Preventive Medicine 167 (2023) 107408

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Appraisal of Kenya's excisable goods management system using interrupted time series analysis: A case of cigarettes and cigars excise tax revenue

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ARTICLE INFO

Keywords:
Illicit trade
Tobacco
Cigarettes
Track and trace systems
Excise tax
Developing countries
Africa
Kenya

ABSTRACT

The government of Kenya introduced the Excisable Goods Management System (EGMS) in November 2013, which is a form of Track and Trace Systems (TTSs) for excisable goods, including cigarettes and cigars. This study appraised the EGMS with a focus on its impact on cigarette and cigars excise tax revenue and possibly control of related illicit trade in Kenya. Illicit trade in cigarettes and cigars pose significant health risks owing to increased access to tobacco products, besides contributing to loss of government revenues. The study utilised an Interrupted Time Series Analysis (ITSA) to assess impacts of the EGMS on monthly cigarette and cigars real excise tax revenue over the period April 2013 to March 2017. The results show that the difference between the pre-intervention and post-intervention slopes of the real excise tax revenue was positive and statistically significant, suggesting a change in excise tax revenue trends. The hypothesis of an immediate level change in excise tax revenue was however not supported, possibly due to the initial implementation challenges that dampened a 'jump' in real excise tax revenue. These findings suggest that TTSs need to be complemented by sustained efforts to achieve maximum compliance levels and impact in both the short term and the long term.

1. Introduction

Illicit trade in tobacco products present adverse socio-economic challenges including public health consequences, environmental and social harm, including those resulting from consumption of substandard products (European Union, 2015). Cross-country studies reveal that eliminating illicit cigarettes reduce its consumption while concurrently increasing tax revenues from the legal cigarettes market (Joossens et al., 2009; Goodchild et al., 2022). These impacts are higher where previously there existed higher volume of illicit cigarettes. Thus, interventions to address the challenges posed by illicit trade in tobacco and tobacco products has remained an issue of policy interest in many countries, Kenya included.

Illicit trade in tobacco products can be undertaken both by illicit and legitimate market players. Activities of legitimate players can contribute to illicit trade if they participate in unscrupulous activities such as under-declaration of production or smuggling back of products declared for exports (World Bank, 2019; Kieyah et al., 2014). The extent to which illicit trade thrives depends on multiple factors such as corruption levels, capacity and intensity of monitoring by authorities, and applicable penalties for the offences (Kieyah et al., 2014).

One of the innovative ways that is gaining prominence in addressing this challenge is the adoption of the Track and Trace Systems (TTSs), which enables real time monitoring of a product's movement throughout its supply chain from the point of production or importation to the consumers. Tracking entails monitoring products from the point of production or importation to the retail point while tracing entails the capability to identify the historical or present location of a product (European Union, 2015).

The TTSs have been applied in various areas including in tracking and tracing of shipments of goods (Shamsuzzoha and Helo, 2011); the supply, and distribution of food products (Aung and Chang, 2013); and tobacco products (Tayyan, 2013; European Union, 2015). Owing to these applications, TTSs have become indispensable tools to combat illicit trade in tobacco products (European Union, 2015; World Health Organization, 2013a).

Tobacco control initiatives acknowledge the potential role of TTSs in tackling illicit trade (World Health Organization, 2013b; Gallagher et al., 2020). Some of these global initiatives include the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) and the Protocol to Eliminate Illicit Trade in Tobacco Products (PEITTP) (World Health Organization, 2003, 2013b). These two policy

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https://doi.org/10.1016/j.ypmed.2022.107408
Received 12 September 2022; Received in revised form 18 December 2022; Accepted 27 December 2022
Available online 29 December 2022

initiatives require Parties to establish tracking and tracing system as effective measures for curbing illicit trade in tobacco products including illicit manufacturing and counterfeiting, among others (World Health Organization, 2003; World Health Organization, 2013b).

The Excisable Goods Management System (EGMS) is a form of TTS that was first implemented in Kenya in November 2013 (Government of Kenya, 2013). Selected excisable goods are required to be affixed with excise stamps to facilitate traceability. Kenya's EGMS was implemented in two phases. The first phase covering cigarettes, wines, spirits and beer was effected on 5th November 2013 (Kieyah et al., 2014); while the second phase covering bottled water, juices, soda, energy drinks and other non-alcoholic beverages, food supplements and cosmetics was effected in November 2019 (Kenya Revenue Authority, 2019a; Kenya Revenue Authority, 2019b).

Hitherto, the challenge of illicit trade in tobacco products in Kenya persisted over the years (Kieyah et al., 2014; Anti-Counterfeit Authority, 2020), triggering various policy interventions in the past, albeit with varying levels of success. Past notable interventions specifically aimed at curbing illicit trade in tobacco products were implemented in 2003, and in 2010/2011 before the introduction of EGMS in 2013. The associated success and challenges of these earlier interventions are summarised in Fig. 1, which reveals that interventions have evolved both in terms of technology used and tax structure.

Source: Authors' construct based on World Bank (2019).

The EGMS Regulations requires domestic manufacturers and importers of excisable goods to register their operations; install the EGMS in their production lines or import facilities; and affix every package of specified excisable goods with an excise stamp. The Regulation further requires the excise stamps to facilitate tracking of the excisable goods along the supply chain; and players in the supply chain including manufacturers, importers, distributors, and retailers are required to verify and authenticate the stamps and excisable goods before admitting them into their premises (Government of Kenya, 2013).

Kenya's EGMS has capabilities that facilitate use of digital excise stamps to verify products along the supply chain, giving the end consumers an opportunity to establish authenticity of products through a Quick Response code using a smartphone application. The EGMS system has three key components: Factory flow labelling and verification system; hand-held scanners that allow operators to verify authenticity of the product; and smartphone application that allows the end consumer to verify product authenticity (Fig. 2).

Source: Authors' construction.

With respect to its transmission mechanism, the introduction of the EGMS was expected to increase "declared production" of cigarettes and cigars and decrease levels of illicit trade in these products as a result of traceability capabilities. Fundamentally, the increase in declared production is through the EGMS' design feature of capturing and relaying real time production levels within production and importing firms to a central repository managed by KRA which is Kenya's national tax administration agency. This capability together with the stationing of the KRA officers at tobacco products manufacturing firms was expected to curtail under-declaration of actual production levels of cigarettes and cigars. Additionally, the rollout of EGMS, supported by enhanced market surveillance by KRA was expected to address other forms of illicit trade including counterfeits and cross border smuggling due to increased possibilities of detection.

The implementation of the EGMS was expected to not only increase the level of excise tax revenue but also alter the trend of excise tax revenue for the targeted excisable goods. All else equal, products for which the EGMS was implemented were expected to experience an increase in excise tax revenue after introduction of the system in November 2013. This was plausibly to be accompanied by a decline in the volume of illicit products.

While anecdotal evidence suggests the EGMS has yielded positive results in terms of addressing illicit trade in tobacco products (Ross, 2017), a quantitative impact assessment of this system is yet to be done with regards to its excise tax revenue enhancing role that possibly result from reduction in levels of illicit trade. The revenue enhancing role and combating illicit trade are interrelated and are generally considered to be success factors in TTSs (Joossens et al., 2009; Chaloupka et al., 2015; Goodchild et al., 2022). This study seeks to examine cigarette and cigars excise tax revenue before and after the implementation of EGMS and draw implications for research and policy. The insights gained from this study can inform policy interventions and learning experiences for other

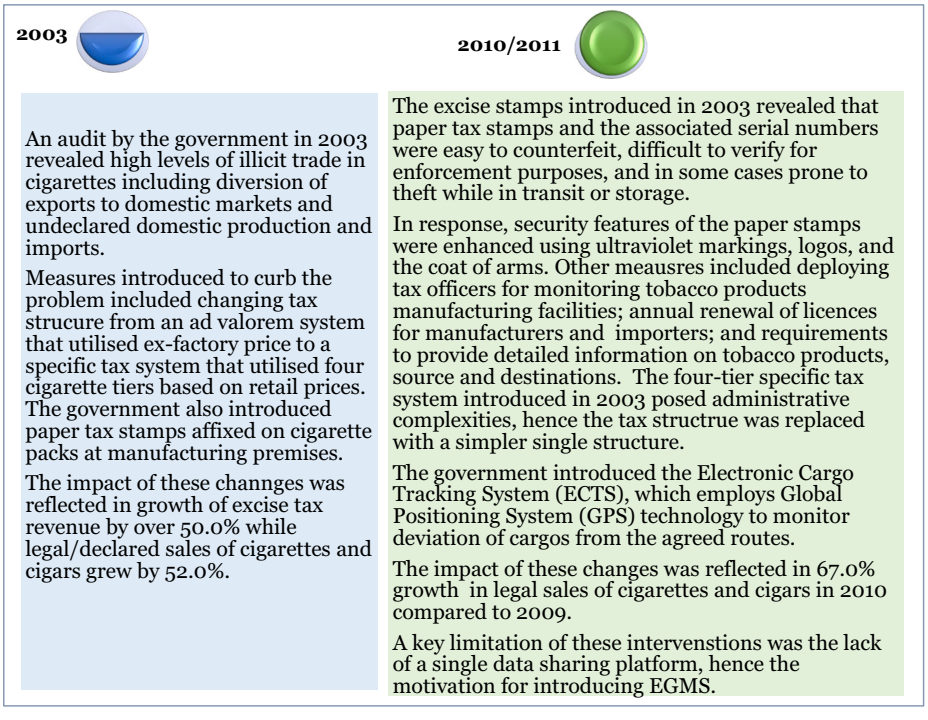

Fig. 1. Past interventions to curb illicit trade in tobacco products.

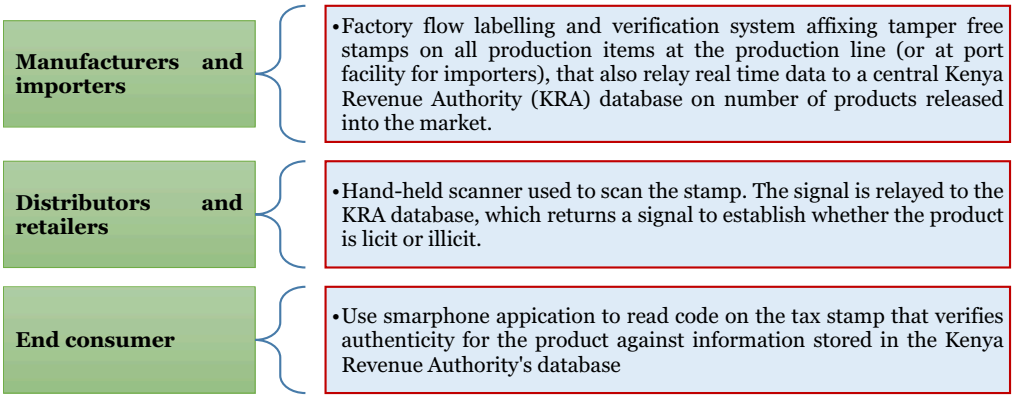

Fig. 2. Key Components of EGMS and Verification Capabilities.

developing countries that intend to roll out similar systems.

2. Methods

2.1. Empirical model

To examine the pre- and post-excise tax revenue changes, this study applied intervention analysis techniques using real excise tax revenue time series data for cigarettes and cigars, which are the main tobacco products in Kenya for which time series data is available. The assessment of impact of an intervention such as the introduction of a new regulation is usually done using randomized experiments (Angrist and Pischke, 2009; Lagarde, 2012). However, in most cases, due to study design, data, or cost related challenges, alternative study designs or quasi experimental design is the only option available to evaluate policy impacts (Lagarde, 2012). One of the quasi-experimental designs commonly used for analysing the impact of a policy change is the Interrupted Time Series Analysis (ITSA) (Box and Tiao, 1975; Lagarde, 2012; Linden, 2015; Vujić et al., 2016; Bernal et al., 2017). ITSA is used to model procedures that incorporate effects of exogenous interventions, such as policy changes, in the analysis of time series data. The approach has been used in other areas of study including in public policy and regulatory actions (Muller, 2004; Briesacher et al., 2013). More recently, the method has been applied to analyse effects of tobacco excise tax increases on smoking prevalence (Wilkinson et al., 2019; Ma et al., 2013).

There are two general ways widely used in specifying an interrupted time-series regression model that can be applied for a single series. The estimation processes can use a standard ordinary least squares (OLS) regression but in presence of autocorrelation, an autoregressive moving average (ARMA) model is applied (Linden, 2015). The OLS framework is viewed as a more flexible approach (Linden, 2015) and is therefore applied in this study. The regression model for this study was specified as follows:

$$Y_t = \beta_0 + \beta_1 Time + \beta_2 EGMS_l + \beta_3 Time^* EGMS_l + \beta_4 MAY + \beta_5 JUNE + \varepsilon_t \quad (1)$$

Where; Y_t, the dependent variable, is the real excise tax revenue of cigarettes and cigars measured monthly from April 2013 through March 2017. β_0 represents the intercept of the estimated regression equation, reflecting the measure of real excise tax revenue at the baseline level or when the independent variable, Y_t, is fixed at zero. *Time* represents the time variable and its coefficient, $\beta_1$measures the monthly average change in excise tax revenue, representing the pre-intervention trend. $EGMS_l$ is an intervention dummy that measures a possible change in level ("immediate treatment effect") of real excise tax revenue and takes values of zero in the pre-intervention period and 1 in the post intervention period. Its coefficient, β_2 measures the change in level of Y_t after the introduction of the EGMS. The interaction term of the two variables, *Time* and $EGMS_l$ and its coefficient β_3 represents the difference between the pre-intervention and post-intervention slopes of the real excise tax revenue. Thus, it measures a possible change in trend of real excise tax revenue following the intervention, which can be interpreted as a *treatment effect over time*, or simply the *sustained effect of the policy intervention*. The coefficients β_4 and β_5 measure the seasonality effects on the dummy for the months of May and June. As was established by statistical tests outline in Section in 3.2, the higher excise tax revenue during the months of May and June show presence of seasonality. Besides the coefficients discussed above, use of the *itsa* command in Stata also provides a coefficient estimate for the post intervention slope, which is reported in the results.

2.2. Data

The data on real excise tax revenue of cigarettes and cigar series spanned 48 months (from April 2013 to March 2017). The intervention point reflected by the remitted excise tax revenue is December 2013. Since excise taxes are realized by firms as transactions take place (in a specific month) but are remitted to KRA by 20th day of the following month, we aligned the collected excise tax revenue for November 2013 (when EMGS was introduced) to the period when they are expected to be remitted, that is, December 2013. Even though data was available for more recent periods, the analysis was restricted to the period up to March 2017 because there were other interventions in form of excise tax policy changes that may act as confounders. Therefore, including periods after March 2017 would comingle the tax policy change and the EGMS effects. Further, the focus of this study was only on the EGMS intervention. All excise tax data was sourced from KRA. This nominal monthly excise tax revenue was converted into real excise tax revenue using the monthly consumer price index for cigarettes using July 2013 as the base month.

3. Results and discussions

3.1. Descriptive analysis

A scatter plot is a useful data visualisation tool in time series analysis including those for intervention analysis (Bernal et al., 2017). Fig. 3 displays the scatter plot and trends of real excise tax revenue for cigarettes and cigars. The values exhibit spikes corresponding to the months of May and June, signalling seasonality as firms strive to meet tax returns compliance timelines for any pending arrears for excise tax. The dotted vertical line represents the intervention period – As noted earlier, while EGMS was introduced in November 2013 excise tax revenue for this month was remitted to KRA the following month (December 2013 in this case). Thus, the intervention period corresponds to December 2013. A plausible explanation for the spikes during the months of May and June is that excise tax revenue tends to increase in the period before the

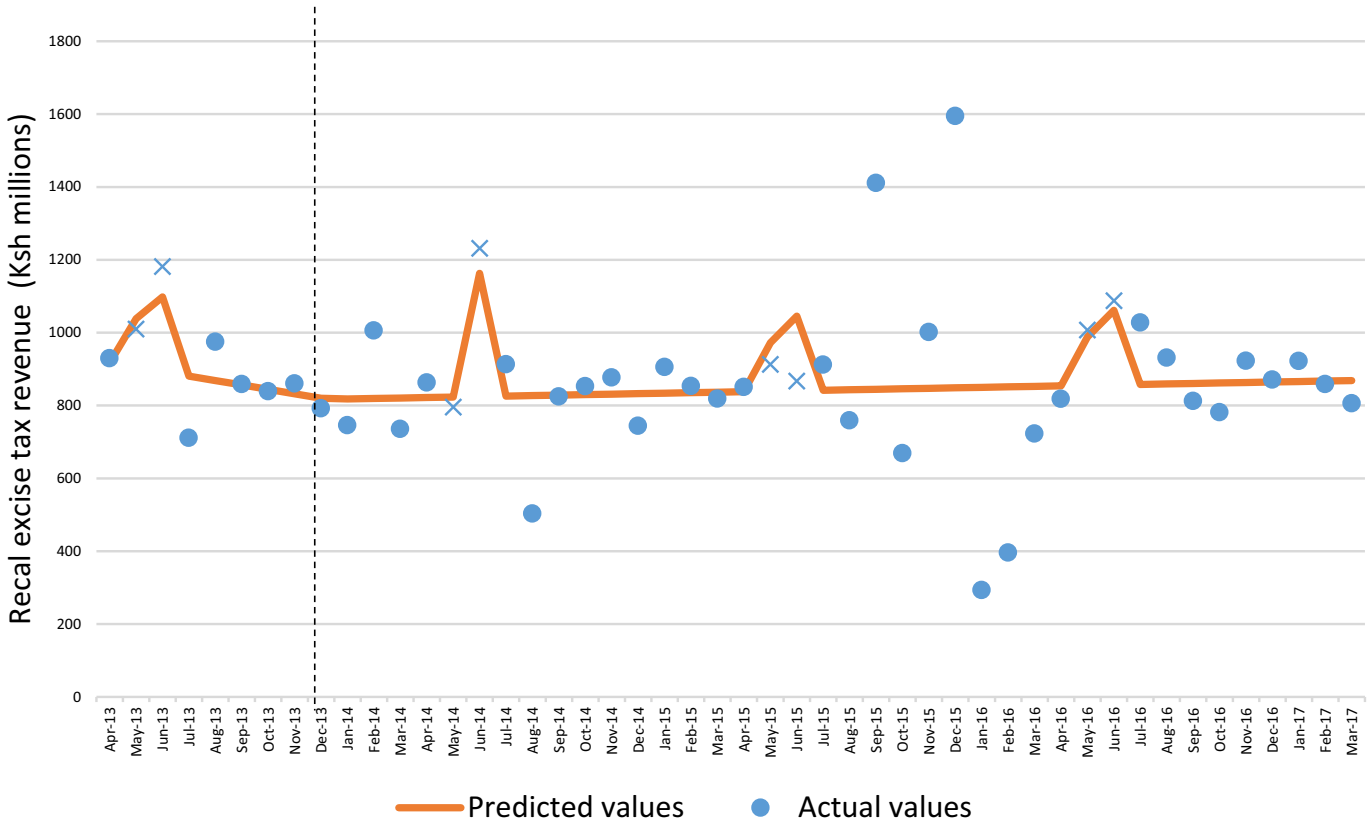

Fig. 3. Monthly real excise tax revenue for cigarettes and cigars (April 2013 to March 2017) (Ksh Millions).

end of each financial year in June. The rise in realized revenue could be associated with the intensified measures by the revenue authority to meet the annual revenue targets as well as the efforts by the firms to meet tax returns compliance deadlines. The dip in remitted excise tax revenue in the months of July could be explained by the relative slowdown in tax mobilization efforts that would be reasonably associated with a new financial year.

Data sources: Authors' illustration based on Kenya Revenue Authority (KRA) data. The spikes, which are also marked x for the actual values, correspond to the months of May and June.

The scatterplot suggests a change in trend before and post the intervention, initially downward sloping but slightly trending upwards post the EGMS intervention. A more pragmatic approach to ascertain any trend changes would be to include a variable that captures any possible trend changes in the period before and after the introduction of the EGMS. Guided by the time series scatter plot of cigarette and cigar revenue it is hypothesized that the introduction of the EGMS may have had effects on the level and trend of the real revenue.

The summary statistics are presented in Table 1. The mean monthly cigarette revenue was Ksh 876.2 million. The mean for the EGMS dummy ($EGMS_t$) of 0.8 implies that 80.0% of the observations fall after the intervention period of December 2013. The mean of 0.1 for May and June dummies reflects the fact that there were four observations each (May/June) between April 2013 and March 2017, corresponding to the points of seasonality.

3.2. Regression analysis of the impacts of EGMS

The data was tested for stationarity using the Augmented Dickey-Fuller (ADF) test which indicated that the series was stationary. The data was also checked for presence of seasonality effects. The findings indicate that the realized excise tax revenue for the months of May and June were significantly higher than the other months. Seasonality dummies for the months of May and June were therefore introduced in the model as specified in Eq. (1). Addressing seasonality in ITSA is vital as it could serve as a confounder and therefore biased results (Bernal et al., 2017; Linden, 2015). The autocorrelation function and the partial autocorrelation function processes of the real monthly excise tax revenue series exhibited exponential decay, suggesting no evidence of autocorrelation. Subsequently, the time series data for cigarettes and cigars real excise tax revenue for the period April 2013 through March 2017 was used to fit an OLS regression model of the form specified in Eq. 1. To mitigate any traces of autocorrelation or heteroskedasticity in error terms, the Newey-West standard errors were used (Newey and West, 1987). The results are reproduced in Table 2a. The F-test ($Prob > F = 0.0000$) indicates that the model as a whole has an explanatory power.

The starting level of real excise tax revenue is estimated at Ksh 917.2 million, and this was declining every month by an average of Ksh 12.1

Table 1
Descriptive statistics.

	Observations	Mean	Minimum	Maximum	Std. dev.
Real excise tax revenue (Ksh millions), *Yt*	48	876.2	293.3	1594.8	211.3
Pre-intervention trend (*Time*)	48	24.5	1.0	48.0	14
Level change dummy ($EGMS_t$)	48	0.8	0.0	1.0	0.4
Change in trend ($Time * EGMS_t$)	48	23.6	0.0	48.0	15.4
Seasonal dummy (*MAY*)	48	0.1	0.0	1.0	0.3
Seasonal dummy (*JUNE*)	48	0.1	0.0	1.0	0.3

Source: Authors' calculations based on Kenya Revenue Authority (KRA) data

Table 2a
Regression results.

				Number of observations = 48 F (5,42) = 22.57 Prob > F = 0.0000	
	Coefficient	95% confidence interval		Newey-West standard error	*P*-value
Constant	917.2	854.6	979.7	31.0	0.000
Level change dummy ($EGMS_l$)	10.0	−68.6	88.7	39.0	0.798
Pre-intervention trend (*Time*)	−12.1	−20.8	−3.5	4.3	0.007
Change in trend (*Time* * $EGMS_l$)	13.5	3.4	23.5	5.0	0.010
Seasonal dummy (*MAY*)	133.2	63.1	203.3	34.8	0.000
Seasonal dummy (*JUNE*)	205.0	77.6	332.3	63.1	0.002

Source: Authors' estimations based on Kenya Revenue Authority (KRA) data.

million within the sample period (as indicated by the coefficient of the pre-intervention trend, which is statistically significant [$P = 0.007, 95\ \%\ CI = -20.8, -3.5$]. The negative pre-intervention coefficient corroborates the downward sloping trend observed in the scatter plot in Fig. 3.

The coefficient of $EGMS_l$ (as measured by level change in Table 2) though positive was not statistically significant [$P = 0.798, 95\ \%\ CI = -68.6, 88.7$] suggesting no evidence of a change in level of excise tax revenue. This means there was no immediate intervention ("treatment") effect, possibly due to the implementation challenges that may have dampened a substantial "jump" in reported real excise tax revenue for cigarettes and cigars. Part of the initial implementation challenges related to the installation of the EGMS and compatibility in production or import facilities of the manufacturers or importers of cigarettes and cigars. The coefficient of the interaction term (Pre-intervention trend*-*Level change*) measuring difference between the pre-intervention and post-intervention slopes of the real excise tax revenue suggests a statistically significant increase in the trend of excise tax revenue relative to the pre-intervention period [$P = 0.010, 95\ \%\ CI = 3.4, 23.5$]. This means a trend effect of the policy intervention, with difference in slopes of Ksh. 13.5 million per month. This change in slopes could suggest mitigation of the initial implementation bottlenecks (which dampened immediate level change), improved monitoring along the supply chain, enhanced awareness on capabilities and benefits of EGMS by actors along the supply chain, and industry acceptance of the intervention.

The post-intervention slope was also generated using Stata's *itsa* command as a post-estimation result (Table 2b). The postintervention slope on its own is not statistically significant, though positive [$P = 0.419, 95\ \%\ CI = -1.95, 4.61$]. The statistically significant trend effect together with a positive but statistically insignificant post-intervention slope suggest that the EGMS intervention may have been successful in 'arresting' downward trend during the pre-intervention period. These findings suggest the importance of other complementary measures such as monitoring and enforcement to realise substantial growth in excise tax revenue, beyond the improvements as compared to the pre-intervention period.

4. Conclusions

Kenya introduced EGMS in November 2013, as a form of TTS for cigarettes and cigars. This study quantitatively examined how EGMS impacted on excise tax revenue for cigarettes and cigars, with implications for illicit trade in tobacco products. ITSA was used to assess possible impacts of EGMS on real excise tax revenue for cigarettes and cigars. Regarding the effects on excise tax revenue, the focus was on level and trend changes (Linden, 2015; Bernal et al., 2017) to respectively correspond to an immediate treatment effect and a sustained effect of the policy intervention. The findings indicate that there was a *trend effect* of the EGMS, but not an *immediate level change*. To realise substantial positive impacts of policy, the findings imply that TTSs need to be complemented by sustained efforts to achieve maximum compliance in both the immediate and the long-term. An important initiative is to leverage on the capabilities of TTSs and the immense opportunities articulated in its framework for tracking and tracing.

Table 2b
Results of post-intervention slope.

	Coefficient	95% confidence interval		Newey-West standard error	P-value
Post-intervention slope	1.33	−1.95	4.61	1.62	0.419

Source: Authors' estimations based on Kenya Revenue Authority (KRA) data.

Limitations of the study

Future efforts to assess impacts of track and trace systems like EGMS need to embrace complementary avenues. In the context of the current study, there were no available surveys on the levels of illicit trade in cigarettes and cigars within the Kenyan market, to provide complementary empirical evidence on waning levels of illicit trade following the EGMS intervention. Nonetheless, changes in excise tax revenue servea as a signpost for possible impacts of EGMS. Future studies can seek to bridge this gap. Other countries seeking to embrace TTS should consider implementing surveys as a means to providing corroborative evidence on levels of illicit trade following such interventions.

Disclosure of funding and Conflict of interest

There is no known conflict of interest in undertaking this study. During the early stages of this work, financial assistance was provided by the African Capacity Building Foundation (ACBF) as part of capacity building on policy research towards tobacco control.

Credit author statement

Adan Guyo Shibia: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Writing - original draft, Writing - review and editing. Boaz Munga: Conceptualization, Data curation, Formal analysis, Methodology, Writing - original draft, Writing - review & editing. Eldah Onsomu: Conceptualization, Methodology, Writing - original draft, Writing - review and editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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