Beer Taxation in Kenya: An Assessment

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Abstract

In Kenya, excise taxes on beer contribute a significant share of government revenue. The government is therefore interested in establishing the optimal excise tax rates for the different types of beer—lager and stout. The optimal tax rate means that the government maximizes revenue from beer taxation. This paper attempts to show the revenue-maximizing tax rate in the beer subsector in Kenya. The study uses two methodological approaches to derive the price elasticity necessary in computing the revenue-maximizing tax rate. The first methodology is the partial-adjustment model. While this model has been found to provide satisfactory estimates of demand elasticity, it does not take into account persistence in consumer behaviour. The second approach takes into account persistence in consumer behaviour and hypothesizes that consumers have a strong memory. The study underpins the importance of a time horizon in evaluating the revenue-maximizing tax rates and confirms the argument that the short-run price elasticity is not appropriate for making policy choices. In addition, the study demonstrates that the assumption about the shape of the demand curve has important implications for the revenue-maximizing tax rate. The conclusion from the study is that there is need to carefully evaluate beer taxation in the country. The study results suggest that lowering the taxes on beer is likely to increase the level of production with subsequent increase in tax revenue.

Contents

List of tables and figures

Abbreviations

GLS	generalized least squares
M0	money outside banks
OLS	ordinary least squares
PAM	partial-adjustment model
RLBEER	representative aggregate lager beer
SEAS	seasonal dummy
SUR	seemingly unrelated regression
VAT	value-added tax

Executive Summary

Objective

In Kenya, excise taxes on beer contribute a significant share of government revenue. Furthermore, the relative importance of excise revenues from beer has increased over time. In 1990, excise revenue from beer and spirits accounted for 14.2% of non-oil excise duty revenues. By 1998, this figure had increased to 58.1%. The brewing industry is also an important player in the economy as a major employer and source of other government revenue from value-added and corporation profit taxes. For a government that has a limited tax base, revenue from beer taxation is highly valued. The government is therefore interested in establishing tax rates that maximize revenue from beer.

Methodology

The task of determining revenue-maximizing excise tax rates involves estimating the statistical relationship between beer demand and tax revenue. From economic theory, the demand for a good depends on the price of that good, the price of related goods and consumer income. Estimation of the statistical relationship for the determinants of beer demand gives elasticities that are important in determining the effect that changing taxes would have on beer demand and hence revenues. The price elasticities that are obtained from the demand model are used to compute the revenue-maximizing tax rates. By treating lager and stout beers as substitutes for each other, this paper estimates separate models for the demand for lager and stout beers. Revenue-maximizing tax rates for lager beers are then computed from the estimated price elasticities.

The link between price elasticities and revenue is straightforward. If the demand for beer is price elastic, then a small increase in the price of beer translates into a proportionately larger decline in the demand for beer. To the extent that excise taxes have the result of increasing prices, then a change in taxes will have an inverse effect on revenues (that is, an increase in tax rates results in lower revenues and vice versa). On the other hand, if the demand is inelastic, an increase in the price translates in a proportionately smaller decline in the demand for beer. Consequently, tax changes will have a positive effect on revenues (an increase in tax rates results in increases in revenue and vice versa).

In evaluating the revenue-maximizing tax rates, it is important to take into account the time element: of short run versus long run. In the short run, price changes may have only a limited impact on the quantity of a good consumed. But as time progresses, consumers adjust so that they substitute away from the relatively more expensive goods. Short-run price elasticities are therefore not appropriate for making policy choices. In this study, long-run price elasticities are used to compute the revenue-maximizing tax rates.

The study uses two methodological approaches to estimate the demand for lagers and stouts. The first is the partial-adjustment model, which also replicates studies done in Kenya (see Okello 1997). While this model has been found to provide satisfactory estimates of demand elasticities, it does not take into account persistence in consumer behaviour. The second method takes this persistence into account and hypothesizes that the current consumption of beer is dependent on present and past own-prices, cross-prices and income. That is, consumers have a strong memory.

In empirical estimation, assumptions made should be clearly understood. In establishing the revenue-maximizing tax rates, it is important to keep in mind the assumed functional form of the demand curve. Two extreme cases can be considered: linear and constant elasticity demand curves. Both of these curves may be viewed as extreme, with the relevant demand curve somewhere between the two. The assumption about the shape of the curve has important implications.

Empirical estimates of the revenue-maximizing tax rates

Currently, lager beer attracts an excise tax at the rate of 85%. The results of the current study show that, assuming constant elasticity of demand, the partial-adjustment model yields a revenue-maximizing rate of 89.3% while the dynamic model gives a rate of 62.5%. The evidence suggests that the revenue-maximizing tax rate is probably between 62.5 and 89.3%. Theoretically, the dynamic model that takes into account persistence in consumer behaviour is more plausible than the partial-adjustment model. Thus, the revenue-maximizing rate may be much closer to 62.5 than to 89.3%.

If a linear demand curve is assumed, then much lower revenue-maximizing tax rates are obtained (23.6 and 19.2% for the partial-adjustment and the dynamic model, respectively). While the linear demand curve may not be a good approximation, the true functional form is likely to be between the two curves assumed. This would suggest that revenue-maximizing tax rates are likely to be lower than the current rates.

Conclusion

The evidence emerging from this study suggests that beer taxation needs to be carefully evaluated and that lowering the taxes on beer is likely to increase the level of production with subsequent increase in tax revenue. The study also suggests that the country's tax structure needs to be carefully evaluated, taking a general equilibrium approach so that revenue, employment and production effects are taken into account. This may be considered the long-term goal of effective taxation in Kenya.

1 Introduction

The Kenya government generates a significant amount of revenue each year from indirect taxes. These taxes include import duties, value-added taxes on domestic and imported manufactured goods, excise duties, export duties, licence fees and specific levies. As shown in table 1, the Kenya government generated excise tax revenue equivalent to 18.6% of total tax revenue in the 1996/97 financial year and an estimated 19.5% for 1997/98. Of the indirect taxes collected by the government, excise taxes contributed 30.1% of the total in 1996/97 and an estimated 31.5% in the 1997/98 financial year.

Table 1. Magnitude of excise taxes in Kenya

Financial year	Proportion of excise tax in total revenue	Proportion of excise taxes in indirect taxes
1989/90	8.2	12.1
1990/91	8.8	13.3
1991/92	13.8	21.0
1992/93	13.6	20.2
1993/94	11.8	19.4
1994/95	17.9	29.9
1995/96	18.4	30.3
1996/97	18.6	30.1
1997/98	19.5	31.5

Source: *Statistical abstract* (Kenya. Central Bureau of Statistics 1995, table 185(a)) and *Economic survey* (Kenya. Central Bureau of Statistics 1999, table 6.4)

Goods selected for excise coverage typically exhibit one or more of the following characteristics as summarized in McCarten and Stotsky (1995). First, the government closely supervises their production and sales, that is, they are sumptuary goods or services. Second, they are characterized by price-inelastic demand schedules. The commodity must have low price elasticity, or consumers will shift from taxed to non-taxed substitutes and little revenue will be obtained, with potential excess burden. Third, they have an income elasticity of demand greater than unity; that is, they are luxury goods or services. In terms of progressivity, the basic rule is that excise taxes should be applied to commodities with high income elasticity of demand; that is, as income rises consumption rises by a greater percentage (Due 1994). Fourth, the government regards their consumption as lacking merit or as likely to cause negative externalities or source of income. In other words, as noted in Bolnick and Haughton (1998), when the use of a good or service causes negative externalities the standard prescription is to levy a Pigovian (corrective) tax, which forces the supplier to internalize the costs of the negative side effects. Thus, excise taxes levied on particular goods and services are typically with discriminatory intent.

Apart from the characteristics noted above, there are three key reasons why a set of commodities or services is selected for excise taxation. The most compelling reason is to generate revenue for the government. Another reason is that the commodity is seen as a sumptuary good and so the excise tax is intended to internalize negative externalities generated by the consumer. Lastly, the excise tax may be used as a tool for improving vertical equity.

The Kenya government generates a significant amount of its indirect tax revenue every year from the taxation of beer through excise duty and the value-added tax. The key tax levied on beer is the excise tax. It is at an ad valorem rate (tax according to the value of a good) rather than being levied at specific rates on the volume of domestic production, as was the case before. Bolnick and Haughton (1998) note that with the evolution of excise taxes from specific rates to ad valorem rates, they are levied on domestic consumption rather than production. Table 2 shows the percentage share of total excise revenue collections in Kenya between 1990 and 1998 by commodity. The contribution of beer is evidently rising in the contributory share of beer and spirits from 14.2% in 1990 to

Table 2. Excise revenue by commodity (percentage share) in Kenya, 1990–1998

Commodity	1990	1991	1992	1993	1994	1995	1996	1997	1998
Beer and spirits	14.2	32	53.4	57.9	55.5	56.1	56.9	56.8	58.1
Sugar	12.9	10.5	4.4	4.2	0.0	0.0	0.0	0.0	0.0
Cigarettes	72.4	53.5	32.2	37.3	37.2	35.6	34.8	35.2	34.7
Others	0.5	4.0	10.0	7.0	7.3	8.3	8.3	7.9	7.1

Source: *Statistical abstract* (Kenya. Central Bureau of Statistics 1995, table 184) and 185(a)) and *Economic survey* (Kenya. Central Bureau of Statistics 1999, table 6.6).

58.1% of excise duty revenues by 1998. The contribution of cigarettes on the other hand has fallen over the period from a share of 72.4% in 1990 to 34.7% in 1998.

Apart from being a source of tax revenue, producing beer in Kenya also generates jobs directly as well as both upstream and downstream. Manufacturing beer in the country contributes to the economy by creating jobs in other direct and indirect ways in the following subsectors:

- retail outlets where a large number of people are employed in bars, restaurants and hotels
- distributors and stockists of beer produced in the country
- farmers who supply the barley required for the malting process
- contractors and transporters in the wholesale and retail trade and barley-growing sector
- suppliers to the beer manufacturing plants including printers, detergent manufacturers, advertising agencies and those involved in other tertiary activities

Currently, lager beer in Kenya attracts an excise tax at the rate of 85% while stouts are taxed at 60%. McCarten and Stotsky (1995) observe that high rates of taxation should not be applied in developing countries on those sumptuary goods with low-income elasticities of demand because the resulting tax burden is highly regressive and because the exhibited low price elasticities defeats the putative intent of deterring consumption. On the other hand, if the tax on a particular commodity is set high enough, the revenue yield of the tax declines because sales of the commodity decline. This is because the whole tax is usually borne by the consumer.

The near universal assumption is that excise taxes, by adding to the cost of producing the particular items, will be reflected in higher prices, under usual competitive conditions, and thus will be borne in relation to consumer spending on the items (Due 1994). Due (1994) notes that this has been shown to be an oversimplification, because of the possibility of shift in factor prices as demand for the taxed products falls, particularly in a relatively open economy.

A revenue-maximizing tax rate lies at some intermediate point between the high rate resulting in tax revenue decline and a zero rate. At a rate below the revenue-maximizing tax rate for sumptuary goods, increasing the rate both enhances revenue and depresses consumption. Once the revenue-maximizing tax rate has been exceeded, a trade-off between the two goals emerges and policymakers must identify the relative importance they attach to generating additional revenue and reducing consumption.

Clearly, the beer industry is important in Kenya both as a source of revenue for the government and as an employer in the economy. Assuming that the government's objective in levying the excise tax is to generate revenue, determining whether the current rate of excise tax is the revenue-maximizing rate becomes important. In other words, if the central purpose of excise taxation is to raise revenue, then it must be done in a reasonably non-distorting, equitable and sustainable way and above all, it must raise the maximum revenue possible. And as pointed out earlier, Bolnick and Haughton (1998) show that for a tax system to continue to raise adequate revenue, it helps if taxes are income elastic.

This study attempts to show the revenue-maximizing excise tax rate in the beer subsector in Kenya. Domestic beer manufacturers insist that the government could maximize revenues if the rate of excise tax on beer were lower than the current levels. For example, Bolnick and Haughton (1998) found that as a fraction of the pretax retail prices for 17 sub-Saharan Africa countries, the excise tax was about 75% on beer in 1993. This rate is much lower than the high rate of 85% of the excise tax on Kenyan beer. This may indicate that there is scope for change in policy and tax administration to lower the excise tax rates. In their agenda for research, Bolnick and Haughton (1998) pose the question of whether the excise tax rate exceeds the revenue-maximizing levels, in which case can higher revenues be achieved with lower tax? An answer is needed to determine the revenue-maximizing tax rates, and thus to assess whether excise rates sometimes go beyond this revenue-maximizing point. The answer to this question could be country dependent. Hence the importance of this study and its application to the excise taxes on beer in Kenya.

Three important derivatives from this exercise become important. First, if the revenue-maximizing excise tax is lower than the current rate, it calls for lowering the tax rates to increase the revenue base. Second, as the economy is facing a lengthened recession, it is advisable to reduce some of these taxes to stimulate production and consumption, as long as the changes in tax revenue will be insignificant. In the long run, it will increase tax revenue. Understanding the appropriate size of the price elasticity for beer will determine whether tax revenue falls or rises in the short run.

A reduction in the beer tax would reduce the price of beer. This reduction would give rise to generally stronger economic activity. New jobs would be created and a stronger economy would significantly reduce the cost of the tax decrease to the government treasury. If beer consumption and the economy are unaffected by the tax reduction, the government budget deficit would be increased. One would, however, expect increased beer consumption. The increase in beer consumption would somewhat mitigate the decrease in tax receipts, and more importantly, stronger economic activity would boost other taxes.

Several elements would play a significant role in reducing the cost to the Treasury. Income and payroll taxes would increase as the economy strengthens and employment rises; corporate profit taxes would increase as profits grow; and government spending might be reduced because of lower inflation and reduced unemployment. These results would not only derive from the immediate reduction in the price of beer but also from the multiplicative effects as the initial impact ripples into other areas of the economy. Initially, the increased demand for beer benefits the domestic brewing industry and the wholesalers and retailers of its products. Suppliers to the industry benefit as well, particularly the glass and metal container industries. Real output in all these sectors would rise, and employment gains would follow. It is important to take into account the dynamic effects that would work through the economy in this period of low economic activity.

Current assessments of revenue loss or gain are based on structural parameters (elasticities) that may have been affected by structural changes in the economy. It is necessary in this study to take into account the structural (long-run) elasticities and the short-run elasticities that determine short-run adjustments and then to re-estimate in light of these structural changes in the economy.

2 Theoretical Demand Model for Lager and Stout Beer in Kenya

What is the effect on revenue from changes in excise tax rates? To determine the revenue-maximizing tax rate, it is important to know the price elasticities for beer. One needs to estimate the elasticities of demand and supply. Hence, as a starting point, the study will formulate and estimate a beer-demand model. It needs to be mentioned that the income elasticities also provides information in regard to sensitivity of beer consumption to taxes. The feeling is that the revenue-maximizing tax rate may also be dependent on income elasticities. Hence, the beer-demand model must incorporate a mechanism that can determine income elasticities. This, we feel, may be the weakness found in previous estimations of beer-demand equations in Kenya. However, a real problem arises—how does one capture income, considering that people in both the formal and the informal sector consume beer? The latter's income may not be reflected in the published statistics. This approach argues that the price elasticities of interest varies with the information set included in the model. Therefore, we must move from a simple elasticity estimation method and strive to include as much information as may be necessary or available.

Since the ad valorem excise tax is different for stout and lager beer, separate demand equations will be estimated for each of these two types of beer.[1] The own-price demand elasticity for beer can then be used to calculate the elasticity of excise tax revenue with respect to the tax rate. This empirical assessment will take care of both long-run and short-run elasticities. With these elasticities, the effect that reducing the current excise tax rate would have on government revenue can be shown, as is argued by local beer manufacturers.[2]

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[1] A more elaborate method would be to estimate a system of beer-demand equations for the different brands of lager beer. This would take care of the substitution effect of consumers switching from one brand to another. The likely difficulty in this approach is that the time-series data might have gaps, depending on when the brand was introduced in the market.

[2] McCarten and Stotsky (1995) note that the elasticity of excise tax revenue with respect to the tax rate is equal to one plus the own-price

The starting point in determining the effects of changing the excise tax rate is to adapt a simple economic model for beer demand similar to the one presented in Griffiths et al. (1993). From the theory of consumer choice, the demand for a good will depend on the price of that good, on the prices of other goods, particularly substitutes and complements, and on income. For beer, it is reasonable to relate the quantity demanded to the price of beer, the price of other liquor, the price of all other remaining goods and services, and income. Algebraically, the relationships for the lager and stout beer are as presented below:

$$q_{LB} = f(p_{LB}, p_{SB}, p_L, p_R, y) \tag{1}$$

$$q_{SB} = f(p_{LB}, p_{SB}, p_L, p_R, y) \tag{2}$$

where

q_{LB} = demand for lager beer

q_{SB} = demand for stout beer

f = functional form of demand relation

p_{LB} = tax-inclusive price of lager beer

p_{SB} = tax-inclusive price of stout beer

p_L = tax-inclusive price of other liquor

p_R = price of all other remaining goods and services decomposed from the consumer price index

y = disposable income[3]

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elasticity for the excisable commodity times the share of tax in the tax-inclusive price.

$$(\partial R/\partial t)(t/R) = 1 + \eta(t/P)$$

where η is the own-price demand elasticity.

[3] Given monthly data on beer demand and prices, the issue arises of what measure of disposable income to use. Current data on disposable income in Kenya are from national accounts. However,

The price of beer and other liquor is tax inclusive. Estimation of the model will give the relevant own-price, cross-price and income elasticities, which are important in determining the effect lowering excise taxes would have on beer demand and hence government revenue. An additional explanatory variable that can be included in the above model is one that captures the demographic structure. For instance, the consumption of beer can be estimated as a function of the proportion of the adult (21+) population that is aged 21 to 29, and the proportion aged 30 to 39. Both these terms are important in explaining per capita beer consumption. The impact of an increase in the proportion of the 21–29-year-olds in the adult population and the increase in the proportion of 30–39-year-olds may be significant variables in the model.

The current high tax rates on excisable products are seen as reflecting price-inelastic demand. For beer, that means that high taxes would not much deter consumption. If alcohol taxes rise, total spending on alcohol by the household will rise (because the demand is inelastic). This needs to be investigated for Kenya. Before quantifying the above relationships, we need to specify a particular functional form for *f*. Using the natural logarithms, the commonly used log-linear functional forms for demand relations are

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this study explored the possibility of using average earnings from the public and private sectors by finding if there are surveys of average earnings in the informal sector from which net out income taxes. The appropriateness of this approach needs to be explored further. Further, presence of informal sector income may understate the income elasticities. To remedy this, the question was asked whether beer consumption depends on permanent or current income. With a large informal sector, this becomes problematic in the model. One therefore can supplement the estimation by using a proxy measure for current income geared towards consumption, that is money outside banks (M0).

$$\ln q_{LB} = \beta_{11} + \beta_{12} \ln p_{LB} + \beta_{13} \ln p_{SB} + \beta_{14} \ln p_L + \beta_{15} \ln p_R + \beta_{16} \ln y \qquad (3)$$

$$\ln q_{SB} = \beta_{21} + \beta_{22} \ln p_{LB} + \beta_{23} \ln p_{SB} + \beta_{24} \ln p_L + \beta_{25} \ln p_R + \beta_{26} \ln y \qquad (4)$$

The first subscript on the β coefficients refers to the equation while the second subscript refers to the variable. That is, β_{ij} is the coefficient of the *j*th variable in the *i*th equation. Models 3 and 4 are convenient because they preclude infeasible negative prices, quantities and income, and because the coefficients are in the form of elasticities. It is also hoped that the models will be adequate in explaining beer consumption in Kenya. From the foregoing, it is apparent that estimating standard demand elasticities is relatively straightforward and can be based on time-series data. However, Bolnick and Haughton (1998) issue a word of caution that determining revenue-maximizing tax rates is sensitive to the functional form of the demand curve. The first objective is to estimate the parameters β_{11}, β_{12}, . . . β_{26}. Except for the intercept parameters, all these parameters are elasticities.

A relevant piece of non-sample information can be derived for the beer demand models: if all prices and income go up by the same proportion, no change would be expected in the quantity demanded. This reasonable result has been shown to hold true in household-demand theory. It can be imposed in the models through the restrictions requiring that

$$\beta_{12} + \beta_{13} + \beta_{14} + \beta_{15} + \beta_{16} = 0 \qquad (5)$$

$$\beta_{22} + \beta_{23} + \beta_{24} + \beta_{25} + \beta_{26} = 0 \qquad (6)$$

Thus it is possible to say something about how quantity demanded should not change when prices and income change by the same proportion, and this information can be written in specific restrictions on the parameters of the demand models.

The foregoing economic models are a good basis for specifying corresponding statistical models, which with appropriate data can be used to examine the estimates from sample information. To turn equations 3 and 4 into statistical models, random error terms are introduced and assumptions made about the probability distribution of the error terms. These random errors could reflect demand or consumption shocks hitting the beer market. Including subscript *t* to denote the *t*th observation, the statistical models can be written as

$$\ln q_{LBt} = \beta_{11} + \beta_{12} \ln p_{LBt} + \beta_{13} \ln p_{SBt} + \beta_{14} \ln p_{Lt} + \beta_{15} \ln p_{Rt} + \beta_{16} \ln y_t + e_{1t} \qquad (7)$$

$$\ln q_{SBt} = \beta_{21} + \beta_{22} \ln p_{LBt} + \beta_{23} \ln p_{SBt} + \beta_{24} \ln p_{Lt} + \beta_{25} \ln p_{Rt} + \beta_{26} \ln y_t + e_{2t} \qquad (8)$$

Using matrix notation usually applied for linear models, the models become

$$\mathbf{y}_i = \mathbf{X}_i \beta_i + \mathbf{e}_i , \; E[e_i] = 0 \text{ and } E[e_i e_j^{'}] = \sigma_{ij} I , \; i, j = 1, 2. \qquad (9)$$

The assumptions about the models are as follows. First, disturbances have a zero mean. That is, we anticipate that shocks will be short lived and will not have a strong memory. Second, in a given equation, the disturbance variance is constant over time, but each equation can have a different variance. Third, it is assumed that two disturbances in different equations but corresponding to the same period are correlated (contemporaneous correlation). Lastly, disturbances in different periods, whether they are in the same equation or not, are uncorrelated, that is, autocorrelation does not exist.

3 Empirical Estimates of Demand for Lager and Stout Beers

The statistical model resulting from the economic model is a system in which more than one regression equation can be estimated. The equations in such a system may appear unrelated in the sense that they can each be estimated separately using ordinary least squares (OLS). However, Zellner and Theil (1962) showed that efficiency could be achieved by combining a number of equations that, at first glance, seem unrelated. That is, it is possible to improve on separate OLS estimation if the disturbances in each equation are correlated across equations in the seemingly unrelated regression (SUR) equations. Contemporaneous correlation is often a reasonable assumption. Since two demand equations are being considered in this study, it is quite likely that, in a given period, any omitted factor will have a related effect on the two equations. However, if the beer demand system of equations fulfils one of the two conditions under which OLS is identical to the generalized least squares (GLS), then there is nothing to gain by treating the equations as a system. It can be shown that OLS and GLS will yield identical results as long as the explanatory variables in each equation are identical. In such a case the long-run (structural) elasticities necessary for determining the revenue-maximizing excise tax rate would have to be estimated using OLS if the assumptions about the homoskedastic and non-autocorrelated error terms in the model hold. This is, however, an empirical question, and the approach followed is first to estimate single equations of lager and stout beers and if then necessary to combine the two into a system.

3.1 OLS estimation of demand for lager beer

From the foregoing discussion, the first step in assessing whether the current excise taxes are high is to estimate the price elasticities for lager and stout beer and then compute the revenue-maximizing tax rate. Several brands of lager beer are available in Kenya. The brands produced by East African Breweries Limited (EABL) have been chosen for this study, given that the company has been present in Kenya over the years. Monthly data for the sales and prices of beer brands that EABL produces were used, covering the period from January 1990 to December 1998. A representative brand for the lager beers was chosen—Tusker 500 ml, which has a consumption market share of close to 40%.

Following on from the proposed theory, a demand function was estimated for Tusker beer as a function of own-price, cross-price and a proxy for income. The results are given below:

$$\ln q_{LBt} = \underset{(2.12)^{**}}{2.82} - \underset{(-5.75)^{*}}{1.10}\ln p_{LBt} + \underset{(3.32)^{*}}{0.72}\ln p_{SBt} + \underset{(2.24)^{**}}{0.45}\ln m0_t + \underset{(1.67)}{0.31}\ln p_{Rt} + \underset{(6.80)^{*}}{0.46}\ln q_{LB,t-1}$$

$$-\underset{(-3.99)^{*}}{0.01}T + \underset{(5.55)^{*}}{0.19}SEAS - \underset{(-4.30)^{**}}{0.39}D954$$

n = 107; R^2 = 0.89; RBAR^2 = 0.88; D-W = 1.70; Jarque-Bera LM normality test: chi-square = 1.54 with 2 degrees of freedom; RESET (2) = 0.12 – $F(1,97)$; t-statistic in parentheses, * and ** significance at 1 and 5%, respectively.

The estimation results of the demand for lager beer, Tusker in this case, show the expected sign that all are significant at 1 and 5% levels except for the price of all other goods captured through the consumer price index. Diagnostic tests of the estimation indicated that the parameters were more stable when a seasonal dummy (SEAS) rather than a period-specific dummy was used. Thus, a seasonal dummy for the festive Christmas period was found highly significant. A trend variable (T) was also important in diagnostics, especially the normality and specification tests, as it was significant at the 1% level. The trend variable was introduced in the estimation, as it was clear from the examination of the data that quantity of beer consumed was dependent on time.

The results show that Tusker beer is price elastic with an own-price elasticity of –1.1. This is similar to the elasticity estimate by Okello (1997). Therefore, since excise taxation has a direct effect on prices, a change in the taxation level, assuming other factors remained constant, would have an inverse effect on beer sales. That is, a 1% increase (decrease) in price as a result of excise tax variation would lead to a 1.1% decrease (increase) in the volume of beer consumed. The cross-price elasticity on the other hand with stout beer (Guinness) is 0.72, which is higher than the 0.3 given in Okello (1997). The implication is that, all other things being equal, a variation in the price of stout beers does not have a more than proportionate movement in the demand for lager beers. Hence, reducing the tax on stout beers by 1% would only lead to less than a proportionate 0.72% increase in consumption of lager beer, implying a subdued substitution effect.

Another important result is the income inelasticity of the lager beer. Income in the model is proxied by the money in circulation outside banks, that is M0, as the decision to drink is influenced more by what people have in their pockets than by their wealth. Thus it is anticipated that beer consumption is driven more by current income rather than wealth. Moreover, M0 covers the whole economy as opposed to the total wage payment data, which covers only the formal sector employment. Use of the total wage payments instead of M0 showed a negative and significant relationship between lager beer sales and income. This was counterintuitive, hence the decision to use M0 as the proxy for income.

At this juncture it is important to mention that the estimation of the beer demand would have benefited enormously had disaggregated time series of data on sectoral incomes been available.[4] The distribution of income appears to have worsened as suggested by real wages in the formal sector increasing, while real incomes in the informal sector have declined. Assuming that informal sector consumers have higher income elasticities than the formal sector beer consumers, then beer consumption could have declined sharply in the informal sector as real income has declined. This decline could be even faster than would be suggested by aggregate income figures. Diagnostic test for structural breaks through the Chow test (CUSUM and CUSUMSQ tests), which would answer this question, would not be valid for this model because of the existence of a lagged dependent variable. Nor, because of the lagged dependent variable, would the recursive estimation be valid; it runs a series of regressions by adding one observation per regression and is also used for tests of structural change and its accompanying printed recursive residuals and CUSUM tests. We are therefore left with the Jarque-Bera asymptotic LM normality test and the Ramsey RESET test as the key diagnostics of our data and of our model specification, respectively.

Limitations in this model should be recognized up front. First, the seasonal dummy used, just like in Okello (1997), relates to one month, the festive season of December. But beer consumption has peaks at the end of each month. Secondly, use of partial adjustment formulation restricts the adjustment process. Third, yet another perceived weakness of the model needs to be addressed before proceeding to estimate stout demand. That is the question of whether there is cause for concern with the estimates as they are based on one brand of malt beer (Tusker 500 ml) rather than a measure closer to the aggregate market. In any case, it can be argued that the indirect

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[4] The authors would like to acknowledge Graham Glenday's comment on an earlier version of this paper on the relevance of disaggregated sectoral incomes on beer demand in Kenya.

taxes apply to the whole market rather than a measure closer to the aggregate market. In other words, is the choice of Tusker 500 ml to represent the malt lager beer market likely to overstate the price elasticity? This question can be answered by establishing whether an equation that uses a more aggregate measure of malt beer sales and a beer price index gives elasticity estimates that are significantly different from those reported from the OLS estimation using only the Tusker 500 ml.

Since the data on beer sales and prices were by brand, an attempt was made to come up with an aggregate beer sales and price measure. For the quantity demanded, a representative aggregate lager beer (RLBEER) was constructed using the market shares of the brands as weights. The beer price index was, on the other hand, constructed as a Paasche price index of the various lager brands prices. These are the estimation results using the aggregate data:

$$\ln RLBEER_t = \underset{(-0.93)}{-1.58} \underset{(-5.07)^{*}}{-1.17\ln BPI_t} \underset{(3.06)^{**}}{+0.75\ln p_{SBt}} \underset{(2.43)^{*}}{+0.57\ln m0_t} \underset{(1.81)}{+0.36\ln p_{Rt}}$$

$$\underset{(6.34)^{*}}{+0.47\ln RLBEER_{t-1}} \underset{(-3.52)^{*}}{-0.01T} \underset{(4.48)^{*}}{+0.17SEAS} \underset{(-4.16)^{*}}{-0.41D954}$$

n = 99; R^2 = 0.82; RBAR^2 = 0.80; D-W = 1.71; Jarque-Bera asymptotic LM normality test: chi-square = 1.99 with 2 degrees of freedom; RESET (2) = 3.55 – F(1, 89); *t*-statistic in parentheses, * and ** significance at 1 and 5%, respectively.

These results indicate that the choice of Tusker 500 ml does not overstate the price elasticity of lager beer results and hence discount any fear that the Tusker 500 ml is inappropriate as a representative lager beer. Estimating the Tusker 500ml equation for the same sample as the representative beer results in a price elasticity of –1.15. Therefore, even with the decline in the market share of this brand over the period since liberalization in 1993 to the current 40% share of EABL sales the estimation results show that the short-run price elasticity of the lager beers is more than unity.

3.2 OLS estimation of demand for stout beer

The brand for stout beer that has the highest market share is Guinness, and for this reason its sales and prices were used to estimate the demand function for the stouts. The estimation of demand for this brand did not fit with the explanatory variables included in the equation for the lagers. Indeed, the money supply (M0) as a proxy for income was found insignificant in the equation. Using the total wage payments did not give any better results than those obtained with money supply. The implication for this is that income is not a significant determinant for the demand for Guinness (stout) beer. This may sound surprising to conventional theory but may be motivated on the basis that beer is a concurrent consumption that is dependent on the liquidity position of the consumer rather than planned consumption on the basis of wages. It shows that its consumption is more responsive to prices. The estimated equation for the demand for Guinness beer is given below. The estimated results were not as satisfactory as those of the lagers in the normality test of the residuals. However, the RESET specification test of the model accepts the null hypothesis that the coefficients for the predicted dependent variables are not significantly different from zero, which is acceptable.

$$\ln q_{SBt} = -1.20 - 2.29 \ln p_{SBt} + 1.00 \ln p_{LBt} + 1.42 \ln p_{Rt} +$$
$$\quad (-0.88) \quad (-4.29)^{*} \quad (2.59)^{*} \quad (3.62)^{*}$$

$$0.75 \ln q_{SB,t-1} + 0.20 SEAS$$
$$(14.61)^{*} \quad (2.68)^{*}$$

R^2 = 0.84; RBAR^2 = 0.83; D-W = 2.26; Jarque-Bera = 3.18 (0.20); RESET = 0.02 (0.89); *t*-statistic in parenthesis, * significance at 1%.

The estimates show a highly significant price-elastic relationship of demand for stout beers with own-price. The own-price elasticity of 2.29 indicates that a 1% change in the price for stout beers would lead to a 2.29% change in the demand for the beer in the opposite direction. Thus, the rate of the excise taxes does matter to the consumers, given the price-elastic nature of the stouts. As for the substitution effects determined by the cross-price elasticity, unit elasticity was obtained in the estimation, implying that consumers would switch to lager beer from stout beer proportionately to the change in the price of the lagers. A 1% increase (decrease) in the price of lagers would lead to a 1% increase (decrease) in the demand for stouts. The price of other goods, the lagged stout beer quantities, and the seasonal dummy were all significant.

The magnitudes of the estimates in the above equation are lower than what has previously been estimated. Okello (1997) reports an own-price elasticity of 5.49 for Guinness and a cross-price elasticity of 3.88 with other beers. The obvious implication is that the revenue-maximizing rates for excise tax for the stouts would be different as they are elasticity dependent.

3.3 System estimation of the beer-demand model

It was indicated above that it is important to be conscious of a possible correlation between the disturbances of two equations that may appear unrelated. Contemporaneous correlation is always a reasonable assumption when one is dealing with branded products in a particular market. Therefore, the two OLS equations above were estimated using the seemingly unrelated regression method to see whether efficiency can be gained, as this method takes care of any contemporaneous correlation. Table 3 compares the OLS estimates to the seemingly unrelated regression (SUR) results of the demand for lager and stout beers. Residuals of the two equations in the system were found to have a correlation of 27%, implying that the disturbances are not entirely unrelated. The parameters (elasticities) estimates from SUR are not significantly different from the OLS estimates, but the cross-price elasticity in the

$\ln p_{LBt}$

$\ln p_{SBt}$

$\ln p_{Rt}$

$q_{LB,t-1}$

$q_{SB,t-1}$

equation for the stouts is much higher under SUR. The two types of beer are price elastic, but the cross-price elasticity is much higher for the stouts. In other words, consumers would be more responsive in their choice between the lagers and the stouts were the excise tax to be varied for the stouts rather than for the lagers.

Haughton (1998a) suggests that the elasticities reported in table 3 may be thought of as short-run elasticities. Using the coefficients for the lagged dependent variables, the estimated value of the quantity adjustment parameters in each SUR equation is 0.52 (1–0.48) for lagers and 0.25 (1–0.75) for stouts. This implies 52% of the adjustment to prices and income takes place for lagers and 25% for stouts. Dividing the coefficients of the independent variables in each equation by the respective adjustment parameters as shown in Haughton (1998a) can therefore derive the long-run elasticities. Table 4 shows these elasticities computed using the SUR estimates for lager beer.

Table 4. Elasticities of demand for lager beer in Kenya

	Elasticity of demand for lager beer

	Short-run	Long-run
With respect to price of lager beer	–1.10	–2.12
With respect to price of stout beer	0.69	1.33
With respect to price of other goods	0.34	0.65
With respect to income	0.31	0.60

The long-run elasticities are more useful in determining the revenue-maximizing tax rate as opposed to the short-run elasticities. The magnitudes for the own-price and cross-price elasticities are plausible and are actually significant. The magnitudes of the long-run elasticities for the stouts are very high. This is due to the low adjustment parameter of 0.25. However, the short-run elasticities are not as high as in Okello (1997). This is unlike the case for lagers where those arrived at from this study are comparable in magnitudes to those in Okello (1997). Table 5 shows the short-run and long-run elasticities for stout beer from the SUR estimation.

Table 5. Elasticities of demand for stout beer in Kenya

	Elasticity of demand for stout beer	
	Short-run	Long-run
With respect to price of stout beer	–2.51	–10.04
With respect to price of lager beer	1.50	6.00
With respect to price of other goods	1.17	4.68

3.4 Dynamic model estimation of the long-run elasticities

The estimation so far has entailed the implicit specification and fitting of a partial-adjustment model (PAM). Haughton (1998a) found that the partial-adjustment model gives satisfactory estimates of demand elasticities. However, a question can be raised whether this is the best representation of the consumers' behaviour. As noted in Judge et al. (1988), because of habit persistence and lags in consumer behaviour, current consumption of beer can be hypothesized as a function of current and lagged prices and income. In other words, the effect of a change in income or prices is not felt at once or at a single instance; the impact on beer demand is distributed over a number of future points in time. Thus, it is necessary to move away from contemporaneous effect assumptions and incorporate dynamic behaviour in consumption. The lagged effects may arise as noted above from habit persistence and possibly because of institutional or technological constraints or expectations. Therefore, while the estimation so far is similar to those undertaken in previous works of assessment of excise taxation (Okello 1997, Haughton 1998a), it may be appropriate to investigate whether introducing time lags for independent variables in the beer demand model leads to significantly different elasticity estimates.

Several compelling reasons suggest this approach. First, as has been pointed out, there is some level of persistence in behaviour. Thus we anticipate that every variable in the model will have a strong memory. If so, it is necessary to estimate a dynamic equation of an AR(k) process and then provide the long-run solution. This will mimic the adjustment process that we expect in economic analysis. Finally, it is unlikely that when the price of a good changes there will be no reaction by either the cross-price or the income elasticity. To assume a PAM is to assume away other reactions. The best approach is then to add to PAM by allowing dynamic adjustment for all the variables in the system, that is, by choosing the AR(k) process and k appropriately. It can then be shown that PAM is a subset of the AR(k) process, where we have imposed no restrictions.

To address the above question of having lags in independent variables, the theoretical model was re-estimated, introducing three lags for the dependent and independent variables. Using the partial coefficient of determination for each of the explanatory variables (including the lagged ones), the model was reduced systematically to one that was believed to have the appropriate lag structure.[5] The reduced model contained first-period and second-period lags for quantity demanded, second-period lag for the price of stout beer and first-period lag for money. The reduced model was then used to give a long-run solution; it is reported here with standard errors in parenthesis:

$$\text{Ln}q_{LBt} = \underset{(4.27)}{2.26} - \underset{(0.48)}{2.60}\ln p_{LBt} + \underset{(0.72)}{2.47}\ln p_{SBt} + \underset{(0.62)}{1.811}\ln m0_t$$

$$- \underset{(0.63)}{0.76}\ln p_{Rt} - \underset{(0.42)}{1.48}D954 - \underset{(0.004)}{0.02}T - \underset{(1.55)}{5.21}SEAS$$

The lags of the variables are consistent with what is reported by Haughton (1998a) as short-run elasticities. This is because they still adjust every year for the lags. When one solves out, the solution mimics a long-run solution, or what may be called steady state. This is because in solving we assume complete adjustment will have taken place. That is why they are long run elasticities.

The results in the long-run solution confirm that the demand for lager beer as obtained in the long-run elasticities of the SUR estimation is price elastic. In the next section, we determine the revenue-maximizing tax rate for lager beer using the elasticities from the SUR-estimated partial-adjustment model and the solved long-run model that has incorporated lags in the explanatory variables. We present both approaches to show what is found in the general literature and also what needs to be done to improve on the restriction method and results.

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[5] The process of model reduction uses the concept of marginal density in probability theory. What essentially happens is that each lag is assessed using the *t*-ratio and partial R^2 to show its contribution to the overall model. If not important, the lag is deleted. The model reduction progresses until an acceptable outcome is achieved. This is estimation subject to linear restrictions.

4 Revenue-maximizing Excise Tax Rate for Beer in Kenya

As indicated in the introduction, governments are often tempted to raise more money through higher beer taxation. A low tax rate yields low revenue, and a government can generate additional revenue by raising the tax rate. But it may also be that the prevailing rate is much higher than the revenue-maximizing rate, leading to suboptimal revenue yield. In this section, we attempt to determine whether the existing excise tax rate for lager beer in Kenya maximizes revenue. The methodology used to calculate the optimal tax rate is discussed in Haughton (1998b). Haughton and Glenday (1994) also discuss the appropriate method for analysing tax policy and estimating revenue.

A revenue-maximizing tax rate depends on two important factors. First, if demand is more elastic because of adequate substitutes, the revenue-maximizing tax rate will be low. Second, the tax rate on close substitutes also affects the optimal tax rate in regard to government revenue. If the tax rate on the close substitute is high, it follows that the revenue-maximizing rate on the targeted good will be high too. The long-run elasticities are used to determine the revenue-maximizing tax rates for the reason given in Haughton (1998b). That is, in the short run, high elasticities will yield substantial revenue, but over time consumers will shift away from consuming beer or the product in question, making the long-run elasticities (with their associated lower maximum tax rates) appropriate.

Two sets of revenue-maximizing tax results are discussed in Haughton (1998a), one-market and two-market rates. The one-market rates assume that tax rates on close substitutes do not change. Thus, the task in our case would be to determine the revenue-maximizing tax rate on lager beer, assuming that the tax rate on stouts remains constant. The two-market rates, on the other hand, would be the revenue-maximizing tax rates if these rates for the lagers and stouts were simultaneously set with the intention of maximizing revenue. The revenue-maximizing tax rates computed in this section are based on the assumption that the tax rates of stouts do not change. Another important assumption is that the supply curve of lager beer is infinitely elastic, that is, the supply curve is horizontal. It is therefore possible to derive the formula for revenue-maximizing tax rate t^* for a given demand function (see Haughton 1998b). For a linear demand function, t^* can be determined as follows:

$$Q = a + bP \qquad (10)$$

Where Q is the quantity of beer, P is the retail price of the beer and $b < 0$. When an excise tax is imposed, the retail price rises to $P_0(1+t)$ and the quantity consumed would be expected to decline to, say, Q_1. The tax revenue (R) from this policy would be

$$R = tP_0Q_1, \text{ where } Q_1 = a + b(P_0(1+t)),$$

which implies that

$$R = tP_0(a+bP_0(1+t)) = aP_0t + aP_0^2t + bP_0^2t^2 \qquad (11)$$

Taking the first derivative of equation 11 with respect to the tax rate t and equating it to zero yields the revenue-maximizing tax rate t^* in a one-market good with infinite elastic supply, which is given by

$$t^* = \frac{-(a + bP_0)}{2bP_0} = \frac{-Q_0}{2bP_0} \qquad (12)$$

Equation 12 can be expressed in elasticity form if we define the own-price elasticity as

$$\eta = \frac{dQ}{dP}\frac{P}{Q}$$

For a given point in the demand curve, $b = dQ/dP$ such that

$$\eta = b\frac{P_0}{Q_0}$$

and therefore

$$t^* \approx \frac{-1}{2\eta} \tag{13}$$

If the demand function was one of a constant elasticity demand curve such as the one estimated in the sections above, the revenue-maximizing tax rate can be derived as below (see Haughton 1998b). The constant elasticity demand function is

$$Q = cP^{\eta}$$

Therefore, the tax revenue function would be

$R = tP_0Q_1$ where $Q_1 = c[P_0(1+t)]^{\eta}$

This yields

$$R = tP_0 cP_0^{\eta}(1+t)^{\eta} = t(1+t)^{\eta} cP_0^{1+\eta}$$

Using the first-order condition of optimization with respect to *t*, the revenue-maximizing tax rate for one-good market with a constant elasticity demand curve is given as:

$$t^* = \frac{-1}{1+\eta} \tag{14}$$

The revenue-maximizing tax rate for the lagers was computed using equations 13 and 14, the long-run elasticities of –2.12 SUR estimation in table 4 and that of –2.6 in the solved long-run model above. Results are in table 6.

Table 6. Revenue-maximizing tax rates for lager beer with different demand curves

	Own-price elasticity of demand (%)	
	–2.12	–2.6
Linear demand—equation 13	23.6	19.2
Constant elasticity of demand—equation 14	89.3	62.5

The results in table 6 confirm the Haughton (1998b) conclusion that the revenue-maximizing tax rates are much lower with the linear-demand curve, indicating that the functional form of the demand curve is extremely important. Assuming that the demand for lager beer in Kenya is globally a constant elasticity curve, the two demand curves result in revenue-maximizing tax rates of 62.5% for the more dynamic model and 89% for the partial-adjustment model—89% being the highest rate at which the tax can be set given the less restrictive nature of the constant-elasticity demand curve as differentiated from the linear-demand curve.

The current excise tax rate for the lagers is 85%. Given the revenue-maximizing rate of 89% from the partial-adjustment model, this means that there is no scope for the government to generate more revenue by increasing taxes beyond the current rate. If the Kenyan beer drinker follows the partial-adjustment model where the 85% could be justified, there are still secondary issues to do with the beer industry and the theory of revenue-maximizing tax rates. The question to be answered is, what is the cost to the economy of revenue-maximizing tax rates? Can the government lower the tax rate for beer and still optimize both social and economic welfare?

But a more important point might be overlooked in the current excise tax regime in any argument that the excise tax rate on beer should remain at 85%. The retail price used in the demand-function estimation and which the consumer observes in deciding whether to consume beer or not has both the excise tax and the value-added tax (VAT) components. Knowing the number of taxes and their set levels is not of any significance to consumers, as the important point to them is the consumer (retail) price of the beer. In terms of policy, however, it is fundamental to be aware of the various taxes.

In fact, as things stand now, the current beer taxation rate is above 85% in the context of the revenue-maximizing tax rate because of VAT, which like the excise tax is ad valorem. The revenue-maximizing tax rate arrived at of 89% under the partial-adjustment model should not simply be interpreted to mean the optimal excise rate. The excise tax rate ought to be lower because of VAT, which forms the retail price. This is not stressed in the theory of revenue maximization as applied in this study's analysis, possibly because previous studies deal with only one kind of tax levied on a particular good. The implication, however, is that the calculated revenue-maximizing tax rate must be interpreted as taking cognizance of the two taxes.

The case for lowering the excise rate is stronger if the elasticity used in computing the revenue-maximizing tax rate is taken from the more likely consumer behaviour, where consumers adjust to both the quantities consumed previously and the past prices and money holding. In this case the revenue-maximizing tax rate would be 62.5%. This more dynamic model allows consumers to adjust to the key determinants of the quantity of beer they demand. This then leads to the conclusion that if the current tax rate is to remain at 85% the government may incur a loss from not operating at the revenue-maximizing tax rate.

5 Conclusion

In this study, we have shown two polar cases in model building. We have followed the literature and replicated the results of other studies, and we arrive to the conclusion that beer is price elastic. If a good is price elastic, then lowering the price increases the quantity sold or consumed by a higher proportion than the amount of price fall. This also works for excisable products. More revenue will be raised when the price is lowered—consistent with lowering the tax rate.

- We tend to favour the dynamic solution because it imposes few restrictions on the adjustment process. Figure 1 shows the three positions: the dynamic model (t^*, ER^*) where t^* = 62.5%, the current position (t', ER') where t' = 85% and the partial-adjustment model (t^c, ER^c) where t^c = 89%. These approaches show two polar levels of revenue-maximizing tax rates of 89% and 62.5%. We favour the latter. If we go by our model results, we argue that it is necessary to move from *B* to *A* and increase excise revenue.

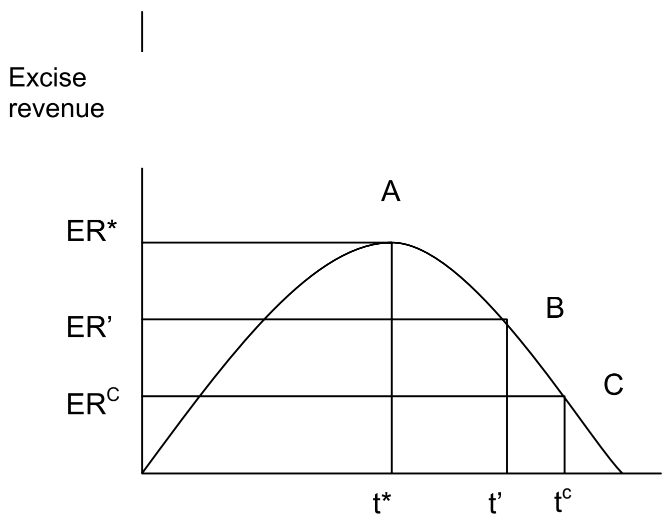

Figure 1. Excise revenue and various tax rates.

References

Bolnick, B., and J. Haughton. 1998. 'Tax policy in sub-Saharan Africa: Examining the role of excise taxation.' African Economic Policy Discussion Paper No. 2. Equity and Growth through Economic Research/PSGE. Cambridge, Massachusetts: Harvard Institute for International Development.

Due, J.F. 1994. 'Excise taxes.' Policy Research Working Paper No. 1251, Policy Research Department. Washington, DC: World Bank.

Griffiths, W.E., R.C. Hill, and G.G. Judge. 1993. *Learning and Practicing Econometrics*. New York: John Wiley and Sons.

Haughton, J. 1998a. 'Estimating demand curves for goods subject to excise tax.' African Economic Policy Discussion Paper No. 12. Equity and Growth through Economic Research/PSGE. Cambridge, Massachusetts: Harvard Institute for International Development.

Haughton, J. 1998b. 'Calculating the revenue-maximizing excise tax.' African Economic Policy Discussion Paper No. 13, Equity and Growth through Economic Research/PSGE. Cambridge, Massachusetts: Harvard Institute for International Development.

Haughton, J., and G. Glenday. 1994. 'Notes, problems and examples on tax policy analysis and revenue estimation.' International Tax Program. Cambridge, Massachusetts: Harvard University.

Judge, G.G., R.C. Hill, W.E. Griffiths, H. Lutkepohl, and T.C. Lee. 1988. *Introduction to the Theory and Practice of Econometrics*, 2nd ed. New York: John Wiley and Sons.

Kenya. Central Bureau of Statistics. 1995. *Statistical abstract*. Nairobi: Government Printer.

Kenya. Central Bureau of Statistics. 1999. *Economic survey*. Nairobi: Government Printer.

McCarten, W.J., and J. Stotsky. 1995. 'Excise taxes.' In: S. Parthasarathi, ed., *Tax policy handbook*. Washington, DC: International Monetary Fund.

Okello, A. 1997. 'An analysis of excise taxation in Kenya.' Equity and Growth through Economic Research/PSGE. Cambridge, Massachusetts: Harvard Institute for International Development.

Zellner, A., and H. Theil. 1962. 'Three stage least squares: simultaneous estimation of simultaneous equations.' *Econometrica* 30:54–78.

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