An Econometric Analysis of the Illicit South African Tobacco Market

by

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Declaration

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Abstract

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This paper investigates the constraint imposed on the legal tobacco market by the presence of illicit cigarettes. You need to use **Latex syntax** in this environment. E.g. Boshoff *et al.* (2020) and Tschantz en Froeb (**?**).

This is the second paragraph of my English abstract.

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Chapter 1

Introduction

This study examines the relationship between the legal and illegal tobacco markets in South Africa. Section 3.2 discusses the data used and how it was cleaned. Section 3 explains the methodology, where a VECM model is presented. The final section details discussion points (4). The appendix contains the full model outputs.

Chapter 2

The Illicit Tobacco Market

The health problems associated with tobacco consumption are significant and have been well-documented (Tingum et al, 2020:62). Worldwide, smoking is one of the leading causes of preventable deaths; and in South Africa 23% of the total deaths in 2018 were smoking-related (Statistics South Africa). Given the large and negative impact of smoking, the tobacco market has come under increasing scrutiny by governments and health organizations. A significant component of the tobacco market is the illicit cigarette trade, which the Financial Action Task Force (2012:7) defines as

> "... the supply, distribution and sale of smuggled genuine, counterfeit or cheap white tobacco products."

The illicit tobacco market gives rise to concern on three main fronts: public health, tax evasion, and criminal activity. From a public health perspective, illicit cigarettes make smoking more affordable and thereby increases tobacco access (van der Zee et al, 2019:242). Cheaper cigarettes may induce non-smokers to smoke, increase the volume of cigarettes consumed by smokers, and decrease the likelihood that smokers will quit smoking (Pechacek et al, 2018:pagenumber; van der Zee et al, 2019:242).

According to the International Agency for Research on Cancer, tobacco use is more prevalent among low socio-economic groups, and the poor are more sensitive to cigarette prices (IARC, 2011:276). Consequently, the health problems linked to smoking are disproportionately higher among the poor, which results in a greater burden on the public healthcare sector (). In South

Africa, the healthcare costs associated with smoking amounted to R14.48 billion in 2016, which accounted for 4.1% of health spending (). In addition to the healthcare costs, there are indirect costs linked to smoking such as the loss of productive lives and loss of productive days due to illness (Boachie et al, 2020). In 2016, the total cost of smoking to South Africa was R42.32 billion (0.97% of GDP).

Evidently, the public health and economic costs of tobacco use are extensive. In an effort to reduce tobacco use, many countries have implemented tax and price policies on tobacco products (Chaloupka, Straif, Leon). For a middle-income country, South Africa was considered to be at the forefront of tobacco control policies, including excise duties, for many years (Vellios). From a fiscal perspective, excise tax on cigarettes is a source of government revenue, which is undermined by the illicit tobacco industry. Blah ble estimates the loss of income due to the illicit market to be R123123 The loss of income

Chapter 3

Methodology

3.1 Theoretical Model

The long-run relationship between the legal cigarette market and the illicit market is modeled as a vector error correction model

3.2 Data

The sample period for this study runs from January 2012 to March 2020. Monthly data is used such that there are 99 observation points for each variable in the data set. One of the advantages of using monthly data rather than annual data is that it allows for more degrees of freedom. The data used includes figures for the prices and volumes of cigarettes in South Africa, tobacco excise duties, VAT, and disposable income.

To prepare the data for analysis the most popular price category (MPPC) was identified as the 20-cigarette pack. Then a weighted average of before-tax 20-pack prices was used as a base price. The excise duty per 20's pack and VAT and were then added to the base price to calculate the price of licit cigarettes. The licit, illicit and disposable income amounts were adjusted for inflation, taking December 2016 as the base month and year, respectively.

For the statistical analysis in sections 3.3 and 3.4, all of the variables have been transformed into log form to reduce variability. A price ratio has been constructed by dividing the real price of licit cigarettes by the real price of illicit cigarettes. Theory suggests that consumers are more concerned with relative price changes than absolute price changes.

Figure 3.1 below plots the variables at levels. The graphs indicate that the series are not stationary, which is formally tested below in section 3.3.

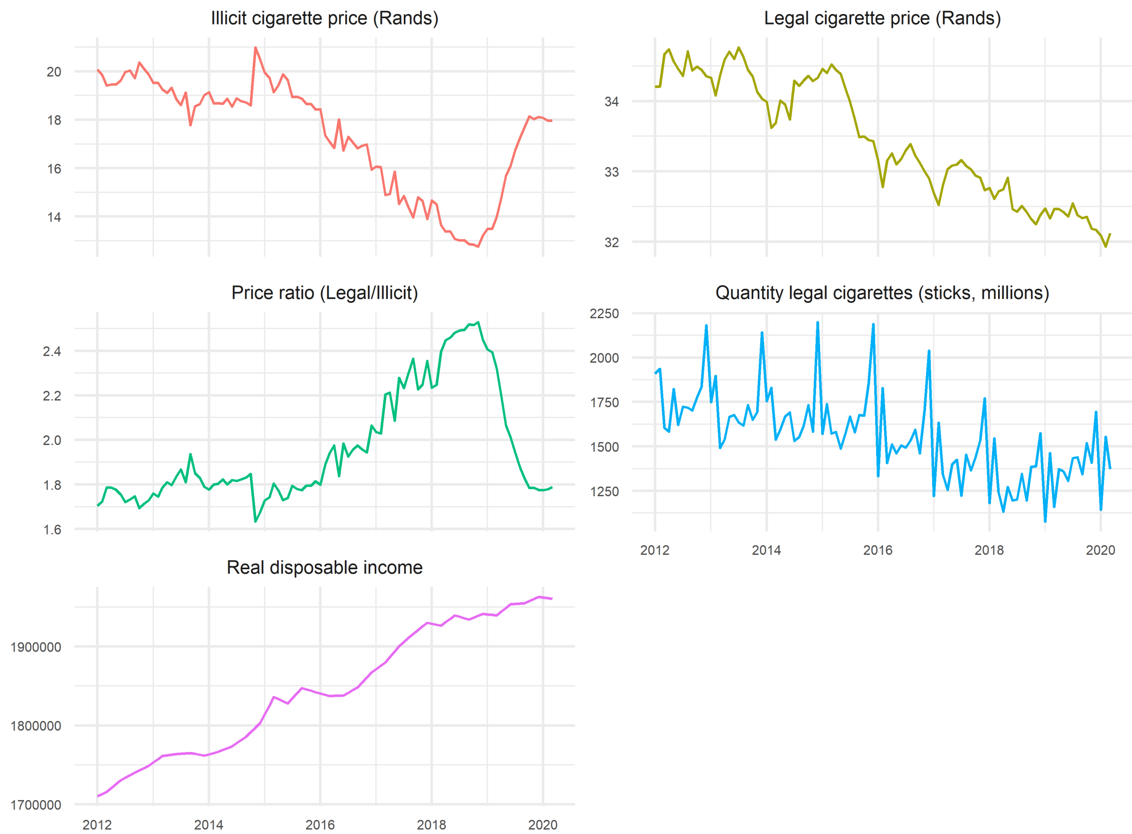

Figure 3.1: Plot for variables at levels

3.3 Stationarity and Cointegration

To test whether the series are stationary, three tests were employed: the Augmented Dickey-Fuller (ADF), and Phillip-Perron (PP) unit root tests, and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) stationarity test. The results of the ADF and PP tests in figures A.1 and A.2 (presented in appendix A) show that the log of the real price ratio and the log of real per capita disposable income series are non-stationary at the 5% level of significance.

Both the ADF and PP tests reject the null hypothesis that the log of quantity of legal cigarettes consumed contains a unit root at a 5% level of significance. The ADF test p-values at a 5% significance level for the quantity of legal cigarettes, price ratio, and disposable income are 0.01, -1.44, and 0.81 respectively. The PP test p-values are 0.01, -2.54, and 0.412 respectively. The KPSS test (figure A.3) rejected the null hypothesis of stationarity for all three variables with a p-value of 0.01 for each variable. Based on the KPSS test, each one of the variables is assumed to be non-stationary in levels.

However, after first differencing each of the series, all three tests indicate that the variables are stationary at a 5% level of significance. The ADF and PP tests reject the null hypothesis that the series contain a unit root after they have been differenced, as shown in tables A.4 and A.5. The KPSS test fails to reject the null hypothesis of stationarity for the differenced series with p-values of 0.1 for every variabe as shown in table A.6. Given that the series are non-stationary in levels and are stationary in first differences, a cointegration approach can be used to check whether a long-run relationship exists among the variables.

To test for conintegrating relationships, two tests were employed: the Johansen Trace test for Cointegration, and the Johansen Maximum Eigenvalue test for Cointegration.

The Johansen Trace Test for Cointegration indicates that there is one cointegrating vector. As shown in table B.1, the test statistic of 44.1 is larger than 41.1 (the critical value at a 1% level of significance). Thus, the null hypothesis is rejected, where the null hypothesis is that there are zero cointegrating vectors. However, the test statistic 10.2 is lower than 17.9 (the critical value at a 10% level of significance). This means that the null hypothesis cannot be rejected even at a 10% signicance level, where the null hypothesis is that there is 1 or fewer cointegrating vectors.

The results of the Johansen Maximum Eigenvalue test are presented in table B.2. Similar to the Trace test, the Maximum Eigenvalue test shows that there is a single cointegrating vector. The test statistic 33.9 exceeds the critical value of 26.8 at a 1% level of significance. Therefore the null hypothesis - that there is no conintegration - is rejected at a 1% significance level. However, the null hypothesis that there is 1 or fewer cointegrating relationships cannot be rejected, even at a 10% significance level. Here, the test statistics of 8.48 lies below the 10% critical value of 13.8.

3.4 Vector Error Correction Model

The price ratio captures a relative change of the legal price compared to the illicit price. If the ratio shrinks, it indicates that the cost of legal cigarettes decreased relative to the cost of illicit cigarettes. There should be a negative long run relationship between the price ratio and the quantity of legal cigarettes. There should be a positive sign for the cointegrating relationship, which there is. The coefficient for the real disposable income variable should be negative for the long-run relationship (so that the reverse sign is positive); whereas the sign is positive in the Vecm results below.

Table 3.1: Long run coefficient

r1
1
0.398
1.5

Table 3.2: Short tunrun coefficient

ECT	Intercept	QDP -1	PRATIO -1	REAL -1
-0.9443(0.1526)***	27.7687(4.4890)***	-0.1910(0.0964).	-0.9964(0.3181)**	2.3116(4.4102)
-0.0077(0.0511)	0.2274(1.5033)	0.0148(0.0323)	-0.1555(0.1065)	0.3575(1.4769)
0.0010(0.0030)	-0.0299(0.0870)	0.0004(0.0019)	0.0019(0.0062)	0.5833(0.0855)***

If the real disposable income variable is excluded then the Vecm results are as follows. The coefficient for

3.5 Residual Testing

1.00	**r1.00**
QDP	1.00
PRATIO	0.75

1.00	**ECT**	**Intercept**	**QDP -1.00**	**PRATIO -1.00**
Equation QDP	-0.64(0.14)***	5.05(1.08)***	-0.35(0.09)***	-0.91(0.35)*
Equation PRATIO	0.01(0.04)	-0.07(0.34)	0.01(0.03)	-0.17(0.11)

Chapter 4

Analysis

Chapter 5

Conclusion

Appendices

Appendix A

Stationarity Testing

Table A.1: Augmented Dickey Fuller Tests

	Statistic	**p-value**	**Alternative**
Quantity legal cigarettes	-4.67	0.01	stationary
Price ratio	-1.44	0.808	stationary
Disposable income	-3.31	0.0739	stationary

Table A.2: Phillips-Perron Unit Root Test

	Statistic	**p-value**	**Alternative**
Quantity legal cigarettes	-119	0.01	stationary
Price ratio	-2.54	0.952	stationary
Disposable income	-12.1	0.412	stationary

Table A.3: KPSS Unit Root Test

	Statistic	**p-value**	**Alternative**
Quantity legal cigarettes	1.89	0.01	non-stationary
Price ratio	1.35	0.01	non-stationary
Disposable income	2.56	0.01	non-stationary

Table A.4: ADF Test for Differenced Series

	Statistic	**p-value**	**Alternative**
Quantity legal cigarettes	-6.36	0.01	stationary
Price ratio	-3.43	0.05	stationary
Disposable income	-3.57	0.04	stationary

Table A.5: Phillips-Perron Unit Root Test for Differenced Series

	Statistic	**p-value**	**Alternative**
Quantity legal cigarettes	-153	0.01	stationary
Price ratio	-120	0.01	stationary
Disposable income	-40.6	0.01	stationary

Table A.6: KPSS Stationarity Test for Differenced Series

	Statistic	**p-value**	**Alternative**
Quantity legal cigarettes	0.0229	0.1	non-stationary
Price ratio	0.275	0.1	non-stationary
Disposable income	0.062	0.1	non-stationary

Appendix B

Johansen Cointegration Tests

Table B.1: Johansen Trace Test

	Statistic	**10%**	**5%**	**1%**
r<=2	1.74	7.52	9.24	13
r<=1	10.2	17.9	20	24.6
r=0	44.1	32	34.9	41.1

Table B.2: Johansen Maximum Eigenvalue Test

	Statistic	**10%**	**5%**	**1%**
r<=2	1.74	7.52	9.24	13
r<=1	8.48	13.8	15.7	20.2
r=0	33.9	19.8	22	26.8

List of References

Boshoff, W.H., Froeb, L.M., Minnie, R. and Tschantz, S.T. (2020). Bargaining competition and vertical mergers. *SSRN Electronic Journal*. ISSN 1556-5068. Available at: https://www.ssrn.com/abstract=3760634