indicates the month of adoption of mobile money as a means of merchant payments, as gathered from survey data. Outcomes are log transformed and extracted from RRA administrative data. We restrict to respondents for which at least one pre- and post-adoption period is observed.

Figure A9 Impact of MoMo adoption on VAT filing behaviour: EBM users and non-EBM users

(a) EBM users   (b) not EBM users

Note: The figures report coefficients on dummies capturing periods before and after adoption, estimated in a diff-in-diff setting. The vertical line indicates the month of adoption of mobile money as a means of merchant payments, as gathered from survey data. Outcomes are log transformed and extracted from RRA administrative data. We restrict to respondents for which at least one pre- and post-adoption period is observed.

Figure A10 Impact of MoMo adoption on VAT filing behaviour: audited firms and not audited firms

(a) audited firms   (b) not audited firms

Note: The figures report coefficients on dummies capturing periods before and after adoption, estimated in a diff-in-diff setting. The vertical line indicates the month of adoption of mobile money as a means of merchant payments, as gathered from survey data. Outcomes are log transformed and extracted from RRA administrative data. We restrict to respondents for which at least one pre- and post-adoption period is observed.

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