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The Potential of Digital ID Systems for Tax Administration: The Case of Ghana

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Summary

Digital identification systems (DIS) have great potential for strengthening tax administration. This paper examines the practical implications of integrating DIS with tax administration in Ghana. Studying system integration and data sharing between the Ghana Revenue Authority and the National Identification Agency, we evaluate the impact of replacing taxpayer identification numbers (TINs) with personal identification numbers (PINs) linked to a Ghana Card. By analysing administrative data and surveying 1,000 businesses in Accra, the study investigates registration patterns, tax perceptions and outcomes, and assesses improvements in data quality post-integration.

The findings reveal a significant increase in the number registered for tax following system integration, particularly female and younger taxpayers. The impact on revenue is uncertain, and there is mixed compliance observed for PIN-based registrations. Those registered for tax for the first time after integration perform much worse than taxpayers who were migrated from TIN to PIN. Tax payment significantly improves for PIN-based registrations, mainly due to the technical design of the e-payment platform. While integration improves data on taxpayers' addresses, it worsens that on the economic sector. The study also shows that there is no significant improvement in taxpayers' attitudes and perceptions, despite simplified registration processes.

The paper offers policy recommendations, emphasising the need for targeted strategies and investment in administrative capacity to maximise the potential of digital ID systems to shape taxpayer attitudes and enhance tax compliance.

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Contents

Tables

Acknowledgements

Acronyms

DIS	Digital identification systems
GRA	Ghana Revenue Authority
GUIN	Ghanacard Unique Identification Number
ID	Identification
LIC	Low-income country
NIA	National Identification Authority
PAYE	Pay-As-You-Earn
PIN	Personal identification number
PIT	Personal income tax
RGD	Registrar General's Department
TIN	Taxpayer identification number
TREP	Taxpayer Register Expansion Program
URA	Uganda Revenue Authority
VAT	Value added tax
WURI	West Africa Unique Identification for Regional Integration and Inclusion

1. Introduction

The rapid expansion of public interest in building digital public infrastructure reflects the belief that strong foundational digital identification systems (DIS) can unlock enormous development gains. A foundational DIS is 'an identification system primarily created to manage identity information for the general population and provide credentials that serve as proof of identity for a wide variety of public and private sector transactions and services' (World Bank 2024). This kind of system allows government institutions to exchange and integrate data from different sources, and to receive information about individuals who are identified by a unique identifier. The fact that governments are better able to identify citizens and share data about them can strengthen a variety of government systems, including taxation, public financial management, and social protection.

The argument for the positive impact of DIS on tax administration in low-income countries (LICs) revolves around several expected benefits. First, relying on DIS is expected to enhance the taxpayer registration function by providing more information on taxpayers' identities. This is achieved by linking every taxpayer to a verified ID, improving the management of taxpayer registers. DIS contribute to better data quality, including taxpayers' name, contact details, and location, eliminating reliance on self-reporting, and minimising error-prone manual input. In contexts where tax registers are often inaccurate and it is difficult to identify taxpayers,[1] DIS are considered particularly valuable. This is even more relevant in contexts, like Africa, where curbing the informal sector is a priority, and policy targets for registration numbers are set very high. DIS can help identify potential taxpayers who are operating informally or exploiting loopholes in the tax registration process, and use their ID data to create a more accurate taxpayer profile.

Second, DIS have the potential to enhance the experience of taxpayers. The integration of DIS with tax registration can streamline the registration process. It can reduce the administrative burden for individuals by extracting identity data from their ID numbers on the national identification agency's system. The registration process reduces to a single interaction with public officers, either at the point of registering for a national identity document or for tax purposes, and potentially reduces the compliance cost for taxpayers. Information on the individual's current economic activity can be collected when they register for a national ID, and, as in Ghana, communicated to the tax agency. Alternatively, when registering with the tax agency the ID number can be requested and used

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[1] Of the 61 Tax Administration Diagnostic Assessment Tool (TADAT) assessments conducted in LICs from 2013 to 2020, only 20 per cent of tax authorities had a score of good or very good for knowledge of the taxpayer database, and 5 per cent for the accuracy of information on the taxpayer register.

to automatically pull personal data from the national ID register, as in Uganda (Scarpini *et al.* 2024). More broadly, an improved taxpayer experience can lead to the whole tax system being perceived as more transparent, with generally more positive perceptions.

Third, the availability of better quality digitised data can help tax administrations to improve their monitoring and enforcement. The unambiguous identification of taxpayers through integration with DIS can help tax administrations to make tax evaders comply. Those evading tax tend to exploit loopholes in the registration system by creating multiple identities. This gap is addressed by the direct matching of tax records with a valid and unique ID number. Better quality data from DIS also has the potential to enhance the overall governance and management of revenue authorities. The new data can facilitate a shift towards a more data-centric model, enabling improved performance targeting, forecasting, and statistical analysis.

Finally, at a broader level, DIS offer the opportunity to enhance data sharing between institutions, which is crucial for tax administrations that are heavily dependent on third-party identity data. The use of DIS serves as an example, and encourages increased inter-institutional cooperation across government. In turn, good data exchange lead to many benefits – improving the operational efficiency of government and driving economic growth, enabling access to essential services for people, and building trust (Dolan, Satapathy and Sabiti 2024).

Considering these significant potential benefits, how do digital ID systems practically enhance tax administration in low-income countries in terms of registration numbers, the quality of administrative data, and collecting revenue? As a case study to address this, this paper evaluates the impact of a system integration between the Ghana Revenue Authority (GRA) and National Identification Authority (NIA), which allowed the sharing and use of individuals' digital ID data by the tax administration. The goals of integration were to facilitate tax registration and curb informality. From 1 April 2021 the taxpayer identification number (TIN) of individual taxpayers is, at least in theory, discontinued and replaced by the personal identification number (PIN) associated with an individual's digital national ID, a Ghana Card. All new individual registrations with GRA are now associated with a PIN, apart from those not eligible for a Ghana Card. Existing ones are matched to PINs whenever possible (more on the challenges with this in Section 2).[2] Thanks to a data exchange platform (Ghanacard Unique Identification Number (GUIN)) GRA gets access to individual-level personal information in NIA data, and automatically enrols new taxpayers

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[2] As we show in Section 4.1, only 7 per cent of existing TINs have been matched to Ghana Card PINs as at February 2023, two years after the policy came into effect.

who may have an income-generating activity. Information on occupation, collected by NIA at the point of ID registration, is particularly important for this.

For this study GRA gave access to administrative data on the taxpayer register, tax returns, and payment data. The taxpayer register shows whether a taxpayer has an existing TIN or Ghana Card PIN as their tax identification number. We complement this data with new data from a survey of 1,000 individual businesses in Accra. We first explore registration patterns after system integration. We also capture the correlates of registrations under a Ghana Card PIN, in individual and business-related characteristics. We then assess the impact of registration under a Ghana Card PIN on tax outcomes, for both tax filing and payment. We also measure if being registered under a Ghana Card PIN is associated with improving the quality of GRA's administrative records. Finally, to understand the results on tax outcomes, we investigate differences in tax attitudes and perceptions between taxpayers registered under a Ghana Card PIN and a TIN. We consider key elements as perceived probability of audit, how easy the tax system is to navigate, face-to-face interactions with GRA, justification of tax evasion, and perceived fairness of the tax system.

We produce several findings. First, the integration between GRA and NIA registers has proven highly effective in augmenting tax registration numbers and expanding the tax base. The system integration and consequent registration of citizens with suspected income-generating activities led to a threefold increase in numbers from April 2021 to March 2022. Taxpayers under a Ghana Card PIN were two-thirds of total individual registrations in 2022. The registration effort was particularly effective in bringing female and younger taxpayers into the tax net compared to registrations under a TIN.[3] We also find that more educated and married taxpayers are more likely to be registered under a Ghana Card PIN than a TIN.

Second, we highlight results of the impact of ID-based registrations on revenue generation. ID-based tax registrations do not significantly improve filing outcomes overall. New entrants registered with a PIN after the policy implementation are 17 per cent less likely to file for any tax compared to standard registrations. These new entrants also report slightly less personal income tax (PIT). However, for taxpayers who registered with a TIN before April 2021 and were later assigned a PIN, the outcomes are much more positive. These taxpayers are 30 percentage points more likely to file for any tax, translating to a 116 per cent increase compared to the control group's mean. They also declare about US$800 more value added tax (VAT), an 85 per cent increase over the control group. For compliance with tax payment, the results show that ID-based registrations significantly improve the likelihood of paying any tax by 7.6 percentage points, a

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[3] We exploit the partial uptake of the shift to using a Ghana Card PIN as the tax identification number to compare taxpayers with a PIN or a TIN.

16 per cent rise compared to the control group's mean of 47 per cent. These taxpayers also pay US$478 more Pay-As-You-Earn (PAYE) and US$364 more VAT. The positive impact is particularly strong for taxpayers who were matched to a PIN. They are 25 percentage points more likely to pay any tax, pay US$600 more PAYE and US$1,200 more VAT than the control group. Conversely, new registrations paid less VAT than standard registrations during the same period, which may be because they are smaller businesses operating below the VAT threshold.

Third, when considering the impact on the quality of tax administrative data, we document how integration significantly improved the availability of information on the address of taxpayers. At the same time, integration made the quality of other data worse, such as information on the economic sector. This may be due to the nature of new ID data integrated with the GRA's system. While the DIS register keeps information on individuals' physical address, it has no data on economic sector. This is a key piece of information for tax administration, which is often poorly captured in tax registers.

Finally, using survey data, we explore possible reasons behind the limited impact on behaviour. Taxpayers registered under a Ghana Card PIN have less interaction with tax officials. But they do not have a significantly improved perception of the tax system, from willingness to comply to fairness, and do not believe it is easier to comply with tax obligations. This could explain why tax filing and payment do not change much for registrations under a Ghana Card PIN. It could be that the simplified registration process just makes one of the many steps taxpayers have to take to comply with taxes easier, leaving other tasks untouched – such as filing, paying, claiming, and appealing.

With this study we significantly contribute to existing knowledge around the potential of third-party data, and specifically third-party register data, for tax administration. We add to the very thin literature around digital IDs for tax administration. Most examples are in technical reports rather than proper evaluations – such as with Adhaar in India (Alonso *et al.* 2023). Only one study directly assesses a similar integration with national ID databases and its impact on outcomes such as registration and the quality of administrative data. Scarpini *et al.* (2024) study a system integration for tax registration in Uganda, where the tax administration was given access to ID data from the national identification agency. In Uganda, while TINs continued to be used, they were now associated unambiguously with an ID number.[4] The authors find that the implementation of

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[4] This integration facilitated the creation of Instant TIN, an online registration process that streamlined taxpayer registration. Under this system, individuals put their national identification number into the online platform, triggering the automatic pulling of data from the National Identification and Registration Authority's system. A unique taxpayer identification number (TIN) is promptly generated, and the Uganda Revenue Authority (URA) automatically captures essential personal details, such as taxpayer's name, and date and place of birth.

the ID-enabled tax registration system in 2022 accounted for 35 per cent of total registrations – approximately 350,000 taxpayers. The surge in registration was particularly prominent among entities that were previously operating informally.[5] The authors also document how system integration is considered a substantial improvement to URA's internal processes. It significantly reduces the time and resources spent on registration, and prevents duplication of identities in the taxpayer register. At the same time, there is widespread acknowledgement that the system should be improved to allow data validation, and reduce its negative effects on data quality.

Beyond ID data, recent studies produce interesting results on the potential for third-party register information to strengthen tax administration. In South Africa, Lediga, Riedel and Strohmaier (2020) evaluate synchronisation of the tax and business registers. Similar to Ghana, the authority's strategy was to encourage registration and produce a cleaner and more comprehensive taxpayer register. Despite the synchronisation leading to a threefold increase in registration numbers the extra registrations did not translate into increased revenue, probably due to poor compliance by newly registered firms (Lediga *et al.* 2020).

More positive evidence comes from middle- and high-income countries – although on third-party data rather than national ID information. Kleven *et al.* (2011), one of the first works in the area, find that there is almost no tax evasion in Denmark on income reported by third parties. The tax evasion rate for self-reported income is 42 per cent. Adhikari *et al.* (2022) exploit granular geographic data on the use of payment cards throughout the US, and find that Form 1099-k, which requires payment processors or settlement agencies to report electronic payments received by businesses to the Internal Revenue Service, has had a significant positive impact on taxation and compliance of small businesses. Mittal and Mahajan (2017) find that since Delhi firms were required to report all purchases and sales with other firms in 2012 the tax authority were able to check any mismatches easily, and tax paid by wholesalers increased by 29 per cent. Research in China finds that integrated third-party data enabling automatic synchronisation and verification of tax-related data with information from entities like banks, customs, social insurance, and industry, significantly reduced evasion of corporate income tax (Li, Wang and Wu 2020). Evidence from South America also shows the relevance of third-party information. Brockmeyer *et al.* (2019) find that an increase in third-party coverage for firms increases compliance. Earlier results from Pomeranz (2015) reinforce this through a field experiment that found that third-party recordkeeping works as a preventive element in Chile.

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[5] In Uganda Instant TIN became a crucial tool for the Taxpayer Register Expansion Program (TREP), a URA mass registration campaign. It helped TREP field officers to streamline registration when operating door-to-door or at a one-stop shop. In-the-field TREP accounts for 39 per cent of Instant TIN registrations.

Finally, we also contribute to the abundant mixed evidence around the effectiveness of tax formalisation strategies. While promising evidence is found on the potential of technology to boost property taxation and the identification of taxable properties (Knebelmann 2022; Okunogbe and Santoro 2023), more mixed results emerge with national-level taxes. The two studies on property tax registration evaluate new technologies to identify hidden properties, with positive results on tax collection. Our study, instead, focuses on national-level tax administration and specifically on income taxes – which can be more easily hidden than physical assets (such as buildings and land). A key lesson from this literature is that initiatives aimed at formalisation and registration often fail to increase tax revenue (Gallien, Moore and van den Boogard 2021; Benhassine *et al.* 2018; Moore 2022; Groening *et al.* 2024). This could be justified, as these digitalisation efforts aim to facilitate registration and not increase revenue, and often succeed in this. Nevertheless, the presence of a larger number of taxpayers on the tax register does not automatically result in increased tax revenue. This is mainly because very small taxpayers are registered, who have little capacity to contribute to revenue (Mascagni *et al.* 2022). Mass registration risks clogging the taxpayer register, and increases the administrative costs for tax agencies managing a bloated tax net (Groening *et al.* 2024; Scarpini *et al.* 2024).

This study is relevant for policy. As shown in Appendix Table A1.1, many African countries have introduced digital IDs or are in the process of piloting and introducing a DIS. They plan to eventually integrate DIS with other government services, including tax administration. These digitalisation projects are often backed by international donors with considerable funding. Extracting lessons from Ghana, we propose several practical policy recommendations for the Ghanaian government. These are also important for other African countries embarking on similar projects. We discuss how mass registration drives, strengthened by integration with DIS data, often do not raise substantial extra revenue – as shown for the mixed impact of new registrations after April 2021. It is promising to see positive results for already existing taxpayers matched to a PIN. Tax administrations should understand how new entrants differ from those who have been matched, and how to bring all taxpayers to the same level of compliance. We also elaborate how tax administration only partially benefits from the availability of more data, especially as DIS data does not contain some information that is important for tax administration, such as economic sector and business address. We finally discuss the policy implications of these integration solutions on taxpayers' practical experience of the tax system. We suggest how policymakers can use DIS to shape taxpayers' attitudes, and thus compliance behaviour.

The paper is structured as follows. Section 2 describes the context of the study and system integration. Section 3 presents the research design. Results are

discussed in Section 4, and taxpayers' perceptions from the survey are explored in Section 5. Section 6 concludes.

2. Context

2.1 Country context

Ghana has a tax-to-GDP ratio of about 14 per cent, in line with the African average of 15.6 per cent (OECD/AUC/ATAF 2023).[6] In 2021 VAT was the major contributor to tax revenue, 29 per cent of the total. Corporate income tax accounted for 23 per cent, and personal income tax for 15 per cent (OECD/AUC/ATAF 2023). The poor revenue collection is frequently attributed to the substantial presence of informal businesses (Besley and Persson 2014; Medina and Schneider 2019). Medina and Schneider (2019) estimate that the informal economy in Ghana was 40 per cent of GDP in 2015. Another study estimates that informal work represented 89.2 per cent of total employment in Ghana (Baah-Boateng and Vanek 2020). Like many African governments, Ghana is making a significant effort to generate sufficient revenue – particularly in the aftermath of the Covid-19 pandemic (Ghana Ministry of Finance 2023). The Ghana Revenue Authority (GRA) is investing heavily in initiatives aimed at formalisation and registration. These aim to bring informal entities into the tax framework, and potentially increase tax revenue.

2.2 Harmonising the tax and ID registers

With its vast informal economy, GRA has decided to use third-party data from the National Identification Authority (NIA) to help it identify new taxpayers. From 1 April 2021, GRA and NIA integrated their systems so identity information in the NIA register is transferred to GRA. This gives GRA a record of every Ghanaian over 18 years old who has a Ghana Card, the national ID document, with its associated PIN. This record includes the date of birth, residential address, and occupation or source of income.

This exchange of information from NIA to GRA allowed three main developments. First, taxpayer data was synchronised with identity data, and stored under a single unique identifier in the GRA's register – the Ghana Card PIN. The first aim of data integration was to substitute all existing individual TINs with Ghana Card PINs. Second, it transferred from NIA to GRA all the ID records for citizens who were not registered. This allowed GRA to register them for personal income tax (PIT) if the information on occupation from NIA showed they might be involved in an economic activity. This is in line with the GRA's long-term goal of increasing revenue by tackling the issue of informality.[7] Third, it guaranteed that all individual

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[6] The African average is for 33 African countries (OECD/AUC/ATAF 2023).

[7] From our informant interviews we gathered that the short-term goal of this exercise was to widen the tax net by between 2.5 million to 5 million people by the end of 2022 (Interview GRA01, March 2023, Accra, Ghana).

taxpayers who enrolled with NIA after April 2021 would use their Ghana Card PIN as their ID number for tax purposes.

To be able to substitute TINs with PINs, first GRA had to merge its taxpayer register with identity records coming from NIA. This was essential to achieve the objectives of integration without bloating the tax register with duplicate records, with the same taxpayer being identified with both a TIN and a PIN. First, identity information from NIA was automatically matched with taxpayer information on the GRA's tax register, and existing TINs were replaced with PINs wherever possible. The automatic match was performed using information available in both GRA's and NIA's records, such as citizens' first name, surname, and date of birth.

Not surprisingly, integrating the databases of two different institutions did not result in a perfect match. There were discrepancies between the records on the NIA's and GRA's registers. GRA did not have complete matching of information, and could not transfer all individual TINs to PINs. Some discrepancies were due to women changing their name after marriage.

To be able to link as many PINs as possible with existing TINs, GRA carried out an extensive sensitisation campaign for its own staff and the general public. This informed them that the Ghana Card PIN was going to be used as the tax identification number. Campaigns targeted at existing taxpayers encouraged them, if they had a Ghana Card, to manually enable the transition from a TIN to their PIN through the online portal or Unstructured Supplementary Service Data (USSD) app. GRA gave local offices a mandate to enforce the transition from TINs to PINs for taxpayers that were registered for tax with them. This was not centrally enforced, and local offices were left to manage it on their own. Some local GRA offices put more effort into enforcing and performing manual matching of identities than others. As a result some records are still unmatched, and there are potentially duplicates on the GRA's register.

Another challenge to the integration process was that the Ghana Card's coverage is still quite limited. The Ghana Card is the national ID document in Ghana, and its PIN is needed to access almost all public services and many private ones, including registration with GRA.[8] Data from NIA suggests that at the end of 2023 only half the Ghanaian population had a Ghana Card (NIA 2023).[9,10] To facilitate the TIN-to-PIN transition when citizens were registered with GRA but not NIA, NIA

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[8] People need to enrol with NIA to: (i) do business with GRA, (ii) register business with the Registrar General's Department, (iii) open a bank account, (iv) register vehicles, (v) apply for/renewing a passport, (vi) register land, (vii) clear goods from the ports/airport, and (viii) get a driver's licence.

[9] Authors' calculation based on information from NIA website and World Bank Open Data (2023).

[10] In theory the Ghana Card is replacing documents like a driving licence or voter ID as the valid document for GRA registration.

set up offices in 34 GRA offices around the country.[11] At the time of the interviews in March 2023 the transition of existing individual TINs to PINs was complete, but matching existing TINs to PINs was still in progress.

In addition to harmonising unique identifiers across two important government registers – NIA and GRA – the integration initiative aimed to provide GRA with information on citizens with informal economic activities so they could register them for tax. This data was stored in the NIA database under information on the citizens' occupation at the time of registration.

Once they had the identity data, GRA could automatically register for personal income tax (PIT) any citizens who appeared to have an income-earning occupation on the NIA register, but not on GRA's. Using contact information extracted from the NIA database, GRA sent newly registered taxpayers an SMS informing them of their registration with GRA and giving them their tax identification number – which was the same as their Ghana Card PIN. The SMS also invited new taxpayers to visit GRA in person to start their tax compliance process, verify details, and provide further information on their economic activity to establish their tax liability – if any. The information on residence from the NIA integration is used to assign new taxpayers to taxpayer service centres. According to our interviewees, system integration mainly brought the self-employed – retailers, businessman, and consultants – onto the GRA's radar.

However, our interviewees revealed that when GRA randomly sampled 50,000 new taxpayers to test the reliability of contact information received from NIA, it was only able to reach 33,000 of them by phone.[12] This suggests that a substantial proportion of taxpayers registered and contacted by GRA in this way may not have responded to GRA's massive media outreach, and communication about their new status as taxpayers. This reduced the benefits of mass registration. Evidence from other countries shows that, while third-party data helps increase the number of registrations, its impact on the overall quality of data on the tax register and gains in revenue are less positive due to the information that tax administrations obtain being out of date (Gallien *et al.* 2023; Scarpini *et al.* 2024).

Our interviews with the GRA Registration Unit show how the challenges GRA faced in the integration process manifested practically. Our interviewees said that the records of about 14.6 million people were obtained through data integration with NIA. Before integration there were around 6 million taxpayers on the GRA's register – only around 3 million of the NIA's records matched existing records on the GRA's register. It was not clear how many of the unmatched 3 million

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[11] Since the TIN-to-PIN transition implementation period Ghana Cards are not issued at GRA premises.

[12] Interview GRA01, March 2023, Accra, Ghana.

taxpayers on the GRA's register were duplicates of existing accounts.[13] By 31 March 2022 there were 18 million taxpayers on the GRA's register, an increase of over 12 million. The GRA's target, to expand the tax base by 5 million new taxpayers by 2022, had been successfully achieved.

Individuals and companies were registered through different ways before integration. For individuals, registration and issuing TINs took place at the GRA premises before integration, after providing the information needed on a registration form. For organisations the procedure has not changed. It involves two steps – one at the Registrar General's Department (RGD), and one at GRA. RGD shares basic information on registered companies with GRA through an integrated register, and the profile and tax liability of new CIT taxpayers is obtained at the GRA's premises where a TIN is issued. Those paying CIT still use and are identified by their earlier TIN for tax matters.

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[13] Interview GRA01, March 2023, Accra, Ghana.

3. Research design

In this section, we first describe the different data sources used in this study. We then explain the methodological approach followed in analysing the data, and extract our key results.

3.1 Data sources

We use two different data sources – administrative data on all taxpayers in Ghana, as shared by GRA, and original data from a survey in Accra. For administrative data we have access to a rich set of taxpayer-level data, shared in February 2023. We have access to the taxpayer register, which contains all registrations from 2011 to 2022. Excluding those paying PAYE at source, there are 250,000 individuals registered for personal income tax, the focus of our analysis. An additional 83,000 registrations for companies were discarded. While GRA estimates of 12 million new registrations brought in by the integration with NIA cover all tax types, we focus on self-employed taxpayers. Their compliance behaviour is more interesting to study than employees paying PAYE at source, the majority of new entrants into the tax register, as it is voluntary and self-assessed.[14] This exercise is useful to understand how third-party data can improve compliance where it is most challenging – with self-assessed income tax declaration.

Importantly, register data shows whether a taxpayer is registered with a PIN – extracted from their national ID card – or a TIN. This means that we do not perform the matching ourselves, but access an already integrated and updated taxpayer register after the policy came into place. This information is crucial to run our analysis comparing the two groups of registrations. Further, the dataset contains valuable taxpayer-level information, such as registration date, gender, date of birth, and tax centre of reference. Additionally, we use tax returns and payment data, again shared by GRA. The dataset dates back to 2011. It uses the full year period for district-level analysis, and only 2021/22 for taxpayer-level analysis (see Section 3.2).[15] These datasets include all different tax types paid over ten years, including VAT, PAYE withheld and remitted on behalf of employees, personal income tax, withholding tax, and the Ghana Education Trust Fund (GETFUND) levy. The key outcomes indicating tax compliance behaviour are derived from these datasets – the tax amount filed and paid for each tax type.

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[14] We do not have this information as we only accessed the register of self-employed individuals, not PAYE-registered taxpayers.

[15] The fiscal year is from July 2021 to June 2022.

We merge the register with returns/payments data for each taxpayer and tax type, using the taxpayer ID number.

An important limitation in the administrative data is that we do not know how the integration to a PIN took place. While we know the taxpayer is linked to a PIN, we cannot differentiate between the following scenarios: (i) the taxpayer was assigned a tax identification number when voluntarily registering for a Ghana Card, thus entering the tax system directly with a PIN; (ii) the assignment of a tax identification number was forced and automatic, with GRA acting on the new DIS data without the new entrant's knowledge; (iii) an already registered taxpayer, encouraged by GRA, voluntarily migrated their TIN to a PIN; and (iv) this migration was forced and automatic when GRA progressively cleaned its register and connected existing taxpayers to a valid PIN, matching its data with NIA's. This limitation is important, and knowledge of mechanisms behind integration could have helped better understand the mixed impact we find in our analysis. As we show in Section 4.1, only a minority of pre-existing taxpayers have been migrated or migrated voluntarily to a PIN as at February 2023. A small proportion (7 per cent) have a PIN despite being registered before the policy was introduced (2021), indicating that the matching of their records and migration to a PIN was successful. Despite the low numbers, we also present results by disaggregating registrations by new PIN-based entries and migrated ones, to add further nuances around points (iii) and (iv).

For the second data source, we collected detailed survey data from a sample of more than 1,000 merchants in Accra. The survey company first performed a thorough listing exercise in the field to identify potential respondents and reach the required sample size of 1,000. Two conditions were used to be eligible in the listing exercise. First, all respondents are based in the Greater Accra Region, and are representative of population distribution across the six sub-districts. This was due to budget constraints, which did not allow us to work outside the capital. According to the tax register, a sizeable 42 per cent of individual taxpayers are based in Accra. Second, all survey participants are individuals who are registered with GRA for income tax.

The questionnaire, carefully designed with inputs from GRA, is structured according to different modules. After receiving consent from participants we collected demographic information, such as gender, age, and education, and business-related characteristics, including monthly sales, keeping books of accounts, use of internet, and having a bank account. After that, a module on tax perceptions captured opinions on various aspects of the tax system, which are used as key outcomes in our analysis of taxpayers' perceptions. A final module focussed on registration status. We asked if respondents had a Ghana Card, when they got it, and whether their tax identification number is the same or different to their Ghana Card PIN. Follow-up questions, specific to respondents

with a PIN as their tax number, asked about changes in turnaround time, face-to-face interaction, and time spent on tax matters.

The survey took place in May-June 2023. Our sample is restricted to 966 traders who answered the question on whether their PIN is their tax identification number. Of these, 129 (13.4 per cent) have their PIN as their tax identification number. Sample summary statistics are reported in Appendix Table A1.2. Female traders are a sizeable 38 per cent of the sample, and a similar percentage have higher education. Traders are running small businesses, with the overwhelming majority (86 per cent) having less than 5 employees. Books of accounts are kept by 78 per cent of the sample, and just under half use the internet at work or trade online. Two-thirds have a bank account. Average sales are about GH₵33,000 (US$1,736), and median sales are GH₵17,500 (US$921). Interestingly, 55 per cent worked informally before registering with GRA. They registered for tax on average eight years ago, well before the PIN-TIN integration strategy.

The survey data is meant to complement and enrich information provided by administrative data at all levels of analysis, and is used to shed light on the main results on tax compliance behaviour. It produces additional evidence on the impact of using the Ghana Card for tax registration on a range of tax attitudes and perceptions, from perceived probability of audit to fairness of the tax system – all arguably related to tax compliance. The survey sample is different to the broader population of taxpayers registered in 2021/22. Taxpayers in the survey have been registered with GRA on average for eight years, which means they are more experienced and older taxpayers. The different evidence we produce in Section 4.1 around drivers of tax registration with the Ghana Card is probably due to this.

3.2 Methodology

3.2.1 Determinants of tax registration through Ghana Card

We use a probit model for our dummy (0-1) outcome variable (having a PIN as a tax identification number) to explore the drivers of PIN-based tax registration. As explained earlier, we are only able to differentiate how PIN-based registration with GRA took place by identifying taxpayers who migrated their TIN to a PIN, based on whether they were registered for tax before 1 April 2021. We therefore talk about PIN-based tax registration for simplicity, but acknowledge that this terminology captures different scenarios, namely migrated PINs, voluntary, and automatic registrations after 1 April 2021.

We perform the analysis of drivers of PIN-based tax registration using both administrative and survey data. As explained earlier, with administrative data we are able to study patterns of taxpayers across the whole country, while with

survey data we are restricted to the capital. The model specification for administrative data is given by:

$$\Pr(Y_i = 1) = \phi(\beta_1 ATC_i + \beta_2 Female_i + \beta_3 Age_i) \tag{1}$$

where Y_i is a binary variable equal to 1 if the tax identification number is a Ghana Card PIN, and 0 if it is a TIN; ATC_i is a binary variable equal to 1 if the tax registration centre is Accra; $Female_i$ is a binary variable equal to 1 if the taxpayer is female; Age_i are dummy variables for different age groups – 18 to 24, 25 to 34, 35 to 44, 45 to 54, and above 54. We restrict this analysis to registrations in 2022 to make the two groups more comparable, and to include a full year with the Ghana Card-based tax registration policy in place. Importantly for our estimation, even after the mandate to register through a Ghana Card, TINs have still been issued (Section 2). This partial compliance with the mandate enables us to compare the two categories of registrations.

The model specification for survey data reads as follows:

$$\Pr(Y_i = 1) = \phi(\beta_1 L5E_i + \beta_2 Informal_i + \beta_3 Female_i + \beta_4 Married + \beta_5 RegYear + \beta_6 OT + \beta_7 Educ + \beta_8 AccBooks + \beta_9 MSAM + \beta_{10} Internet + \beta_{11} BankAcc) \tag{2}$$

where Y_i is a binary variable equal to 1 if the taxpayer's PIN is their tax identification number, and 0 otherwise; $L5E_i$ is a binary variable equal to 1 if the number of employees is less than 5; $Informal_i$ is a binary variable for a business that was informal before registration – at least as reported in the survey;[16] $Female_i$ is a binary variable equal to 1 if the taxpayer is female; $Married_i$ is a binary variable equal to 1 if the taxpayer's civil status is married; $RegYear$ is the year of business registration; OT_i is a binary variable equal to 1 if the business is involved in online trading; $Educ_i$ is a binary variable equal to 1 if the taxpayer has higher education; $AccBooks_i$ is a binary variable equal to 1 if the business keeps books of accounts; $MSAM_i$ is a binary variable equal to 1 if the business monthly sales is above the median; $Internet_i$ is a binary variable equal to 1 if the business uses internet; and $BankAcc_i$ is a binary variable equal to 1 if the business has a bank account.

For both probit regressions, we compute the additional step of presenting the results in terms of marginal effects of the regressors. This approach helps to better interpret the output coefficients of a probit regression. The marginal effects of the regressors indicate how much the (conditional) probability of the outcome variable changes when you change the value of a regressor, holding all other regressors constant at some values.

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[16] Contrary to a similar study on ID integration run in Uganda (Scarpini *et al.* 2024), in Ghana we do not have information on informality before registration. We use a survey-based measure, and collect this information by asking the question: 'Were you operating as an informal business before registering with GRA?'. We use this data in the survey-based analysis.

In this analysis, and the ones below, the choice of explanatory variables is inevitably dependent on the data sources used. For survey data analysis we can leverage more information on taxpayers. With administrative data we chose all taxpayer information available, which is interesting to explore per se and can directly relate with registration status. With survey data we picked those variables that are more likely to matter in describing the profile of PIN-based registrations. These are basic demographics (gender, education, and civil status), business-related features (size, informal status pre-registration, registration year, keeping books of accounts, and having a bank account), and technology-related variables (online trading, and having access to the internet).

3.2.2 Impact of tax registration through Ghana Card on tax outcomes

We perform this analysis both at the taxpayer level and the more aggregate level of tax districts, following the approach of Lediga *et al.* (2020). While the taxpayer-level analysis captures correlation, the district-level two-way fixed effects analysis is better suited to measure causal estimates.

At the taxpayer level, we investigate whether there is any significant difference in tax returns and payment outcomes between taxpayers that registered with GRA through a PIN and those that did not, who went through the standard tax registration process. Given the structure of the data, we cannot run a difference-in-difference model or a two-way fixed effects model as the returns are available only after registration with GRA. The treatment indicator itself is in the registration type, meaning that we do not have pre-treatment observations. To remedy this structural feature, we simply run a regression model where filing outcomes for 2021/22 are regressed on an indicator for the type of registration. We restrict to 2021/22, as this is when the policy was in action. We consider the following outcomes: (i) propensity to file a tax return; (ii) propensity to pay any tax; (iii, iv) amounts filed and amounts of tax paid. We adopt an ordinary least squares (OLS) framework with fiscal year fixed effects – repeating the analysis both with and without additional control variables to enhance statistical precision. When it comes to propensities, we adopt a probit model; when exploring effects on amounts we use a simple OLS linear model.

The model specification without controls is given by:

$$Y_i = \beta PIN_i + \varepsilon_i \qquad\qquad (3)$$

The model specification with controls and with errors clustered at district level *d* is instead:

$$Y_i = \beta PIN_i + Controls_i + \varepsilon_d \qquad\qquad (4)$$

where Y_i are the various outcome variables. PIN is a binary variable equal to 1 if the taxpayer is registered with GRA through a PIN, and 0 otherwise. The control

variables include a binary variable equal to 1 if the tax registration centre is Accra; a binary variable equal to 1 if the taxpayer is female; and dummy variables for different age groups – 18 to 24, 25 to 34, 35 to 44, 45 to 54, and above 54. We also control for the registration year. We run the regression three times: (i) pooling together all registrations 2011-2022, (ii) restricting to new registrations happening after the PIN-based registration policy came into place in April 2021, and (iii) restricting to registrations before the policy that have been migrated to a PIN. In doing so, we are able to add more nuance to heterogenous effects across these two types of registrations, intrinsically very different.

In line with Lediga *et al.* (2020), we explore district-level impact by constructing a treatment variable based on the intensity of PIN-based tax registrations for each district. In doing so, we perform a more robust analysis aimed at measuring causal impacts. We calculate the share of PIN-based registrations over the total of registrations for each district *d*, and then group the districts in the bottom two quartiles to one group (weakly treated) and the top two quartiles to another group (strongly treated). We use a two-way fixed effects model (2FE) with district-level *d* and time (yearly) fixed *t* effects. The time period covers tax returns and payments from 2011 to 2022. The 2FE model is:

$$Y_{dt} = \beta \text{Treatment}_{dt} + \delta_d + \gamma_t + \varepsilon_{dt} \qquad (5)$$

where Y_{dt} are the various outcome variables at the district level *d* in time *t* – the propensity to pay tax; the amount of tax paid; the propensity to make a tax return; and the amount of tax return made. Treatment_{dt} is a binary variable equal to 1 if the district is considered to be strongly treated, and 0 if the district is considered to be weakly treated.

3.2.3 Effects on data quality

We use an additional probit model, outlined below, to examine associations between PIN-based tax registration, now considered an independent variable, and the quality and accuracy of GRA taxpayer register data as our dummy (0-1) dependent variable:

$$\Pr(Y_i = 1) = \phi(\beta \text{PIN}_i + Controls_i)_i \qquad (6)$$

In this case, Y_i is a set of taxpayer-level indicators for data quality, namely: (i) a dummy for excessively large or small individuals' age (or outliers, measured as more than twice the normalised difference between age and the overall mean); (ii) a dummy for missing gender information; (iii) a dummy for missing physical address; and (iv) a dummy for missing sector of activity. Finally, *PIN* is our key explanatory factor, taking a value of 1 for a PIN-based tax registration and 0 for registration through a TIN. The control variables are the same as in equation (1), and are used here as control variables to make the estimation more precise.

3.2.4 Taxpayers' perceptions

Finally, we dig deeper into the survey data to shed light on the potential mechanisms that could explain our findings on tax compliance behaviour. We explore whether there is any difference in tax attitudes and perceptions between taxpayers registered through a PIN or a TIN. We estimate the following regression model with district fixed effects, without and with controls:

$$Y_i = \beta PIN_i + Controls_i + \varepsilon_i \qquad\qquad (7)$$

where Y_I are several perception outcome variables: (i) perceived audit probability, measured over a scale from 0 per cent to 100 per cent;[17] (ii) perceived ease of navigating the tax system, built as an indicator variable for whether the taxpayer thinks that navigating the tax system is very or somewhat easy;[18] (iii) number of face-to-face interactions with GRA;[19] (iv) justification of tax evasion, built as an indicator variable;[20] (v) perceived fairness of the tax system, built as an indicator variable for whether the taxpayer thinks that the tax system is very or somewhat fair;[21] and (vi) satisfaction with public services, built as an indicator variable for whether the taxpayer is very or somewhat satisfied with public services.[22] Indicator outcomes are regressed using a probit multivariate model, while the continuous ones are fit into a standard OLS one. PIN_i is a binary variable equal to 1 if the taxpayer's PIN is the tax identification number and 0 otherwise. The controls include: business has less than five employees, business was informal before registration, business owner is female, business owner is married, business owner has higher education, registration year, business is involved in online trading, business keeps books of accounts, the business' median sales are above the median, business uses the internet, and business has a bank account.

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[17] Survey question: 'What do you think is the approximate likelihood that you will be selected for audit or review this year regarding your taxes, from 0 to 100?'

[18] Survey question: 'Please tell me, on a scale from 1 to 4, how difficult/easy it is to navigate the tax system?'

[19] Survey question: 'How many face-to-face interactions with GRA did you have in the last year?'

[20] Survey question: '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 to pay less tax'.

[21] Survey question: 'On a scale of 1 to 5 how fair do you think the tax system is? 1 being very unfair and 4 being very fair'.

[22] Survey question: 'On a scale from 1 to 5, how satisfied are you with the provision of public services?'

4. Results

In this section we present our main results. We first describe the registration patterns. Then, we capture the key drivers of registration with a Ghana Card. Further, we move to the analysis of effects of Ghana Card tax registrations on tax outcomes. Finally, we measure the association between Ghana Card tax registrations and the quality of GRA administrative data.

4.1 Registration patterns

The system integration resulted in a sharp increase in the number of individuals registered for income tax, from about 80,000 in 2020 to three times higher by the end of 2022. This is less than that given by interviewees at GRA (Section 2), as they were referring to all registrations for all tax purposes, while we focus on income tax payers only. As shown in Figure 1, tax registrations with a Ghana Card are much more prominent than normal registrations in 2022. Importantly, about 95 per cent of PIN-based registrations took place after the policy came into effect. This indicates that the vast majority of PIN-based registrations are new registrations, and are not earlier TIN-based registrations matched with Ghana Card PINs. Migration tasks are still ongoing, and as at February 2023 they represented only about 7 per cent of TIN registrations before April 2021 (when the policy came into effect). In Section 4.3 we further discuss the difference in filing behaviour across the two categories, new and migrated entries. However, the caveat around not knowing if the PIN-registration happened voluntarily from taxpayers or forcefully by GRA action remains.

These results show an immediate benefit from inter-institutional data sharing in boosting the taxpayer base, also documented in Uganda (Scarpini *et al.* 2024). There are, however, important caveats to consider, relating to the capacity of the tax administration to manage ever-increasing registration numbers, and whether all new entrants will eventually remit any tax. For this reason, while more taxpayers are brought into the tax net, it is critical to understand the profile of new entrants and explore their post-registration behaviour in terms of tax compliance.

Figure 4.1 Trend in registrations over time
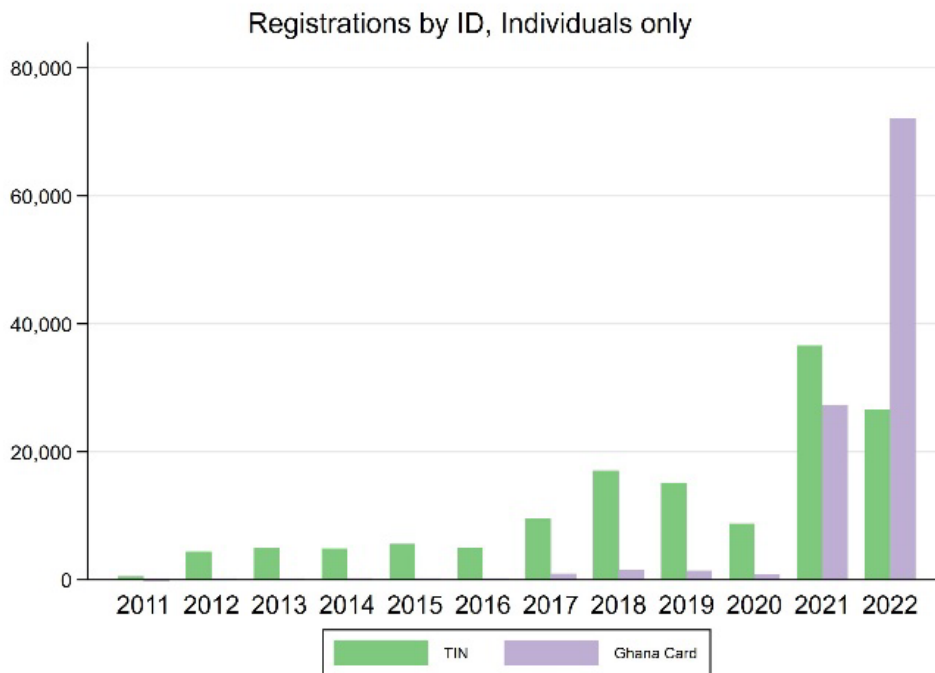
Registrations by ID, Individuals only

Source: Authors' calculations based on administrative data shared from GRA, updated as at February 2023.

4.2 Correlates with tax registration through Ghana Card

We further analyse the profile of taxpayers brought into the tax net through the new initiative to better understand who is more likely to register or be forcedly registered through a Ghana Card. Comparing the profile of individual taxpayers registered through a Ghana Card PIN or a TIN through a standard t-test table shows a significant difference across the two groups (Table 4.1). When using administrative data, taxpayers residing outside Accra, females, and younger people are more likely to be registered under a Ghana Card PIN.

The more detailed survey data results also show that there are significant differences between the two groups. More educated taxpayers and those more connected to the internet, including those trading online, are more likely to have a Ghana Card PIN as their tax account number. The same applies to taxpayers with a bank account. Curiously the gender dimension no longer matters, which it did when considering all individual registrations. This could be due to the fact that the survey sample is located in Accra, where gender disparities might be less relevant.

Table 4.1 T-test table comparing taxpayers registered through Ghana Card PIN and a TIN

Variable	(1) TIN		(2) Ghana Card PIN		Pairwise t-test	
	N	Mean	N	Mean	N	Mean difference
Administrative data						
Accra tax centre	26,595	0.633	72,171	0.198	98,766	0.435***
Female	26,595	0.294	72,171	0.392	98,766	-0.097***
18-24	26,595	0.010	72,171	0.051	98,766	-0.042***
25-34	26,595	0.222 (0.003)	72,171	0.250 (0.002)	98,766	-0.028***
35-44	26,595	0.357 (0.003)	72,171	0.296 (0.002)	98,766	0.061***
45-54	26,595	0.220 (0.003)	72,171	0.205 (0.002)	98,766	0.015***
≥ 35	26,595	0.191 (0.002)	72,171	0.198 (0.001)	98,766	-0.007**
Survey data						
Female	837	0.386 (0.017)	129	0.349 (0.042)	966	0.037
Married	837	0.645 (0.017)	129	0.721 (0.040)	966	-0.076*
Higher education	837	0.367 (0.017)	129	0.473 (0.044)	966	-0.106**
Less than 5 employees	836	0.859 (0.012)	127	0.866 (0.030)	963	-0.007
Books of account	830	0.781 (0.014)	126	0.786 (0.037)	956	-0.005
Biz uses internet	837	0.437 (0.017)	129	0.589 (0.043)	966	-0.152***
Biz trades online	837	0.410 (0.017)	129	0.558 (0.044)	966	-0.148***
Bank account biz	817	0.666 (0.017)	128	0.742 (0.039)	945	-0.076*
Monthly sales above median	751	0.497 (0.018)	115	0.487 (0.047)	866	0.010
Informal business before registering with GRA	806	0.561 (0.017)	129	0.504 (0.044)	935	0.057
Registration year	815	2015.021 (0.268)	126	2015.254 (0.697)	941	-0.233

Source: Authors' calculations based on administrative data shared from GRA, updated as at February 2023.
Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. Results derive from t-tests for mean equality, based on administrative data from GRA, updated as of February 2023.

Results from the regression framework that we use to further investigate the drivers of registration with a Ghana Card PIN converge with those from the descriptive analysis. Figure 4.2a presents the results using administrative data and all individual registrations in 2022 (equation 1, Section 3.2). It emerges that individuals registered through a tax centre in Accra are 39 per cent less likely to have a PIN as their tax identification number. This may be expected, since most taxpayers residing outside Ghana are likely to be in the informal sector, and the new registration drive enabled by the system integration was targeting the

informal sector. In contrast, females (7 per cent) and those aged 18-24 (22 per cent) are more likely to be registered with a PIN. It is not surprising to see young people have a higher chance of registering with a Ghana Card, as most of them are expected to get their national ID when they are 18 years old. This mandatory registration with NIA means it is possible for their data to be shared with GRA for tax registration purposes. More broadly, an argument can be made that rural, female, and younger taxpayers are normally less represented in taxpayer registers. Once registration is expanded *en masse* through mandatory use of the Ghana Card, these categories may be more easily captured in the tax base.

We complement results from administrative data with those from the survey sample by running a similar OLS model (equation 2, Section 3.2). In Figure 4.2b, the regression results suggest a negligible difference between the groups, with those having a PIN as their tax identification number more likely to be more educated and married. Apart from the expected result on education (more educated taxpayers are more likely to follow the tax rules around registration), the married civil status might indicate that married taxpayers are more likely to have a PIN in the first place, and use this for interacting with government – starting from the civil registration office. This more mixed evidence can be due to the survey sample being more experienced and older than new registrations in 2022 in Figure 4.2a, as elaborated in Section 3.1.

Figure 4.2 Correlates of registration through Ghana Card, OLS framework
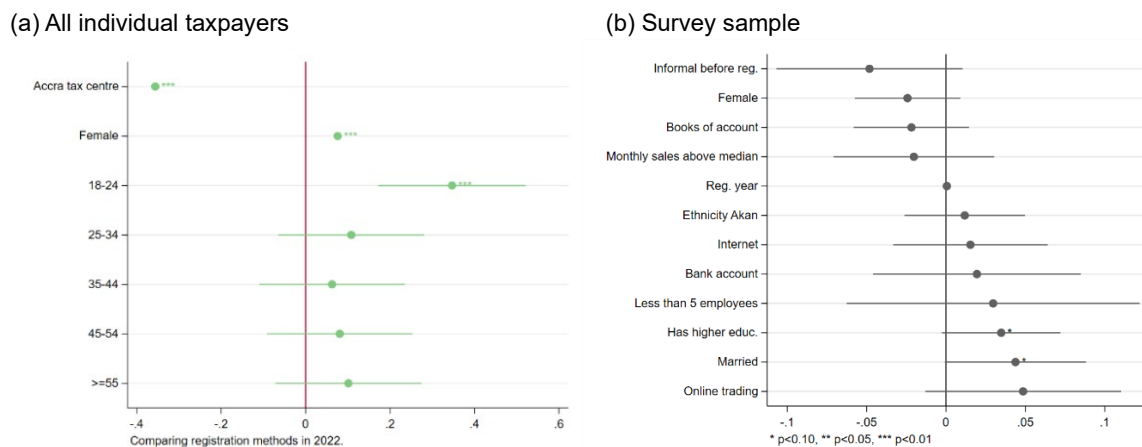
(a) All individual taxpayers

(b) Survey sample

Source: Authors' calculations based on administrative data shared from GRA, updated as at February 2023. Note: Coefficients result from OLS model where the outcome is an indicator variable for whether the taxpayer is registered with PIN, and taking the value 0 if they are registered with a TIN. All data is extracted from GRA administrative data, updated as of February 2023. Tax centre fixed effects are included. More details in Section 3.2.

4.3 Impact on tax revenue

We investigate behaviour after registration for taxpayers registered under a Ghana Card PIN and TIN to determine whether there is a difference in tax compliance. In Table 4.2 we both pool together all registrations (panel a), and repeat the analysis by subgroups (new or migrated entities) to explore heterogeneity (panels b and c). These results are based on the regression framework outlined in equations 3 and 4 in Section 3.2, which aims to capturing correlations only.

Table 4.2 Filing behaviour by registration channel, 2021/22

	(1) Filed any tax	(2) Filed any tax	(3) GETFUND	(4) GETFUND	(5) PAYE	(6) PAYE	(7) PIT	(8) PIT	(9) VAT	(10) VAT
				(a) All registrations						
Ghana Card PIN	-0.012	-0.009	504*	495*	201	203	-743	-704	977**	970*
	(0.022)	(0.022)	(259)	(266)	(180)	(175)	(565)	(563)	(481)	(487)
N	248,572	248,572	12,284	12,284	12,558	12,558	25,505	25,505	27,606	27,606
R-sq.	0.134	0.149	0.009	0.011	0.010	0.011	0.003	0.003	0.004	0.004
T.C. F.E.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
				(b) New registrations, after April 2021						
Ghana Card PIN	-0.043**	-0.042**	-120	-111	3	6	-2,592*	-2,472*	2,453	2,493
	(0.017)	(0.017)	(560)	(560)	(158)	(157)	(1,314)	(1,322)	(2,559)	(2,613)
N	103,946	103,946	2,551	2,551	2,917	2,917	10,029	10,029	4,893	4,893
R-sq.	0.098	0.105	0.023	0.027	0.023	0.027	0.022	0.022	0.010	0.011
T.C. F.E.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
				(c) Migrated registrations, before April 2021						
Ghana Card PIN	0.311***	0.297***	1,368*	1,349*	172	179	-79	-37	832***	819***
	(0.022)	(0.022)	(708)	(709)	(365)	(360)	(968)	(895)	(258)	(258)
N	80,279	80,279	6,174	6,174	6,015	6,015	8,697	8,697	15,064	15,064
R-sq.	0.196	0.218	0.013	0.014	0.013	0.014	0.007	0.007	0.010	0.011
T.C. F.E.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Source: Authors' calculations based on administrative data shared from GRA, updated as at February 2023. Note: Coefficients result from OLS model where the outcome 'Filed any tax' is an indicator variable for whether the taxpayer filed any tax, and taking the value 0 if they did not. Outcomes in columns 3–10 are amounts of tax filed for the various taxes. All data is extracted from GRA administrative data, updated as of February 2023. Tax centre fixed effects are included. More details in Section 3.2.

Three patterns emerge from the correlational evidence in Table 4.2. First, overall, the PIN-based tax registrations are not associated with any strikingly positive outcome in filing (panel a). If anything, weakly significant results are found with the increments in GETFUND and VAT. Second, when disaggregating by registration category and focusing on new entrants only (panel b), it shows that

PIN-based registrations after the policy came into place are 4 percentage points less likely to file for any tax. This translates into a 17 per cent decrease compared to the control group average filing rate (23.5 per cent). They are also declaring less PIT, although weakly significantly. When considering migrated taxpayers (panel c), who registered with a TIN before April 2021 and were subsequently assigned a PIN, it seems that PIN-based registrations are associated with a strong and positive filing outcome. These taxpayers are about 30 percentage points more likely to file for any tax, which translates into a remarkable 116 per cent increase (more than double) compared to the control group mean (25.6 per cent). Importantly, these taxpayers are declaring on average about US$800 more in VAT, which is an 85 per cent increase compared to the control group. Weakly significant increases are also found with GETFUND.

Several interesting results on compliance with tax payments are displayed in Table 4.3. First, across the board (panel a) PIN-based registrations are much more likely to pay any tax, and highly significantly. The positive correlation amounts to a 7.6 percentage point increase, corresponding to a 16 per cent increase compared to the control group mean (47 per cent). PIN-based registrations are also paying US$478 more PAYE and US$364 more VAT. Second, when comparing new registrations (panel b) to migrated taxpayers (c), once again the positive results are mostly driven by the latter category. Migrated taxpayers are associated with a 25 percentage point higher probability of paying any tax (about 50 per cent of the control group mean), the payment of US$600 more PAYE (50 per cent of the control group mean) and US$1,200 more VAT (a sizeable 80 per cent). In contrast, new registrations (panel b), end up paying less VAT than standard registrations in the same period.

We explore similar tax outcomes at the district level, considering the intensity of tax registrations through a Ghana Card PIN and its impact on tax revenue (equation 5 in sec. 3.2). Our analysis finds that districts with a higher proportion of taxpayers registered under a Ghana Card PIN, which we label as 'treated', were more likely to have more tax filings than untreated districts (Appendix Table A1.4). However, they are likely to file less tax, especially PIT and VAT, compared to untreated districts. In contrast, we find no difference in the propensity of making any tax payment between treated and untreated districts. However, treated districts are more likely to pay less PAYE (from withholding on employees) and VAT taxes (Appendix Table A1.5).

Table 4.3 Payment behaviour by registration channel, 2021/22

	(1) Paid any tax	(2) Paid any tax	(3) GETFUND	(4) GETFUND	(5) PAYE	(6) PAYE	(7) PIT	(8) PIT	(9) VAT	(10) VAT
(a) All registrations										
Ghana Card PIN	0.076***	0.076***	168	181	482***	478***	-822	-610	371*	364**
	(0.027)	(0.024)	(185)	(181)	(142)	(140)	(825)	(628)	(187)	(182)
N	216,914	216,914	11,008	11,008	12,862	12,862	84,080	84,080	26,514	26,514
R-sq.	0.231	0.269	0.009	0.011	0.020	0.021	0.001	0.002	0.012	0.016
T.C. F.E.	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
(b) New registrations, after April 2021										
Ghana Card PIN	0.097***	0.088***	-378	-356	456	449	-442*	-493	-948***	-960***
	(0.022)	(0.020)	(242)	(226)	(400)	(400)	(256)	(322)	(353)	(347)
N	88,551	88,551	2,848	2,848	3,016	3,016	27,316	27,316	5,842	5,842
R-sq.	0.212	0.248	0.025	0.033	0.025	0.027	0.008	0.008	0.021	0.027
T.C. F.E.	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
(c) Migrated registrations, before April 2021										
Ghana Card PIN	0.268***	0.248***	753*	757*	600***	601***	-1,895	-2,169	1,204***	1,202***
	(0.030)	(0.029)	(410)	(411)	(165)	(165)	(2,402)	(2,648)	(354)	(350)
N	74,702	74,702	4,906	4,906	6,080	6,080	32,195	32,195	13,328	13,328
R-sq.	0.334	0.365	0.013	0.015	0.055	0.056	0.003	0.003	0.022	0.024
T.C.F.E.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Source: Authors' calculations based on administrative data shared from GRA, updated as at February 2023.
Note: Coefficients result from OLS model where the outcome 'Paid any tax' is an indicator variable for whether the taxpayer paid any tax, and taking the value 0 if they did not. Outcomes in columns 3–10 are amounts of tax paid for the various taxes. All data is extracted from GRA administrative data, updated as of February 2023. Tax centre fixed effects are included. More details in Section 3.2.

In summary, the evidence around the impact of PIN-based registrations is mixed. This is particularly true across two dimensions. The first is the category of registrations. New registrations after April 2021, who entered the tax system directly with a PIN, show poorer compliance than migrated taxpayers, who are associated with better outcomes. These findings might suggest that the effort to mass register taxpayers using their ID records, particularly intense after April 2021, has led the revenue administration to include in their register a considerable number of inactive taxpayers. There may be many reasons for non-compliance by new registrations – including the revenue authority not being able to contact them due to incorrect contact details obtained from NIA, the fact that they have no real tax liability, and tax avoidance.[23]

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[23] These results resonate with those provided by a growing body of literature on the use of third-party data for mass registration (Groening *et al.* 2024; Lediga *et al.* 2020; Scarpini *et al.* 2024).

A second interesting dimension refers to the type of compliance outcome under study. Tax payments are associated with remarkably positive changes for PIN-based registrations, while results for tax filing are less consistent. As we learned from our qualitative interviews with GRA, this is largely attributable to technical details of the tax e-services available for paying taxes. Tax payments, as well as all other payments to government entities, take place on the Ghana.gov platform. Ghana.gov can be considered an excellent example of a centralised, open source architecture providing a revenue collection platform and single point of access to government services for the public sector (Dolan *et al.* 2024).[24] Importantly, Ghana.gov also acts as a catalyst for streamlining services and data exchange. A PIN from a Ghana Card is required to access the platform to make a tax payment. Also, if a Ghana Card is transacting in the payment system but is not in the tax system, the data exchange portal (GUIN) pulls data from NIA and automatically transmits it to GRA. These enforcement and data exchange measures are built into the payment platform. This is not the case for the e-filing portal, which still requires more integration and cross-checking.

4.4 Impact on data quality

We explore the data quality of registrations under a Ghana Card PIN and their implications for the Ghana Revenue Authority. Table 4.4 reports the OLS coefficients on four different data quality outcomes (equation 5 in Section 3.2). All coefficients are highly statistically significant due to the large size of groups we analyse, which enables precise estimations. One major finding is that there are few age outliers in the Ghana Card registration process (col. 1). This is almost guaranteed since national ID cards are used for registration – any exception is probably an error in the registration data. Column 2 shows that no significant effect is found due to missing gender information. This implies it is highly unlikely that gender information is missing during the registration process or on registration data. The possibility of missing gender information has been significantly reduced, as it is a requirement in the Ghana Card registration form.

A positive effect on data quality is found on missing address information (col. 3). There is a substantial decrease of 24 percentage points in missing residential addresses with registration under a Ghana Card PIN. This can be attributed to system integration, which allowed GRA to get data related to residential location. Historically this information was incomplete, and it was not collected accurately in the standard tax registration procedure. Despite filling this gap in the tax register, more information on a residential address from NIA does not necessarily mean

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[24] The platform was initially piloted in 2013 with only 11 agencies. At that time usage was low, and some agencies with lucrative services, such as the Driver and Vehicle Licensing Agency, refused to join it. This was largely due to a lack of trust between agencies around sharing data and revenue percentages on Ghana.gov. In 2017 the platform was redesigned, merging e-services and e-payments. After this the government instructed all agencies to use the platform (Dolan *et al.* 2024).

that this information is correct. The residential address could be out of date, as it was collected when registering for a Ghana Card. We understood from interviews with GRA that they could only reach about 30 per cent of newly registered taxpayers through system integration after the automatic registration. This was probably due to out-of-date residential addresses – and contact information, which was not available in our study. Location information is an example of data that should still be collected by the tax administration, which needs information on business addresses. This is not something that can be easily addressed by a streamlined data exchange with national ID authorities.

Table 4.4 Correlation between registration through Ghana Card and data quality

	(1) Age outlier	(2) Missing gender info.	(3) Missing address info.
Ghana Card PIN	-0.014***	-0.006***	-0.258***
	(0.00)	(0.00)	(0.00)
Controls	Yes	Yes	Yes
Normal reg Y	0.039	0.007	0.298
Pseudo R-sq.	0.007	0.086	0.1759
N	252,756	252,788	252,788

Source: Own calculations on GRA administrative data.
Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Column 1 refers to an indicator for age being larger than twice the standardised difference from the average population age. Column 2 uses an indicator for missing information on gender. Column 3 refers to an indicator for missing physical address. More details on the estimation strategy in Section 3.

Finally, we could not run a probit regression on the accuracy of industry classification as registrations with a PIN do not have this. The NIA database only contained indicative information about a citizen's occupation, and not the industry. The integration with NIA does not affect the quality of this information, and it should be improved by other means.

5. Taxpayers' perceptions

We now consider taxpayers' perceptions, as extracted from survey data. We compare those who are registered through a Ghana Card PIN with those who are registered under a TIN (equation 6 in Section 3.2). We first consider more practical perceptions around taxpayers' experiences in navigating the tax system in Table 5.1. We look at broader opinions on the tax system and government in Table 5.2.

Two interesting results emerge from Table 5.1. First, on the more practical taxpayers' experience, those registered under a Ghana Card PIN are more likely to have less face-to-face interaction with GRA, significantly so without and with controls (col. 5-6). However, this is not likely to be due to the one-step registration experience. Only a quarter of those with a PIN registered after the policy came into effect, and taxpayers have been registered with GRA for about eight years on average. Nevertheless, using the PIN as a tax identification number could imply fewer physical interactions with government officials for reasons other than tax, which may improve taxpayers' perceptions. Second, taxpayers identified with a Ghana Card PIN are less likely to believe they will be selected for audit or review of their taxes (col. 2). This finding is weakly significant, and it is not clear what motivates this result. We believe it could be due to the taxpayers' sense of doing the right thing, or being more compliant across the board.

Table 5.1 Registration through Ghana Card and taxpayers' perceptions

	(1) Perceived audit probability	(2) Perceived audit probability	(3) Easy to navigate tax system	(4) Easy to navigate tax system	(5) No. of face-to-face interactions with GRA	(6) No. of face-to-face interactions with GRA
Ghana Card PIN	-5.92	-7.88[*]	0.04	0.04	-0.06[**]	-0.10[**]
	(3.99)	(3.83)	(0.03)	(0.03)	(0.02)	(0.03)
Controls	No	Yes	No	Yes	No	Yes
Mean of C	24.44	24.44	0.34	0.34	2.10	2.10
R-sq.	0.089	0.168	0.052	0.120	0.035	0.121
N	960	960	966	966	966	966

Source: Authors' calculations based on survey data.

Notes: Coefficients result from OLS model where the outcome 'Perceived audit probability' ranges from 0 to 100, reflecting a taxpayer's perception of their likelihood of being audited or having their taxes reviewed; the outcome 'Ease of navigating the tax system' is an indicator variable of how straightforward individuals find it to use the tax system, taking the value 0 if they perceive it as complex; the outcome 'No. of face-to-face interactions with GRA' represents the number of times a taxpayer has interacted with the tax authority directly. District fixed effects are included. More details in Section 3.2.

We do not, however, find any significant evidence when we explore how easy the tax system is to navigate (col. 3-4). This could be because the whole experience of navigating the tax system might not directly benefit from the PIN integration. A number of other tasks, such as filing, paying, claiming refunds, and appealing, might still be as difficult for taxpayers as previously.

In-depth interviews with GRA officials reveal that system integration may have significantly reduced compliance costs at registration for individuals – at least those involved with visiting GRA to get a tax identification number. However, new taxpayers are still expected to visit GRA to complete the registration process, and to provide additional information that is often missing. There may also need to be additional in-person visits to correct misclassification of taxpayers based on income sources from the NIA's database. As in Uganda, where taxpayers were invited to come to the revenue authority to complete registration, in Ghana system integration did not eliminate all in-person interaction, and the extra costs and unpredictability involved. It is very hard to convince taxpayers to physically come to the GRA building. The same challenge was also particularly severe in Uganda (Scarpini *et al.* 2024).

As a final piece of analysis, Table 5.2 shows that we do not find any significant evidence that being registered with GRA under a Ghana Card PIN has an impact on broader tax perceptions. Taxpayers registered under a Ghana Card PIN are no more positive than those registered with a TIN. This lack of evidence might be due to system integration being recent, and these core tax perceptions can take time to change. It is also true that integration relates to one taxpayer task – registering with GRA. General perceptions around the tax system and provision of public services might not be influenced by a change in identifier for a taxpayer's account. This is more relevant in the case of our sample, where taxpayers have been registered for a long time and have stronger opinions. A second potential interpretation could be that these 'older' taxpayers have been – either randomly or voluntarily – migrated to a PIN through the ongoing matching strategy at GRA. They entered the tax system through the earlier process of issuing a TIN as a tax identification number, and did not go through the new registration process.

Table 5.2 Registration through Ghana Card and broader taxpayers' perceptions

	(1) Never justify evasion	(2) Never justify evasion	(3) Fair tax system	(4) Fair tax system	(5) Satisfied with public services	(6) Satisfied with public services
Ghana Card PIN	-0.09	-0.09	-0.02[*]	-0.01	-0.05	-0.04
	(0.08)	(0.08)	(0.01)	(0.01)	(0.04)	(0.04)
Controls	No	Yes	No	Yes	No	Yes
Mean of C	0.59	0.59	0.14	0.14	2.10	2.10
R-sq.	0.046	0.086	0.013	0.031	0.024	0.059
Observations	930	928	966	963	966	966

Source: Authors' calculations based on survey data.

Notes: Coefficients result from probit regression model where the outcome 'Never justify evasion' is an indicator variable for whether the taxpayer believed that income declaration should be manipulated to reduce tax obligations; the outcome 'Fair tax system' is an indicator variable for whether the taxpayer think the tax system is very or somewhat fair; the outcome 'Satisfied with public services' is an indicator variable for whether the taxpayer is very or somewhat satisfied with public services. District fixed effects are included. More details in Section 3.2.

6. Conclusions

We produce several key findings around the potential of data exchange for tax administration in this study. First, the system integration between GRA and NIA significantly increased the number registered for tax. It captured more women and younger individuals than in existing TIN registrations, with PIN-linked tax registrations the majority of new enrolments. However, the impact of system integration on revenue remains uncertain, at least in the short term, due to mixed outcomes on tax compliance. New registrations via a Ghana Card PIN are less compliant. Migrated taxpayers show a more positive outcome in terms of filing for any tax, and declare more PAYE and VAT. Tax payments improve considerably for PIN-based registrations, most likely due to a technical feature of the Ghana-gov e-payment portal, which is accessed through a Ghana Card PIN. Integration with a Ghana Card improves certain aspects of tax administrative data, such as taxpayers' location – but makes others worse, such as economic sector. Despite simplified registration, taxpayers experience less interaction with tax officials and think there is less enforcement. They do not believe the tax system is better, suggesting that more comprehensive reform may be needed.

Building on these findings, we offer practical policy recommendations for both the Ghana tax administration and other governments embarking on similar integration initiatives (see list in Appendix Table A1.1). First, and consistent with findings from Uganda (Scarpini *et al.* 2024), we show how the use of DIS primarily aims to increase the number of registrations, particularly of smaller taxpayers and businesses. However, mass registration efforts often fall short of expected benefits. They tend to involve many small taxpayers with limited potential for revenue, and are hard to monitor. Tax administrations often lack the resources to ensure compliance effectively. To enhance tax collection and fairness, governments must track and engage with new taxpayers, focusing on those with greater potential and ability to pay. Investment in capacity for traditional enforcement and monitoring should come at the same time as investment in technological innovation. Otherwise, while DIS may boost registration figures, their impact on revenue collection could be limited.

Second, and relatedly, we argue that tax administrations should carefully consider their priorities and targets when embarking on digitalisation processes. DIS are often only used as a tool to expand the tax base and improve taxation of the informal sector, under strict annual registration targets (Moore 2022). Taxpayer registration and formalisation are crucial objectives. However, and linked to the point above, only focusing on registering and taxing numerous small taxpayers might not generate significant revenue, can worsen inequities for the least affluent, and strain administrative resources. A more effective approach could involve a targeted strategy, leveraging new DIS data to identify and tax larger

non-compliant taxpayers, such as high net worth individuals and professionals, while offering straightforward and fair pathways for smaller taxpayers to formalise their businesses. This approach is likely to yield better results (Gallien *et al.* 2023).

Third, it is important to note the success of integrating systems of different government institutions in contexts where data sharing is often hampered by a silo mentality and political resistance (Okunogbe and Santoro 2023). The Ghana case is an excellent example of a way to digitalise and integrate government services. However, the tax administration should consider the implications of data sharing on the quality of its own administrative data, and understand how new DIS data could directly benefit its needs. Policy-makers should note that integration improves data quality on some margins, and makes it worse on others (Groening *et al.* 2024). Sizeable resources have been redirected to data cleaning and maintenance after integration, and this may not be the best use of limited personnel and resources (Scarpini *et al.* 2024).

Fourth, relating to the impressive progress of Ghana with integrated and streamlined systems, tax administrations should build on a particularly powerful feature of the Ghana.gov e-payment portal, which needs a PIN from a Ghana Card. This may explain the positive impact on tax payments, suggesting that similar integration and cross-checks should be required for an e-filing portal.

Finally, regarding the limited impact on taxpayers' perceptions and attitudes, tax administrations should continue to gather data on users' experience with technology, and build in a feedback loop. Specific, ad hoc, technological innovations may have little impact on longstanding taxpayers' opinions of the tax system. In Ghana and Uganda (Scarpini *et al.* 2024), taxpayers need to visit the GRA offices in-person to update their personal information after registration – this is an extra burden. Tax administrations should plan the transition to fully digitalise systems, avoid keeping parallel manual and digital practices, and streamline the taxpayers' experience as much as possible.

In conclusion, more research is needed to understand the transformative impact of digital ID systems and their integration with tax administration. A longer-term analysis of the impact on tax compliance is needed, as well as more detailed information on a taxpayer's journey through the digital system to capture aspects of trust and data privacy. More research on the regulatory and institutional background in Ghana within which this data exchange takes place could help explain this case study. There is no national approach to data exchange systems, but decentralised sectorial practices, like Ghana.gov, offer great promise. This evidence is needed to inform digital transformation in tax administration, which can catalyse reform elsewhere in government. More broadly, Ghana's data exchange journey has many lessons for national governments looking to

maximise the use and reuse of data, and to improve tax administration through digital ID systems.

Appendices

Appendix 1 Tables

Table A1.1 Digital ID systems in Africa

Country	Income classification	Claim of digital (or electronic) ID	Digital ID name	Collects or uses biometric data	Status of implementation
Algeria	Upper-middle-income countries	Yes	National Electronic Biometric Identity Card (CNIBE)	Yes	Rollout
Angola	Lower-middle-income countries	No	National identity	No	Unknown
Benin	Lower-middle-income countries	Yes	eID	Yes	Rollout
Botswana	Upper-middle-income countries	No	Omang	No	Unknown
Burkina Faso	Low-income countries	Yes	Unknown	Unknown	Pilot
Burundi	Low-income countries	Yes	Unknown	No	Plan
Cabo Verde	Lower-middle-income countries	Yes	Sistema Nacional de Identifticação e Autenticação Civil	Yes	Rollout
Cameroon	Lower-middle-income countries	Yes	National digital identity	Unknown	Pilot
Central African Republic	Low-income countries	Unknown	Unknown	No	Unknown
Chad	Low-income countries	Yes	Système National d'Identité Digitale (SNID)	No	Unknown
Comoros	Lower-middle-income countries	No	Unknown	No	Unknown
Congo	Lower-middle-income countries	Yes	Unknown	No	Plan
Côte d'Ivoire	Lower-middle-income countries	Yes	National Registry of Natural Persons (RNPP)	Yes	Rollout
Democratic Republic of the Congo	Low-income countries	No	Unknown	No	Unknown
Djibouti	Lower-middle-income countries	Yes	eID	Unknown	Plan
Egypt	Lower-middle-income countries	Yes	National digital identity	Yes	Plan

Equatorial Guinea	Upper-middle-income countries	Unknown	Unknown	Unknown	Unknown
Eritrea	Low-income countries	No	Unknown	No	Unknown
Eswatini	Lower-middle-income countries	No	National identity	No	Unknown
Ethiopia	Low-income countries	Yes	Fayda ID	Yes	Rollout
Gabon	Upper-middle-income countries	Yes	Carte Nationale d'Identité Electronique (CNIE)	Yes	Plan
Gambia	Low-income countries	Yes	National digital identity (DIDS)	Yes	Plan
Ghana	Lower-middle-income countries	Yes	GhanaCard	Yes	Rollout
Guinea	Lower-middle-income countries	Yes	National digital identity	Yes	Unknown
Guinea-Bissau	Low-income countries	No	Unknown	No	Unknown
Kenya	Lower-middle-income countries	Yes	Maisha Namba/ National Integrated Identity Management System (NIIMS)	Yes	Pilot
Lesotho	Lower-middle-income countries	Yes	National digital identity	Yes	Rollout
Liberia	Low-income countries	No	National Identification Registry	No	Unknown
Libya	Upper-middle-income countries	Yes	National digital identity	Yes	Plan
Madagascar	Low-income countries	Yes	National Unique Identifier (NUI)	Yes	Pilot
Malawi	Low-income countries	Yes	National Registration and Identification System (NRIS)	Yes	Plan
Mali	Low-income countries	No	Unknown	No	Unknown
Mauritania	Lower-middle-income countries	Yes	National digital identity	No	Plan
Mauritius	Upper-middle-income countries	Yes	MNIC 3.0	Yes	Rollout
Morocco	Lower-middle-income countries	Yes	Mon eID	Yes	Rollout
Mozambique	Low-income countries	No	Unknown	No	Unknown
Namibia	Upper-middle-income countries	Unknown	National digital identity	Unknown	Unknown
Niger	Low-income countries	No	National digital identity	No	Plan
Nigeria	Lower-middle-income countries	Yes	National Identity Number	Yes	Rollout
Rwanda	Low-income countries	Yes	Single Digital ID (SDID)	Yes	Plan
Sao Tome and Principe	Lower-middle-income countries	No	Unknown	No	Unknown

Senegal	Lower-middle-income countries	Yes	National digital identity	Yes	Unknown
Seychelles	High-income countries	Yes	SeyID	Yes	Rollout
Sierra Leone	Low-income countries	Yes	National digital identity	Yes	Rollout
Somalia	Low-income countries	Yes	National digital identity	Yes	Rollout
South Africa	Upper-middle-income countries	Yes	Smart Identity Card (Smart ID)	Yes	Plan
South Sudan	Low-income countries	No	Unknown	No	Unknown
Sudan	Low-income countries	No	Unknown	No	Unknown
Tanzania	Lower-middle-income countries	Yes	Jamii Namba/Unique Number ID	Yes	Rollout
Togo	Low-income countries	Yes	Togo eID	Yes	Plan
Tunisia	Lower-middle-income countries	No	Mobile ID	Yes	Rollout
Uganda	Low-income countries	Yes	Ndaga Muntu	Yes	Rollout
Zambia	Lower-middle-income countries	Yes	National digital Identity	Yes	Rollout
Zimbabwe	Lower-middle-income countries	No	National identity	Unknown	Unknown

Source: UCL IIPP DPI map (accessed 22 November 2024).

Table A1.2 Survey sample summary statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Ghana Card PIN is tax identification number	966	0.13	0.34	0	1
Female	966	0.38	0.49	0	1
Married	966	0.66	0.48	0	1
Higher education	966	0.38	0.49	0	1
Less than 5 employees	963	0.86	0.35	0	1
Books of accounts	956	0.78	0.41	0	1
Business uses internet	966	0.46	0.50	0	1
Business trades online	966	0.43	0.50	0	1
Business has bank account	945	0.68	0.47	0	1
Monthly sales (GH₵)	866	33,062	8,179.64	0	250mln
Informal before registration	935	0.55	0.50	0	1
GRA reg year	941	2015	7.68	1970	2023

Source: Own calculations using survey data of traders in Ghana.

Table A1.3 Mean difference by type of registration, 2011-2022

		(1)		(2)		(1)-(2)
		TIN		Ghana Card		Pairwise t-test
Variable	N	Mean/(SE)	N	Mean/(SE)	N	Mean difference
Accra tax centre	142,477	0.56	110,119	0.23	252,596	0.33***
		(0.00)		(0.00)		
Female	142,477	0.32	110,119	0.39	252,596	-0.07***
		(0.00)		(0.00)		
18-24	142,477	0.00	110,119	0.03	252,596	-0.03***
		(0.00)		(0.00)		
25-34	142,477	0.12	110,119	0.21	252,596	-0.09***
		(0.00)		(0.00)		
35-44	142,477	0.30	110,119	0.29	252,596	0.01***
		(0.00)		(0.00)		
45-54	142,477	0.27	110,119	0.23	252,596	0.04***
		(0.00)		(0.00)		
>=55	142,477	0.31	110,119	0.24	252,596	0.07***
		(0.00)		(0.00)		

Source: Authors' calculations based on administrative data shared from GRA, updated as at February 2023. Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. Results derive from t-tests for mean equality, based on administrative data from GRA, updated as of February 2023.

Table A1.4 District-level tax filing outcomes by registration channel, 2011-2022

	(1)	(2)	(3)	(4)	(5)
		GETFUND	PAYE	PIT	VAT
VARIABLES	Filed any tax	(USD)	(USD)	(USD)	(USD)
Treatment	0.08*	-1,379	-1,472	-9,000*	-9,625**
Observations	1,093	606	602	803	720
Number of observations	83	73	71	77	74

Source: Authors' calculations based on administrative data shared from GRA, updated as at February 2023. Note: Coefficients result from OLS model where the outcome filed any tax is an indicator variable for whether the taxpayer filed any tax, and taking the value 0 if they did not. Outcomes in columns 2 – 5 are amounts of tax filed for the various taxes. All data is extracted from GRA administrative data, updated as of February 2023. Tax centre fixed effects are included. More details in Section 3.2.

Table A1.5 District-level tax payment outcomes by registration channel, 2011-2022

VARIABLES	(1) Paid any tax	(2) GETFUND (USD)	(3) PAYE (USD)	(4) PIT (USD)	(5) VAT (USD)
Treatment	0.10	-4,434	-14,670*	-25,108	-15,633*
Observations	1,092	558	696	977	692
Number of observations	82	72	75	76	74

Source: Authors' calculations based on administrative data shared from GRA, updated as at February 2023.
Note: Coefficients result from OLS model where the outcome paid any tax is an indicator variable for whether the taxpayer paid any tax, and taking the value 0 if they did not. Outcomes in columns 2 – 5 are amounts of tax filed for the various taxes. All data is extracted from GRA administrative data, updated as of February 2023. Tax centre fixed effects are included. More details in Section 3.2.

Appendix 2 Figures

Figure A2.1 Registrations by month

Source: Own calculations based on GRA administrative data, updated as at February 2023.

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