Information technology and fiscal capacity in a developing country: evidence from Ethiopia*

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Abstract

Limited fiscal capacity poses a significant challenge in developing countries. Recently, many developing countries have implemented electronic tax systems to improve compliance. However, there is little systematic empirical evidence on the impact. We attempt to narrow this gap using a quasi-experimental evidence from Ethiopia where there has been a recent surge in the use of electronic sales registry machines (ESRM). We use administrative data covering all business taxpayers. We find that ESRM use resulted in a large and significant increase in tax payments (about 20 log points). This effect is driven by firms that are more likely to evade prior to ESRM use. The results highlight the potential role information technology may play in strengthening state capacity in developing countries.

JEL Classification: H26, H32, O10, O55

Keywords: Taxation; fiscal capacity; information technology; developing economy.

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1 Introduction

Economic development requires a state capable of mobilizing fiscal resources to finance the provision of essential public goods – a capacity that many developing countries lack (Bird, 1980; Tanzi and Zee, 2000). For example, in 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 as high for low-income countries [1]. Thus, weak fiscal capacity of the state has received increased attention in the political economics of development (Besley and Persson, 2010; Besley and Persson, 2011; Acemoglu, 2005). Tax enforcement requires gathering detailed earning information on a large number of tax payers. Governments with a bare minimum of tax administration infrastructure, as is typically the case in developing countries, find it costly to monitor earnings and enforce tax compliance.

Advances in information technology (IT) offer a cheaper possibility for gathering and analyzing a large amount of data on tax payers. This has caught the attention of tax authorities throughout the developing countries in their attempt to improve fiscal capacity. In an extensive survey of reforms on tax administration, Bird and Zolt (2008) note that, over the past decades, "reform efforts in tax administration in developing countries have generally centered on information technology (IT)". 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 tax payers, we provide evidence on the impact of using electronic sales register machines (ESRMs) on tax compliance in the context of a developing country. We study a recent reform to expand the use of ESRMs in Ethiopia – a Sub-Saharan African country with one of the lowest per capita incomes in the world and minimal fiscal capacity.

Starting in 2008, the Ethiopian Revenue and Customs Authority (ERCA) – the equivalent of the Internal Revenue Service in the US – required several businesses to use ESRMs.

[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 program has been rolled out over many rounds. The machines register sales and issue receipts (print-outs of an electronic receipt). The transactions are reported on day-to-day basis, via a network, to an ERCA server. Hence, once a firm starts using the ESRM, ERCA receives up-to-date data on the firm's daily revenue. Harsh legal punishments, both financial and long jail terms, have been enacted to discourage failure to issue the electronic receipts. The availability of such data on firms' revenue provides ERCA with the possibility of monitoring reported revenues on a daily basis. This would have been prohibitively expensive and virtually impossible with traditional paper-based receipts.

ERCA has given us access to a unique and confidential administrative dataset on tax payers. Our dataset contains information on the amount of the value added tax (VAT) paid by firms. Introduced in 2003, VAT is the single largest component of domestic indirect tax. Over the past five years, VAT contributed nearly half of the indirect domestic tax and 20 percent of the total domestic tax. Our dataset also has information on the date each tax payer started using the ESRM. The use of ESRM started with a few hundred tax payers in 2008 and gradually expanded. The dataset contains nearly 60,000 tax payers that used ESRMs. The fact that the program was 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, the average tax amount paid by the firms increases substantially after adoption of ESRMs. Secondly, this effect is driven by firms that are more likely to evade taxes prior to ESRM use – suggesting that ESRM use has increased tax compliance by businesses that are likely to evade prior to the introduction of ESRMs. Analysis of trends in the lead up to ESRM use suggests that these effects are unlikely to be explained by preexisting differences between ESRM users and non-users.

This paper contributes to the growing literature on fiscal capacity of the state and tax compliance in developing countries. One of the important challenges for tax authorities in developing countries is lack of accurate information on earnings (Engel et al., 2001;

Fisman and Wei, 2004; Olken and Singhal, 2011; Carrillo and Emran, 2010; Gordon and Li, 2009; Boadway and Sato, 2009). This motivated a number of recent studies that assess alternative policy tools to supply more reliable information to tax authorities. Generally, the studies examine the use of third-party information to verify the accuracy of earnings reported by tax-payers and to minimize tax evasion [see, e.g., Pomeranz, 2013; Carrillo et al., 2014; Slemrod, 2008; Kumler et al., 2013; Naritomi, 2013]. Even though governments in many developing countries are using electronic tax system to improve their ability to gather, analyze and monitor earnings information, we are not aware of any study that examines their impact – 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 a widespread adoption of IT in public service delivery, commonly known as e-governance, assessing the impact remains to be a relatively unexplored area (Garicano and Heaton, 2010). Our study documents evidences on IT and public service delivery in the context of a developing economy.

The paper is structured as follows. In section 2, we discus the institutional background to taxation in Ethiopia. This is followed by a simple theoretical framework in section 3 to guide our empirical analysis. After describing the data in section 4, we report the empirical results in section 5. Finally, we conclude in section 6.

2 Background to taxation in Ethiopia

Our dataset comes from Ethiopia – a country that was ravaged by a long civil war during the Cold War era, and which still remains one of the poorest countries in Sub Saharan Africa. In 2010, Ethiopia's GDP per capita was about one thousand USD in current purchasing power parity. For comparison, this figure is about only a third of the average

in Sub-Saharan Africa and less than one-third of the OECD average.[2]

A relative stability and several economic reforms followed once the civil war ended in the early 1990s. One area of reform has been taxation. The urgent need for fiscal resources is apparent in the lack of basic public infrastructure, such as the roads that are needed to connect 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 reduced mostly due to declining expenditure. Tax revenue as a share of GDP stayed stable at a relatively low level of 12 percent.

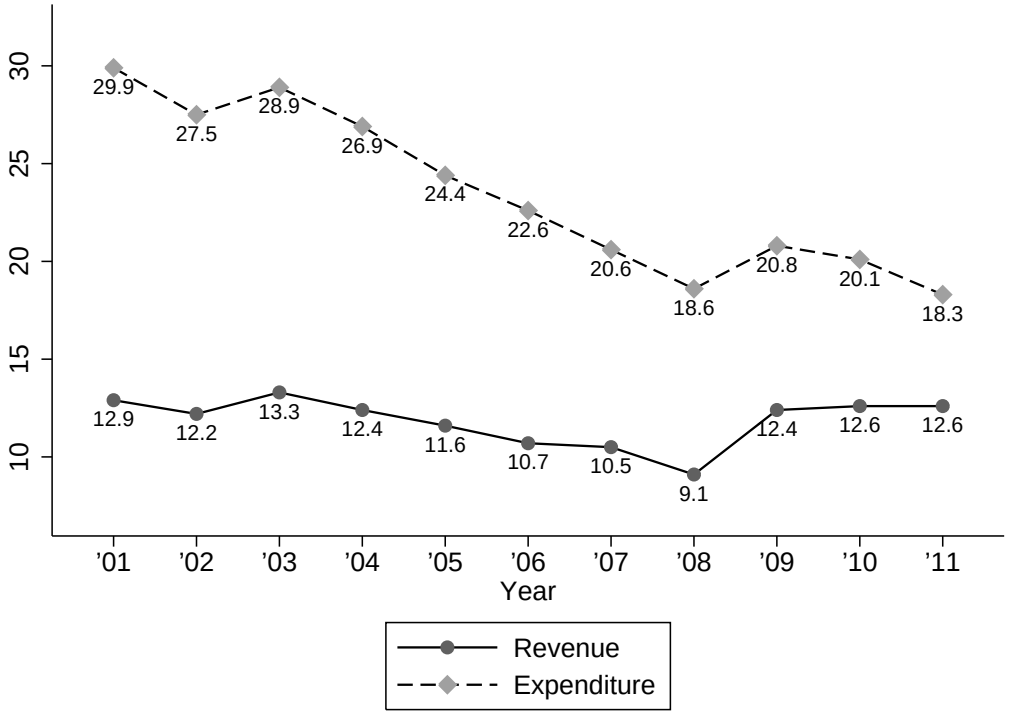


Figure 1: Government revenue and expenditure 2001-2011 (percent of GDP). Source: Ministry of Finance and Economic Development

As is the case with many developing countries that lack a broad tax base, Ethiopia 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

[2]Source: WDI online Data-Bank accessed July 13, 2014. The per capita GDP for OECD, Sub Saharan Africa and Ethiopia, respectively, is 34,483, 3,056 and 1041 US dollars.

from taxes on international trade as percent of total tax revenue. Over the past decade, the government raised more than 40 percent of its tax revenue from international trade – a very high ratio even by the standard of developing countries. About one-third of the revenues comes from income taxes.

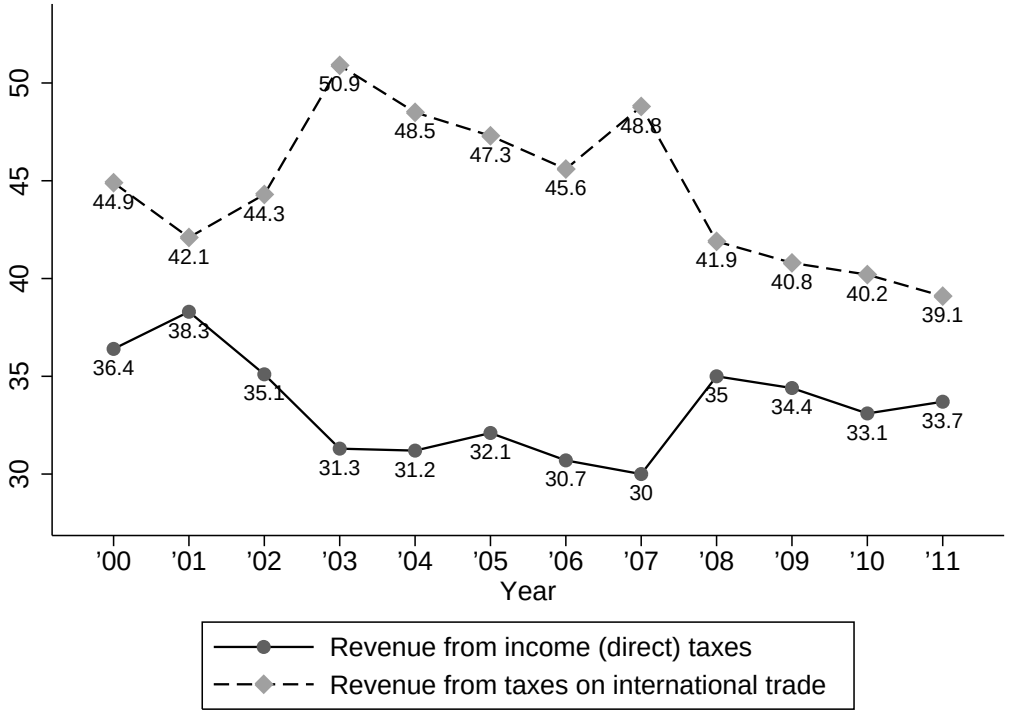


Figure 2: Government tax revenue by source (percent of total tax revenue). Source: Ministry of Finance and Economic Development.

It is against this background that several reforms to improve the tax system have been implemented. The reforms can be categorized into two broad aspects: (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 at broadening the domestic tax base was the introduction of VAT in the year 2003 – the major variable of interest in our empirical analysis. VAT has now become a significant source of government revenue contributing nearly one-fifth of domestic total tax revenue and half of indirect tax revenue over recent years. The VAT rate has been set at 15% since it was introduced.

When it comes to the second reform, namely improving the administrative capacity of

the tax authority, the government emphasized on greater use of IT in tax administration. The first significant IT investment took place in 2004, with the implementation of an integrated electronic database to manage records on taxpayers, called the Standard Integrated Government Tax Administration System (SIGTAS)[3]. The database aims to minimize the cost of maintaining, retrieving and analyzing data on taxes and tax payers. Our data are extracted from this database at ERCA.

The second significant use of IT in Ethiopia's tax system – and the focus of this study – came in 2008 with the introduction of ESRMs. The machines record sales and print out receipts. Moreover, the ESRMs are connected, through a general packet radio service, to ERCA's central database providing data on transactions on daily basis. Thus, the use ESRMs has essentially enabled ERCA to monitor reported revenues on a day-to-day basis – something that would have been prohibitively expensive and virtually impossible with traditional paper-based reporting.

3 A simple framework

In this section, we present a version of the stylized models of tax evasion, albeit structured to help us guide our empirical specification and interpret the results[4]. We are interested in analyzing the impact of implementation of ESRMs. Thus, we first describe the economic environment prior to introduction of ESRMs. We will then introduce use of ESRMs and show the effect.

[3]According to CRC Sogema (i.e., the firm that developed SIGTAS), the SIGTAS software "is designed to meet the needs of developing countries who wish to increase their control over state revenue by equipping themselves with computerized systems. Since 1996, SIGTAS has been implemented in 24 countries located in Africa, the Caribbean, the Middle East, Eastern Europe and Asia." See the site http://crcsogema.com/sigtas-en.html

[4]Boadway and Sato (2009) is one example of several models where firms can avoid taxes by shifting to an informal sector. Keen and Mintz (2004) show how firms compromise their productivity by scaling down their activity in order to avoid paying the VAT.

3.1 The environment prior to introduction of ESRMs

Consider an economy with many firms, where each firm is indexed by $j \in [0,1]$. Assume that the statutory tax rate on the total value added (final sale) is $\bar{\tau} \in [0,1]$. However, the actual tax rate paid by firm j, denoted by τ_j, depends on the level of evasion and may be lower than $\bar{\tau}$.

Tax evasion is a costly activity due to potential legal penalties. We allow for the cost to differ across firms. The difference in cost of evasion may arise because firms may face different levels of difficulty in evading taxes. As we will discuss later, one source of such a difference in the Ethiopian context, could be ownership structure. For example, publicly traded share companies (i.e. firms owned by a large number of shareholders) may need to maintain proper accounting records that are available to the public in order to ensure the accountability of management to the share holders. Thus, the need to produce publicly verifiable accounting records can make it harder for the management to hide the firm's earnings from the tax authority. On the other hand, family-run business do not face the same agency problem (since the owners are also the managers) and may not feel a similar level of pressure to produce accounting reports that can be verified by the public. As a result, family-run businesses, compared to share companies, may find it relatively easier to hide their earnings from the tax authority. For simplicity, assume that there are two types of firms: (i) those who have a lower cost of evasion and hence evade, and (ii) those who have a prohibitively high cost of evasion and hence do not evade. The former ones face an effective tax rate of τ^e that is less than the statutory rate $\bar{\tau}$ while the latter ones pay the statutory rate. The difference $\bar{\tau} - \tau^e$ is the level of evasion by those who can afford to evade.

Consider a simple production technology where output (or total value added) is given by

$$Y_j = L_j^{\alpha}, \qquad \alpha \in (0,1)$$

where L_j is a quantity of input (such as labor) hired by firm j at an exogenously given cost of w per unit, which we normalize to one. With out loss of generality, we are assuming that all firms have the same level of productivity. The firm chooses the quantity of input L to maximize its after-tax profit

$$\pi_j(L_j) = (1-\tau_j)L_j^{\alpha} - L_j$$

where $\tau_j \in \{\tau^e, \bar{\tau}\}$ is the actual tax rate faced by the firm (depending on the firm's ability to evade)[5]. The profit maximizing level of employment, which is given by

$$L_j^* = \left((1-\tau_j)\alpha\right)^{\frac{1}{1-\alpha}}, \tag{1}$$

would be decreasing in the tax rate. The total tax payment by the firm becomes

$$Tax_j = \tau_j Y_j = \tau_j \left((1-\tau_j)\alpha\right)^{\frac{\alpha}{1-\alpha}}, \tag{2}$$

3.2 Impact of ESRMs

If ESRMs minimize tax evasion, we expect the following two patterns in the data.

1. Firms with a high cost of evasion would not be affected by ESRM introduction and their tax payment (in Equation 2) does not change. This holds because ESRM introduction does not affect the effective tax rate by those firms (as they had been fully complying even before the ESRM use).

2. Tax payments by firms that have a lower cost of evasion will change following ESRM use since their effective tax rate increases. This change is given by

[5]Alternatively, we could consider a firm with downward sloping demand curve where the increase in taxes can possibly be transfered to consumer prices or, with evasion, pocketed as profits by the firm (see, for example, Boadway and Sato (2009) for such a framework). This would not change the conclusion. Notice also that we are treating VAT as a tax on the final sale. Thus, we are abstracting from the cascading nature of VAT where firms that paid VAT for their input supplies can claim deductions (see, for example, Keen and Mintz (2004) and Boadway and Sato (2009)). Even though this cascading nature of VAT may be important in principle, it does not seem to be significantly relevant for the Ethiopian case since very few firms did actually claim VAT deductions.

$$\frac{Tax_{post}}{Tax_{pre}} = \frac{\tau_{post}}{\tau_{pre}} \left(\frac{1-\tau_{post}}{1-\tau_{pre}} \right)^{\frac{\alpha}{1-\alpha}}, \tag{3}$$

where Tax_{pre} and Tax_{post} are the total tax payments before and after ESRM use, respectively. Likewise, τ_{pre} and τ_{post}, respectively, denote the effective tax rates before and after ESRM use.

The difference $\tau_{post} - \tau_{pre}$ is the change in the effective tax rate as a result of the ESRM use. This change has two effects. According to the first term in the right-hand side of Equation 3, an increase in the effective tax rate increases tax revenue. However, as captured by the second term, this effect may be attenuated due to the endogenous reaction by the firm to lower output as a result of the increased tax rate. Thus, assuming that the official tax rate lies below the maximum point in the Laffer curve, ESRM use will increase tax payments as long as it minimizes evasion, that is, as long as $\tau_{post} > \tau_{pre}$.

A direct measure of the impact of ESRM use on tax enforcement would be the change in effective tax rate, $\tau_{post} - \tau_{pre}$. However, in the data, we only observe the tax payments Tax_{pre} and Tax_{post}. Hence, we are only be able to estimate the percent change in the tax payment (i.e. $\log(Tax_{pre}/\ Tax_{post})$) rather than the change in the effective tax rate. Given that such an estimate does not account for a possible reduction in output by the firm following increased enforcement (as captured by the second term in Equation 3), the estimate is likely to be lower than the change in the effective tax rate and should be interpreted as a lower bound of the change in the effective tax rate.

4 Data description

Our dataset contains the entire set of firms in ERCA's database. The first key variable in our analysis is the amount of VAT paid by firms. We have monthly unbalanced panel observations on nearly all of the tax payers – consisting of about 85,000 firms. Our data

cover the period from January 2003 – when VAT was introduced in Ethiopia – to July 2014.

Figure 3 plots the total amount of VAT collected by the government during the ten years since introduction of VAT in 2003. The graph presents total VAT both in current and 2003 prices[6]. In nominal terms, the total amount of VAT increased by about 10 folds – from 1.2 billion Birr in 2003 to 13.5 in 2013. A large part of this increase is an effect of inflation. After adjustment for inflation, the total VAT revenue increased by 2.5 folds.

Figure 4 plots the share of VAT in total domestic tax revenue. Already in the first year of its introduction, VAT constituted a significant share, contributing about 23 percent of tax revenues in 2003. The share reached a pick of 33 percent. The VAT share has fallen since then and stood at 20 percent in 2011.

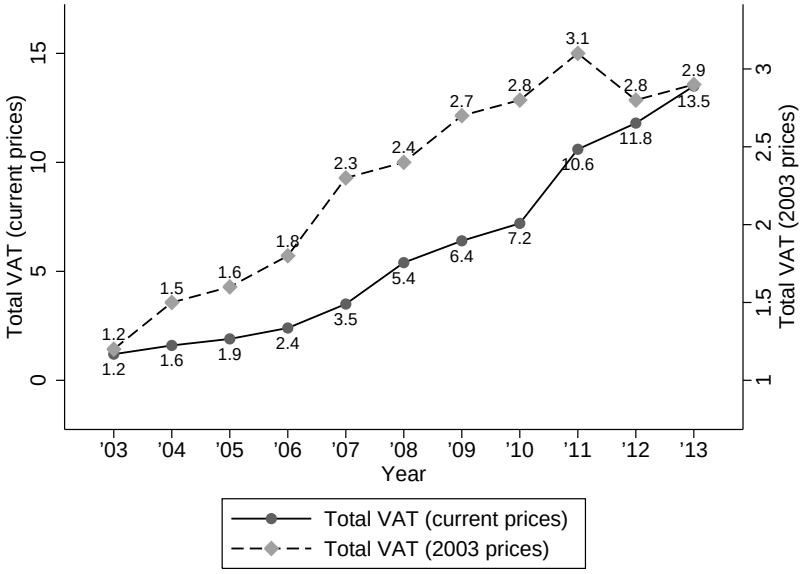


Figure 3: Total VAT revenue (Birr billion).

The legislation to implement the VAT imposed relatively stricter compliance requirements. For example, those registered for VAT are required either to issue receipts that are provided only by ERCA or they must use ESRMs. This naturally implies a higher compliance cost both for firms to adhere to the requirements and for ERCA to enforce

[6]The consumer price index used to compute VAT revenue in 2003 prices

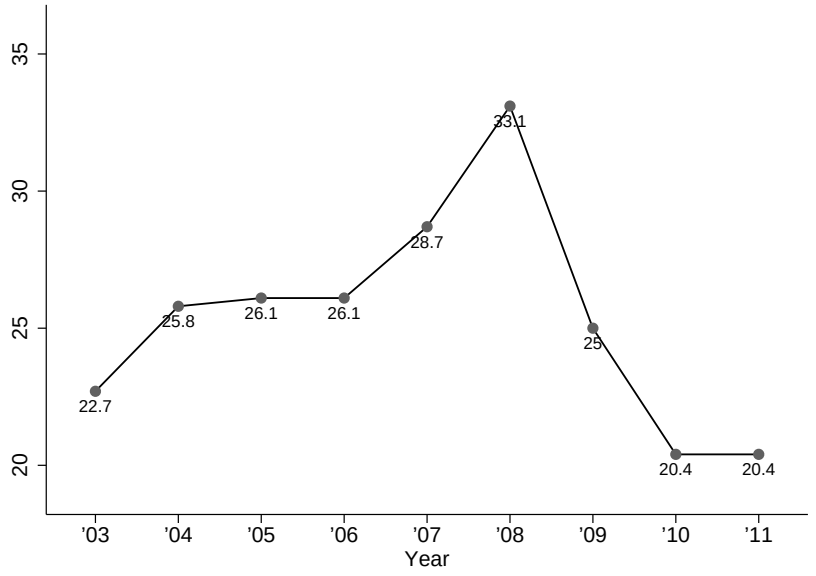


Figure 4: VAT (percent of total domestic tax revenue).

those requirements. As a result, the law excluded smaller firms whose turnover is not deemed large enough to justify the compliance cost to register for VAT[7]. The law requires all firms whose annual turnover exceeds 500,000 Birr to register for VAT. However, in practice, identifying the actual amount of a firm's annual turnover is difficult due to the potential underreporting by firms. ERCA is legally mandated to judge whether a firm's annual turnover exceeds the threshold. Constrained by limited information about firms' actual turnover, ERCA typically resorted to other ad hoc criteria such as sectors and business locations to proxy for firm size. For example, stores operating in major business streets, hotels and jewelry stores are required to register for VAT.

VAT implementation has been expanded gradually and continued to include more firms over recent years. The solid line in Figure 5 plots the number of VAT registered tax payers from 2003 to 2013. Implementation of VAT started with about 2500 firms in 2003 and gradually expanded, reaching about 51 thousands firms in 2013. Initially, ERCA targeted relatively large tax payers to register for VAT. As can be seen from Figure 7, the average VAT per firm decreases over time following expansion of implementation to include relatively smaller firms. In fact, initially, nearly half of the VAT revenue was

[7]For a detailed theoretical discussion on the optimal VAT threshold, see Keen and Mintz (2004)

generated by a few large state-owned enterprises (see Figure 6). As implementation expanded, private firms ended up contributing about 75 percent of VAT revenue.

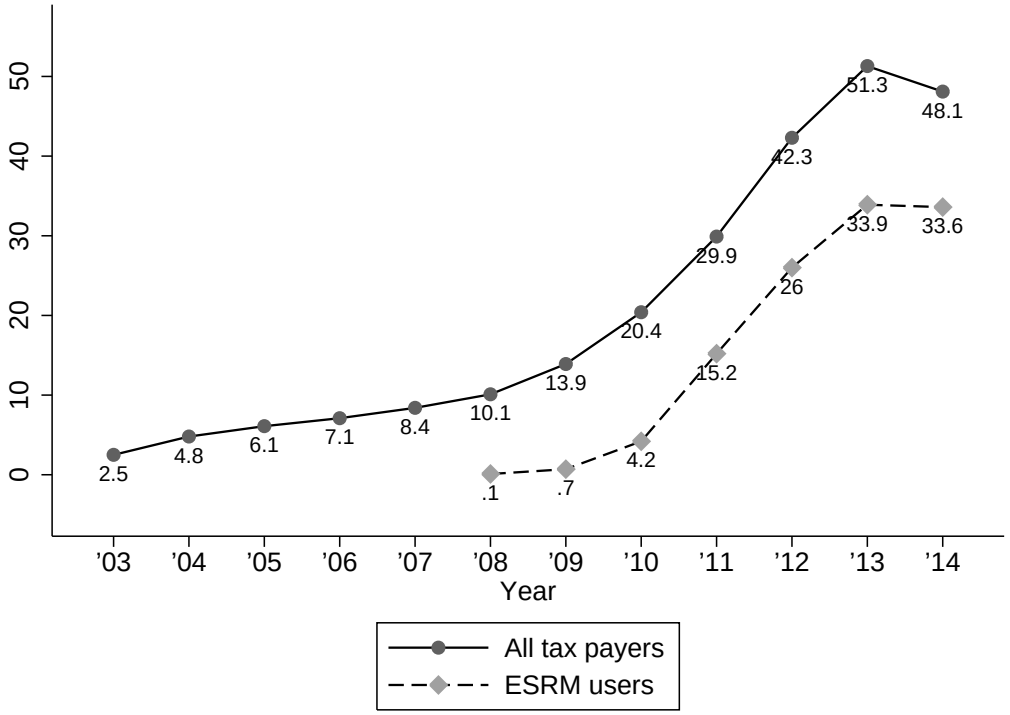


Figure 5: Number of tax payers and ESRM users (thousand).

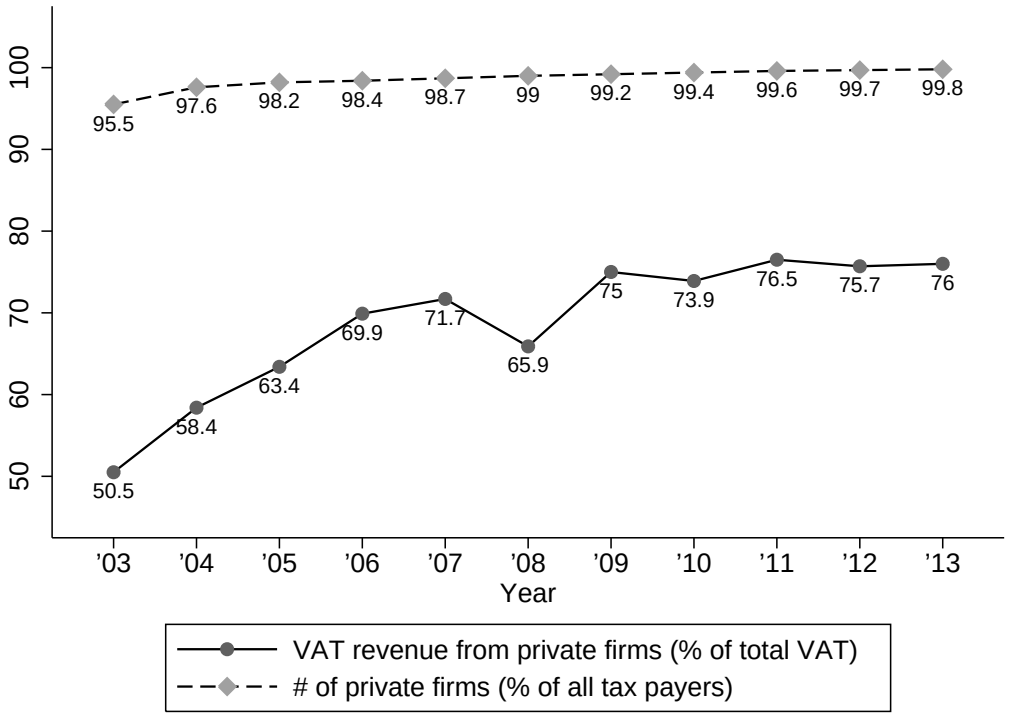


Figure 6: VAT revenue from government versus non-government firms.

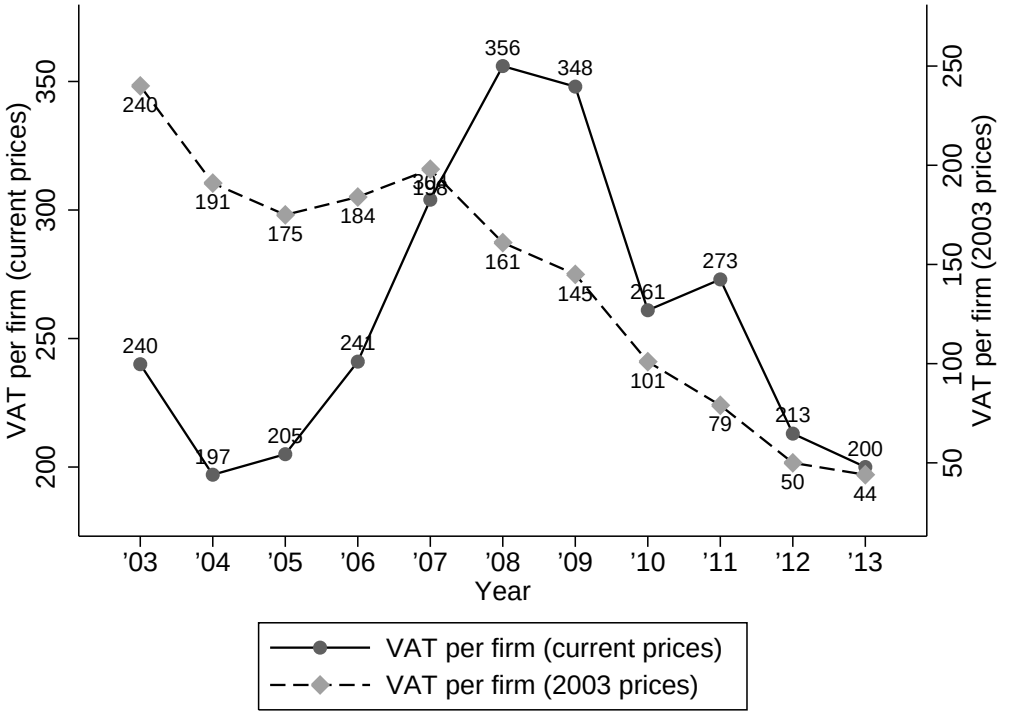


Figure 7: Average monthly VAT revenue per firm (Birr thousand).

The second main variable in our analysis is on ESRM use. ERCA decides which firms should use ESRM. As was the case with VAT registration, not every firm was required to use ESRMs. First, the machines typically cost between 5,000 Birr to 13,000 Birr – a significant sum for many business in Ethiopia.[8] Second, the implementation requires ERCA to have the capacity to handle the information system and monitor compliance (that users register their transactions with ESRMs). Constrained by both 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 ESRMs, the machines are installed at the firm's sales outlets/stores. This is done in the presence of IT technicians from ERCA, who approve whether the installed machine satisfy the technical requirements/standards set by ERCA.

We have data on whether each firm has started using ESRMs, and if so, the date on which the machines went operational. The implementation of ESRMs started with a few hundred firms in 2008 and gradually expanded. In 2013, about 34 thousands tax payers (of the total 51.3 thousands tax payers) used ESRMs (see Figure 5). The introduction of ESRMs was also complemented with measures to improve ERCA's human resources in IT and its capacity to monitor the compliance of tax payers to register their transactions with the machines. In addition, new laws were introduced to provide for harsher punishments for failing to register transactions with ESRMs.

As with VAT registration, ERCA initially targeted relatively large tax payers for ESRM use and gradually expanded implementation to smaller firms. This is also evident when we look at the declining trend in the average VAT per firm among ESRM users (see Figure 8). Notice that the mean VAT is larger for ESRM users than for non-users. We also see that the gap in the average amount of VAT between ESRM users and non-users declines, possibly as a result of more and more relatively smaller firms starting to use ESRMs.

[8]The figures are based on conversations with ERCA officials.

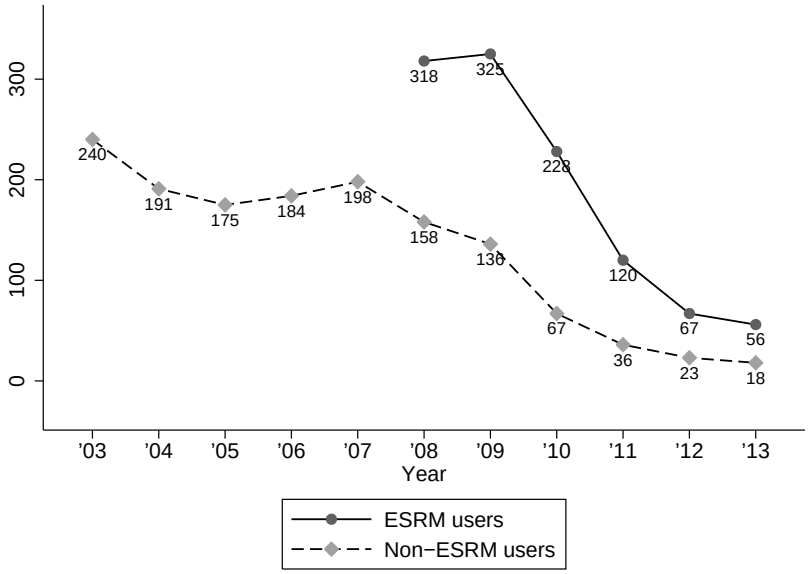


Figure 8: VAT per firm: ESRM users versus non-users (in 2003 prices, Birr thousand).

Table 1: Descriptive statistics: monthly VAT (Birr thousand)

	Observations	Firms	Mean	Standard dev	Standard Error
Sample I: Whole sample					
Overall	738,604	33,158	57.9	705.0	–
(1) Pre-ESRM use	317,190	33,158	50.7	483.9	–
(2) Post-ESRM use	447,135	33,158	63.3	833.5	–
Difference: (2) - (1)	–	–	12.6	–	1.7
Sample II: Personally-owned					
Overall	464,814	25,426	17.8	81.5	–
(3) Pre-ESRM use	176,271	25,426	13.8	61.8	–
(4) Post-ESRM use	288,543	25,426	19.0	91.4	–
Difference: (4) - (3)	–	–	5.1	–	0.2
Sample III: Institutionally-owned					
Overall	273,790	7,732	127.3	1,150.7	–
(5) Pre-ESRM use	140,919	7,732	96.8	720.0	–
(6) Post-ESRM use	132,871	7,732	159.6	1,473.7	–
Difference: (6) - (5)	–	–	62.7	–	4.4

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

Table 1 presents an overview of the moments for VAT. A total of 82,579 firms (i.e. including those that exited during the sample period) paid VAT during the sample period. Of these, 58,076 firms (i.e. 70 percent) have used ESRMs. Of those 58,076 ESRM users, about 58 percent (i.e. 33,243 firms) paid VAT both before and after starting to use ESRMs. The rest of the firms either began using ESRM from the beginning (so that they did not pay VAT before using ESRMs) or they began using ESRMs relatively late that they have not yet paid VAT since using ESRMs. As we will discuss latter, our econometric approach involves comparison of taxes before and after the ESRM use. Hence, we limit our analysis to those tax payers that have paid VAT both before and after using ESRM. We also exclude a few firms that are owned by the government[9]. This leaves us with 33,158 firms and 738,604 observations for the econometric analysis.

Descriptive statistics are reported for the whole sample, as well as two subsamples that differ in ownership structure. As we will discuss in more detail later, ownership structure may have an important implication for tax evasion and impact of ESRMs. We make a distinction between two types of ownership structures: (i) firms that are owned personally, and (ii) those that are owned institutionally. The main difference between these two sets of firms relates to personal and business liability. Institutionally-owned firms are limited liability entities in the sense that claims against those businesses do not extend to the personal property of the business owners. This is not the case with personally owned firms where business liabilities are not distinguished from personal liabilities. That is, in personally-owned firms, claims against the firm extend to the personal assets of the business owner.

The average monthly VAT stands at 57.9 thousands Birr. The average VAT paid by institutionally owned firms is more than twice as large as the one paid by personally owned firms. This is to be expected 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 sub-samples. For personally owned firms,

[9]We exclude government owned firms since we are interested to examine the effect of ESRM use on tax compliance and the government owned firm are less likely to have the incentive to evade taxes.

the average VAT increases by about 38 percent (from 13.8 to 19.0 thousands Birr). The increase in percentage terms is larger for institutionally owned firms – standing at 65 percent (i.e. from 96.8 thousands to 159.6 thousands). This pattern in the data may present the first hint that the use of ESRMs has indeed increased tax payments. However, the simple mean comparison does not take care of several relevant concerns. For example, overall policy changes may confound the introduction of ESRM use. The post-ESRM observations are relatively recent ones, and at least part of the change is likely to come from time trends from confounding facts (such as inflation and firm growth). We will take upon these concerns more carefully with the econometric analysis in the next section.

5 Empirical results

In this section, we look at the empirical evidences on the impact of ESRM use on tax payments. We start with discussion of the econometric approach. We will then present our benchmark results. This will be followed by presentation of the effect for two sub-groups. As outlined in the theoretical discussion, if ESRM use indeed minimizes tax evasion, its effect on taxes should mainly affect firms that were likely to evade prior to ESRM introduction, that is, firms that have a high cost of evasion. We conclude this section with robustness checks of the main results.

5.1 Regression specification

We consider the following regression

$$\log Tax_{j,t} = \sum_{z \in Z} \beta_z I_{j,t,z} + \mu_j + \psi_t + \varepsilon_{j,t} \tag{4}$$

$Tax_{j,t}$ is the tax paid by firm j in time t. $z \in Z = \{\underline{z}, \underline{z}+1, \ldots, -2, -1, 1, 2, \ldots, \bar{z}-1, \bar{z}\}$ denotes the number of periods around the beginning of ESRM use. For periods preceding/following ESRM use, z is negative/positive. $I_{j,t,z}$ is an indicator variable that equals

one if the number of periods around ESRM use for firm j in time t equals z; otherwise, $I_{j,t,z}$ equals zero. μ_j and ψ_t are firm and time/month fixed effects, respectively. $\varepsilon_{j,t}$ is the error term.

Our coefficients of interest are the β_z's. Notice that β_z can be interpreted as the mean of log VAT during quarter z after firm and time effects are partialled out. Thus, the coefficients capture the dynamics in the amount of tax paid by the firm around the period of ESRM use. If ESRM use minimizes tax evasion, we expect higher values of β_z's for $z >= 1$ (i.e. in the aftermath of ESRM use).

A number of remarks are noteworthy about the above regression specification. Inclusion of the firm fixed effect implies that our identification strategy relies on variations within the firm. In doing so, we avoid a potentially significant source of bias that may arise from relying on cross-sectional comparison of groups of firms that used ESRMs with those that did not. Such a bias can occur if firms that are required to use ESRMs are systematically different from those that are not – a realistic scenario given that ERCA does not randomly select firms to use ESRMs.

Our specification, through the inclusion of time fixed effects, is also well-suited to control for several potential sources of bias associated with the passage of time. For example, aggregate economic trends such as economic growth, government spending and inflation may affect both the timing of government's action on ESRM use and the firms' revenue. This could cause a spurious correlation between ESRM adoption and taxes paid by firms. The inclusion of time fixed effects is feasible thanks to the gradual implementation of the program through several rounds (as discussed in Section 4).

Even though the above specification addresses potential biases that may arise from time-invariant firm factors and aggregate fluctuations, it may not completely address all possible sources of bias. For example, if selection into ESRM use is associated other time varying factors that also increase a firm's revenue/sales, the observed increase in tax payments after ESRM use may well be driven by the increase in the firm's revenue (rather than increased compliance). As an illustration, consider a scenario where ERCA's

decision to select a firm into ESRM use coincides with faster revenue growth for the firm. 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.

Unfortunately, we can not directly address this concern in the econometric specification. However, we believe that the observed changes are unlikely to come from such a selection effect due to two reasons. First of all, the criteria used by ERCA to role out ESRM use focused on firm characteristics that are unlikely to fluctuate over time. We have looked at several directives that ERCA issued over recent years to instruct firms to use ESRMs. The directives describe what kind of firms should start using ESRMs. 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 in main business streets were asked to start using ESRMs. In another round, large supermarkets, restaurants, jewelry stores and hotels operating in Addis Ababa (the capital city) were instructed to install ESRMs. This is not surprising. ERCA, as is typically the case for a tax authority in developing countries, has limited information to track the revenues of each firm – a root sources of tax evasion. As a result, ERCA resorted to criteria such as location of business operation and sectors, a kind of firm-specific criteria that are unlikely to fluctuate over time. Thus, effects from such selection criteria are expected to be captured by the firm-specific fixed effects and are unlikely to bias our estimation.

Secondly, we also take a closer look at the trends in tax payments prior to ESRM use. Once we control for firm-specific fixed effects, we do not find any systematic pattern in the data that suggests that changes in tax payments after ESRM use are associated with differences that existed between firms prior to ESRM use. Figure 9 shows this pattern. It presents comparisons of the average VAT for two sets of firms. The averages are computed for deviations from firm-specific means. In the top panel, we compare the average VAT between firms that started using ESRMs during the first quarter of 2010 with ones that did not. We look at the average VAT during the twenty-four months preceding January 2010. In the lower two panels, we do the same comparison but between firms that started

using ESRMs in the first quarter of 2011 and 2012 and those that did not. We see that in the lead up to ESRM use, the firms that started using ESRMs do not appear to show a systematically different trend compared to those that did not start. Of course, the absence of systematic association between timing of ESRM use and the trends prior to ESRM use does not guarantee that any change after ESRM use is caused by ESRMs. However, it suggests that the effects are unlikely to be caused by preexisting differences between ESRM users and non-users.

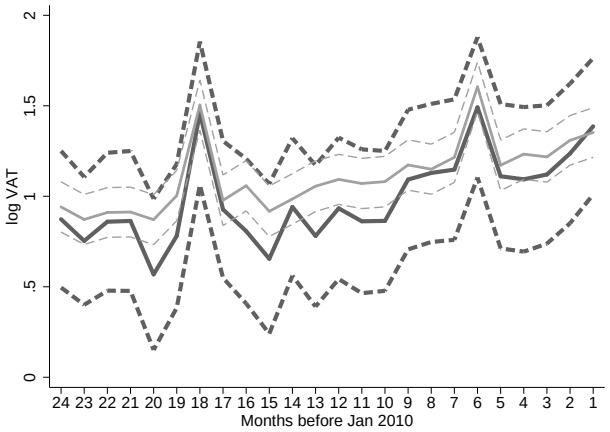
5.2 Benchmark result

We estimate Equation 4 using the fixed-effects regression. Figure 10 reports the benchmark result for the whole sample, consisting of 33,158 firms and 738,604 observations. The graph plots the estimated β's along with the 95 percent confidence interval. In all of our estimations, we cluster the standard errors by each firm. In the main text, we present all of our results using graphs (instead of tables) for the sake of brevity. However, for more accurate figures on the coefficient values and standard errors, we also report the table in the Appendix. On the horizontal axis of Figure 10, we have the number of quarters around ESRM.[10] Negative/positive values indicate the number of quarters preceding/following ESRM use. The coefficient value for the quarter right before ESRM use, i.e. β_{-1}, is set to zero (i.e. dropped from the regression) so that the estimates for mean of log VAT are expressed relative to the mean of log VAT in the period right before ESRM use[11]. Notice that there is no significant trend prior to the introduction of ESRM use, which implies that potential systematic trends in VAT prior to introduction of ESRMs

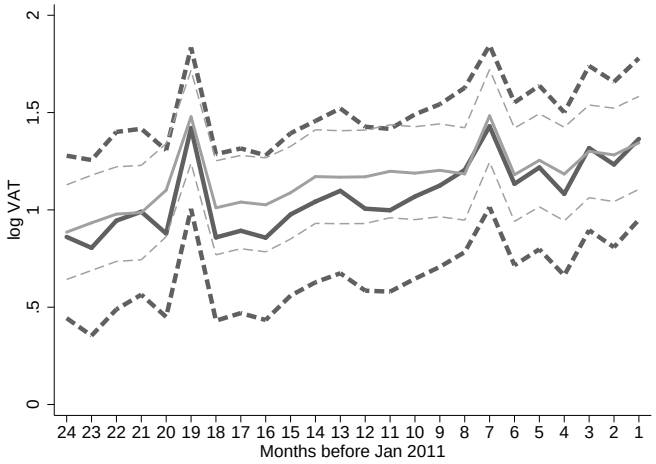
[10]The quarterly interval is chosen as an intermediate option in the trade-off between minimizing noise from using a lower frequency (e.g. a year) and capturing the dynamics by using a higher frequency (e.g. a month). However, our results are still valid although, not surprisingly, more noisy when we estimate the dynamics from month to month.

[11]We report the coefficients for eight quarters (two years) around ESRM use. However, in our estimation, we include the period indicator dummies, I_z's, for as long as possible both before and after ESRM use. We limit the report to the two-years window because a relatively smaller number of firms (less than a quarter of the firms in the whole sample) are observed for periods beyond the two-years window. Thus, we are less confident to relate the coefficients for wider windows with ESRM use (as opposed to changes in the sample composition).

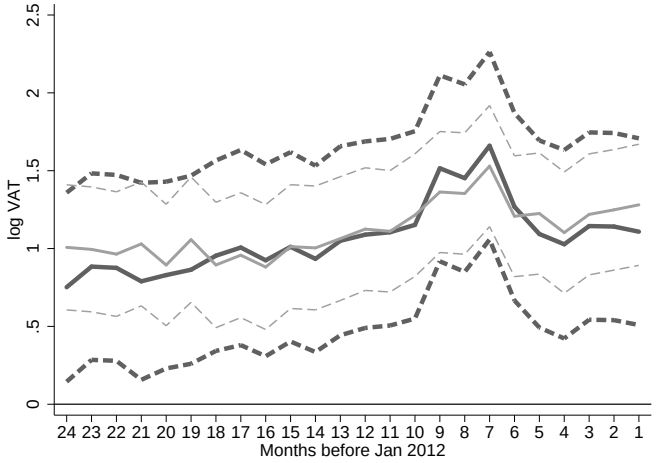
Figure 9: Trends prior to ESRM use: mean log VAT and 95% CI.



(a) Firms that started using ESRM during the first quarter of 2010 (thick line) versus firms that did not (thin line)



(b) Firms that started using ESRM during the first quarter of 2011 (thick line) versus firms that did not (thin line)

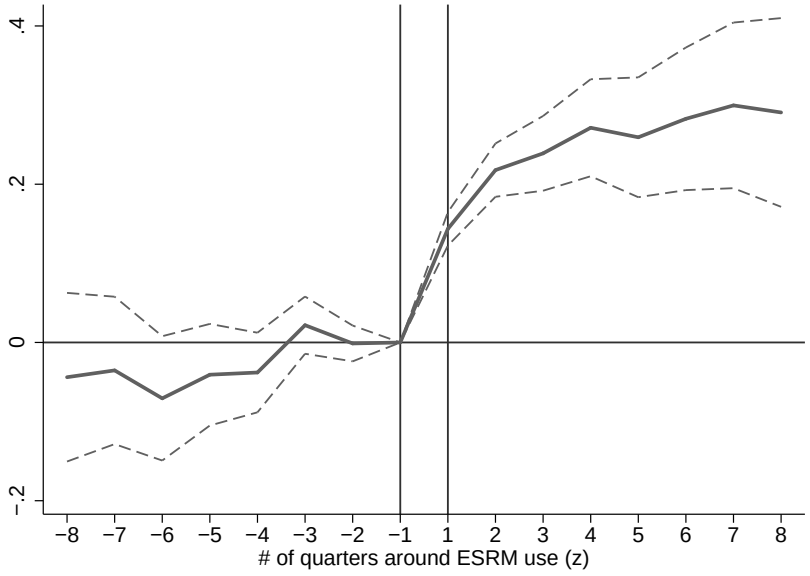


(c) Firms that started using ESRM during the first quarter of 2012 (thick line) versus firms that did not (thin line)

are essentially captured by the firm and time fixed effects.

We see that there is a large and statistically significant increase in the VAT right after introduction of the ESRM. Already in the first quarter after ESRM use, the VAT increases by 14 log points compared to the level right before introduction of the ESRM (which is normalized to zero). The increase picks around the sixth quarter after ESRM use, with increase of about 30 log points. The effect also seems to flatten in latter periods (with some sign of reversal).

Figure 10: Impact of ESRM use on Log VAT (estimated β_z's and 95% CI).



5.3 Heterogeneous effects

We now turn to the second hypothesis in the theoretical framework – that the firms that have a higher cost of evasion, and had not been evading even prior to ESRM use should not be affected by its introduction. To examine the empirical validity of this prediction, one needs to distinguish firms that had been complying before ESRM use from those that had not. However, by its nature, tax evasion is a covert action, hence a difficult one to detect. And we are not in a position to identify for certain 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 make a distinction between two types of ownership structures: (i) firms that are owned personally, and (ii) those that are owned institutionally. We define a firm as institutionally owned one if it is registered, under Ethiopian law, as a limited liability entity. By limited liability, we mean that any claims against the firm do not extend to personal property 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 (such as loan or merchandise delivery contracts) is likely to 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 is likely to be linked to 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, a personally owned firm can maintain a relatively higher creditworthiness despite the opacity of its records of the firm's financial state because the business records may not necessarily tarnish the owner's personal creditworthiness. This would be the case, for example, if an 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 dependence of the creditworthiness of an institutionally owned firm on a legally verifiable financial record is more likely to make it harder for the firm to evade taxes since the same records can be used by the tax authority to trace the firm's revenue. By the same

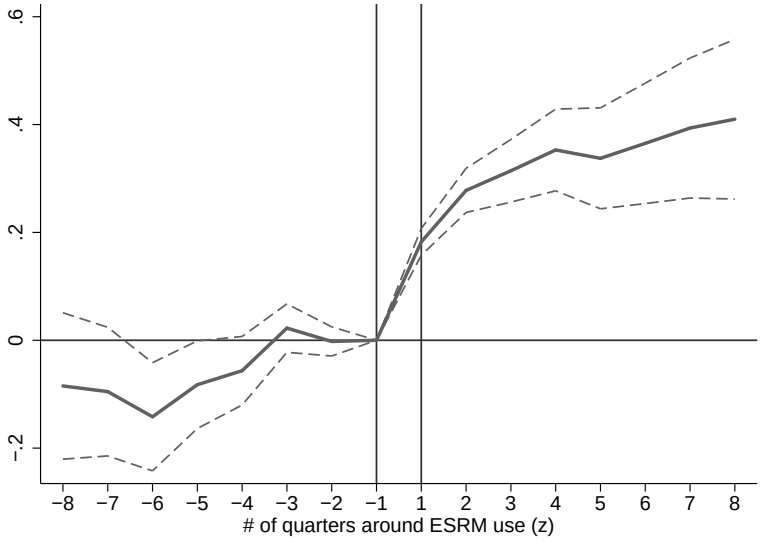
token, personally owned firms can find it relatively easier to evade taxes because they can still keep a relatively healthy creditworthiness (depending on the owner's personal creditworthiness) despite the lack of a reliable financial record on the firm's business activity.

There are also other plausible reasons why institutionally owned firms may find it harder to evade taxes. Institutionally owned firms typically tend to be large in size and to have many owners (like share holder companies and cooperatives). As opposed to firms owned personally , which are usually owned and run by families, the managers of share companies are not necessarily the owners. Instead, the share holder companies are typically managed by professional managers who act as agents of the share holders – an agency relationship that necessitates the need for availability of verifiable information to share holders about the performance of the managers. This information is partly available in the form of relatively reliable accounting records on earnings by the firm. Availability of such information for a large number of shareholders, usually released in public, makes it difficult for the managers to hide their earnings from the tax authority. Moreover, their relatively larger size makes them a valuable revenue source for the government. This revenue potential in turn provides the tax authority with more incentive to monitor their compliance closely. In fact, many developing countries have a special enforcement unit – commonly known as a large tax payer unit – within their tax administration that is dedicated to handling large tax payers (Baer, 2002). This is also true in Ethiopia, and this probably makes it harder for institutionally owned firms to evade taxes even prior to ESRM use.

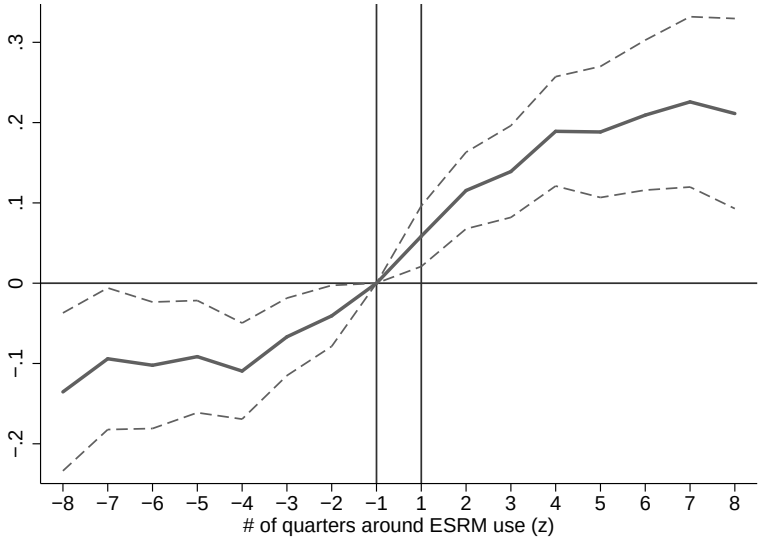
Figure 11 presents the estimated impact of ESRM use from two regressions – one for each set of firms. The top panel depicts the estimated coefficients for the personally owned firms while the bottom one shows the coefficients for institutionally owned ones. For the sake of brevity, the coefficient for the quarter right before ESRM use, β_{-1}, is normalized to 0 in both of the regressions.[12] Consistent with our discussion above, for

[12]That is, the indicator dummy for quarter -1 (I_{-1} in Equation 4) is dropped from the regression. This does not affect the results since the results do not depend on a particular choice of normalization.

Figure 11: Impact of ESRM use on Log VAT (estimated β_z's and 95% CI)



(a) Personally owned firms



(b) Institutionally owned firms

institutionally owned firms, the VAT trend does not appear to show any change in the aftermath of ESRM. This is not the case for personally owned firms. We observe a large and significant break in the VAT trend following ESRM use. Right after ESRM use, VAT (for personally-owned firms) increases by about 18 log points. This increase is larger than what we found for the whole sample (14 log points), suggesting that the results for the whole sample are driven by personally owned firms.

5.4 Robustness checks

We undertake two sets of robustness checks that pertain to two major concerns with the above regressions.

The first concern in our specification is differential time trends. We allowed for time fixed effects, which controls for potential confounding aggregate variables. However, the time fixed effects do not account for variations in time trends across subsets of firms. For example, firms in different regions may have different time trends. And if ESRM use is expanded across regions in a non-random pattern, the differential time trends across regions may bias our estimated effect. This is a reasonable concern given that ESRM use was first rolled out primarily to businesses within the capital city, and only expanded latter on to regions outside the capital. To some extent, this concern does not seem worrisome given that we did not see any major systematic difference between firms that had just started using ESRM and those that did not (see the discussion on Figure 9). However, as a further robustness check, we make use of the information on the administrative unit of the firms' locations in the dataset. We run the regressions allowing for district-specific time effects (for eighty-one districts). The R-squared increases substantially from low of 9 percent up to 70 percent, implying a substantial variation in time trends across districts. However, as can be seen from Figure 12, the results are robust for this specification. This indicates that the implementation of ESRMs is unlikely to be associated with district specific time variations. We also run the regressions controlling for district-specific linear time trends and find similar results (not reported).

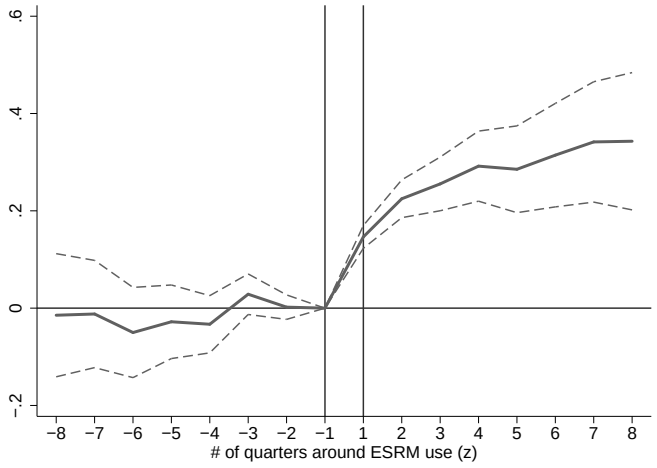
A further issue relates to potentially differential time trends across sectors (rather than regions) in a way that the variations in time trends correlate with the implementation of ESRMs. Our dataset contains relatively detailed information on business types (or sectors). There are 193 types of sectors in the data. [13]. Thus, we also check the robustness of our results to controlling for sector-specific time effects. We find that the results are still the same (not reported).

The second concern relates to the composition of our sample. As discussed in Section 4, both the number of those registered for VAT and ESRM use have been increasing overtime. ERCA has been gradually expanding the list of firms that should pay VAT as well as those that should use ESRMs (see Figure 5). Thus, even if we present VAT trends for two-years window (eight quarters) around the beginning of ESRM use, not all the firms in our sample are observed during the entire period in the two-years window. Some of them started paying VAT relatively recently, hence they have not been in the tax record long enough to be observed for two years before ESRM use. Similarly, some firms started using ESRMs relatively recently, and hence they have not used ESRMs long enough to be observed for two years of ESRM use. This means that the number of firms with non-missing values decreases as we move further away from the beginning of ESRM use (i.e. as z in Equation 4 goes further from zero). Hence, part of the observed dynamics in the periods around the beginning of ESRM use could be a result of this change in composition of firms, rather than the actual effect of ESRM use.

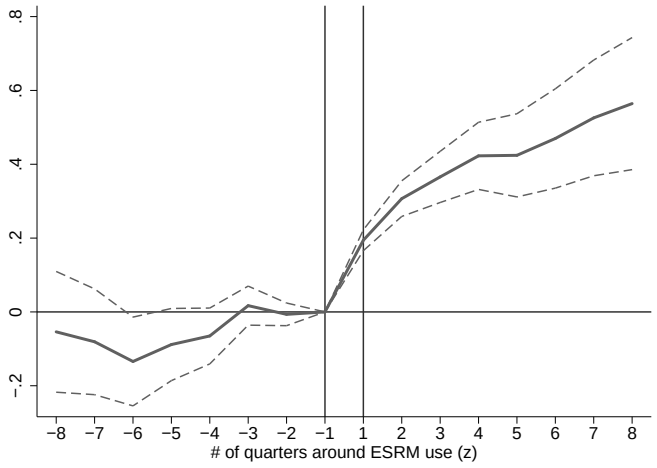
In order to address this concern, we run the regression including only the firms that are observed for at least a year before and a year after ESRM use (i.e. a total of two years). This would ensure that, for at least within a one-year window around the beginning of ESRM use, the dynamic is not affected by changes in composition of the firms. This results in a drop in the sample size: from 33,158 firms and 738,604 observations in the whole sample to 13,525 firms and 449,577 observations. The decline in the number of firms is much more pronounced than the decline in number of observations because the

[13]The 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).

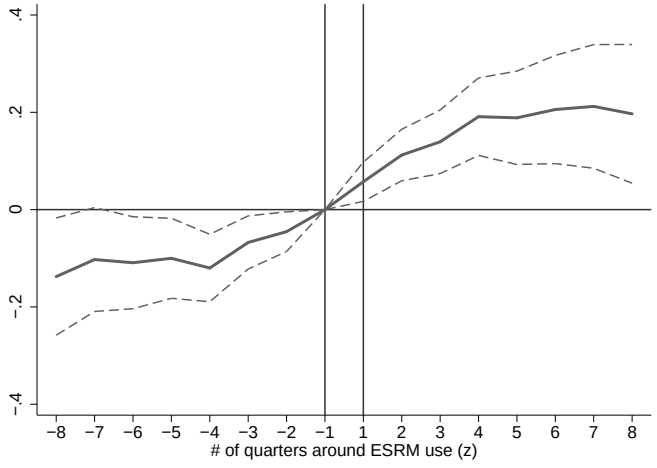
Figure 12: Impact of ESRM use on Log VAT (estimated β_z's and 95% CI): controlling for district-specific time trends.



(a) All firms



(b) Personally owned firms



(c) Institutionally owned firms

firms in the dropped sample have been observed for a shorter time. The two major patterns that we found in the earlier regressions – that there is a significant increase following ESRM use and that this effect is primarily driven by personally owned firms – remain intact when we limit the sample to firms that are observed for at least a year. As a further robustness check, we also run the regressions including only firms that are observed for at least two years before and after ESRM use (i.e. four years in total). Our sample size falls further to 336,164 observations and 7860 firms. The two main results still hold. This finding suggests that the effect in the aftermath of ESRM use is not a result of changes in the sample composition.

6 Conclusion

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

We find that tax payments by firms increase in the aftermath of ESRM use. Analysis of trends prior to ESRM use suggest that the effect is unlikely to be caused by pre-existing differences in trends. We also find that the effect is driven primarily by personally owned firms, which we believe are more likely to evade taxes. We find no effect for firms that are institutionally owned. This result suggests that the ESRM use minimized evasion among firms that are more likely to evade taxes.

By and large, the results in this paper suggest that the use of ESRMs has increased tax compliance by the firms that used ESRMs. 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 qualification. We estimated the effect on firms that were already registered as tax payers – a relatively small fraction of the firms in the Ethiopia. If increased enforcement via ESRM use forces firm to operate underground – where the government cannot require them to use ESRMs – the revenue gains from ESRM use may be attenuated due to increased informality. The extent to which increased enforcement through ESRM use leads to a higher level of informality should be an interesting agenda for future research.

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Table 2: Impact of ESRM use on the VAT

	Model with aggregate time fixed effect						Model with district-specific time fixed effects					
Ownership type:	Both		Personal		Institutional		Both		Personal		Institutional	
# of quarters around ESRM use:												
-8	-0.04	(0.05)	-0.08	(0.07)	-0.14^{a}	(0.05)	-0.01	(0.06)	-0.05	(0.08)	-0.14^{b}	(0.06)
-7	-0.04	(0.05)	-0.10	(0.06)	-0.09^{b}	(0.04)	-0.01	(0.06)	-0.08	(0.07)	-0.10^{c}	(0.05)
-6	-0.07^{c}	(0.04)	-0.14^{a}	(0.05)	-0.10^{b}	(0.04)	-0.05	(0.05)	-0.13^{b}	(0.06)	-0.11^{b}	(0.05)
-5	-0.04	(0.03)	-0.08^{b}	(0.04)	-0.09^{b}	(0.04)	-0.03	(0.04)	-0.09^{c}	(0.05)	-0.10^{b}	(0.04)
-4	-0.04	(0.03)	-0.06^{c}	(0.03)	-0.11^{a}	(0.03)	-0.03	(0.03)	-0.07^{c}	(0.04)	-0.12^{a}	(0.04)
-3	0.02	(0.02)	0.02	(0.02)	-0.07^{a}	(0.02)	0.03	(0.02)	0.02	(0.03)	-0.07^{b}	(0.03)
-2	-0.00	(0.01)	-0.00	(0.01)	-0.04^{b}	(0.02)	0.00	(0.01)	-0.01	(0.02)	-0.05^{b}	(0.02)
1	0.14^{a}	(0.01)	0.18^{a}	(0.01)	0.06^{a}	(0.02)	0.15^{a}	(0.01)	0.19^{a}	(0.01)	0.06^{a}	(0.02)
2	0.22^{a}	(0.02)	0.28^{a}	(0.02)	0.12^{a}	(0.02)	0.22^{a}	(0.02)	0.31^{a}	(0.02)	0.11^{a}	(0.03)
3	0.24^{a}	(0.02)	0.31^{a}	(0.03)	0.14^{a}	(0.03)	0.26^{a}	(0.03)	0.37^{a}	(0.04)	0.14^{a}	(0.03)
4	0.27^{a}	(0.03)	0.35^{a}	(0.04)	0.19^{a}	(0.03)	0.29^{a}	(0.04)	0.42^{a}	(0.05)	0.19^{a}	(0.04)
5	0.26^{a}	(0.04)	0.34^{a}	(0.05)	0.19^{a}	(0.04)	0.29^{a}	(0.05)	0.42^{a}	(0.06)	0.19^{a}	(0.05)
6	0.28^{a}	(0.05)	0.37^{a}	(0.06)	0.21^{a}	(0.05)	0.31^{a}	(0.05)	0.47^{a}	(0.07)	0.21^{a}	(0.06)
7	0.30^{a}	(0.05)	0.39^{a}	(0.07)	0.23^{a}	(0.05)	0.34^{a}	(0.06)	0.53^{a}	(0.08)	0.21^{a}	(0.06)
8	0.29^{a}	(0.06)	0.41^{a}	(0.08)	0.21^{a}	(0.06)	0.34^{a}	(0.07)	0.56^{a}	(0.09)	0.20^{a}	(0.07)
Observations	738604		464814		273790		738604		464814		273790	
Firms	33158		25426		7732		33158		25426		7732	
R^2	0.10		0.09		0.12		0.69		0.67		0.63	
Firm fixed effects	Yes		Yes		Yes		Yes		Yes		Yes	
Aggregate time fixed effects	Yes		Yes		Yes		No		No		No	
District-specific time fixed effects	No		No		No		Yes		Yes		Yes	

This table presents the estimated impact of ESRM use. The results are reported for the whole sample of firms and two subsample that differ in ownership type. The first three columns control for firm and time fixed effects. The last three columns control for firm fixed effects and district-specific time effects. Standard errors clustered by the firm are in parentheses. The left most column presents the number of quarters around ESRM use. Negative/positive values indicate the number of quarters before/after ESRM use. The coefficient on quarter -1, i.e. the quarter right before ESRM use, is normalized to zero.

^{a} significant at the 1 percent level, ^{b} significant at the 5 percent level, ^{c} significant at the 10 percent level.