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Building fiscal capacity in developing countries: Evidence on the role of information technology*

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Abstract

Limited fiscal capacity poses a significant challenge in developing countries. To mitigate this challenge, the adoption of electronic tax systems has been at the forefront of tax reforms; however, there is little systematic empirical evidence on the impact of such reforms. We attempt to narrow this gap by documenting evidence from Ethiopia where there has been a recent surge in the use of electronic sales registry machines (ESRMs). Using administrative data covering all business taxpayers, we find that ESRM use resulted in a large and significant increase in tax payments. Moreover, this effect is driven by firms that were more likely to evade taxes prior to ESRM use. The results highlight the potential role that information technology may play in strengthening state fiscal capacity in developing countries.

JEL Classification: H26, H32, O10, O55

Keywords: Developing economy; fiscal capacity; information technology; taxation.

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1. Introduction

Weak fiscal capacity of states has received increased attention in the political economics of development (Besley and Persson, 2010; Besley and Persson, 2011; Acemoglu, 2005). Economic development requires a state capable of mobilizing fiscal resources to finance the provision of essential public goods – a capacity that developing countries tend to lack (Bird, 1980; Tanzi and Zee, 2000). For example, in the year 2006, the average GDP share of government revenue in low-income countries was 12.1%; however, for high-income OECD countries, the figure stood at 25.2% – twice the amount we observe in low-income countries [1]. Tax enforcement is a costly activity that requires the gathering of detailed earning information on a large number of taxpayers. Thus, governments with the bare minimum of a tax administrative infrastructure, as is typical of developing countries, commonly find it difficult to monitor earnings and enforce tax compliance.

The advance in information technology (IT) offers a cheaper way to gather and analyze large amounts of data on taxpayers. This has caught the attention of tax authorities throughout developing countries in their efforts to improve fiscal capacity. In an extensive survey of such reforms, Bird and Zolt (2008) note that over the past decades, "reform efforts in tax administration in developing countries have generally centered on information technology." Nevertheless, there has been little, if any, systematic empirical evidence on the impact of those reforms. In this study, using administrative firm-level panel data on a large number of business taxpayers, we provide evidence on the impact of using the electronic sales register machines (henceforth 'ESRMs') on tax compliance in the context of a developing country. The focus of our study is a recent reform to expand the use of ESRMs in Ethiopia – a Sub-Saharan African country with one of the world's lowest per capita incomes and a minimal fiscal capacity.

Starting in 2008, the Ethiopian Revenue and Customs Authority (ERCA) required several businesses to use ESRMs. The program has been rolled out over many rounds.

[1] The figures are from World Development Indicators online data-base, accessed on June 28, 2014. The definition of high-income OECD and low-income countries follows the World Bank categorization.

The machines register sales and print out receipts. The transactions are then reported via a network to an ERCA server. Hence, once a firm starts using ESRMs, ERCA receives daily data on the firm's revenue. This provides ERCA with the ability to monitor reported revenues on a daily basis. With the traditional paper-based receipts, this would have been prohibitively expensive and virtually impossible.

Even though one can expect the massive amount of earnings data provided by ESRMs to make tax evasion harder, it is not obvious whether the machines will necessarily lead to higher tax compliance. The machines do not enforce tax rules by themselves; they merely provide information. Whether the information is utilized to improve tax compliance depends on a host of institutional factors. For example, business owners may still evade taxes by paying more bribes to corrupt tax officers, who would otherwise use the new set of earnings data to track evasions. The ESRMs do not guarantee that individuals accused of tax evasion will not manipulate their way out through the court system. Even if the earning information is present in the records, the use of that information to enforce tax compliance depends upon the legal institutions. In situations where institutions are weak, as is typically the case in developing countries, the impact of extra earnings information may be minimal. Thus, whether such a technology actually helps improve tax collection in the context of developing countries is an open empirical question.

Fortunately, ERCA has given us access to a unique and confidential administrative data set on value added tax (VAT) payments by businesses. Our data-set contains information on the amount of VAT paid by firms. The advantage of an administrative data-set is that it provides precise figures on tax payments, something difficult to obtain from ordinary surveys. VAT was introduced in 2003. Over the past years, it has been the single largest component of domestic indirect tax. It contributed nearly half of the indirect domestic tax revenues and 20% of the total domestic tax revenues. Our data-set also has information on the date each taxpayer started using ESRMs. The use of ESRMs started with a few hundred taxpayers in 2008 and gradually expanded to cover about 60 thousands firms. The fact that the program has been rolled out over several rounds provides

us with a useful opportunity to estimate the impact of ESRM use while controlling for potential biases that may arise from time-invariant firm-specific factors and changes in overall trends.

We find two major patterns in the data. First, tax payments increase substantially after the adoption of ESRMs. Secondly, this effect is driven by firms that are more likely to evade taxes in the absence of ESRM use, suggesting that ESRM use has helped minimize tax evasion.

This paper contributes to the growing literature on the fiscal capacity of the state and tax compliance in developing countries. One of the important challenges for tax authorities in developing countries is the lack of accurate information on earnings (Engel et al., 2001; Fisman and Wei, 2004; Olken and Singhal, 2011; Gordon and Li, 2009; Boadway and Sato, 2009). This motivated a number of recent studies that assess alternative policy tools to provide tax authorities with more reliable information. Generally, the studies examine the impact of third-party information to verify the accuracy of earnings reported by the taxpayer and minimize tax evasion (see, e.g., Carrillo et al., 2014; Pomeranz, 2015; Slemrod, 2008; Kumler et al., 2013; Naritomi, 2013). Even though governments in many developing countries are using the electronic tax system to enhance their ability to gather, analyze and monitor earnings information, we are not aware of any study examining the these policies – a gap that our study attempts to narrow.

Our paper is also related to the literature on the impact of IT on economic outcomes. These studies have mostly focused on the effect of IT on private sector productivity (Bresnahan et al., 2002; Stiroh, 2002; Brynjolfsson and Hitt, 2000). Despite the widespread adoption of IT in public service delivery, commonly known as 'e-governance', assessment of the impact remains relatively unexplored (Garicano and Heaton, 2010). A few recent papers have studied the impact of IT use on public service delivery in the context of developing countries. Using evidence from India, Muralidharan et al. (2014) study the impact of using biometrically-authenticated payment systems on the effective delivery of targeted social transfer payments. Lewis-Faupel et al. (2014) document the impact

of electronic procurement on infrastructure provision in India and Indonesia. Our paper contributes to this strand of literature on IT and state capacity building in developing economies.

Research on the impact of tax reforms in developing countries is severely limited due to the lack of accurate data on tax payments. Our paper contributes to the few but significant advances that have recently been made in the use of administrative tax data from developing countries to study tax reforms (see, e.g., Kleven and Waseem, 2013; Best et al., 2015).

The paper is structured as follows. In Section 2, we discuss the institutional background of taxation in Ethiopia. This will be followed by a simple theoretical framework in Section 3. We report empirical results in Section 4 and final concluding remarks will follow in Section 5.

2. Background to VAT and IT reforms in the Ethiopian tax policy

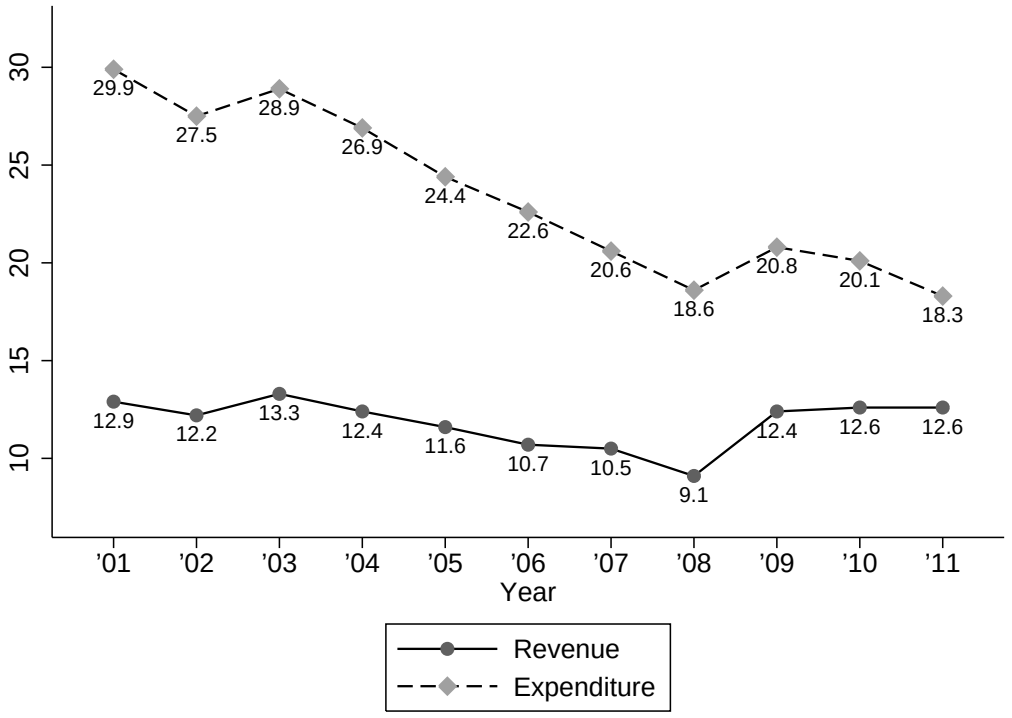
Our data-set comes from Ethiopia – a country that was ravaged by a long civil war during the Cold War era and still remains one of the poorest countries in Sub-Saharan Africa. In 2010, Ethiopia's GDP per capita was about 1,000 USD in current purchasing power parity. For comparison, this figure is only about a third of the average in Sub-Saharan Africa and less than one-thirtieth of the OECD average.[2]

Relative stability and several economic reforms followed once the civil war ended in the early 1990s. One area of reform has been taxation. The need for fiscal resources was no more apparent than in the lack of basic public infrastructure such as roads that are needed to connect the markets across the country; however, as can be seen in Figure 1, the gap between tax collection and the government's need for fiscal resources has resulted in a substantial gap between tax revenue and government expenditure. The gap seems to have steadily narrowed mostly due to the declining expenditure. The tax revenue as a

[2]Source: WDI online data bank accessed on July 13, 2014. The per capita GDP for OECD, Sub-Saharan Africa and Ethiopia, respectively, are 34,483, 3,056 and 1041.

share of GDP remained stable at a relatively low level of 12%.

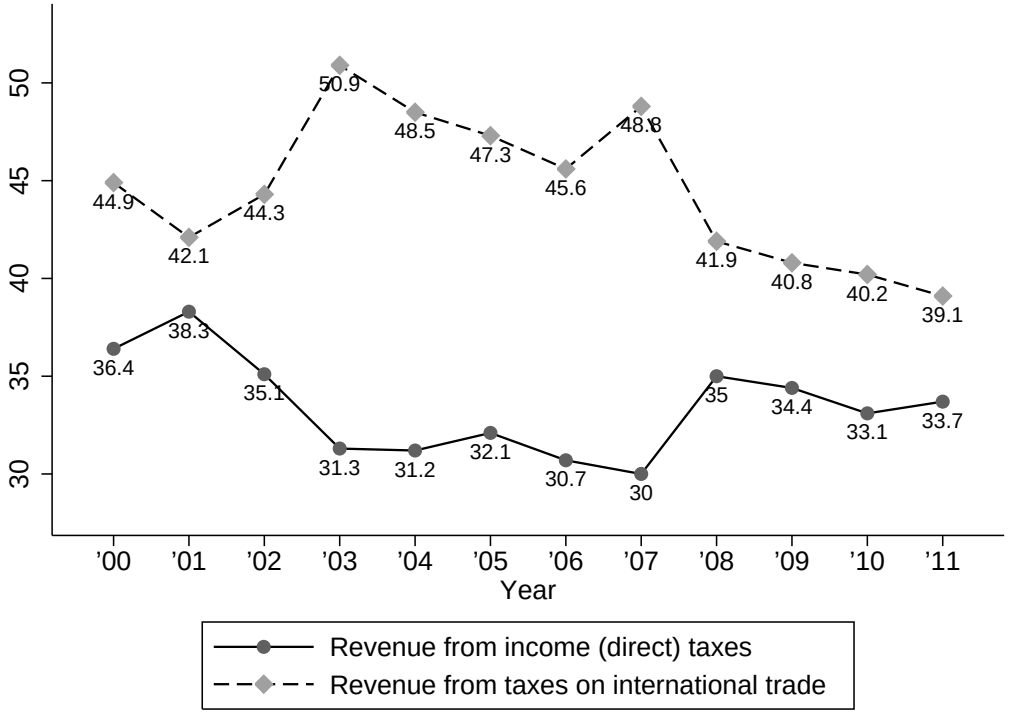
Figure 1: Government revenue and expenditure during 2001-2011 (percent of GDP). Source: Ministry of Finance and Economic Development



As is the case with many developing countries that lack a broad tax base, Ethiopia also relied heavily on taxes on international trade – a kind of tax that is relatively easy to enforce but probably more distortionary to the economy. Figure 2 plots government revenue from taxes on international trade as a percent of the total tax revenue. Over the past decade, the government raised more than 40% of its tax revenue from international trade – a very high ratio even by the standards of developing countries. About a third of the revenues come from income taxes.

It is against this background that several reforms to improve the tax system have been implemented. The reforms can be categorized into two broad types: (1) introducing new taxes to broaden the domestic tax base, and (2) improving the administrative capacity of the tax authority. One of the major reforms that aimed to broaden the domestic tax base was the introduction of VAT in 2003 – the main variable of interest in our empirical

Figure 2: Government tax revenue by source (percent of total tax revenue). Source: Ministry of Finance and Economic Development.



analysis. The VAT has become a significant source of government revenue contributing nearly one-fifth of domestic total tax revenue and half of indirect tax revenue. Since its introduction, the VAT rate has been set at 15%.

The VAT implementation has been expanded gradually and continued to include more firms. The solid line in Figure 3 plots the number of VAT-registered taxpayers during the years 2003-2013. The implementation of VAT started with about 6,000 firms in 2003 and gradually expanded, reaching about 97,000 firms by the end of 2014.[3]

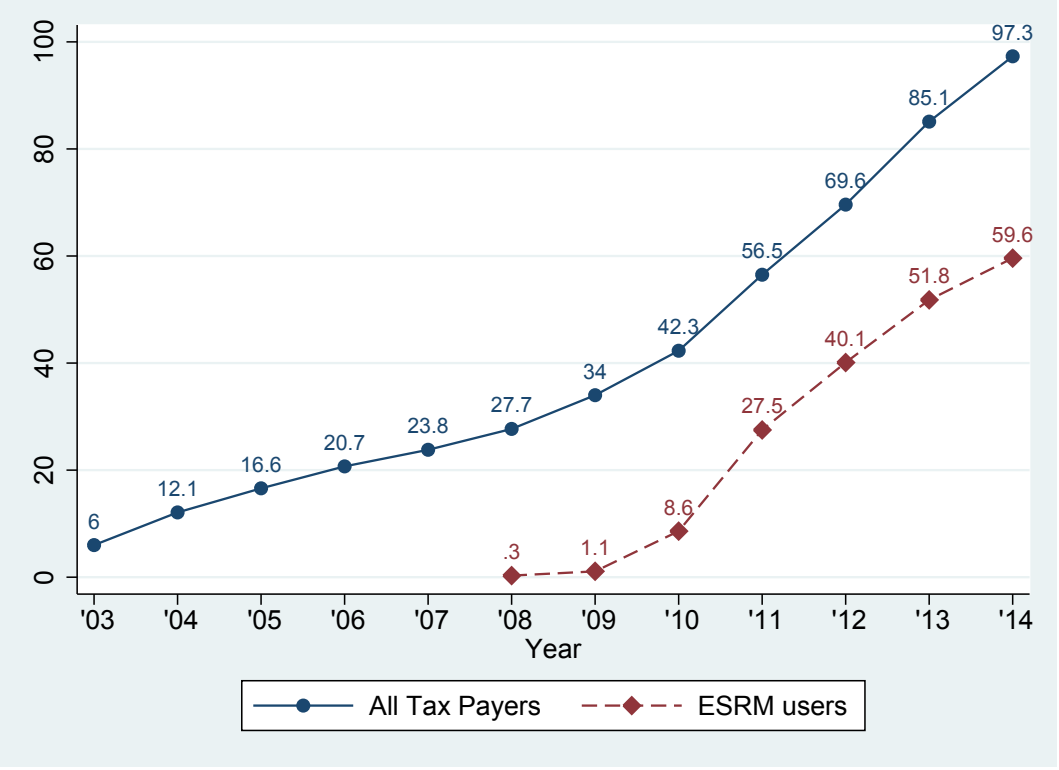
When it comes to the second reform – namely, improving the administrative capacity of the tax authority – the focus has been on greater use of IT in tax administration. The use of of ESRMs, which were introduced in 2008, has been at the center of this reform.

[3]The legislation to implement the VAT imposed relatively stricter compliance requirements. For example, VAT registered business are required to use either ESRMs or paper receipts that are supplied by ERCA. This naturally implies a higher compliance cost both for firms to adhere to the requirements and for ERCA to enforce those requirements. As a result, the law excluded smaller firms whose turnover is not deemed to be large enough to justify the compliance cost to register for VAT. For a detailed theoretical discussion on the optimal VAT threshold, see Keen and Mintz (2004).

As has been the case for the VAT registration, not every firm is required to use ESRMs mainly for two reasons. First, the machines typically cost between 5,000 to 13,000 Ethiopian Birr, a significant sum for many businesses in Ethiopia.[4] Second, the implementation requires ERCA's capacity to handle the information system and monitor compliance (i.e., that users register their transactions with the ESRMs). Constrained by both of these factors, ERCA expanded the list of businesses that are required to use ESRMs over several rounds. Once ERCA decides that a firm should use ESRM, the machines are installed at the firm's sales outlets/stores. This is done in the presence of IT technicians from ERCA who assess whether the installations satisfy the technical requirements/standards set by ERCA.

The implementation of ESRMs started with a few hundred firms in 2008 and gradually expanded. By 2014, about 50,000 taxpayers (out of over 97 thousands taxpayers) used ESRMs (see Fig. 3).

Figure 3: Number of VAT payers and ESRM users ('000).



[4] At the current official exchange rate, the amount would be about 250 to 650 USD. The figures are based on our conversation with ERCA officials.

3. ESRM and tax compliance: a theoretical discussion

3.1. Impact of ESRMs

We now briefly discuss how ESRMs may affect tax evasion in the context of low fiscal capacity, as is the case in Ethiopia. According to Ethiopian law, all VAT-registered businesses are required to issue receipts. Failure to issue receipts may lead to legal punishments – both financial and prison time. The receipts form the basis for auditing the volumes and types of transactions when business file their tax returns. Businesses are required to file their VAT return at the end of every month. In such a monitoring system, tax evasion can happen in two major ways. First, businesses may conduct sales without issuing receipts (or using counterfeit receipts). Transactions conducted without receipts can easily be excluded from the tax return due to the difficulty of tracing transactions in the absence of the receipts. Secondly, even transactions for which receipts have been issued may not be reported to the tax authority. This depends on the likelihood that the government audits tax returns and goes through the receipts to verify whether all earnings recorded in the receipts were actually reported. If the probability of such an audit is low, businesses may underreport earnings even from transactions for which receipts have already been issued. Thus, holding the severity of legal punishment constant, two factors provide important incentives for tax compliance:

(i) the likelihood of detection when business transact without issuing receipts (or transact using counterfeit receipts); and

(ii) the likelihood of detection/auditing when firms underreport earnings for which receipts have already been issued.

Increases in these likelihoods would raise the expected cost of tax evasion. Hence, all else equal, one would expect tax compliance to increase with increases in these likelihoods. According to Ethiopian law, legal punishments on tax evasion (be it through failure to issue receipts or underreporting transactions for which receipts have been issued) do

not depend on whether the firm uses ESRMs. Regardless of whether the taxpayers are using ESRMs or traditional paper receipts, they are subject to the same level of penalty should they be found guilty of tax evasion. Thus, what can vary between ESRM users and non-users are the likelihoods of detection discussed in (i) and (ii) above.

There are several reasons why these probabilities may vary between ESRM users and non-users. Remember that ESRMs are directly connected to the servers at ERCA so that they automatically report transactions when the machines issue receipts. Hence, the consistency between the amount of transactions filed in tax returns and the amount registered by ESRMs can easily be checked with an automated system almost instantaneously. This means that it is virtually impossible to underreport transactions for which receipts have been issued by ESRMs. This would not be the same for businesses that use paper-based systems where the auditing requires an enormous amount of accountant time in order to manually review all receipts. Moreover, the extra authority that audit officials would have in the paper-based system may also open more room for evasions through the bribing of audit officials.

Regarding the likelihood of detection when businesses transact without issuing receipts (or transact using counterfeit receipts), there are again plausible reasons why ESRM users may face higher risk. Typically, ERCA detects whether businesses issue valid receipts through its officers who visit stores unannounced and pose as customers. Thus, the likelihood that such an officer will show up in a store is a crucial factor. The daily feedback that ERCA receives about business transactions from ESRMs may thus help ERCA to target businesses that report suspiciously low levels of transactions. This kind of targeting would not be practical for businesses that use paper-based systems since ERCA lacks daily updates on their reported earnings. Thus, an ESRM user may face a higher risk of store visit by ERCA official when its daily reports are suspiciously low.

Another way to evade taxes is by issuing counterfeit receipts. Producing counterfeit paper receipts (in the paper-based system) appears to be relatively easy compared to manipulating the ESRMs that are quite sophisticated electronic machines with layers of

security features.

In order to capture the above intuitions formally and describe a simple testable prediction, let $y_i >$ be the value added by firm i. For simplicity, we assume y_i is exogenous. In the absence of any evasion, the amount of total VAT paid by the firm would equal τy_i, where $\tau \in (0,1)$ is the VAT rate. However, the VAT payment with evasion is given by $(1-e)\tau y_i$; thus, $e \in (0,1)$ denotes the rate of evasion. Tax evasion is a costly activity to the firm, due both to the risk of penalty and/or the amount of effort (e.g., bribes) needed to avoid penalty. Accordingly, firms would face a trade-off between the gains and costs of evasion. In order to caputure this trade-off, assume that the decision on the rate of evasion is an outcome of the following maximization problem by the firm:

$$\max_{e\in[0,1]} \left(e - \alpha_i \left(ESRM_i\right) \frac{e^2}{2} \right) \tau y_i$$

where $\alpha_i \left(ESRM_i\right) e^2/2$ captures the cost of evasion, which is assumed to be convex so as to ensure existence of an interior solution. α_i is a parameter measuring the cost of evasion, which can vary across firms. It is also a function of $ESRM_i$, which is an indicator variable for whether the firm is an ESRM user or not: $ESRM_i \in \{1 = \text{user}, 0 = \text{non-user}\}$.

Assuming an interior solution to the above maximization problem, the actual VAT payment by the firm is given by

$$VAT_i^*(ESRM_i) = \left(1 - \frac{1}{\alpha\left(ESRM_i\right)} \right) \tau y_i$$

where $1/\alpha\left(ESRM_i\right)$ is the optimal rate of evasion by the firm. The effect of ESRM use on the firm's VAT payment, denoted by β, becomes

$$\beta \equiv \log\left(\frac{VAT_i^*(1)}{VAT_i^*(0)} \right) = \log\left(\frac{\alpha(1)-1}{\alpha(1)} \right) - \log\left(\frac{\alpha(0)-1}{\alpha(0)} \right) \tag{1}$$

Thus, if ESRM use increases the cost of evasion (by making it harder to hide), as discussed above, $\alpha(1) \geq \alpha(0)$ and β would be positive. In Section 4.1, we present our empirical framework to estimate β in (1).

3.2. Ownership structure and impact of ESRMs

One can reasonably expect that the impact of ESRMs may vary across firms. For example, consider firms that face a very high cost of evasion even in the absence of ESRM use, which is captured by a larger value for $\alpha(0)$. Looking at Equation 1, the effect of ESRMs would be relatively low for such firms. This can hold for two reasons. First, if the firm has been fully complying even in the absence of ESRM use, the introduction of ESRMs is unlikely to lead to a significant change in the cost of evasion, which is assumed to be high even before ESRM use. So the difference between $\alpha(1)$ and $\alpha(0)$ is likely be relatively low. Secondly, the effect on β of a unit difference between $\alpha(1)$ and $\alpha(0)$ decreases as $\alpha(0)$ increases. The intuition behind this result is straightforward. If a firm already has a very low rate of evasion to begin with, say 0.01%, then the use of ESRMs can at most increase tax revenues by 0.01%.

It is quite challenging to empirically examine whether the effect of ESRMs depends on the cost of evasion prior to ESRM use. By its nature, tax evasion is a covert action, hence difficult to detect. And we are not in a position to identify for sure the compliance status of each firm. Nevertheless, we try to make some progress by relying on a set of priors – that we base on our reading of the institutional context in Ethiopia – about differences in the likelihood of evasion across different groups of firms.

We distinguish between two types of firms that differ in ownership structures: (i) firms that are owned personally, and (ii) those that are owned institutionally. We define a firm as institutionally owned if it is registered, under the Ethiopian law, as a limited liability entity. By limited liability, we mean that any claims against the firm do not extend to the personal properties of the business owners. Thus, for example, in the event of default by the firm, the holder of the debt can only claim assets registered under the firm. This is

not the case with personally owned firms, where business liabilities are not distinguished from personal liabilities.

One may plausibly expect that such a difference in ownership structure can affect a firm's incentive to maintain financial records that are legally verifiable. An institutionally owned firm enters into contracts as an independent financial entity. This means that the firm's creditworthiness in contractual obligations (e.g., loan or merchandise delivery contracts) would depend on the firm's ability to present a legally verifiable record of its financial state. That is, if an institutionally owned firm does not have a legally verifiable record, a creditor would be less able to put an effective claim on the firm's assets.

On the other hand, the credit worthiness of a personally owned firm cannot be distinguished from the owner's personal credit worthiness. This is the case because a creditor can file claims against personal assets of the owner in the event of default by a personally owned firm. Thus, despite the opacity of its financial records, a personally owned firm may not be constrained in contractual relationships as long as the owner's personal creditworthiness is in good shape. This would be the case, for example, if the owner has a relatively large amount of personal wealth registered outside the firm that a creditor can claim in the event of default by the firm.

Arguably, this need to maintain sound financial records by institutionally owned firms would make it more difficult for them to evade taxes since those same records can be used by the tax authority to trace their revenue. By the same token, personally owned firms can find it relatively easy to evade taxes because they can still keep a healthy creditworthiness (depending on the owner's personal creditworthiness) despite the lack of a reliable financial record of the firm's business activity.

There are also other plausible reasons why institutionally owned firms may find it harder to evade taxes. They typically tend to be large in size and owned by a larger number of owners (like share holder companies and cooperatives). Such companies tend to hire outside managers. On the other hand, personally owned firms are typically owned and run by members of the same family. Since the managers act as agents of the share-

holders, this agency relationship necessitates the availability of verifiable information to the owners regarding the performance of the managers. In the case of large shareholder companies, this information is typically available in the form of periodic earning performance reports to shareholders. Availability of such information for a large number of shareholders, usually released to the public, would make it difficult for the managers to hide the company's earnings from the tax authority. For these reasons, we expect the impact of ESRMs to be relatively larger on personally owned firms.

4. Empirical Results

4.1. Estimation framework

In order to estimate the effect of ESRM use on VAT paid by firms that we describe in Equation 1 above, we consider the following regression:

$$\log VAT_{j,t} = \beta \times ESRM_{j,t} + f(x_{j,t}) + \mu_j + \psi_t + \varepsilon_{j,t} \tag{2}$$

$VAT_{j,t}$ is the VAT paid by firm j in month t. $x_{j,t} \in \{-\bar{x}, \ldots, -2, -1, 0, 1, 2, 3 \ldots, \bar{x}\}$ denotes the number of months around the beginning of ESRM use, within a window period of $\bar{x}$ number of months before and after the beginning of ESRM use. $x_{j,t}$ is equal to zero for the first month of ESRM use; so negative/positive values denote the number of months before/after the beginning of ESRM use. $f(x_{j,t})$ is a function that varies smoothly with $x_{j,t}$. We will consider alternative functional forms for $f(.)$ along with different window periods. μ_j and ψ_t are firm and time fixed effects, respectively. $\varepsilon_{j,t}$ is the error term.

$ESRM_{j,t}$ is an indicator variable that equals one for the periods after ESRM use, and zero otherwise. Our coefficient of interest is β. It is meant to capture the shift in VAT following ESRM use.

The key assumption in the above regression framework is that, absent ESRM use, the VAT dynamics can be reasonably captured by the smooth function $f(.)$. That is, the introduction of ESRM use should not coincide with factors that may have led to a

discontinuous shift in VAT.

Broadly speaking, there are three sets of potential possibilities that may violate this assumption. We believe that none of those possibilities pose a serious challenge in our case. Lets take a closer look at each of them.

The first potential source of bias is a possible correlation between expansion of ESRM use and other macro variables that may affect firm revenue. Aggregate economic trends such as economic growth, government spending and inflation may affect both the timing of the government's action on ESRM use and the firms' revenue. For example, the government may expand the use of ESRMs when its financing needs increase, say, due to increased government expenditure. However, increase in government expenditure may as well affect firm revenues due to changes in aggregate demand, causing a spurious correlation between ESRM adoption and taxes paid by firms. The time-fixed effects included in the specification above address this kind of concern. The inclusion of time fixed effects is feasible thanks to the gradual implementation of the program through several rounds (as discussed in Section 2).

The second possible source of bias relates to potentially systematic and time-invariant differences between firms that use ESRMs and those that do not. For example, if ESRM users tend to engage in sectors that are more productive, they may report a higher level of VAT simply because of their superior productivity (as opposed to the effect of ESRM use). This potential problem is addressed in our specification due to the inclusion of firm fixed effects. Our identification relies on variations within the firm as opposed to a cross-sectional comparison between groups of firms that used the ESRM and those that did not.

A third source of bias arises if selection into ESRM use is associated with other time-varying factors that lead to a discontinuous jump in firm's revenue. In this case, the estimated β from the above regression may as well be driven by jumps in the firm's revenue (rather than increased compliance). This would be the case, for example, if ERCA decides to select firms into ESRM use following some productivity shifts in the firms'

characteristics (such as product innovation) that are not observable in the data. Even if the rate of evasion by the firm has not decreased, the total tax payment by the firm may increase (following ESRM use) simply because the firm's revenue has increased as a result of the unobserved shift.

Unfortunately, we can not directly address this concern in the econometric specification. However, following our extensive interviews with ERCA officials and reviews of documents that outline roll-out of ESRM use, we believe that such a selection pattern by ERCA is unlikely to be a significant factor to drive the empirical patters. First of all, the decision regarding which firms should start using ESRM is undertaken by ERCA, as opposed to firms voluntarily choosing to sign up for ESRMs. Moreover, ERCA's decision is legally binding since failure to follow ERCA's order to use ESRMs carries the threat of losing one's business license. Thus, whether a firm uses ESRM is largely an outcome of ERCA's decision rather than self-selection by the firms. This implies that selection into ESRM use is conditioned on the information set by ERCA (i.e., what ERCA knows about each firm). Note that if signing up for ESRM was left for upto choice by firms, selection into ESRM use would have been largely conditioned by the firms' information set. Fortunately, since the criteria used by ERCA to role out ESRM use is relatively well-documented, one can reasonably judge whether selection into ESRM use is conditioned on time-varying firm-specific factors that can lead to a discontinuous jump in the firms' revenue.

ERCA has used various criteria to roll out ESRM use, and we have been able to look at several directives that outline the criteria. The directives describe what kind of firms should start using ESRMs. In the appendix (Table A1), we report a summary of directives that were issued during July 2009 to July 2011. The table was provided to us by ERCA. Typically, factors like business sectors and location of business activities are used to determine whether a firm should start using ESRMs. For example, in one of the rounds, firms operating on the main business streets of Addis Ababa (capital city) were ordered to start using ESRMs. In another round, supermarkets, restaurants, jewelry stores and

hotels operating in Addis Ababa were ordered to install ESRMs. The use of these kind of very rough criteria may not be surprising to those familiar with tax administrations in developing countries. ERCA, as is typically the case for tax authorities in developing countries, has limited information to track revenues of each firm, which is one of the root causes of tax evasion to begin with. As a result, ERCA resorted to easily observable criteria such as location of business operation and sector. These kinds of criteria mostly reflect firm attributes that are unlikely to fluctuate over time.

A closer look at the trends in tax payments prior to ESRM use also seems to complement this assumption. The patterns do not appear to suggest that timing of selection into ESRM use is associated with systematic shifts in VAT payments prior to ESRM use. Figure 4 reveals this pattern. It presents comparisons of the average VAT for two sets of firms (in log scales). In the top panel, we compare the average VAT of firms that started using ESRMs during the first quarter of 2010 with those that started afterwards. We look at the average VAT during the 12 months preceding January 2010. In the lower two panels, we conduct the same comparison between firms that started using ESRMs *during* the first quarter of 2011/2012 and those that started *after* the first quarter of 2011/2012. In the lead up to ESRM use, a visual look at the patterns does not appear to suggest firms which started using ESRMs earlier show a systematic break in their trends compared to those that started later on.

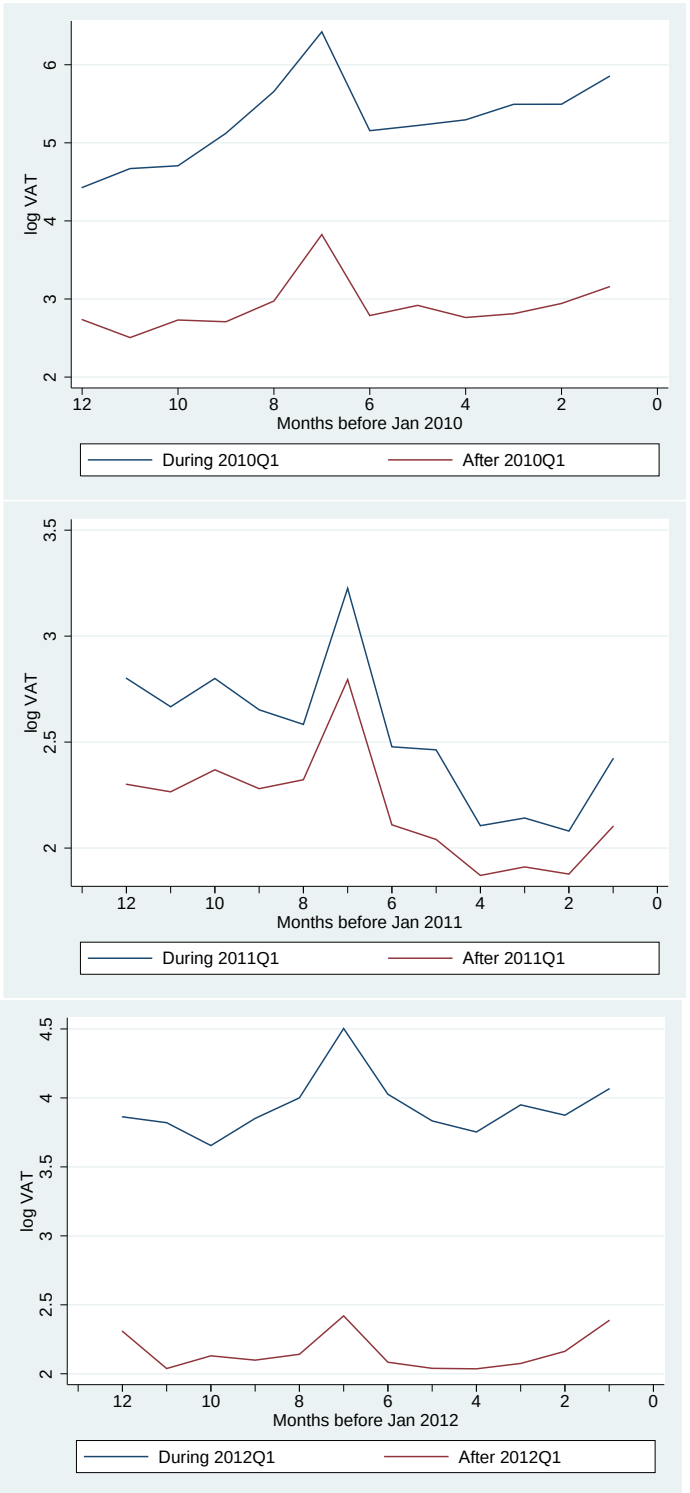
4.2. Descriptive statistics

Our data set contains the entire set of VAT-registered firms in ERCA's database, covering the period from January 2003, the year of VAT introduction in Ethiopia, to the end of 2014. As discussed in Section 4.1, our econometric approach exploits variations within the firm. Hence, we limit our analysis to those taxpayers that have paid VAT both before and after using ESRMs[5]. We also exclude a few firms that are owned by the government[6].

[5]The rest of the firms either began using ESRMs from the start (so that they have not paid VAT before using ESRMs) or have never started using ESRM.

[6]We exclude government owned firms since government owned firms are less likely to have an incentive to evade taxes.

Figure 4: Trends in VAT prior to ESRM use



Notes: This graph shows a comparison of trends in log VAT. The top panel plots the means of log VAT for two groups of taxpayers: those that started using ESRMs in the first quarter of 2010 and those that started afterwards. Similarly, the middle/bottom panel presents similar comparisons between groups of taxpayers that started using ESRM in 2011Q1/2012Q1 and those that started after 2011Q1/2012Q1.

This leaves us with a total of 32,053 firms and 497,397 observations for the econometric analysis.

Table 1 presents an overview of the moments for VAT. The descriptive statistics are reported for the whole sample as well as two sub-samples that differ in ownership structure: (i) firms that are owned personally, and (ii) those that are owned institutionally. As we discuss in Section 3.2, ownership structure may have an important implication for tax evasion and impact of ESRMs.

The average monthly VAT is about 43,000 Birr. The average VAT paid by institutionally owned firms is about 122,000 Birr, which is about nine times the amount paid by personally owned ones (14,000). This is somehow not surprising given that personally owned firms are typically family-run small businesses. Comparing the amount of VAT paid by firms before and after ESRM use, we see that there is an increase for both subsamples. For personally owned firms, the average VAT increases by about 17% (from 12,600 to 14,700 Birr). The growth in VAT payments is more or less the same for institutionally owned firms (18%).

4.3. Regression results

We begin presenting our results with a visual display of the empirical patterns. Figure 5 depicts the VAT dynamics around the beginning of ESRM use. The horizontal axis shows the number of months around ESRM use, where negative (positive) values show the number of months before (after) the beginning of ESRM use. The vertical axis shows the mean of log VAT for each of the 48 months listed on the horizontal axis. The means are computed on log of VATs that are deviations from firm- and period-specific means. Thus, the pattern in Figure 5 is after we net out variations owing to time-invariant firm-specific factors and aggregate trends. This is done by regressing log VAT on firm- and time-fixed effects, and averaging the residuals for each period around the beginning of ESRMS use.

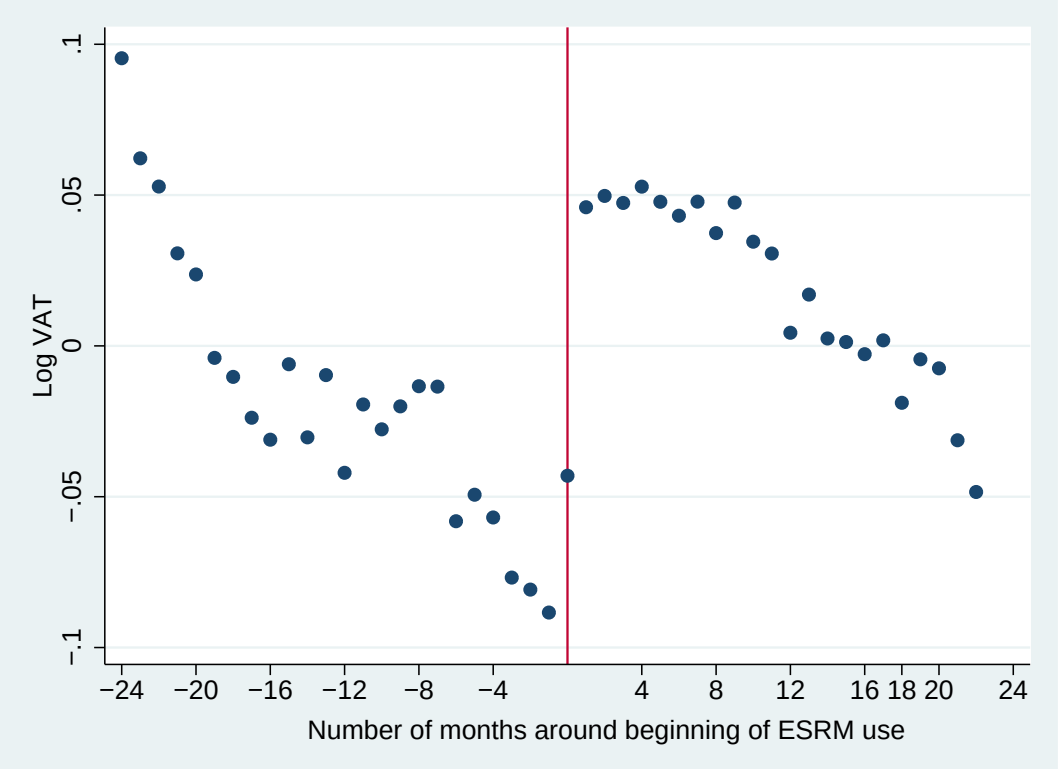
The message from Figure 5 is quite stark: there is a highly visible break in the VAT

Table 1: Descriptive statistics: monthly VAT

		Observations	Firms	Mean (thousand Birr)	Standard dev	Standard Error
Panel I: Whole sample						
	Overall	497,397	32,053	43.14	729.83	–
(1)	Pre-ESRM use	184,166	32,053	44.64	464.42	–
(2)	Post-ESRM use	313,231	32,053	42.26	847.94	–
	Difference: (2) - (1)	–	–	-2.38	–	2.14
Panel II: Personally-owned						
	Overall	362,953	25,198	14.00	78.96	–
(3)	Pre-ESRM use	124,009	25,198	12.58	63.13	–
(4)	Post-ESRM use	238,944	25,198	14.74	86.03	–
	Difference: (4) - (3)	–	–	2.16	–	0.28
Panel III: Institutionally-owned						
	Overall	134,444	6,855	121.80	1,394.74	–
(5)	Pre-ESRM use	60,157	6,855	110.73	803.50	–
(6)	Post-ESRM use	74,287	6,855	130.76	1,731.37	–
	Difference: (6) - (5)	–	–	20.03	–	7.65

The table presents descriptive statistics of VAT per month (thousand Birr). The statistics are reported for the whole sample as well as two sub-samples that differ in ownership type – personally-owned versus institutionally-owned firms. The table also presents a comparison of VAT before and after ESRM use. The standard error for the difference between the mean of VAT before and after ESRM use is reported in the last column.

Figure 5: VAT payments and ESRM use.



Notes: This graph shows the mean of log VAT for each month around the beginning of ESRM use. The means are calculated on deviation of log VAT from firm– and period– specific means.

trend following the beginning of ESRM use.

Turning to econometric estimations, the coefficient β in our regression specification essentially estimates this break by assuming that, in the absence of ESRM use, the VAT dynamics would have followed a smooth pattern captured by $f(.)$.

Table 2: Impact of ESRM use on VAT

	Functional form of f		
	(1) Quadratic	(2) Cubic	(3) Quartic
Panel (A): All firms			
Coefficient on *ESRM*	0.165***	0.128***	0.129***
	(0.007)	(0.008)	(0.008)
Number of firms	32,053	32,053	32,053
Observations	497,397	497,397	497,397
R^2	0.042	0.042	0.042
Panel (B): Individually owned firms			
Coefficient on *ESRM*	0.205***	0.164***	0.162***
	(0.009)	(0.009)	(0.010)
Number of firms	25,198	25,198	25,198
Observations	362,953	362,953	362,953
R^2	0.046	0.047	0.047
Panel (C): Institutionally owned firms			
Coefficient on *ESRM*	0.069**	0.021	0.021
	(0.016)	(0.018)	(0.018)
Number of firms	6,855	6,855	6,855
Observations	134,444	134,444	134,444
R^2	0.040	0.041	0.041

This table reports the estimated impact of ESRM use on log VAT. The coefficients are estimates of β in Equation 2. The three columns report estimates under three alternative polynomial assumptions about the functional form of f in Equation 2. The top panel reports results for all firms in the sample. The middle and bottom panels report coefficients for individually owned and institutionally owned firms, respectively. In all of the regressions, firm and time fixed effects are controlled for. Robust standard errors clustered by firm are reported in parentheses.
*** Significant at 1%.
** Significant at 5%.
* Significant at 10%.

Table 2 presents the benchmark results. Results are reported for alternative functional assumptions about $f(x_{j,t})$ in Equation 2. In column (1), we assume that $f(.)$ is a quadratic

polynomial. Coefficients in columns (2) and (3) are estimated assuming that $f(.)$ is a third- and fourth-degree polynomial, respectively. We report results from a window period of 48 months around ESRM use – 24 months before and 24 months after ESRM use. However, we also experimented with several alternative windows (e.g., 36 and 24 months), and found that the results are not particularly sensitive.

Panel (A) reports the estimated effects of ESRM use for the whole sample. In all of the columns, the coefficients are positive and statistically significant. According to these results, the impact of ESRM use ranges from 12.8 to 16.5 log points.

The two bottom panels report the results for the two sub-samples that differ in ownership structure. Panel B reports the results for individually owned firms. Coefficients for institutionally owned firms are reported in Panel C.

As discussed in Section 3.2, the effect of ESRMs is expected to be larger among individually owned businesses. This seems to be confirmed in the data. Compared to the coefficients in Panel C, the coefficients in Panel B are larger. Moreover, while the coefficients are statistically significant across all columns in Panel B, only the quadratic specification yields a significant coefficient in Panel C.

The estimations in Table 2 allow for time-fixed effects, which control for potential confounding aggregate variables. However, as we discuss in Section 4.1, the aggregate time-fixed effects do not account for differential time trends between ESRM users and non-users that may be caused by factors other than ESRM use. And if the differential time trends happen to affect patterns of selection into ESRM use, the above estimates would be biased. We argued in Section 4.1 that, given the criteria that ERCA used to roll out the program and the pre-trend patterns displayed in Figure 4, this kind of selection problem does not seem to pose a significant concern. However, to further mitigate this concern, we run the regressions allowing for differential time trends across locations and sectors.

Table 3 reports the results allowing for location-specific time-fixed effects. Our sample includes 67 administrative regions. Allowing for region-specific time-fixed effects

Table 3: Impact of ESRM use on VAT

	Functional form of f		
	(1) Quadratic	(2) Cubic	(3) Quartic
Panel (A): All firms			
Coefficient on *ESRM*	0.165***	0.128***	0.128***
	(0.008)	(0.008)	(0.008)
Number of firms	32,053	32,053	32,053
Observations	497,397	497,397	497,397
R^2	0.050	0.050	0.050
Panel (B): Individually-owned firms			
Coefficient on *ESRM*	0.208***	0.164***	0.163***
	(0.009)	(0.009)	(0.010)
Number of firms	25,198	25,198	25,198
Observations	362,953	362,953	362,953
R^2	0.057	0.058	0.058
Panel (C): Institutionally-owned firms			
Coefficient on *ESRM*	0.077**	0.024	0.024
	(0.017)	(0.019)	(0.019)
Number of firms	6,855	6,855	6,855
Observations	134,444	134,444	134,444
R^2	0.051	0.051	0.051

This table reports the estimated impact of ESRM use on log VAT. The coefficients are estimates of β in Equation 2. The three columns report estimates under three alternative polynomial assumptions about the functional form of f in Equation 2. The top panel reports results for all firms in the sample. The middle and bottom panels report coefficients for individually owned and institutionally owned firms, respectively. In all of the regressions, firm fixed effects and region-specific time fixed effects are controlled for. Robust standard errors clustered by firm are reported in parentheses.

*** Significant at 1%.

** Significant at 5%.

* Significant at 10%.

addresses the concern that ERCA may have expanded ESRM use in areas that recently experienced (or are anticipated to experience) a significant productivity shock. We see that the R-squared shows some increase, which implies existence of differences in time trends across districts. However, the coefficients remain more or less intact, indicating that the estimated effects are unlikely to be driven by the differential patterns of ESRM enrollment across geographic units.

Table 4: Impact of ESRM use on VAT

	Functional form of f		
	(1) Quadratic	(2) Cubic	(3) Quartic
Panel (A): All firms			
Coefficient on *ESRM*	0.157***	0.134***	0.136***
	(0.008)	(0.008)	(0.008)
Number of firms	32,053	32,053	32,053
Observations	497,397	497,397	497,397
R^2	0.065	0.065	0.065
Panel (B): Individually-owned firms			
Coefficient on *ESRM*	0.188***	0.170***	0.175***
	(0.009)	(0.009)	(0.010)
Number of firms	25,198	25,198	25,198
Observations	362,953	362,953	362,953
R^2	0.072	0.072	0.072
Panel (C): Institutionally-owned firms			
Coefficient on *ESRM*	0.072**	0.020	0.019
	(0.017)	(0.019)	(0.019)
Number of firms	6,855	6,855	6,855
Observations	134,444	134,444	134,444
R^2	0.081	0.081	0.081

This table reports the estimated impact of ESRM use on log VAT. The coefficients are estimates of β in Equation 2. The three columns report estimates under three alternative polynomial assumptions about the functional form of f in Equation 2. The top panel reports results for all firms in the sample. The middle and bottom panels report coefficients for individually owned and institutionally owned firms, respectively. In all of the regressions, firm-fixed effects and sector-specific time-fixed effects are controlled for. Robust standard errors clustered by firm are reported in parentheses.

*** Significant at 1%.

** Significant at 5%.

* Significant at 10%.

We also run the regressions allowing for differential time trends across sectors. Table 4 reports the results where we include sector-specific time-fixed effects. These regressions are meant to mitigate the concern that the timing of ESRM roll-out may have coincided with other sectoral shocks that may affect tax payments. Our data-set contains relatively detailed information on business types (or sectors). There are 178 types of sectors in the data[7]. Once again, the coefficients remain largely the same, suggesting that the coefficients are not driven by differential patterns of ESRM enrollment across sectors.

5. Conclusion

Limited fiscal capacity of states has received increased attention as an important constraint to economic development. Building fiscal capacity is not a costless endeavor. It requires a vast administrative infrastructure capable of gathering, analyzing and monitoring earning information on a large number of taxpayers. Thus, the use of electronic systems has attracted governments in many developing countries as a relatively cheap alternative for monitoring earnings information and improving fiscal capacity. In this study, we document the first empirical evidence on one such policy experiments using micro data from Ethiopia.

We find that tax payments by firms increase in the aftermath of the ESRM use. We also find that the effect is driven primarily by personally owned firms, which we believe are more likely to evade taxes. This result suggests that ESRM use minimized evasion among firms that are more likely to evade taxes.

By and large, the results suggest that the use of ESRM has increased tax compliance. Thus, the evidence points to a possible positive contribution of the IT revolution to fiscal capacity in developing countries. However, this conclusion comes with an important caveat. We estimated the effect on firms that are already registered as taxpayers. This list of businesses does not cover a large number of micro and small enterprises in the country

[7]Business type categories are based on ERCA's definition, and do not necessarily coincide with standard categorizations (like the sector/industry divisions by the UN).

that operate informally and not registered as taxpayers. Thus, the success of this program crucially depends on whether it can be extended to this large informal segment of the economy. Thus, future research looking at further role out of such programs to include the informal sector may provide useful insight.

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A. Appendix

Table A1: Criteria for rolling out ESRM use – summary of directives issued by ERCA

Date when directive was issued	Types of firms required to start using ESRMs by the directive
–	VAT-registered hotels, super-markets, cafeterias, pastries and beverage groceries
July 7, 2009	All large tax payers except government-owned firms, banks, insurance companies, transport companies
October 11, 2009	Jewelry stores
December 4, 2009	Category A or B hotels, super-markets, cafeterias, pastries and beverage groceries, butcheries*
February 5, 2010	Category A or B furniture stores, building materials stores, auto spare part stores, electronics and computer stores, leather suppliers and electrical appliances stores
March 30, 2010	All VAT-registered businesses operating in Addis Ababa except insurance companies, banks, transport companies and government enterprises.
December 22, 2010	All VAT-registered businesses operating in Addis Ababa
April 21, 2011	All businesses operating in major malls in Addis Ababa
July 30, 2011	All category A and B businesses operating in Addis Ababa except transport companies

Source: ERCA. This table presents a summary of directives issued by ERCA during July 2009 to July 2011. The second column presents the type of firms that are required to start using ESRMs by the directives. The table is a translation of the original document in Amharic (translated by the authors).

* Firms are categorized into A or B based on their size. Category A firms are relatively larger than B.

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Limited fiscal capacity poses a significant challenge in developing countries. To mitigate this challenge, the adoption of electronic tax systems has been at the forefront of tax reforms; however, there is little systematic empirical evidence on the impact of such reforms. We attempt to narrow this gap by documenting evidence from Ethiopia where there has been a recent surge in the use of electronic sales registry machines (ESRMs). Using administrative data covering all business taxpayers, we find that ESRM use resulted in a large and significant increase in tax payments. Moreover, this effect is driven by firms that were more likely to evade taxes prior to ESRM use. The results highlight the potential role that information technology may play in strengthening state fiscal capacity in developing countries.

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