

Working paper

Reaping the benefits of Electronic Billing Machines

Using data-driven tools to improve VAT compliance

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Executive Summary

Electronic Billing Machines (EBMs) enable revenue authorities to monitor formal business transactions and thus offer the potential to improve VAT compliance. However, because firms can choose not to issue receipts or issue false receipts, EBMs do not offer truly objective tax reporting and have thus offered limited benefits to tax collection. Using examples from Rwanda, this paper argues EBMs can have transformative impacts for VAT compliance, but only when combined with data analytics and receipt audits to enforce EBM receipt issuance. This can be done using a three-step approach: initial ‘benchmark audits’ can establish firms’ true sales patterns; data analytics then flag firms deviating from this pattern, which trigger automatic ‘mystery shopper’ audits to verify non-compliance and sanction the firm. EBMs combined with these measures offer a powerful way to ensure firms accurately report on VAT liabilities, which may significantly improve domestic revenue mobilisation in countries with high VAT non-compliance.

Keywords: Electronic Billing Machines; VAT; Tax Compliance; Rwanda

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1. Introduction

Many governments around the world have recently introduced ‘Electronic Billing Machines’ (EBMs). These devices aim to combat non-compliance with VAT by monitoring business transactions. This paper assesses the impact of these EBMs on improving tax yields, and offer suggestions for how best to use EBMs to improve VAT tax compliance in the future.

Section 2 highlights why raising VAT compliance is critical for increasing domestic revenue mobilisation in developing countries. Section 3 provides an overview of the literature on Electronic Billing Machines (EBMs) and other ‘Electronic Fiscal Devices’, including their impact on tax revenue across countries, followed by a more in-depth case study of the impact of EBMs in Rwanda. Section 4 illustrates how EBMs can best be used to improve VAT compliance; here we explore the ways in which firms with EBMs can evade VAT and argue that this can best be addressed when complemented with joint receipt audits and targeted data analytics. Section 5 then recommends how to sequence such EBM tools effectively by integrating them within a broader tax compliance framework and target various EBM tools based on taxpayers’ risk-type. It is hoped that these suggestions will enable tax authorities to better make use of EBMs, and use them as an integral part of their tax compliance systems.

2. The importance of VAT compliance for Domestic Revenue Mobilisation

Improving VAT compliance is one of the most critical issues for domestic revenue mobilisation in developing countries for two reasons. Firstly, VAT revenues tend to dwarf all other tax revenue streams, so that even small improvements have relatively large impacts. Secondly, the data generated to observe VAT liability generates a paper-trail that strengthens a revenue authority’s ability to enforce tax compliance across all domestic tax types.

2.1 The importance of VAT for tax yields

The introduction of VAT can be seen as one of the most significant developments in tax policy of recent decades (Keen and Simone, 2004). VAT adoption has increased from 47 countries in 1990 to over 140 today (IMF, 2011). Over this period, VAT has quickly expanded to be the largest share of domestic tax revenue. For instance, in 2011, VAT collections amounted to 36% of tax revenue across the East African Community, and 24% in the Southern African Development Community (IMF, 2013). Across 15 African countries, consumption taxes (VAT and excise duties) now make the biggest single contribution of any tax to revenue, accounting for over 36% of revenue (ATAF, 2016).

However, VAT is also still “a work in progress” (IMF, 2011) with considerable tax yield potential from improved compliance. To illustrate this, we extend a study on Rwandan tax compliance, which calculates the compliance gap for different tax types by comparing the measurement of declared and real incomes through audit reports (Mascagni et al, 2016).²

Table 1 firstly shows the estimated compliance gap across different tax types in Rwanda.³ This shows the lowest compliance gap for Pay-as-you-earn (PAYE, less than 2%), which can be explained through the focus on third-party (employer) reporting of wages (Kleven et al, 2011). In contrast, compliance gaps are 38% for VAT, suggesting that VAT compliance still faces significant challenge. The highest compliance gaps are found for PIT and CIT (upwards of 70%), and driven by small companies outside of Kigali with low enforcement pressures.

A focus on compliance rates alone would suggest that CIT/PIT audits for small taxpayers would be most appropriate to improve tax yields. However, the cost of auditing a large number of dispersed, small taxpayers with poor accounting practices tends to be high. In return, as mentioned in Mascagni et al, (2016) “*the revenue implications would almost certainly be disappointing. These taxpayers are likely to generate small amounts of revenue*”.

Table 1 calculates the hypothetical impact of improved tax compliance across tax types in Rwanda;⁴ it suggests that improving VAT tax compliance outweighs benefits from CIT/PIT by almost twice as much (99 billion versus 54 billion). This amounts to an increase of 2 percentage point increase in tax revenue as share of GDP, compared to a 1.3 percentage point increase from CIT/PIT combined. Hence, to improve domestic revenue mobilisation, VAT seems the most appropriate direct focus.

*Table 1: Hypothetical impact of improved tax compliance by tax type, Rwanda 2012/13
(Source: Author’s calculations based on Mascagni et al, 2016).*

Tax Type	Tax Revenue for 2012/2013			Estimated Compliance Gap (%)	Hypothetical Impact of Improved Tax Compliance	
	RwF billion	Tax Share (%)	Share of GDP (%)		Additional Tax Yield (RwF billion)	Change in Share of GDP (%)
VAT	259	34.3	5.3	38.3	+99	+2.0%
PAYE	186	24.6	3.8	1.8	+3	+0.1%
CIT	39	5.1	0.8	72	+28	+0.6%
PIT	36	4.7	0.7	72.6	+26	+0.5%
Excise	103	13.7	2.1	N/A	-	-
Other	133	17.6	2.7	N/A	-	-
Total	756	100.0	15.4	N/A	+156	+3.2%

² Because of the small number of audits carried out in Rwanda, taxpayers that are more likely to evade are more likely to be audited, so that audit reports provide an unrepresentative sample. The authors account for this by weighing taxpayers’ compliance gap by the share of its group in the overall population (e.g. large and medium; small and medium in Kigali; or small and medium outside of Kigali).

³ Due to the large estimated variance, the authors caution that these figures should be seen as indicative only.

⁴ Calculated by estimating the overall tax yield with a 0% tax compliance gap.

2.2 Positive externalities associated with improved VAT compliance

Improving the VAT system also generates a third-party paper trail that strengthens a revenue authority's ability to enforce tax compliance, for VAT as well as for other taxes.

Reliable information flows and third-party reporting on income and transactions (e.g. employer-reported wage incomes) make it much harder for taxpayers to evade without detection. Information from these streams can easily be compared to tax returns, thus allowing the revenue authority to uncover fraudulent reporting (Kopczuk and Slemrod, 2006; Kumler et al., 2013).

VAT incentivises firms to reliably report their purchases, because this allows them to deduct input costs from their VAT bill (Agha and Haughton, 1996). Both buyer and seller firms are legally required to record the same transaction in their books, thus providing the revenue authorities a paper trail to cross-check transaction amounts. Firms are typically discouraged from colluding on any transactions through opposing incentives: the buyer benefits from overstating the input cost, while the seller benefits from understating the sale. The buyer thus acts as the third-party, recording a transaction that generates a liability for the supplier (Bird and Gendron, 2007).

Yet, most developing countries have considerable challenges in observing transactions and accessing third-party information (Gordon and Li, 2009; Besley and Persson, 2012). Here, the VAT's 'self-enforcement' mechanism is also often flawed because "*it can be expected to work only in interaction with credible deterrence on part of the tax authority*" (Pomeranz, 2014). Without this, taxpayers may collude to omit transactions (sharing the benefits of VAT evaded). For that reason, Pomeranz (2014) finds that in an experiment in Colombia, improving VAT compliance for sales to final consumers (e.g. sending letters to threaten with a potential audit) leads to important spillover effects for the whole supply chain. When a firm is forced to charge proper VAT on its sales, it is more concerned with claiming back VAT on inputs, and thus to accurately report their suppliers' transactions, triggering a verifiable paper trail and increasing VAT payments for all parties down the supply chain.

Another empirical study from Brazil found that VAT can also help reduce other compliance challenges by incentivising small firms to formalise in order to claim tax credits on purchases made. This thus also made it more likely for new firms to register for other tax types, including personal and corporate income tax (De Paula and Scheinkman, 2010).

Combined with the spillover effects, improving VAT compliance can thus contribute to formalising value chains, and may also offer important positive externalities on yields for other tax types. Hence, if EBMs provide a viable way to improve VAT compliance, this can have potentially transformative impacts for tax collection in developing countries.

3. The impact of EBMs on Tax Revenue

This section will provide an overview of the literature on Electronic Billing Machines (EBMs) and other ‘Electronic Fiscal Devices’ to improve tax revenue. We start with an overview of how EBMs work and which countries have adopted them. Next, we offer a broad account of the impact of EBMs on tax revenue in a sample of countries. Lastly, we provide a more in-depth case study of Rwanda to explain the limitations of EBMs alone to improve tax compliance.

3.1 What are Electronic Fiscal Devices?

Technological devices to combat VAT non-compliance by monitoring business-to-business and business-to-consumer transactions are jointly referred to as ‘Electronic Fiscal Devices’ (Casey and Castro, 2011). The use of such fiscal devices has spread gradually over time, with the underlying technology becoming increasingly sophisticated. The types of devices used thus depends strongly on the time of introduction. These can be broadly be divided into three generations (de Swardt, 2015):

The first generation of electronic fiscal devices were electronic tax registers, also known as ‘*Sales Data Controllers*’ (*SDCs*). These SDCs operate as sales terminals and contain an offline fiscal memory that captures each transaction’s core tax information, typically the classification of goods, value of goods sold, rate of tax, and tax value. This fiscal memory cannot be wiped or reset by loss of power. It can only be accessed by authorized personnel with the relevant electronic key (typically the tax administration), to download the data for detailed verification and analysis. This type of EFD was dominant until the turn of the century (Casey and Castro, 2011).

With the advent of the internet, EFDs received an important upgrade in the mid-2000s with the integration of a ‘*General Packet Radio System*’ (*GPRS*). This second generation of devices uses the mobile phone network to directly send any transaction data on demand or on a regular schedule from SDCs to the revenue authority central server. It thus allowed tax

administrators to remotely access daily transaction updates without the need to be physically present (Casey and Castro, 2011).

Following the ability to send data via the internet, the third generation of EFDs can better avoid ‘tampering’ using various encryption methods that place a digital sign on each receipt. This is done by linking each SDC with a ‘*Certified Invoicing System*’ (CIS), which generates a unique key that is printed on the receipt. This makes it easier for the revenue authority to trace back any specific receipt issued (on suspicion of fraud), and gives additional assurance that the invoices are tamper-proof and correct⁵ (Casey and Castro, 2011).

Table 2 presents an overview of the roll-out of EFDs for a selection of countries. This shows that EFDs have been made mandatory in a large numbers countries. Kenya was the first adopter in Sub-Saharan Africa in 2005, and since then many others have followed including Tanzania, Ethiopia and most recently Rwanda and Malawi. South Korea has extended the scope of EFDs to all business. EFDs have therefore been an important and influential policy innovation in tax administration internationally.

Table 2: Sample of EFDs used, (Source: adapted from Casey and Castro, 2011)

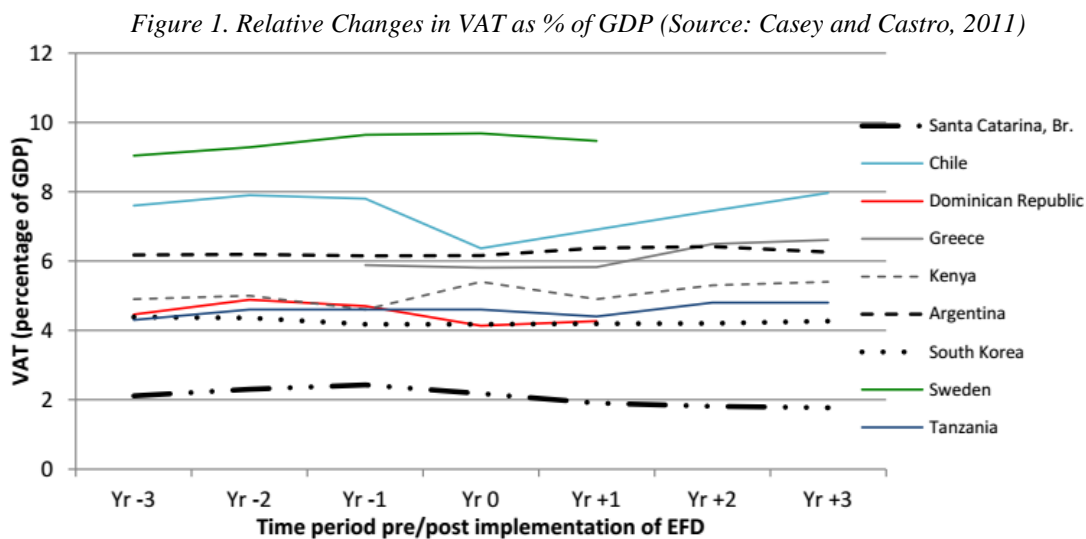
Country	Year	Type of EFD	Scope
<i>First Generation</i>			
Greece	1988	SDC	All VAT registered
Bulgaria	1993	SDC	All VAT registered
Moldova	1993	SDC	All VAT registered
Brazil (State level)	1994	SDC	All Sales Tax registered
Argentina	1995	SDC	All VAT registered
Romania	2000	SDC	All VAT registered
Mexico	2000	SDC	All VAT registered
Montenegro	2001	SDC	All VAT registered
<i>Second Generation</i>			
South Korea	2005	SDC + GPRS	All businesses
Paraguay	2008	SDC + GPRS	Sector VAT registered
Sweden	2010	SDC + GPRS	All VAT registered
<i>Third Generation</i>			
Chile	2003	SDC + GPRS + CIS	All VAT registered
Kenya	2005	SDC + GPRS + CIS	All VAT registered
Ethiopia	2008	SDC + GPRS + CIS	All VAT registered
Dominican Republic	2009	SDC + GPRS + CIS	All VAT registered
Tanzania	2010	SDC + GPRS + CIS	All VAT registered
Kosovo	2012	SDC + GPRS + CIS	All VAT registered
Panama	2012	SDC + GPRS + CIS	All VAT registered
Rwanda	2013	SDC + GPRS + CIS	All VAT registered
Hungary	2014	SDC + GPRS + CIS	All VAT registered
Malawi	2015	SDC + GPRS + CIS	All VAT registered

⁵ While EBMs issue receipts that correctly capture VAT liabilities, such receipts may still not truthfully reflect all transactions. Firms could issue a receipt where no items were sold in order to claim back VAT inputs, and so can still be a considered a ‘fake’ receipt (see below).

3.2 The impact of Electronic Fiscal Devices on Tax Revenue

Given the considerable tax potential in many countries from improving VAT compliance and the general effectiveness of third-party reporting (see section 2.2), many countries looked towards EFDs with high expectations to improve tax yields. To analyse this impact, an IMF study (Casey and Castro, 2011) considered whether trends in VAT revenue collection as a percent of GDP differed after introduction of the EFDs for a sample of 9 countries.

The results are shown in Figure 1, where year zero reflects the EFD implementation year. This suggests that introducing EFDs is not generally associated with any noticeable improvement in VAT revenue. The one exception relates to the case of Chile, where introduction of EFDs was associated with a considerable *drop* in tax yields, and which only managed to regain its original VAT-to-GDP ratio after additional three years of tax collection.



While such macro-figures indicate that EFDs tend not to deliver any large, transformative impact on tax collection, it cannot definitively identify the effects of VAT. This is partly because additional tax reforms are often implemented in parallel to improve revenue performance, so that general trends may over- or under-estimate the true impact of EFDs (Casey and Castro, 2011).

3.3 The impact of EBMs on Tax Revenue: Rwanda Case-Study

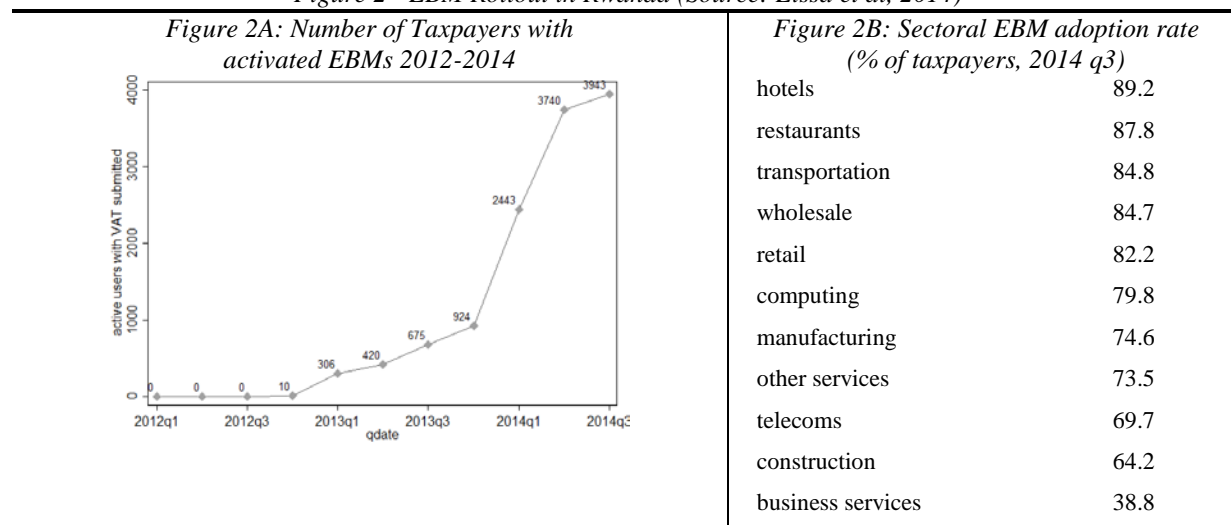
To provide a more detailed understanding of the effect of EFDs in tax compliance, it is helpful to consider the case of introducing EBMs in Rwanda. Eissa et al (2014) provide one

the first rigorous evaluations of EFDs on tax revenue, and the only to our knowledge that tries to identify the way in which such EFDs influence tax compliance.

In August 2013, Rwanda adopted a new law that stated that all businesses registered for VAT must provide customers, at each sale, a certified VAT receipt generated by a third-generation EFD: the Electronic Billing Machine, which contains a Sales Data Controller (SDC) with GPRS and a Certified Invoicing System (CIS) all working together. This must be purchased from a Rwanda Revenue Authority (RRA)-approved vendor and activated by the RRA.

Roll-out for the EBMs started in March 2013 and was extremely rapid, as shown in Figure 2A. By September 2014, 18 months after initiating the roll-out, over 3,943 taxpaying firms had active EBMS.⁶ This corresponds to 77.8% of all VAT-registered firms at that time. From Figure 2B, we see that EBM adoption was highest in the hotel and restaurant sectors (at 89.2 and 87.8 percent, respectively) followed closely by transportation, wholesale and retail at over 80 percent take-up. The lowest adoption was for business services, which include legal, financial and management consultancy services.

Figure 2 - EBM Rollout in Rwanda (Source: Eissa et al, 2014)



To estimate the effects of EBMs on VAT payments, Eissa et al (2014) employ a difference-in-differences econometric strategy.⁷ They find that on average, the introduction of EBMs resulted in a VAT increase of 5.4 percent. This is relatively little, and much lower than

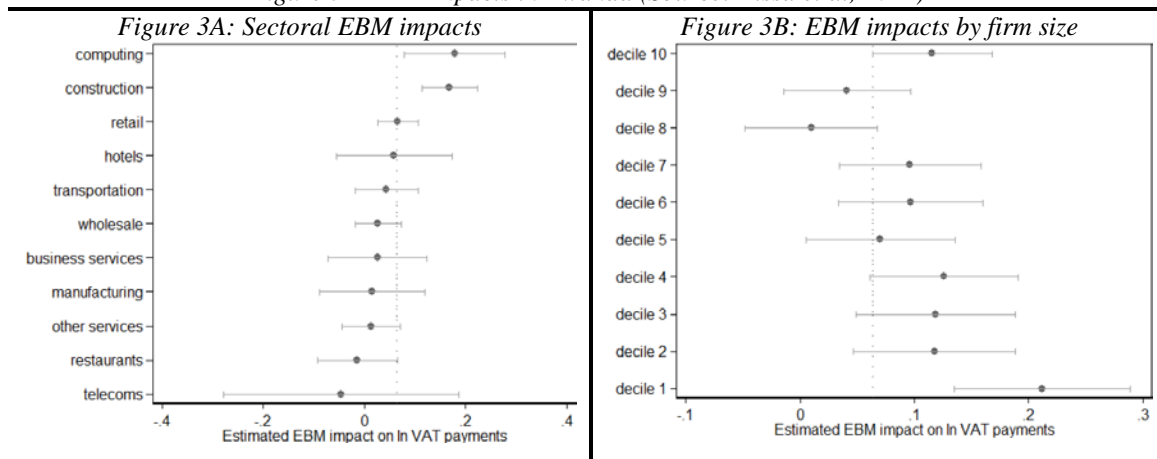
⁶ This has since grown extensively, in line with other taxpayer registration, so that by July 2016 there were a total of 13,238 active EBM machines in Rwanda (RRA, 2016)

⁷ The study's preferred estimate uses a triple-difference specification that considers the change in VAT payments as the dependent variable to difference out both sector- and firm fixed effects.

expected by the Rwandan Revenue Authority. To put this figure in perspective, it is helpful to note that firms were asked to cover the cost of their EBM equipment (USD \$250), while median firm VAT liability is around USD\$66 per year. The EBM-associated VAT payments thus only exceeds the machine cost in the fourth year.

Figure 3 below shows the heterogeneity in EBM impacts. Firstly, treatment effects are broken down by sector (Figure 3A). This shows the largest impacts occur for computer and construction sectors, while the impact for sectors such as telecoms, restaurants, and other services is statistically indistinguishable from zero. One likely explanation for this is that the computer- and construction sectors are subject to larger, but less frequent transactions that are more easily evaded. In contrast, sectors such as telecom and restaurants are sectors with high-frequency transactions that were already more subject to tax compliance monitoring. Secondly, when considering firm size (Figure 3B), the general pattern is that firms with lower initial turnover and more likely to increase their tax compliance using EBMs. This again could be explained through small firms' lower expected risk of being audited and caught for non-compliance. If so, EBMs thus ensure more consistent VAT compliance across sectors as well as firm sizes (Eissa et al, 2014).

Figure 3 - EBM Impacts in Rwanda (Source: Eissa et al, 2014)



Most critically, the study then tried to identify why EBMs had a much lower than expected impact on tax yields. This was done through a small-scale 'mystery shopper' study where enumerators made random visits to EBM-active retail shops to identify their extent of EBM utilisation. This showed that EBM receipts were issued to consumers in only 21 percent of shop visits, when not explicitly requested. Yet, asking for the receipt increased EBM receipt issuing to 63 percent of visits. If tax administration officers sit with the shopkeeper the

overall receipt issuing increases to 94 percent of transactions. This suggests that the *key challenge to low EBM impacts is non-utilisation of EBMs for receipt issuing*.

The first studies on EBMs thus provide a sobering conclusion. These devices should not be seen as a “silver bullet” of tax administration. As noted by Casey and Castro (2011): “*the deployment of fiscal devices alone cannot by itself achieve meaningful results, whether in terms of revenue gains or permanent compliance improvements*”. The case of Rwanda further shows that EBMs alone do not have a large impact on VAT compliance because they do not form a true third-party reporting system: firms can still choose not to comply by not issuing EBM receipts.

Yet, EBMs can provide an important means to improve VAT compliance. The key, however, is to leverage the new data that is provided by EBMs. The next section will provide more detail on how this can be done.

4. Improving the benefits of EBMs for tax compliance

This section aims to illustrate how EBMs can best be used to improve VAT compliance, with a specific focus on Rwanda. We firstly explore the ways in which firms with EBMs can evade VAT. Secondly, we present a framework for how EBMs can best improve VAT compliance when complemented with receipt audits and targeted data analytics. Lastly, we provide detailed examples of how such complementary EBM interventions can be structured, and what the benefits and challenges of different interventions are.

4.1 Methods of VAT Evasion for Firms with EBMs

As shown in the previous section, EBMs by themselves cannot ensure accurate VAT reporting and cannot be considered a true third-party information because taxpayers still have to be trusted to consistently and truthfully utilise the EBM machines to process any transaction.

There are three main ways in which firms can prevent EBMs to provide accurate sales data to revenue authorities⁸:

1. **Non-Issuing of Receipts.** This is often the most severe, and pervasive challenge. As shown in Eissa et al (2014), a “mystery shopper” exercise in Rwanda suggests that for some sectors, firms with EBMs only issue receipts 20% of the time, which can thus

⁸ Based on Author’s interviews with the Rwandan Revenue Authority

amount to VAT evasion through under-reporting of sales of up to 80%. This is the main priority for improving compliant use of EBMs.

2. **Issuing of Fake Receipts.** Firms can also choose to over-report their purchases in their VAT declarations by issuing fake EBM receipts. While less common, such fraudulent activities can significantly undermine VAT collection. For instance, Rwanda recently uncovered a case of RwF 6.8 billion (USD \$8.5 million) where 25 firms were selling fake EBM receipts for other firms to claim tax deductions (The New Times, 8/09/16). This is thus another important compliance issue to tackle.
3. **Understating of Prices / Misclassifying Item Tax Rate.** Firms can also reduce their VAT bill by understating prices (under-reporting sales) or by misclassifying the tax rate on specific items (e.g. applying a '0'-rate for specific items instead of the appropriate legal VAT rate).

While these problems are pervasive, what makes these problems stand out is that *these compliance issues can often be systematically identified using data generated by EBMs, especially in comparison with a database of 'true' (VAT compliant) transactions.*

For instance, if a firm has been issuing reliable EBM receipts for some time, and all of sudden there is a drop in the number of receipts, this is suspicious behaviour that may indicate evasion. Similarly, if a supplier issues a fake receipt, it means that it does not report a legitimate buyer, or misreports the transaction amounts. An automated comparison of the transaction between the buyer- and supplier firms facilitated by the EBMs should be able to spot any deviations. Lastly, we can also look at a firm's items sold and prices to see possible misclassification (e.g. the share of zero-rated items compared to other firms, or clear differences in item prices).

From this, we can identify two critical features that drive the VAT compliance potential of EBMs. Firstly, EBMs allow for real-time monitoring of VAT transactions, which is key to establish firm-level patterns of EBM usage. Secondly, EBMs reduce the cost of VAT compliance auditing, which auditors can observe directly by identifying whether a firm provides legitimate receipts. Jointly, these two features should form the basis of any EBM compliance strategy.

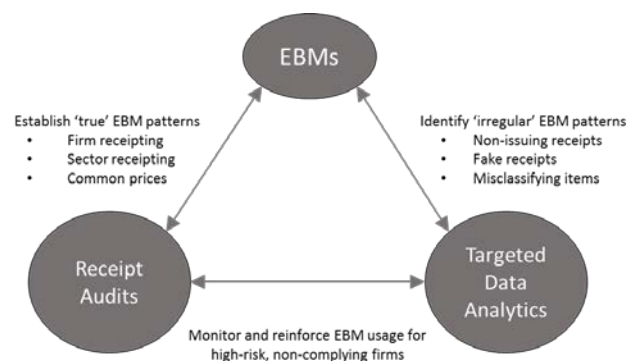
4.2 A Model for improved VAT tax compliance through EBMs

We argue that the best way to use EBMs to improve VAT compliance is to introduce them alongside two complementary interventions (Figure 4). Firstly, there is need for interventions

that reinforce the issuing of EBM receipts where non-compliance is identified (receipt audits). These also provide data to establish true patterns of sales, which is used by the second intervention type. This second intervention uses targeted data analytics that automatically identifies when a firm is engaged in ‘irregular’ or ‘suspicious’ behaviour (e.g. issuing much fewer receipts than usual, issuing receipts without buyer-firm corroboration, or misclassifying items). We argue that the most powerful way in which EBMs can reinforce voluntary VAT compliance is by taking both approaches jointly; a data-driven approach to ‘spot’ irregular patterns and automatically ‘remind’ EBM users of non-complying behaviour. This approach brings together all three components of the model in Figure 4.

EBMs thus open up the potential for a large number of new, complementary interventions. In the next sections, we will give examples of possible interventions and will briefly discuss each in turn.

Figure 4: A Model for Improved VAT Compliance through EBMs (Source: Author)



4.3 Improving VAT Compliance through EBM receipt audits

The main aim of receipt audits is to increase a firm’s legitimate receipt issuing. Yet, this also has a secondary effect: it can better establish the ‘true’ (VAT compliant) EBM receipt patterns, of that particular firm and of ‘similar’ firms. Absent these audits, it is possible that *most* firms in a sector choose not to issue receipts consistently (as indicated in Rwanda by Eissa et al, 2014), so that EBM data does not show true sales patterns, and evaders cannot be identified. Receipt audits can thus help to establish ‘true’ EBM sales patterns (e.g. average number of receipts issued by each firm, and common item prices).

We can identify three main ‘receipt audits’ that have been used across the world, each with a different focus and intention: consumer audits, benchmark audits and mystery shopper audits.

Consumer Audits

Consumer Audits are perhaps the most well-known intervention to improve receipt issuing. Many countries have introduced some form of monetary rewards, including tax refunds or receipt lotteries offering (monetary/in-kind) prizes to consumer who collect receipts (Bird, 1992; Cowell, 2004; Marchese, 2009).⁹ Evidence from Brazil suggests that such a consumer audit can significantly increase receipt issuing, and that this initiative increased VAT yields by around 22% over four years (Naritomi, 2013). However, provision of such incentives can be expensive, and their functionality will depend strongly on the appropriate policy design. For instance, initial results from an EBM lottery in Rwanda that uses a small number of in-kind prizes to incentivise consumers to request receipts were generally disappointing.¹⁰ Consumer audits also tend to be indiscriminate: consumers can submit any type of receipt. Such audits often do not target high-risk firms or sectors, and may need to be accompanied by other audit types to tackle the most pervasive non-compliance (see next section).

Benchmark Audits

Benchmark Audits were introduced in Rwanda shortly after EBMs were first rolled-out.¹¹ For this audit, a Revenue Authority official sits with a targeted firm's cashier, generally for two days, and ensures all transactions are issued using the EBM, and each customer receives a proper receipt. The aim for this is to establish a reliable benchmark of the average daily receipts and turnover made by that firm. If the firm later deviates from this benchmark, an automatic audit is issued.

To establish a 'true' EBM pattern, this audit works particularly well in conjunction with data analytics. It also provides a means for training new firms how to use their EBMs. However, it is relatively expensive (e.g. requiring two auditor days), and there is a risk that sales on these days are non-representative.

Mystery Shopper Audits

Mystery Shopper Audits are another way to audit receipt issuing. For this method, tax auditors wait outside a shop (ideally plain-clothed, to avoid suspicion) and ask customers for their receipts. Alternatively, plain-clothed tax auditors may make purchases directly. If no legitimate receipt is provided, the auditors then approach the firm to issue a penalty. In Rwanda, such penalties increase in size after repeated violations, and are relatively small the

⁹ A sample of countries with such monetary incentives include Argentina, Bolivia, Brazil, Chile, China, Italy, Portugal, Puerto Rico, Rwanda, Slovakia and South Korea, among other.

¹⁰ Based on Author's interviews with the Rwandan Revenue Authority

¹¹ Based on Author's interviews with the Rwandan Revenue Authority

first two times, but after a third time may result in closure of the business for 30 days (Table 4). This approach can cost-effectively identify the *share* of transactions issued a valid EBM receipt for any particular firm or sector (auditors could visit as many as 30 firms per day). This depends on firms not noticing the presence of the mystery shopper auditors. Alternatively, if this is done while wearing tax administration badges, it serves more as a gentle ‘reminder’ to taxpayers to issue receipts (with less ability to catch non-compliance and issue sanctions). The downside of this approach is that, unless repeated over time, a brief one-off visit may not be representative of firm behaviour. The overall potential of this approach is currently being investigated by an IGC study (Zeitlin et al, forthcoming).

Table 3: Penalties for EBM receipt evasion in Rwanda, source: RRA website

Punishable Act	Penalties
1 st Offence – Not issuing an electronic invoice	Fine: 10x value of the evaded VAT
2 nd Offence - Not issuing an electronic invoice	Fine: 20x value of the evaded VAT
1 st Offence - Electronic invoice with under-valued price	Fine: 10x value of the evaded VAT
2 nd Offence - Electronic invoice with under-valued price	Fine: 20x value of the evaded VAT
1 st Offence – Failure to comply (other EBM obligations)	Fine: Rwf 200,000
2 nd Offence – Failure to comply (other EBM obligations)	Fine: Rwf 200,000
Third Offence (any type)	Penalty may include: 1) Closure of business activities for a period of thirty days. 2) Being barred from bidding for public tenders. 3) Withdrawal of a business register. 4) Being published in nationwide newspapers.

4.3 Improving VAT Compliance through Targeted EBM Data Analytics

Receipts audits are often difficult to target, and their effects tend to be temporary, so that non-compliant firms will quickly move back to their old ways when they feel the revenue authorities have stopped monitoring¹². For this reason, it is key to use targeted data analytics to automatically identify ‘irregular’ EBM patterns (e.g. in terms of receipt issuing, discrepancies between buyers and sellers, and suspicious item pricing). This could help flag out all three forms of VAT non-compliance.

To initiate EBM data analytics, it may be important to start small and gradually seek to expand the number of functionalities. Below we will describe such stages applied to Rwanda, through a special project set up by the International Growth Centre to support the Rwanda Revenue Authority.

EBM Data Portal

As described in the previous section, most EBMs are essentially little computers in which firms have to ‘programme’ their various items (i.e. goods or services sold). This is set up in

¹² Based on Author’s interviews with the Rwandan Revenue Authority

such a way that when sent through to the revenue authority, some elements are very easily recognisable (e.g. a firm's Tax Identification Number, the overall amount sold and the VAT due). Yet other elements on each receipt are not so controlled. For example for item description, firms can simply write whatever they want in order to be as flexible as possible (e.g. allow for different languages, many item types).

Many revenue authorities choose only to consider this first part (i.e. the receipt 'totals'). The rest of the receipt is often disregarded, due to the computational complexity of 'parsing' and 'cleaning' this data into a useful format.¹³ However, this strongly limits the compliance potential of the EBM data. A first step that was conducted in Rwanda was thus to ensure the Revenue Authority could *access* the full data from previous receipts, and produce easy abilities to filter and summarise specific variables. This is the most basic, initial step to conducting any form of (static) EBM compliance analysis.

First Extension: EBM Compliance Dashboard

Based on the initial data available, the next step would be to identify patterns in EBM usage, and then consider where firms are strongly deviating from such patterns (signalling non-compliance). This process is still at an early stage in Rwanda, but will likely include specific firm-level indicators for each of the three EBM compliance issues. Hence, the dashboard will assess large shifts within-firm, as well as big differences within-sector in the number and value of receipts offered. Similarly, through comparison of supplier EBM returns to buyers' VAT declarations, possible issuing of fake receipts should be identified. Lastly, suspicious item prices, or obvious misclassification of items by tax type can be noted through patterns observed in EBM receipt item prices and descriptions.

Second Extension: High-frequency Updates, Automatic Item/Sector Classification

Given the rich, unexplored data that is available in many countries with EBMs, it can be helpful to initially focus only on historical data. However, especially when using EBM data for audit purposes, or to monitor a specific firm for consistent compliance over time (e.g. after a specific intervention), it can be important for revenue authorities to have access to the most recent EBM data. As a second extension, the EBM data portal project will seek to explore high-frequency (i.e. overnight) cleaning of the raw data, which is then automatically integrated into the database, and updates the compliance dashboard.

¹³ For Rwanda, each receipt came in a long text form. It required writing designated code in order to recognise each individual receipt, and separate out all the relevant information into different columns in order to obtain critical receipt features such as item name, cost, quantity, transaction date and time of purchase.

In addition, to best address item-specific compliance challenges (e.g. zero-rating item prices), there is a need to understand item descriptions. This is difficult because for most EBMs, firms can simply write whatever description they want. To bring together many similar items (e.g. different types of ‘Coca Cola’, irrespective of any potential spelling errors or use of local language in the description), members of the EBM data portal project have started to develop coding that can automatically clean and classify specific items based on their descriptions. This is making use of advanced language processing (e.g. spell-checkers, dictionaries) and machine learning approaches. Such detailed item classifications together with machine learning approaches would further allow firms to be classified based on their items sold, which can further improve sector-specific audit strategies.

Targeted data analytics thus offer considerable benefits. Their first main challenge, however, is their high initial set-up cost (often requiring considerable technical expertise, as noted above). Secondly, there is also a risk that revenue authorities have more data than they know how to handle. For this, it is key to develop tailor-made compliance assessment tools that are designed in close collaboration with the revenue authority, to ensure it offers the appropriate features and design to facilitate easy integration in auditors’ daily work routines. Thirdly, there is also need for additional personnel dedicated directly to such EBM data analytics, which may also need targeted training and support.

4.4 Improving VAT Compliance by using EBM data with complementary measures

The most powerful way to improve VAT compliance through EBMs is to use the same data-driven approaches not only to *identify* non-compliance, but also to automatically *reinforce* EBM usage for non-complying firms. This could possibly be pursued by offering firms their prefilled VAT returns, or by sending out automated taxpayer feedback based on suspected non-usage of EBM machines.

Prefilling VAT Returns

EBMs are often introduced in Rwanda as a tax facilitation programme by creating an automatic, digital copy of all receipts. However, firms are still required to keep their own records and issue their own tax returns, resulting in cases where there is a large deviation between their EBM receipts and their VAT declaration, possibly due to record-keeping challenges. Mascagni (2016) notes that taxpayers in low-income countries are particularly burdened by complexities in filing tax returns due to lower literacy and less availability of trained accountants. One way to improve this is to move towards a pre-filled VAT return

statement based on firms' EBM usage. This could also further reduce the likelihood of firms issuing fake receipts, by pre-populating a firm's permissible deductions. For this to work, it is key that EBM receipts provide a comprehensive and reliable account of VAT duties.

Automated Taxpayer Feedback

Providing taxpayer feedback has also shown to be a powerful tool to improve voluntary VAT compliance. This combines a true 'facilitative' component (notifying upcoming tax reporting deadline) with an increased awareness that the revenue authority is monitoring the specific taxpayer's behaviour and so raising the probability of audit and sanctions for non-compliance (Slemrod et al, 2001; Kleven et al, 2011).

In a recent study in Rwanda, Mascagni et al, (2016) found that sending a 'reminder' by either letter, email or text message, of a firm's upcoming tax obligations all had a strong and significant effect on firms' payment of Corporate Income Tax. Applying such an approach to EBM receipt issuing could offer a powerful means to improve EBM receipt issuing compliance.

Any such an intervention will require the establishment of a strong data analytics programme, which can reliably identify 'irregular' patterns of receipt issuing. On this basis, it could send out automated text messages to firms to 'remind' them of suspicious behaviour. For instance, taxpayers could be informed that the revenue authority has noticed a large drop in receipt issuing and requested to clarify if there is anything wrong with the EBM device; it could be asked for a voluntary quarterly VAT revision based on suspicious tax declarations (fake receipts) or suspicious price patterns.

5. Integrating EBM Compliance Activities within a Tax Compliance

Framework

The previous section showed that there are many possible interventions revenue authorities can adopt to improve VAT compliance through EBMs. However, given this range of options, it is helpful to provide some guidance on the proper sequencing and prioritisation of such tools by integrating them within a broader tax compliance framework. This section we will first introduce such modern models of tax compliance, and then recommends how best to sequence EBM compliance activities with a special focus on Rwanda.

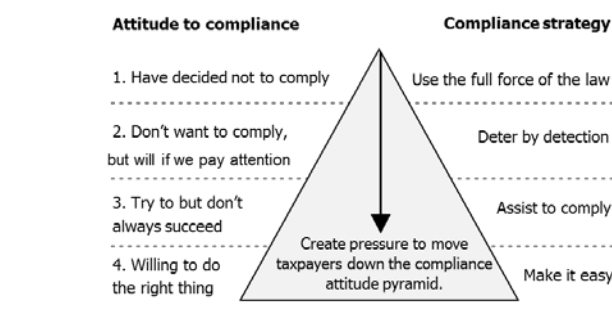
5.1 Modern Models of Tax Compliance

For many revenue bodies around the world, tax compliance is driven primarily by an ad-hoc, “bottom-up” approach to auditing individual cases. While such an approach may help address compliance issues for any particular case, it does not provide any systematic solution to improving overall tax compliance. Yet, especially for developing countries with few available audit resources, it is important to ensure that any audit strategy is cost-effective. Many revenue authorities have therefore moved towards a more strategic, “top down” tax compliance which seek to improve voluntary compliance through a risk-driven approach (OECD, 2006). This is based on two principles.

Firstly, the overall objective for most tax compliance frameworks is to create the environment which will best ensure *taxpayers’ voluntarily compliance*. This is illustrated in a compliance attitude pyramid (Figure 4). Taxpayers are assumed to move up or down this pyramid depending on various drivers (incl. tax information, incentives and sanctions). The main aim of revenue authorities is to employ strategies that affect these drivers in order to progressively move taxpayers down to lower levels of the compliance pyramid and ensure voluntary compliance.

This suggests that the most cost-effective way to improve compliance will likely involve a small number of high-profile enforcement activities (targeting high-risk evaders), close monitoring and reviewing of activities (for medium-risk evaders) and improved tax information and facilitation activities for the majority of taxpayers. All sanctions should also serve to remind *other taxpayers* of the risks associated with deliberate non-reporting of liabilities, but also seek to reward and facilitate their compliance (OECD, 2004; 2006).

Figure 5: A Model of Tax Compliance, (Source: OECD 2004)



Secondly, these models separate taxpayers into different priority groups. Risk-Based Frameworks (Figure 3, ATO 2014) prioritise taxpayers based on i) their likelihood of misreporting tax obligations and ii) the consequences of non-compliance (e.g. financial impacts and influence over sector tax confidence). This then leads to four taxpayer ‘types’, each with their own appropriate response.

1. **Higher risk taxpayers (high risk, big consequences).** Here, real-time deterrence is advisable. This may include continuous monitoring and comprehensive audits. This will likely be cost-effective for tax yields, and is also key for compliance signalling to other groups (see below).
2. **Key taxpayers (low risk, big consequences).** For this group, regular monitoring and maintaining close relations with such larger companies, combined with careful reminders of voluntary disclosure related to any observed errors may result in maximising tax compliance.
3. **Medium-risk taxpayers (high risk, low consequences).** For this group, detailed audits may not be cost-effective. Instead, periodical reviews and audits that focus on specific risks may be more efficient, and may help identify specific issues that can be addressed systematically.
4. **Lower-risk taxpayers (low risk, low consequences).** Monitoring these taxpayers periodically will help confirm the lower risk categorisation, but follow-up audits are often not a priority.

Figure 6: Risk-Differentiation Framework (Source: Australian Taxation Office, 2014)



5.2 How to prioritise EBM tax compliance activities

We can now explore how best to improve VAT compliance through EBMs, using such a tax compliance framework. This will be illustrated using the case of Rwanda.

Firstly, if the main aim of any EBM compliance strategy is to ensure higher self-enforcement of EBM usage, firms *need to be aware that they face a credible threat to non-usage* (see section 2.2, and Pomeranz, 2014). This requires three different elements to be in place:

- **Reliable identification of EBM non-usage:** revenue authorities need to be able to reliably and cost-effectively identify when a firm is not using their EBMs (having a firm history of ‘true’ receipts and ability to identify shifts in receipting patterns). Any EBM compliance strategy should prioritise adopting those components (e.g. receipts audits and data analytics) that best assist the revenue authority in reaching this capacity.
- **Credible threat to EBM non-usage:** revenue authorities need to be willing and able to enforce receipt issuing whenever any firm is expected not to issue receipts, and these sanctions need to be sufficiently punitive. For Rwanda, this is difficult because the first two sanctions are relatively minor (up to 20 times the VAT evaded) while the third sanction may be too grave (closing down the firm for up to 30 days) (see Table 3). As a result, firms do not mind the first two sanctions, while the revenue authority is reluctant to issue the third sanction.¹⁴ Adopting additional higher-value intermediate sanctions may assist.
- **Extensive communication strategy:** revenue authorities should communicate their focus and ability to enforce EBM receipting for any specific sector through a series of media (including flyers, radio and television). This will further facilitate voluntary tax compliance.

Secondly, prioritisation of taxpayers is more difficult for EBMs where whole sector may have low compliance and may not likely issue EBM receipts (as suggested by Section 3.3 for Rwanda). In this case, focusing intensively on improving compliance for a small sample of firms would likely place them at an unfair disadvantage (forcing them to raising prices by the full cost of VAT, while others keep evading) and may likely put them out of business. For that reason, *any strategy that seeks to enforce EBM receipt issuing should likely be pursued sector-by-sector*. Within such a strategy, there may still be room to separate all firms into one of each of the four ‘risk quadrants’.

- For the **high-risk, high-return taxpayers (market leaders)**, receipt issuing can be enforced in real-time using a three-step combination of initial benchmark audits to

¹⁴ Based on the author’s interviews, no Rwandan firm has been closed down due to non-issuing of receipts.

establish true receipting patterns, data analytics to automatically flag any firms deviating from this pattern, followed by an automatic ‘mystery shopper’ audit to sanction the firm in question.

- For all other **low-risk, high-return taxpayers**, it is helpful to keep monitoring and periodically review their receipt issuing patterns to possibly ‘remind’ them of any irregular behaviour.
- To improve voluntary compliance for **all other taxpayers**, it is key that this approach is communicated strongly and effectively to the whole sector.

After establishment, this EBM compliance approach should be relatively cost-effective, as the data analytics are partly automated, and the team of auditors can use such data to target a large number of high-risk firms to ‘mystery-shop’ each day. If successful, over time this strategy could thus even be extended to the relatively numerous high-risk, low-return taxpayers.

In sum, EBM tools can provide a very powerful way to drive up a sector’s share of firms that consistently and reliably utilise their EBM devices, and thus improve VAT compliance. However, in order to best target such EBM tools, we note that these should become part of an overall EBM compliance strategy should be seek to encourage voluntary EBM compliance, and offer different, targeted compliance interventions for different taxpayers, based on their initial risk/consequence-types. For some, there may be a need for real-time enforcement, while for others the presence of a well-communicated, credible threat to identify and tackle EBM non-compliance may be sufficient.

6. Conclusion

This paper has aimed to address what it considers a critical tax policy question for developing countries: how best to improve compliance for Value Added Taxes (VAT) using Electronic Billing Machines (EBMs). This question is critical because improving VAT compliance is arguably the core priority of tax authorities in developing countries due to its immediate promising tax yields, and because EBMs are often the primary tool identified for achieving such VAT compliance.

However, to date, the overall effect of EBMs on tax yields has been disappointing. This paper argues that this is primarily because EBMs do not offer a true third-party tax reporting mechanism (such as is often the case for employer-reported wage income), because firms can choose not to use EBMs to issue receipts or choose to issue false receipts. However, we argue

that EBMs still offer an important mechanism for compliance by producing the necessary data to ‘spot’ EBM non-compliance.

We argue that the best way to use EBMs to improve VAT compliance is to introduce them alongside two complementary interventions: receipt audits and data analytics. Receipt audits help directly increase EBM receipt issuing, and help establish a ‘true’ pattern of firms’ EBM usage. Examples of such receipt audits include consumer audits (e.g. tax receipt lotteries), benchmark audits (which help establish a general pattern of daily receipts) and mystery shopping audits (where plain-clothed auditors inquire if consumers have received an EBM receipt and otherwise sanction a firm). Targeted data analytics are key to identifying irregular patterns and thus spotting non-compliance early on. An example of this in Rwanda comes from a designated ‘EBM Data Portal’, which aims to automatically clean, organise, and filter real-time EBM data to produce a compliance dashboard that notifies the Rwandan Revenue Authority of suspicious firm-level EBM behaviour (e.g. a large drop in a firm’s average number of receipts issued). Finally, we note that the most powerful tools combine these two features. This could possibly be pursued by offering firms prefilled VAT returns, or sending out automated taxpayer feedback based on suspected non-usage of EBM devices.

We further note that to best encourage EBM compliance, firms need to be aware that they face a credible threat from non-usage of EBMs. To ensure this, revenue authorities should develop the ability to enforce EBM receipt issuing in real-time for high-risk taxpayers. This can be done using a three-step combination: initial benchmark audits to establish true receipting patterns, data analytics to automatically flag any firms deviating from this pattern, followed by an automatic ‘mystery shopper’ audit to sanction the firm in question.

This new approach to improving EBM compliance is currently piloted in Rwanda, where the International Growth Centre is supporting the Rwandan Revenue Authority to strengthen its capacity to develop receipt audits, and establish an EBM data portal. The overall results from this will be closely monitored, and provide a leading direction for tax compliance research in sub-Saharan Africa.

In sum, by integrating cutting-edge technology and data-driven approaches into tax collection systems, we believe that this approach can offer an important way for sub-Saharan African governments to leap-frog into significantly improving their tax administration abilities.

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