

A STUDY OF THE CAUSES OF THE REAL NET-OF-TAX CIGARETTE PRICE INCREASES IN SOUTH AFRICA (1990 – 2012)

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Abstract

From the 1990's onwards the cigarette industry in South Africa has imposed substantial increases in the real net-of-tax price of cigarettes. Past research has presented various possible reasons for this increase, however none of this research has incorporated the effect that the international environment might have on price setting in the cigarette industry through tariffs. Using a Bertrand duopolistic model this paper presents a theoretical model to explain the effect that tariffs, and other relevant causal factors such as excise taxation might have on the real net-of-tax price. The relationships that exist between the real net-of-tax price and causal factors are then subjected to a preliminary analysis using an Autoregressive Distributed Lag Model. The results indicate that there is a relationship between the price of cigarettes and various causal factors. The results do not however substantiate what caused the real net-of-tax price increase from 1990's onwards. The paper attributes this to various limitations in the preliminary analysis process and suggests how these could be rectified. The paper hence presents a useful foundation to understanding the nature of the existing relationships between the price of cigarettes and various causal factors and how best these can be modelled.

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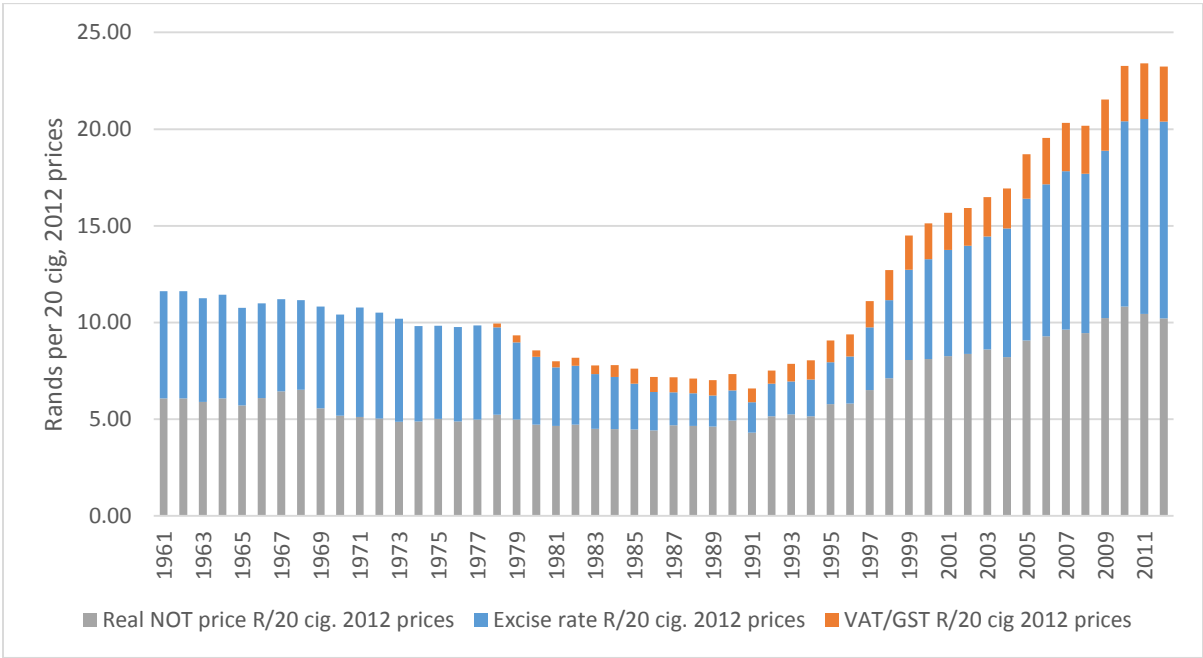
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1. Introduction

The South African cigarette industry has been imposing high increases in the real net-of-tax (NOT) price over the past 20 years. Based on price data obtained from the Budget Review, between 1990 and 2013, the real NOT cigarette price has increased substantially by approximately 107%. This has occurred in the presence of rising excise taxes and some researchers have concluded that the cigarette industry has used this opportunity to increase the real NOT price of cigarettes (Van Walbeek, 2006). This can be established by looking at the graph below.

Figure 1.1: Composition of the real retail price of cigarettes in South Africa (1961-2012)



Source: Budget Review, various years

Figure 1.1 shows the composition of the real retail price between 1961 and 2012. Specifically it shows the trends in the real NOT price, the excise tax rate and the Value Added Tax/General Sales Tax from 1961 to 2012. Between 1960 and 1980, the real retail price is seen to be decreasing. According to Van Walbeek (2006) this was mainly

because of a significant decrease in the level of the excise tax. In South Africa, the excise tax is levied as a specific tax. In the 1980's the nominal excise tax increases were very low and hence these increases were eroded by the high inflation rate during this time period. Between 1961 and 1991 the real retail price of a pack of cigarettes decreased from R6.17 to R3.50 (Van Walbeek, 2006). Of this decrease, 75% was due to a decrease in the excise and sales taxes. A substantial increase in the retail price can then be seen from 1990 to 2012. This increase is driven primarily by the substantial increases in the real NOT price of cigarettes during this time period. Specifically, the increase in the real NOT cigarette prices accounts for more than 40% of the increase in the real retail price of cigarettes during from 1990 to 2012 (Van Walbeek, 2006). The rate of these increases seems to slow down in 1999.

The phenomenon of increasing NOT prices in the presence of rising excise taxes is not unique to South Africa; in 1983, Harris(1987) noted that an increase in the federal excise tax in the United States of America (USA) resulted in non-cost related increases of 20% in the NOT prices of cigarettes. This illustrates that it is not uncommon for industry prices of cigarettes to increase when excise taxes are raised.

What is interesting to note is that these price increases in South Africa are coupled with a highly concentrated cigarette market in which the top three firms (British American Tobacco, Japan Tobacco International and Phillip Morris International) account for 95.4% of the total market value of the cigarette industry in South Africa. Of these three firms, British American Tobacco (BAT) is the one with the most pricing power with a market share of 89.5% as of 2012 (MarketLine, 2013). The near monopoly position that BAT holds in the cigarette market is further cemented by the high tariffs on cigarettes imposed by the South African government. As of 2005, tobacco was among the top 5 protected sectors with an effective rate of protection in excess of 40% (Edwards, 2005). Data for the year 2010 indicates that the weighted average tariff on cigarettes in South Africa was almost double that of Brazil, and approximately six times that of the USA (United Nations Commodities Trade Statistics Database [UN-COMTRADE], 2013). South African cigarette import tariffs are therefore exceptionally high.

The aim of this paper is to examine the real NOT cigarette price increases in South Africa from the 1990's onwards and attempt to discover what could have caused these increases. This paper's main contribution will be to consider how developments in the international market could have had an impact on the real NOT price of cigarettes in South Africa. This paper will do so by reviewing literature on the causes of real NOT price increases in the cigarette industry in South Africa and in other countries. These causes will be discussed under six categories; high market concentration in the cigarette industry, input costs, excise taxes, advertising bans and other tobacco control measures, reduced cigarette consumption, and other possible explanations. This paper will then examine the developments in the international market and their impact on the real NOT price of cigarettes in two ways. Firstly a theoretical framework will be presented based on existing models in international trade. Secondly this framework will be used to present testable hypotheses which will then be modelled empirically using an Autoregressive Distributed Lag Model (ARDL).

2. Background

2.1 The Cigarette Industry in South Africa

The story of the cigarette manufacturing industry in South Africa is really the story of the Rembrandt Group (Van Walbeek, 2005). The Rembrandt group has been around since the formation of its predecessor, the Voorbrand Tobacco Company, in 1940. In 1948 Voorbrand was replaced by the Rembrandt Group. Rembrandt's non-South African tobacco interests were represented by its subsidiary, Rothmans International (Van Walbeek, 2005). This subsidiary was sold to UK based British American Tobacco plc. By the time of the sale Rembrandt had 85% of the South African cigarette market, with its closest competitor being British American Tobacco (then known as United Tobacco Company). As a result of the acquisition of Rothman's by BAT, BAT South Africa's market share currently dominates the cigarette industry (Van Walbeek, 2005). The

respective market shares of BAT and other major companies in the cigarette industry are as seen in the table below;

Table 2.1: Percentage Market Shares of Firms in the South African Cigarette Industry

Company	% Share
British American Tobacco Plc	89.5
Japan Tobacco Inc.	4.2
Philip Morris International Inc.	1.7
Other	4.6

Source: MarketLine, 2013

Each of the companies mentioned above produces numerous cigarette brands. BAT's Peter Stuyvesant brand has the highest sales volume of all the cigarettes consumed in South Africa. As of 2012, 40.9% of the cigarettes sold in retail outlets were of the Peter Stuyvesant brand. Furthermore, all the top six most consumed cigarette brands in South Africa are manufactured by BAT (Euromonitor, 2014). This is an indicator of just how thoroughly BAT dominates the cigarette market in South Africa.

It is interesting to note that the three companies mentioned in Table 2.1 above, are among the four cigarette companies with the highest market share globally (MarketLine, 2013). This implies that high market concentration in the cigarette industry is not unique to South Africa. This also implies that these companies' ability to influence cigarette prices is not only limited to the domestic South African market.

The high concentration of the cigarette industry in South Africa could in part be responsible for the increase in the real NOT cigarette prices. This is because this concentration gives the major cigarette companies the opportunity to utilize their market power and increase mark-ups with the aim of making super normal profits. This effect of high market concentration in the cigarette industry is exacerbated by the barriers to entry present in the cigarette industry in South Africa. The stringent tobacco control measures in South Africa deter entry of potential competitors. This, coupled with the high concentration of the cigarette industry provides a conducive environment for higher

prices as firms are no longer worried that making super normal profits will attract new entrants.

2.2. International Trade and the Cigarette Market in South Africa

2.2.1 Tariffs on imports of tobacco and tobacco products

As mentioned previously, compared to global import tariff rates for tobacco and tobacco products, South African tariffs are relatively high. This could possibly influence price setting in the cigarette industry. The table below provides average ad valorem equivalent import tariff rates of tobacco and tobacco products for various partners in various years. The partner regions looked at are the major ones with which South Africa presently has free trade area agreements. Specifically these are the European Free Trade Area (EFTA, comprised of Norway, Switzerland, Liechtenstein and Iceland), the European Union (EU) and the Southern African Development Cooperation (SADC).

Table 2.1 Average Ad valorem equivalent tariff rates of tobacco and tobacco products in South Africa by product type in various years

Partner	Year			
	1995	2000	2005	2010
<i>Raw tobacco</i>				
SADC countries	0.3709	0.1737	0	0
EFTA countries	0.3709	0.1737	-	0.15
EU	0.3709	0.1737	0.1392	0.0375
Rest of the world	0.3709	0.1737	0.1582	0.15
<i>Cigarettes</i>				
SADC countries	0.3059	0.3007	0	0
EFTA countries	0.3059	0.3007	0.2255	0.4085
EU	0.3059	0.3007	0.2645	0.1121
Rest of the world	0.3059	0.3007	0.3006	0.45
<i>Other tobacco products</i>				
SADC countries	0.3286	0.3286	0	0
EFTA countries	0.3286	0.3286	-	0.2607
EU	0.3286	0.3286	0.2703	0.077
Rest of the world	0.3286	0.3286	0.3286	0.3074

Source: South African Tariff Schedule 1, various years & UN COMTRADE, various years. Some data is missing for EFTA tariff rates

For tobacco and tobacco products, South Africa uses specific tariffs, mixed tariffs (a combination of specific and ad valorem type duties) as well as ad valorem tariffs depending on the product line item. The ad valorem equivalents for the specific tariffs are calculated by dividing the specific tariff value by the import unit values of the

products (import value divided by import quantity). For the mixed tariffs, the ad valorem part of the mixed tariff is taken to be the ad valorem equivalent.

In 1995 and 2000, all the partner regions have the same ad valorem tariffs. This is probably because the various free trade area agreements (FTA) covering the partner regions had not yet come into effect. The EFTA agreement with the Southern African Customs Union (SACU), of which South Africa is a member, only became applicable on 1 May 2008 (South African Revenue Services [SARS], 2013) while the South Africa-EU Trade, Development and Cooperation Agreement (TCDA) was signed in 1999 (European Commission, 2011).

From 2000 onwards, tariff rates decrease for raw tobacco and other tobacco products with the highest decrease being seen in the SADC tariff rates. With the exception of the SADC and EFTA tariff rates, the cigarette tariffs actually increase. It would seem South Africa is hence protecting their cigarette manufacturing industry more than the raw tobacco or other tobacco products industries.

2.2.2 Imports and Exports of tobacco and tobacco products

The importance of international trade in the tobacco and tobacco products industry can be seen by the high volumes of imports and exports of these products by South Africa. Data on this is provided in the tables below;

Table 2.2 Values of Imports of tobacco and tobacco products to South Africa from various countries in various years (1000's of USD)

Partner	Year			
	1995	2000	2005	2010
SADC countries	37558.02	26413.78	26126.59	46477.21
EFTA countries	1671.47	774.244	1659.203	3468.164
Europe	1803.208	3736.19	26210.82	30732.71
USA	10858.1	6191.104	3439.70	3266.839
Rest of the world	12508.472	11018.632	42947.487	131590.477
Total imports	63499.27	48133.95	100383.8	215535.4

Source: UN COMTRADE, various years.

Table 2.3 Percentage Imports of tobacco and tobacco products to South Africa by partners in various years

Partner	Years				
	1990	1995	2000	2005	2010
SADC countries	59.1	54.9	26.0	21.6	59.1
EFTA countries	2.6	1.6	1.7	1.6	2.6
Europe	2.8	7.8	26.1	14.3	2.8
USA	17.1	12.9	3.4	1.5	17.1
Rest of the world	19.7	22.9	42.8	61.1	19.7

Source: Author's own calculations based on data from UN COMTRADE, various years

Looking at Table 2.2 and 2.3, there is generally a high volume of tobacco and tobacco products imports with the highest share of these imports coming from the SADC region in 1990, 1995 and 2010. The imports are further disaggregated into product types in Table 2.4 and Table 2.5 below.

Table 2.4 Values of Imports of tobacco and tobacco products to South Africa by product type in various years (1000's of USD)

Partner	Year			
	1995	2000	2005	2010
<i>Raw tobacco</i>	51306.14	42413.05	77395.54	170959.1
SADC countries	37381.97	26212.37	23023.53	39053.36
EFTA countries	1317.185	356.613	130.171	0.01
EU	259.017	1401.184	12209.49	8874.913
USA	890.13	5611.979	1127.925	2348.317
Rest of the world	11457.838	8830.904	41164.766	120682.5
<i>Cigarettes</i>	11446.62	4798.706	14160.03	29992.52
SADC countries	68.718	151.803	2257.343	7080.556
EFTA countries	354.285	417.631	1529.031	3466.385
EU	996.842	1639.317	8346.022	9134.288
Rest of the world	9877.208	422.679	144.258	912.619
<i>Other tobacco products</i>	746.522	922.193	8828.197	14583.71
SADC countries	107.336	49.607	845.716	343.294
EFTA countries	-	-	-	1.769
EU	547.349	695.687	5655.311	12723.51
Rest of the world	89.763	156.445	2167.518	5.902
Total Imports	63499.28	48133.95	100383.8	215535.3

Source: UN COMTRADE, various years, - represents data that was missing from the data source

Table 2.5 Percentage Imports of tobacco and tobacco products to South Africa by product type in various years (1000's of USD)

Partner	Year			
	1995	2000	2005	2010
Raw tobacco	80.8	88.1	77.1	79.3
Cigarettes	18	9.9	14.1	13.9
Other tobacco products	1.2	1.9	8.8	6.8

Source: Author's own calculations based on data from UN COMTRADE, various years

Looking at Table 2.4 and 2.5 above, the majority of tobacco products imports are of raw tobacco, the biggest share of which is from SADC countries. The share of raw tobacco in total imports has however been decreasing over time. This is mainly driven by increased importation of the other tobacco products.

A similar analysis is done with exports of tobacco and tobacco products. The trends observed are as seen in the tables below.

Table 2.6 Values of Exports of tobacco and tobacco products from South Africa to various countries in various years (1000's of USD)

Partner	Year			
	1995	2000	2005	2010
SADC countries	40329.13	61441.58	21564.24	34912.53
EFTA countries	196.164	1280.432	1050.226	67.508
Europe	4194.056	9457.715	11423.3	39289.97
USA	293.555	923.212	8962.675	9938.011
Rest of the world	14255.53	36041.56	122995.56	158862.58
Total exports	59268.43	109144.5	165996	243070.6

Source: UN COMTRADE, various years

Table 2.7 Percentage exports of tobacco and tobacco products from South Africa by partners in various years

Partner	Years				
	1990	1995	2000	2005	2010
SADC countries	68.0	56.3	13.0	14.4	68.0
EFTA countries	0.3	1.2	0.6	0.0	0.3
Europe	7.1	8.7	6.9	16.2	7.1
USA	0.5	0.8	5.4	4.1	0.5
Rest of the world	24.1	33.0	74.1	65.4	24.1

Source: Author's own calculations based on data from UN COMTRADE, various years

Looking at Table 2.6 and 2.7, there is generally a high volume of tobacco and tobacco products exports with the highest share of these exports going to the SADC region in 1990, 1995 and 2010. The total exports of tobacco products exceed the total imports in 1995, 2000, 2005 and 2010. This is interesting to note as one would expect that given the high level of tariffs compared to the tariffs of other countries, South Africa is not competitive in the international tobacco and tobacco products market. Clearly this is not the case, there is hence no clear trade-related motive for why the tariffs on tobacco and tobacco products are high in relation to those of other countries. The exports are further disaggregated into product types in Table 2.8 and Table 2.9 below.

Table 2.8 Values of Exports of tobacco and tobacco products from South Africa by product type in various years (1000's of USD)

Partner	Year			
	1995	2000	2005	2010
<i>Raw tobacco</i>	59268.43	109144.5	165996	243070.6
SADC countries	40239.13	61441.58	21564.24	34912.53
EFTA countries	196.164	1280.432	1050.226	67.508
EU	4194.056	9457.715	11423.3	39289.97
USA	293.55	923.212	8962.675	9938.011
Rest of the world	14345.52	36041.52	122995.6	158862.6
<i>Cigarettes</i>	47544.96	78568.34	64761.19	101098.8
SADC countries	37389.87	56851.81	12709.83	30410.56
EFTA countries	-	0.196	21.413	-
EU	545.598	2797.462	882.442	88.74
Rest of the world	-	517.883	8335.612	7055.068
<i>Other tobacco products</i>	1530.523	1106.542	65135.43	85556.1
SADC countries	139.022	1054.972	5556.65	1308.014
EFTA countries	-	-	837.075	67.508
EU	615.426	0.163	2954.349	1693
Rest of the world	-	0.007	0.236	2.992
Total Imports	59268.43	109144.5	165996	243070.6

Source: UN COMTRADE, various years, - represents data that was missing from the data source

Table 2.9 Percentage exports of tobacco and tobacco products to South Africa by product type in various years (1000's of USD)

Partner	Year			
	1995	2000	2005	2010
Raw tobacco	51.1	34.7	37.3	47.8
Cigarettes	47.3	64.3	31.2	28.3
Other tobacco products	1.5	0.9	31.4	23.9

Source: Author's own calculations based on data from UN COMTRADE, various years

Looking at Table 2.8 and 2.9 above, similar to the imports, the majority of tobacco products exports are of raw tobacco except in 2000. The biggest share of these raw tobacco exports is to SADC countries. Given the SACU and the lower tariffs South Africa faces when exporting to other SACU member countries, this is not surprising.

3. Why have Real NOT Cigarette Prices been rising: A Data and Literature Review

As mentioned previously, from the 1990's onwards, the real NOT price has increased substantially. Based on a review of the existing literature and data available, the possible causes of the real NOT cigarette price increases are expounded below.

3.1 High market concentration in the cigarette industry

The cigarette industry, as mentioned previously is highly concentrated. This high concentration has been said to give cigarette firm's pricing power which could potentially explain the increase in real NOT cigarette prices.

Van Walbeek (2006) noted that the retail price of cigarettes is shared not only by the cigarette manufacturers but by tobacco farmers, suppliers of other inputs, cigarette manufacturers, suppliers of logistical services, wholesalers and retailers. Due to the high degree of competition between wholesalers and retailers, wholesale and retail margins are kept extremely low (less than 10%). The presence of low retail and

wholesale margins, when combined with the highly concentrated market for cigarettes, provides conducive conditions for cigarette manufacturers to impose high cigarette prices and make abnormal profits.

3.2 *Input costs*

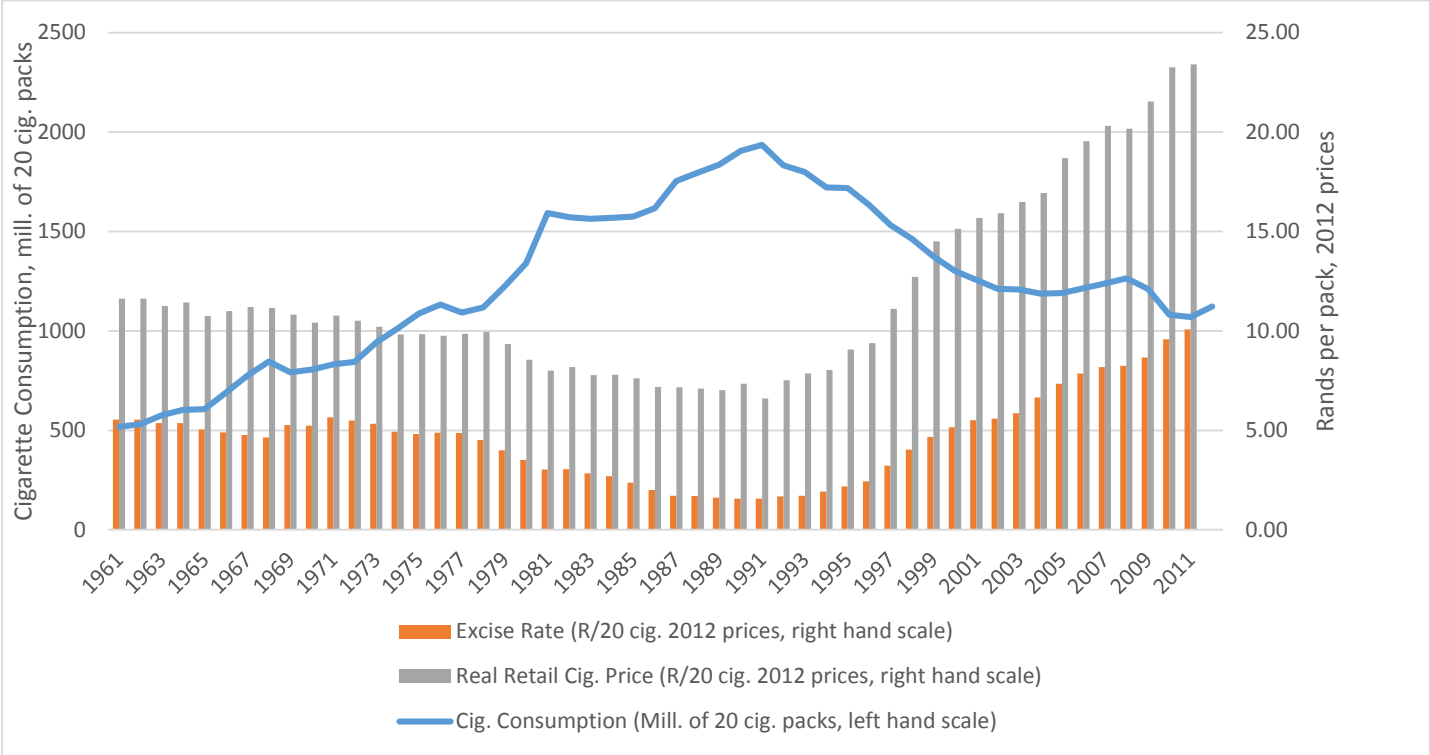
Increases in input costs could also cause increases in the price of a commodity. Van Walbeek (2006), using data from Statistics South Africa (1961 – 2004) analysed input costs in the South African cigarette industry with the aim of determining whether a rise in input costs could be the cause of the increasing real NOT cigarette prices. The main input costs in the cigarette manufacturing process are the costs of leaf tobacco, paper and labor. For leaf tobacco, Van Walbeek (2006) looked at trends in flue-cured and dark air-cured tobacco (only types of raw tobacco produced in South Africa as of 2006). For this and all the other inputs, there was no evidence to indicate that input costs were behind the rise in the real NOT cigarette prices

Van Walbeek (2006) cautioned however that some distortion was to be expected due to the fact that Producer Price Index (PPI) data was used for the analysis of paper costs. The PPI is based on a basket of products rather than the exact paper requirements of cigarette manufacturers in South Africa which might have distorted the results. Van Walbeek (2006) also mentioned that cigarette manufacturing is a capital intensive process. Labor costs therefore would not be expected to increase the real NOT prices of cigarettes.

3.3 *Excise Taxes*

As mentioned previously, researchers have speculated that the increase in excise taxes is a possible cause for the increase in the real NOT cigarettes that has occurred from the 1990's onwards. The trends of both excise taxes and the real NOT cigarette prices can be seen in Figure 3.1 below.

Figure 3.1 Real excise tax rates, real retail cigarette price and cigarette consumption in South Africa (1961 – 2012)



Source: Budget Review, various years

As can be seen above, the excise tax rate fell from 1961 to the early 1990's with the exception of a slight increase between 1967 and 1971. In June 1994 the government announced that it intended to increase the tax burden on cigarettes from 32% to 50% per cent of the retail price, to be phased in over a number of years (Van Walbeek, 2006). This would explain the increasing trend in the excise tax rate seen from the 1990's onwards.

Some researchers have attributed the increase in real NOT cigarette prices to the increasing excise tax. As is seen in Figure 3.1 above, the real retail price from 1990 onwards has risen substantially in the presence of increasing excise taxes. Specifically, for every 10 cents increase in the real level of excise tax between 1990 and 2012, the real retail price of cigarettes has increased by approximately 18 cents. This, according to Van Walbeek (2006), implies that the cigarette firms in the industry are using the opportunity provided by the increase in excise tax to increase the real NOT price as well.

From available data, the excise tax increases have been successful in reducing cigarette consumption. Between 1990 and 2012 the real excise tax rate has approximately doubled. With this increase aggregate cigarette consumption decreased by approximately 41%. Despite the large increases in excise tax, the high concentration in the cigarette industry has enabled the dominant firms to mitigate the effects of the excise tax increases on firm profits (Van Walbeek, 2006). Specifically firms have been able to exponentially increase their markups and hence make up for the increased excise tax burden.

Conclusively, excise tax increases have been used as firms as an opportunity to increase the real NOT price of cigarettes. This has been easily achieved by the firms due to the high concentration in the cigarette market.

3.4 Advertising bans and other tobacco control measures

Numerous tobacco control measures have been put in place in South Africa ever since 1995 when the first tobacco legislation, the Tobacco Products Control Act of 1993, became effective (Van Walbeek, 2005). This legislation was relatively weak in comparison to global tobacco control measures at the time but from 1995 onwards, the tobacco control environment has become progressively more threatening for cigarette industries (Van Walbeek, 2006).

Under the Tobacco Products Control Amendment of 1999 there was a complete ban of all tobacco product advertising and sponsorship (Van Walbeek, 2005). Similar anti-smoking legislature targeted at preventing advertising has also been used extensively in the USA (Farr *et al*, 2001). Looking at the cigarette market in the USA, Farr *et al* (2001) showed that advertising bans limit competition in the cigarette market hence allowing incumbent firms to set high prices. Advertising bans act as a barrier to entry; incumbent firms know that new entrants will find it hard to break into the market and hence are free to raise their mark-ups considerably in comparison to before implementation of the ban. A similar anti-competitive effect due to advertising bans in the US cigarette market was also observed by Tremblay & Tremblay (1999). Given the effect advertising bans were seen to have had in the US cigarette market, advertising bans could have hence had an

anti-competitive effect in South Africa, similar to that mentioned by Farr *et al* (2001) in the USA.

The progression of increased stringency in the tobacco control environment in South Africa has meant that cigarette companies that were already in the market pre-1995 have found it easier to maintain and even cement their market shares. Of the major cigarette companies currently in the South African market only BAT was in the industry before 1995. This would imply that BAT had the opportunity to increase its market share through advertising and other market promotion strategies before such activities were banned hence cementing their share of the market.

Advertising and promotional activities have also been cited by the cigarette industry as the main way to maintain and increase their market share (Lovato *et al*, 2003). The inability to do so would therefore be a deterrent to new firms entering the cigarette industry. Additionally, Tsai *et al* (2005) in his study of the Taiwanese cigarette market found that smokers exposed to adverts of the brand they smoke are less likely to reduce their smoking due to an increase in price. For such consumers, an increase in the real retail price (through an increase in the real NOT price) would hence not result in reduced cigarette consumption as one would expect from general economic theory. The lowered responsiveness to price of consumers exposed to cigarette adverts, combined with the presence of BAT before the increased stringency of the tobacco control environment could partially explain the industry's (and by extension BAT's) ability to impose increases in the real NOT cigarette prices without fear of encouraging new entrants into the cigarette market.

Policies that aim at limiting the prevalence of smoking tends such as excise taxation, advertising bans and other anti-smoking tobacco legislation tend to deter entry of new firms into the cigarette industry (MarketLine, 2013). The tobacco legislation in South Africa combined with the use of excise taxation could have hence provided a favorable environment for the dominance of BAT in South Africa and hence indirectly contributed to the rising real NOT prices.

3.5 Reduced cigarette consumption

The aim of tobacco control measures is the reduction of cigarette consumption. If excise taxation, advertising bans and other anti-smoking legislature is successful in reducing cigarette consumption, this could result in firms raising their markups to ensure that profits are maintained despite the reduction in consumption. According to Barnett *et al* (1995) this is a rational response in the presence of highly stringent tobacco control measures that could potentially reduce cigarette consumption. In such a situation, firms would increase prices in order to extract as much consumer surplus as possible. Furthermore, the fact that the cigarette manufacturing market is highly concentrated implies that the cigarette manufacturers can increase their prices without fear that a competitor will undercut their price.

Research has shown that advertising bans could potentially reduce cigarette consumption. Wifpli & Samet (2009) in their study of the American cigarette market found that after the introduction of the broadcast advertisement ban (1971) in America adult cigarette consumption dropped. Levy *et al* (2008) also found that of the decline in smoking prevalence in Thailand between 1991 and 2006, 21.8% was due to advertising and marketing bans. On the other hand Chaloupka (1999) and Tremblay & Tremblay (1999) found that cigarette advertising has a small/insignificant impact on cigarette smoking. If the advertising ban imposed in South Africa resulted in a drop in consumption, it could have encouraged companies to raise the real NOT price of cigarettes.

Many researchers have found that the use of excise taxation is the most effective tobacco control policy in achieving reduction of cigarette consumption (Van Walbeek, 2003). Djutaharta *et al* (2005) noted that a 10% increase in the excise tax resulted in a 6.1% decrease in consumption in Indonesia and Frieden *et al* (2003) in his analysis of cigarette consumption in New York found that between 2002 and 2003, increased taxation was the main reason for the decline in smoking prevalence.

The real retail price has also been associated in research with declines in cigarette consumption. Chaloupka (1999) found that an increase in cigarette prices would lead to a reduction in cigarette smoking. He calculated that generally the price elasticity of

cigarette demand ranges from -0.3 to -0.5 implying that a 10% increase in cigarettes would reduce cigarette demand by 3% to 5%. For South Africa, these elasticities have been found to be slightly higher and are in the range of -0.5 and -0.7 (Van Walbeek, 2003).

Conclusively, excise taxation, advertising bans, and retail price, through the effect they have on cigarette consumption, could have possibly contributed to a rise in the real NOT price of cigarettes.

3.6 Other possible explanations

Another possible explanation for the increase in the real NOT prices is put forth by Becker *et al* (1994). Based on Becker and Murphy's (1988) rational addiction framework, Becker *et al* (1994) motivated that it is rational for a monopolist to increase cigarette prices if the future demand for cigarettes decreases. In the rational addiction framework, the only reason a monopolist would set low prices (low price is defined as a price where marginal revenue is less than marginal cost) would be if consumption is addictive and the monopolist is able to raise future prices above future marginal costs. The monopolist hence 'traps' consumers with low prices in the present, and only raises the price once future demand for the good, in this case cigarettes, decreases. This reduction in future demand could be caused by increases in excise tax, or increased stringency in tobacco legislature. According to Van Walbeek (2006), this framework fits the South African case well. Real retail prices of cigarettes were relatively low until the 1990's when they started to rise. This was around the same time when the Minister of Health started talking about introducing tobacco control legislation. The Tobacco Products Control Act eventually became effective in 1995. This, combined with the election of the African National Congress to power (1994) with their unsympathetic stance to the tobacco industry, would have signaled to the cigarette manufacturers that the tobacco control environment would only become more stringent. Future demand for cigarettes would hence reduce. Foreseeing this, according to the "rational addiction" framework, the most profitable course of action for cigarette manufacturers would be to raise the real NOT price of cigarettes. This is indeed what happened in South Africa from the 1990's onwards.

Koch (2004) mentioned a possible cause of the real NOT price increases similar to that presented by the “rational addiction” framework. He motivated that two firms may initially be willing to charge a price that is lower than average cost if they anticipate that consumption of the good will result in brand loyalty and high switching costs. The firms will in the future then be able to raise the price. The extent to which the price will be raised will depend on how high the switching costs are and how ingrained brand loyalty is. Addiction represents a psychological switching cost, hence cigarettes can be said to have high switching costs given their highly addictive nature. There is however no literature regarding the nature of brand loyalty in the market for cigarettes (specifically in South Africa). It hence cannot be said with certainty whether Koch’s (2004) reasoning could explain the real NOT price increases.

Koch (2004) further motivated that when firms’ present prices are low, this allows them to gain market share. Once the market share is high enough, the firms can then charge higher prices. This matches the South African case in that real NOT prices fell slightly from the 1960’s to the 1980’s and then started rising from the 1990’s onwards. There has however only been a slight increase in the market share of BAT over this time period, it is hence unlikely that this slight increase in the market share by itself could explain the real NOT price increases.

Koch (2004) finally analyzed the South African cigarette market using a duopolistic Bertrand pricing model that accounted for the differences in the smoking behavior of young new smokers and old addicted smokers (he achieved this using an overlapping generations type model). Koch (2004) concluded that the rise in real NOT prices is due to the lack of interest in cigarette consumption by the young population. This lack of interest was mainly as a result of advertising bans and the ban on other promotional activities in South Africa. Advertising and promotional activities were the main avenues through which young people were introduced to smoking. Their removal hence caused the firms to shift their focus from the young new smokers to the old addicted smokers. Given the nature of addiction and brand loyalty, the firm could hence increase the real NOT prices without fear of losing the old smokers.

Despite putting forth various reasons for the real NOT cigarette price increase seen from the 1990's onwards, the literature fails to account for the effect that high tariffs on tobacco and tobacco products in South Africa could have had on cigarette prices. Chaloupka & Nair (2000) argue that high trade barriers could result in increased monopoly power of incumbent firms. This would hence indirectly feed through to the price of goods in such a market. Based on this fact, the theoretical model proposed next will attempt to account for the effect tariffs have on price setting in cigarette markets, in addition to the effects of excise taxation and market concentration.

4. Theoretical Model

The nature of the interaction between BAT and its next biggest competitor PMI is modelled as a duopoly with the aim of understanding how price is determined in a highly concentrated market with excise taxation and tariffs. This is in line with the assumption made by Koch (2004) in his analysis of the South African cigarette market. Even though BAT has a much higher market share than that of PMI, it cannot be considered a monopolist given PMI's ability to import cigarettes (Koch, 2004). Furthermore, given the fact that international trade is a key component of the South African cigarette market, and that there are not many global firms in the cigarette industry, it is more realistic to model the South African cigarette market as a duopoly than as a pure monopoly.

Specifically, this paper uses the Bertrand theory of duopoly to model the strategic interaction between BAT and PMI. This is similar to work done by Koch (2004) however this paper extends the Bertrand duopolistic model and uses it to model the effect of excise taxes and tariffs on the strategic interaction between the two firms. The extension of the theory to include tariffs is similar to the theoretical extensions by Feenstra (2002) and Helpman & Krugman (1989).

It is assumed that the domestic and import good are imperfect substitutes. This is ideal for the case of PMI (from here on the foreign firm) and BAT (from here on the domestic firm) as the two produce different brands of cigarettes. The price of the domestic good

is denoted by p_1 and the price of the imported good is denoted by p_2 . First, the model will be derived with the assumption that neither company pays tariffs or excise taxes, these will then be added into the model and finally the issue of entry of new firms into the market and the responsiveness of consumers to price changes of both domestic and imported cigarettes will be discussed.

The derivation of the Bertrand model is fully done in Section 9.1 of the Appendix and follows from Davis & Garcés (2010) and Shum (2011).

The following are the assumed demand equations for both the domestically produced and imported cigarettes. The key issue to note here is that the quantity demanded of the domestic cigarettes is inversely related to its own price and directly related to the price of the imported cigarettes. Furthermore, it is assumed that the quantity demanded of the domestic cigarettes is more responsive to a change in its own price than to a change in the price of the imported cigarettes (Shum, 2011). Similarly, the quantity demanded of the imported cigarettes is inversely related to its own price and directly related to the price of the domestically produced cigarettes. It is again assumed that the quantity demanded of the imported cigarettes is more responsive to a change in its own price than to a change in the price of the domestically produced cigarettes ($b_{11} > b_{12}$ and $b_{22} > b_{21}$)

Demand for the domestically produced cigarettes, $q_1 = a_1 - b_{11}p_1 + b_{12}p_2$

Demand for the imported cigarettes, $q_2 = a_2 - b_{22}p_2 + b_{21}p_1$

Elasticity of demand for the domestically produced cigarettes is dependent on b_{11} since

$$\frac{\partial q_1}{\partial p_1} \frac{p_1}{q_1} = - b_{11} \frac{p_1}{q_1}$$

Similarly, Elasticity of demand for the imported cigarettes is dependent on b_{22} since

$$\frac{\partial q_2}{\partial p_2} \frac{p_2}{q_2} = - b_{22} \frac{p_2}{q_2}$$

Cross price elasticity of demand for the domestically produced cigarettes is dependent on b_{12} since

$$\frac{\partial q_1}{\partial p_2} \frac{p_2}{q_1} = b_{12} \frac{p_2}{q_1}$$

Similarly, Cross price elasticity of demand for the imported cigarettes is dependent on b_{21} since

$$\frac{\partial q_2}{\partial p_1} \frac{p_1}{q_2} = b_{21} \frac{p_1}{q_2}$$

It is assumed that both firms face constant marginal costs (c) and that both firms maximize their profits taking the other firm's behavior as given. Prices are hence set simultaneously without the firm's knowing each other's price choice. The profit equations are hence as below;

$$\pi_1 = (p_1 - c) (a_1 - b_{11}p_1 + b_{12}p_2)$$

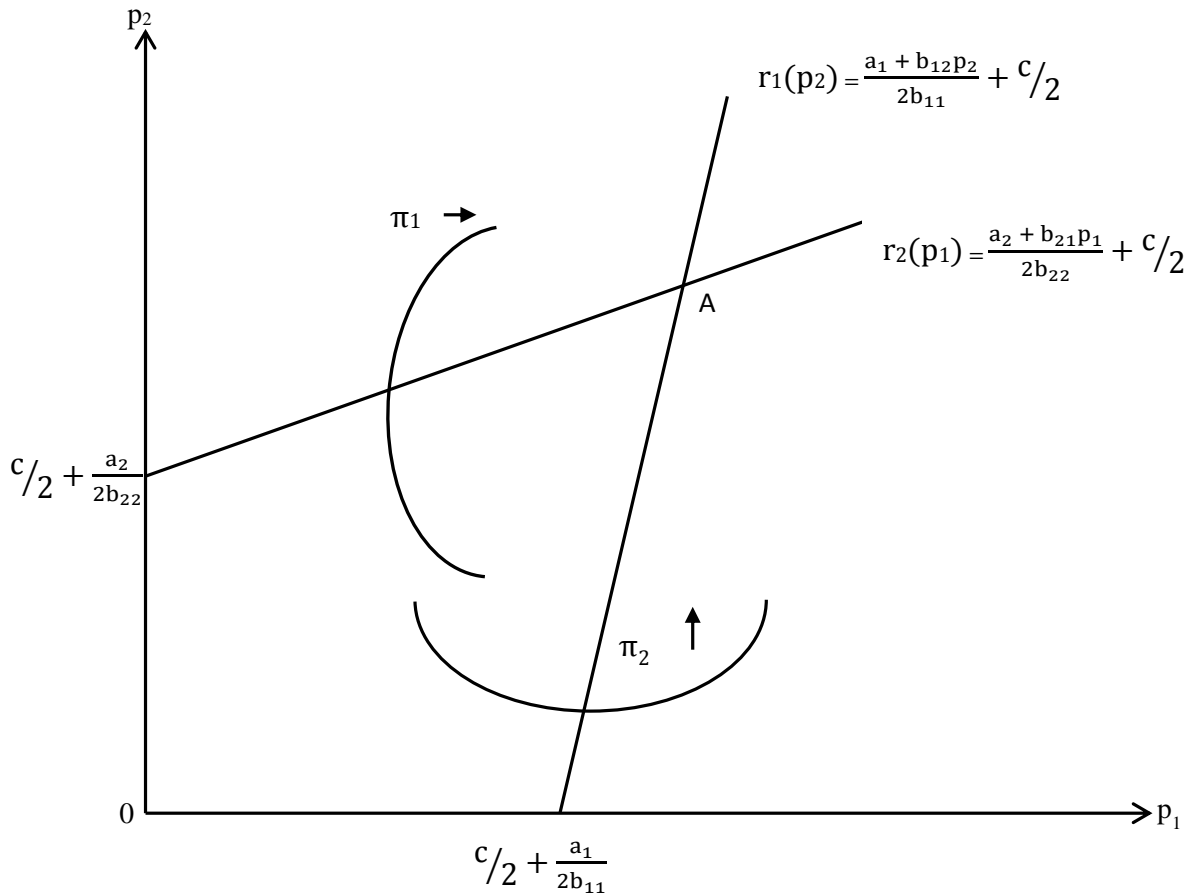
$$\pi_2 = (p_2 - c) (a_2 - b_{22}p_2 + b_{21}p_1)$$

In order to determine the profit maximizing price, profit maximization equations are used. These result in the following first order condition equations for p_1 and p_2 .

$$p_1 = \frac{a_1 + b_{12}p_2}{2b_{11}} + c/2 \tag{1}$$

$$p_2 = \frac{a_2 + b_{21}p_1}{2b_{22}} + c/2 \tag{2}$$

Equations 1 and 2 give the best response functions for both the domestic and the importing firm. These two response functions result in a Bertrand equilibrium at A as is shown below;



The iso-profit curves of the domestic firm π_1 increase to the right (as p increases π_1 increases) while the iso-profit curves of the foreign firm π_2 increase upward (as q increases π_2 increases). From the above diagram, the domestic firm and the foreign firm are strategic complements. The domestic firm and the foreign firm optimally set their prices simultaneously at equilibrium A given their beliefs about what the other firm's price will be.

If symmetric prices are assumed, the price at A can be calculated using equations (1) and (2) and the following result obtained

$$p^* = \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{22}c + 2b_{22}b_{11}c}{4b_{22}b_{11} - b_{12}b_{21}}$$

Because of the symmetric nature of the demand functions this can be simplified as

$$p^* = \frac{a+bc}{2b-d}$$

4.1 The inclusion of an excise tax

If an excise tax is levied on the sale of cigarettes, both the importing firm and the domestically producing firm are directly affected. The excise tax (e) will affect the marginal costs of the firms and their new profit functions will be as below;

$$\pi_1 = (p_1 - c - e) (a_1 - b_{11}p_1 + b_{12}p_2)$$

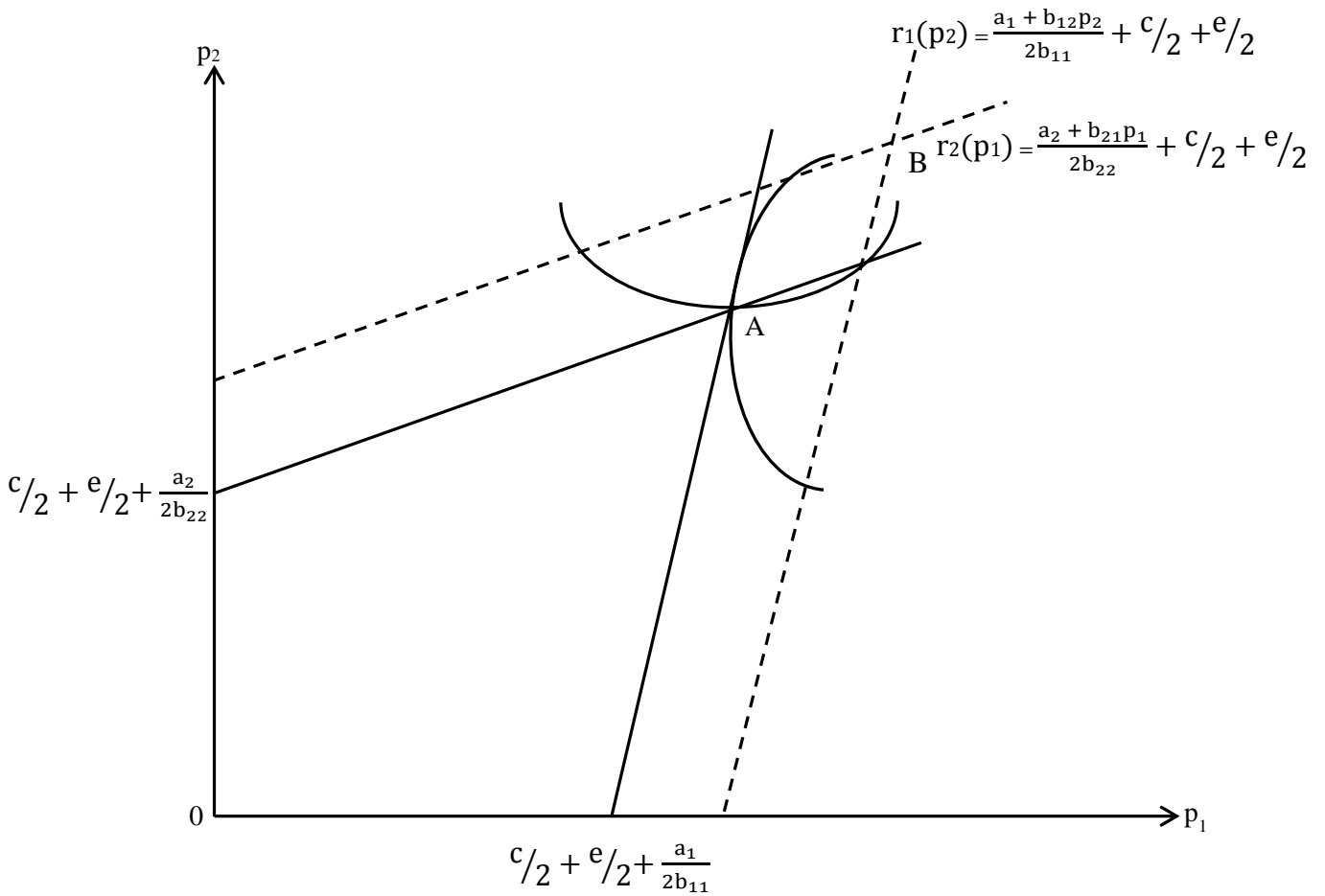
$$\pi_2 = (p_2 - c - e) (a_2 - b_{22}p_2 + b_{21}p_1)$$

The first order conditions result in the following equations for p_1 and p_2 .

$$p_1 = \frac{a_1 + b_{12}p_2}{2b_{11}} + \frac{c}{2} + \frac{e}{2} \quad (3)$$

$$p_2 = \frac{a_2 + b_{21}p_1}{2b_{22}} + \frac{c}{2} + \frac{e}{2} \quad (4)$$

The inclusion of excise taxes changes the Bertrand equilibrium point. This can be seen by graphing the reaction functions in equations (3) and (4) as is shown below;



Again, assuming symmetric prices, the new equilibrium price after the imposition of the excise tax can be calculated from equations (3) and (4) and the following result obtained;

$$p^{**} = \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11} - b_{12}b_{21}}$$

Because of the symmetric nature of the demand functions and the prices, it can be assumed that;

$$p^{**} = \frac{a+bc+be}{2b-d}$$

$$\frac{\partial p^{**}}{\partial e} = \frac{b}{2b-d}$$

In the equation above, b is related to the own price elasticity of demand and d is related to the cross price elasticity of demand. If d was zero (i.e. the domestic cigarettes and the imported cigarettes were independent of each other), a unit change in the excise tax would increase the price of cigarettes by half a unit. Due to the domestic and imported cigarettes being imperfect substitutes, d will always be above zero. The closer the degree of substitution between the domestic good and the imported good the higher the price change in response to a change in the excise tax rate will be. This is because since they are only 2 firms in the market, if the cross price elasticity of demand is high and one firm changes their price slightly, the change in the quantity demanded of the substitute good will be much higher than the change in price that induced it. This increased demand for the substitute good will drive up the price of the substitute good causing a higher increase in the price due to the change in the excise rate than what would have been the case if the goods were not close substitutes ($d=0$). Since prices are determined simultaneously in this model both prices will increase. The closer the degree of substitution between the cigarettes produced by BAT and PMI, the higher the cigarette price increase induced by a change in the excise tax. This could possibly explain the increase in the real NOT price increases in the cigarette market.

4.2 *The inclusion of tariffs*

As mentioned previously, much of the literature attempting to explain the increase in the NOT price of cigarettes fails to include the international environment as a possible explanation for the observed price increases. The inclusion of tariffs in the Bertrand model is hence an important part of this paper's theoretical model.

The levying of a tariff only directly affects the importing firm. The reaction functions of the domestically producing firm will therefore stay the same.

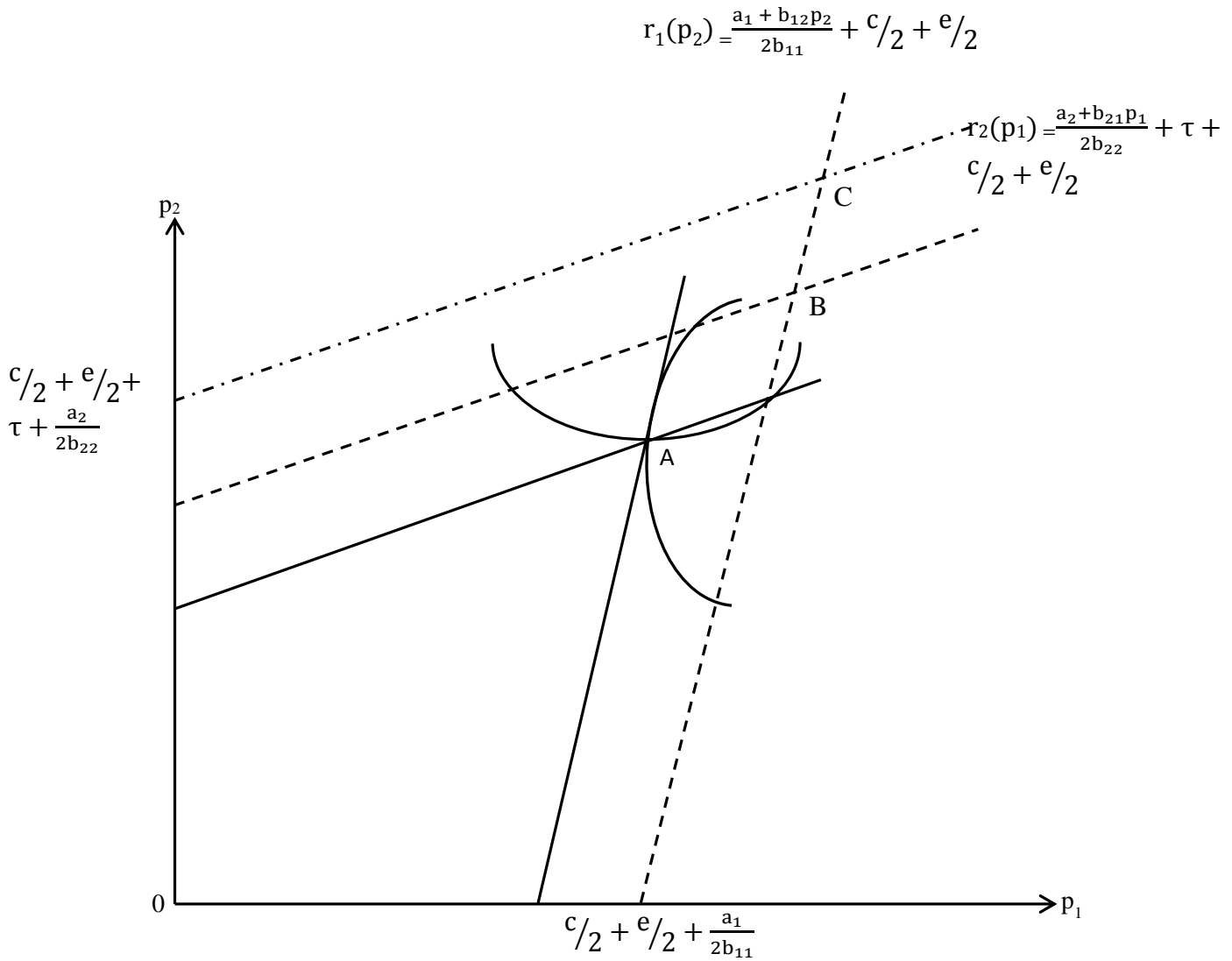
Assuming that $p_2 = p_3 + \tau$, where τ represents the tariff and p_3 is the tariff exclusive foreign price, the reaction function of the importing firm can be recalculated as below. For the sake of simplicity, it is assumed that the tariff is levied as a specific tariff. The profit function of firm 2 therefore becomes

$$\pi_2 = \{p_2 - \tau - c - e\} \{a_2 - b_{22}(p_2 - \tau) + b_{21}p_1\}$$

The first order conditions result in the following equation p_2 .

$$p_2 = \frac{a_2 + b_{21}p_1}{2b_{22}} + \tau + \frac{c}{2} + \frac{e}{2} \quad (5)$$

With this new reaction curves for the importing firm, a new Bertrand equilibrium, C is obtained as is seen below;



Again, assuming symmetric prices, the new equilibrium price after the imposition of the tariff in the presence of the excise tax can be calculated from equations (3) and (5) and the following equation obtained

$$p^{***} = \frac{2b_{22}a_1 + b_{12}a_2 + 2b_{12}\tau + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11} - b_{12}b_{21}}$$

Because of the symmetric nature of the demand functions and the prices, it can be assumed that;

$$p^{***} = \frac{a+bc+be}{2b-d} + \frac{2d\tau}{4b^2-d^2}$$

$$\frac{\partial p^{***}}{\partial \tau} = \frac{2d}{4b^2 - d^2}$$

From the above equation, holding own price elasticity constant, the limit of $\frac{\partial p^{***}}{\partial \tau}$ as d tends to infinity is 0 (L'Hospital's rule). Therefore the higher d is, the less the change in price induced by a change in tariffs. This implies that the higher the degree of substitutability between the goods, the less the pass through of tariffs to the price. This is probably explained by the fact that an importer, knowing that the domestic good and his own are highly substitutable, would be wary to pass through too much of the tariff as a change in price would result in a much larger shift of the consumers to the domestic good. The reverse of this is that if the goods have very low substitutability, the importer would pass through more of the tariff than if the goods were highly substitutable. If the cigarettes produced by PMI and BAT have very low substitutability, this could possibly explain the increase in the real NOT price.

4.3 Entry of new firms into the market.

As mentioned previously, there is literature to suggest that the advertising ban in the cigarette market and consolidation of the market itself has allowed for a highly concentrated cigarette market which has influenced price setting. In this model, the effect of increased market concentration can be studied by looking at the reverse occurrence: what happens when new firms enter the market and market concentration decreases?

The entry of new firms would reduce the responsiveness of each firm's quantity demanded to the prices of the other possible substitutes in the market. This is because as the number of firm's increases, the residual demand faced by any firm in the market becomes less and less.

From the equation $\frac{\partial p^{**}}{\partial e} = \frac{b}{2b-d}$, holding own price elasticity constant, this would mean that the increase in price due to a unit increase in the excise rate would be less than before entry of the firms. This hence implies that market concentration contributes to a higher pass through of excise taxes to cigarette prices.

4.4 Responsiveness of consumers to price changes

The degree of responsiveness of consumers to changes in price is likely to alter the strategic interaction discussed in the theoretical model. Due to the addictive nature of cigarettes and the high brand loyalty consumers attach to their brand, an increase in prices is likely to significantly change the consumer profile for a firm's good. A firm is likely to be left with consumers who are much less responsive to changes in price than would be the case in other non-addictive markets.

When consumers are less responsive to price, this will cause a drop in the own price elasticity of demand (b_{11} and b_{22}). This would make the reaction functions of the firm's steeper hence amplifying the increases in price induced by the excise tax and the tariff.

The theoretical model presented shows that the price set in the market for cigarettes is related to the excise rate and the tariffs. The degree to which the excise rate and the tariffs will affect the price in the market can be influenced by the responsiveness of consumers to price changes (own price elasticity of demand), the degree of substitutability of the goods produced by the firms (cross price elasticity of demand), and the market concentration of the industry. With suitable data, the relationship between the price of cigarettes, and the excise and tariff rates can be estimated.

5.0 Methodology

The aim of the methodology used in this paper is to perform a preliminary analysis on the relationship between the price of cigarettes and the factors that, based on the theory motivated above, would affect this price. This preliminary analysis is purely to check the consistency of the relationships derived in the theoretical model. Specifically the paper makes use of quarterly data from 1990 to 2013 of the following variables. For each of the statistical analyses, all the variables are expressed in natural logarithmic terms to reduce the variance in the data.

- (i) The Consumer price index (CPI) of tobacco and tobacco products obtained from Statistics South Africa (2000 prices). This is used to represent the price of cigarettes
- (ii) The nominal excise rate (in rands per pack of 20 cigarettes) obtained from the Budget Review printed by the Republic of South Africa
- (iii) Tariffs obtained from the South Africa tariff book and the United Nations Commodity and Trade Statistics Database (UN-COMTRADE)
- (iv) The exchange rate (South African rand per US dollar) obtained from the Quantec EasyData database
- (v) Raw tobacco prices in US dollars obtained from the World Bank Global Economic Monitor (GEM) Commodities database. These are converted to rand values using the exchange rate data and are used to represent the international price of raw tobacco.
- (vi) Final consumption expenditure by households obtained from the South African Reserve Bank (SARB) (2000 prices)

The challenge with using quarterly time series data is that it tends to be nonstationary. Variables that are nonstationary tend to not return to a constant value or linear trend over time. Hence the relationship between such series cannot be modelled using Ordinary Least Squares (OLS) estimation as OLS assumes that the variables are

stationary. Furthermore, using OLS to model relationships between nonstationary variables would lead to a spurious regression problem. This occurs when there appears to be a statistically significant relationship between two variables that are unrelated (Wooldridge, 2009).

The difficulty in modelling relationships using nonstationary data is eliminated if the data are cointegrated. If two or more series of data are nonstationary, but a linear combination of the two series is stationary, then they are said to be cointegrated and long-run equilibrium relationships between the two series are said to exist (Engle & Granger, 1987). If series are cointegrated, the residuals of their linear combination are stationary. It is hence possible to make useful inferences on the nature of the short run and long run relationships between the series using least squares estimation.

In order to conduct a preliminary analysis of the relationship between the price of cigarettes and the other variables listed previously the following methodology is used.

5.1 The Augmented Dickey Fuller Test (ADF)

This is a test used to determine whether series data is nonstationary or stationary. This is run first and if the data are stationary, normal OLS estimation methods can be used without the application of any further statistical techniques before doing so. If the data are nonstationary, the first differences of the time series are put through the ADF test. This process is repeated until a stationary series emerges at which point the order of integration of the series can be determined based on the number of differences tested before a stationary series is obtained (Samimi, 1995). This is necessary as the next step (testing for cointegration) requires that the data be integrated of the same order (Ssekume, 2011).

5.2 The Johansen Test of Cointegration

Next, the series are checked for cointegration using the Johansen test of cointegration. This method is used when one suspects that there is more than one cointegrating vector in the dataset. Given that this paper's analysis is a preliminary one, the use of this test is purely for the purpose of ensuring that the variables are cointegrated which implies the existence of a long-run relationship; and to determine how many stable relationships exist between the nonstationary series. Confirming the existence of cointegration is necessary as it allows the use of least squares estimation to study the existing relationship between the series data.

5.3 Estimation of an Autoregressive Distributed Lag Model (ARDL)

Once the presence of cointegration has been established, an ARDL (1 1 1) model is estimated to study the relationship between the price of cigarettes and the other variables listed previously. Important to note here is despite the fact that the Johansen test of cointegration result could indicate the existence of more than one cointegrating vector; for the sake of preliminary analysis this paper only estimates a single equation. It is hence implicitly assumed that all the explanatory variables in the ARDL model are exogenously determined. This is sufficient given the preliminary nature of this paper's analysis and the fact that it allows for the comparison of the empirical relationships to the theoretical relationships developed previously.

The following is the relationship assumed between the price of cigarettes, the international price of raw tobacco, the excise rate, the tariff rate and the income of households

$$CPI_t = \alpha CPI_{t-1} + \beta_1 X_t + \beta_2 X_{t-1} + \varepsilon_t$$

CPI_t is the consumer price index for tobacco products in South Africa at time t . β_1 is the vector of all the coefficients of the international price of raw tobacco, the excise rate, the tariff rate and the income of households, while X_t is the variables vector for all the aforementioned variables. β_2 is the vector of all the coefficients on the lagged term of the international price of raw tobacco, the excise rate, the tariff rate and the income of

households while \mathbf{X}_{t-1} is the variables vector of the lagged terms of all the aforementioned variables. ε_t is an error term whose nature is dependent on the stationarity of the time series in the equation. Specifically, if the time series data for both the explained and explanatory variables is nonstationary, the error term would be expected to be stationary.

The equation above can be written in the form of an error correction model as below;

$$CPI_t = \alpha CPI_{t-1} + \beta_1 \mathbf{X}_t + \beta_2 \mathbf{X}_{t-1} + \varepsilon_t$$

$$CPI_t - CPI_{t-1} = \alpha CPI_{t-1} - CPI_{t-1} + \beta_1 \mathbf{X}_t - \beta_1 \mathbf{X}_{t-1} + \beta_1 \mathbf{X}_{t-1} + \beta_2 \mathbf{X}_{t-1} + \varepsilon_t$$

$$\Delta CPI_t = (\alpha - 1)CPI_{t-1} + \beta_1 \mathbf{X}_{t-1} + \beta_2 \mathbf{X}_{t-1} + \beta_1 \Delta \mathbf{X}_t + \varepsilon_t$$

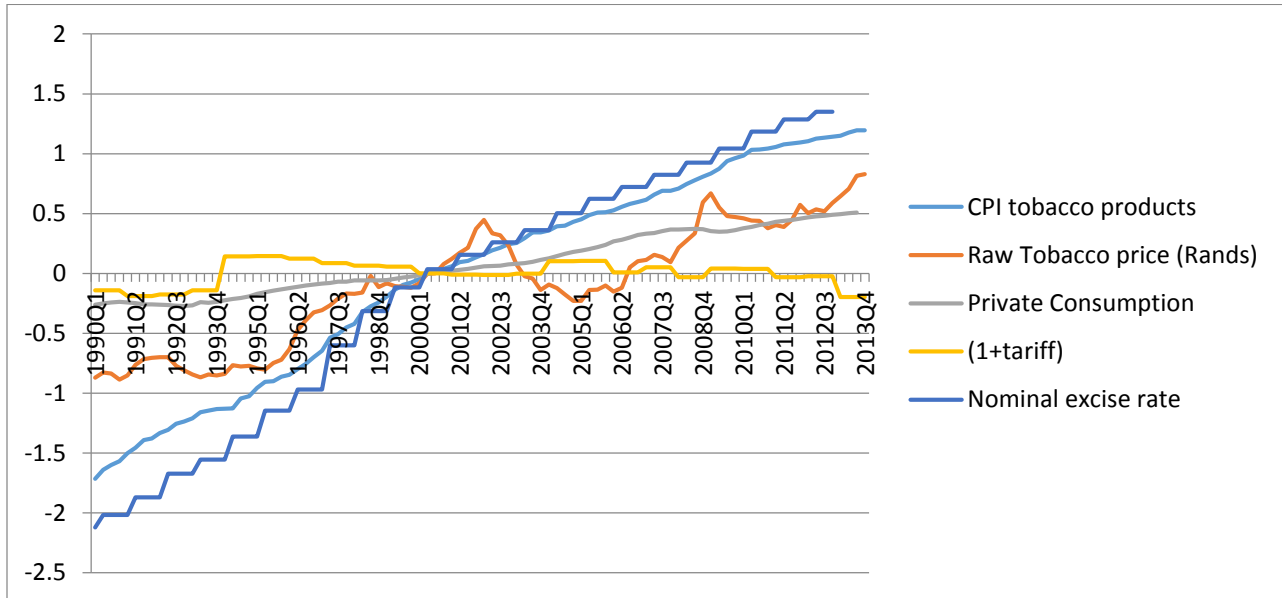
$$\Delta CPI_t = (\alpha - 1) \left\{ CPI_{t-1} + \frac{\beta_1 + \beta_2}{\alpha - 1} \mathbf{X}_{t-1} \right\} + \beta_1 \Delta \mathbf{X}_t + \varepsilon_t$$

$$\Delta CPI_t = -(1 - \alpha) \left\{ CPI_{t-1} - \frac{\beta_1 + \beta_2}{1 - \alpha} \mathbf{X}_{t-1} \right\} + \beta_1 \Delta \mathbf{X}_t + \varepsilon_t$$

The modelling of an equation similar to the one above allow estimates for the β_1 , β_2 and $(1 - \alpha)$ parameters to be obtained. These will then give a preliminary picture of the nature of the aforementioned relationships in the South African cigarette market which can then be compared to the relationships developed in the theoretical model.

6.0 Graphical Analysis

Figure 6.1 Trends in the logarithmic variables of the CPI of tobacco products, the international price of raw tobacco (rands value), private consumption, the tariff rate and the nominal excise tax rate



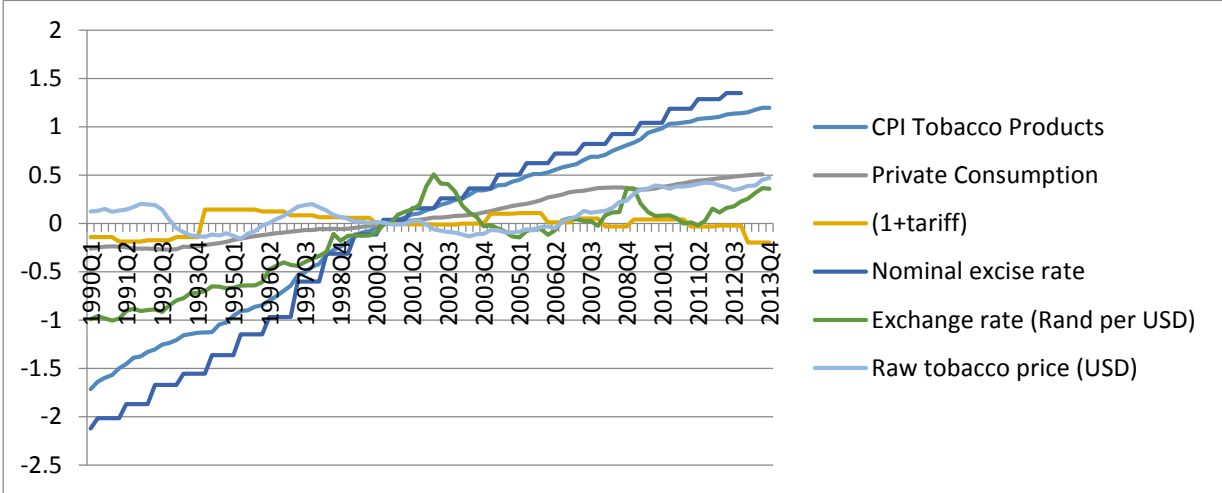
Source: Statistics South Africa, World Bank GEM Commodities Database, SARB, Budget Review, UN COMTRADE & The South African Tariff Schedule, various years

Figure 6.1 above shows trends in the CPI of tobacco products, the international raw tobacco price (in rands), private consumption, (1+tariff) and the excise rate. Tariff changes occur once a year, tariffs therefore would only be expected to cause level changes in the movement of the CPI of tobacco products. This can be seen around 1994Q1 and 1994Q2 where the tariff increased and the slope of the CPI curve also increased slightly. The correlation coefficient between the CPI of tobacco products and the tariff rate however is approximately 0.307. This might indicate the existence of a weak relationship between the two series.

The correlation coefficient between the excise rate and the CPI of tobacco products is quite high at 0.993. This is not surprising as their trends are similar. The excise rate is however increasing faster than the CPI of tobacco products. This implies the presence

of incomplete pass through of excise taxes to cigarette prices, an outcome similar to that of the theoretical model developed previously. Private consumption and international raw tobacco prices are highly correlated to the CPI of tobacco products with correlation coefficients of 0.969 and 0.934 respectively. Looking at the international raw tobacco prices (in rands), its high correlation with the CPI is driven by the high correlation between the CPI and the exchange rate, specifically up to the early 2000's. When the tobacco price is expressed in dollars its correlation coefficient reduces to 0.475 while the correlation between the CPI and the exchange rate is 0.906. It is hence possible that the CPI's relationship to international tobacco price is driven mainly by exchange rate fluctuations. This can be seen in Figure 6.2 below.

Figure 6.2 Trends in the logarithmic variables of the CPI of tobacco products, the international price of raw tobacco (USD value), private consumption, the tariff rate, the exchange and the nominal excise tax rate



Source: Statistics South Africa, World Bank GEM Commodities Database, SARB, Budget Review, UN COMTRADE & The South African Tariff Schedule, various years

The figure above highlights a second interesting observation about the relationship between the raw tobacco prices and the CPI. Post 2000, the exchange rate does not seem to be related to the CPI of tobacco prices. However looking back at Figure 6.1 after 2000, both the raw tobacco price (in dollars) and the CPI of tobacco products exhibit an upward trend. This implies that before 2000, the exchange rate was more important in explaining the trends in cigarette prices than the international price of raw

tobacco. After 2000 however, the international price of raw tobacco was more important in explaining the trends in cigarette prices than the exchange rate. From the two graphs above, raw tobacco prices and the excise rate seem to be the strongest drivers of the CPI of tobacco products.

7.0 Results

7.1 The Augmented Dickey Fuller Test (ADF)

An Augmented Dickey-Fuller (ADF) test is run on the series and their subsequent differences with the aim of determining whether the data are nonstationary and what their order of integration is. The null hypothesis for this test is

H_0 : The series is nonstationary

From the previous graphs, the CPI in tobacco products and the nominal excise rate exhibit substantial upward trends. The ADF test for these two series is hence run with the inclusion of a trend term. The following results are obtained;

Table 7.1 Results of the ADF test

Variable	Level	First Difference
CPI	0.9913	0.0000*
Raw tobacco price	0.9320	0.0000*
Excise Rate	0.8355	0.0000*
Tariff	0.9121	0.0000*
Private Consumption	0.9980	0.0001*

**p-value is significant at 5% level*

All variables are in natural logarithms

For the level ADF, we fail to reject the null hypothesis of nonstationarity as none of the p-values are statistically significant at the 5% significance level and hence conclude that the series are all nonstationary. Looking at the first difference the ADF, we reject the null hypothesis for all the variables since all the p-values obtained are statistically significant at the 5% significance level. We hence conclude that the first differences of these series are stationary. This implies that all the series data are integrated of degree one $I(1)$. The fact that all the data are integrated of the same order allows us to move on and test for cointegration.

7.2 The Johansen Test of Cointegration

Before running the Johansen test of cointegration, the number of appropriate lags to use for the test is has to be determined. Based on the sequential likelihood ratio, the final prediction error (FPE), Akaike's information criterion (AIC) and, the Hannan-Quinn information criterion (HQIC) 4 lags are deemed appropriate (Results in Section 9.2 of

Appendix). The Johansen test of cointegration is hence run with 4 lags and the following results are obtained.

Table 7.2 Results of the Johansen Test of Cointegration

Maximum rank	Eigen value	Trace statistic	5% Critical value
0	-	108.4714	68.52
1	0.42854	59.2299	47.21
2	0.32493	24.6516*	29.68
3	0.13392	11.9987	15.41
4	0.10445	2.2905	3.76
5	0.02569		

**denotes result corresponding to number of cointegrating equations in data*

For the first three rows, our null hypotheses are

H₀: There is no cointegration

H₀: At most there is only one cointegrating equation

H₀: At most there are only two cointegrating equation

The Johansen's test starts with the test for zero cointegrated equations and then accepts the first null hypothesis that is not rejected. This occurs at a maximum rank of 2. There are hence 2 cointegrating equations in our data. The modelling of these equations is beyond the scope of this paper, however a preliminary analysis using Johansen's test of cointegration shows that the nature of the relationship between the international raw tobacco prices and the CPI of tobacco prices is an indirect one, while the CPI is directly related to the rest of the series in our data (output in section 9.3 of Appendix). Furthermore, now that the existence of cointegration has been established, the estimation of the previously specified model can follow.

7.3 Estimation of an Autoregressive Distributed Lag Model (ARDL)

As mentioned previously, for the sake of preliminary analysis a model similar to the following single ARDL model equation is estimated. All the data used are in logarithmic form.

$$\Delta\text{CPI}_t = -(1-\alpha)\left\{\text{CPI}_{t-1} - \frac{\beta_1+\beta_2}{1-\alpha} \mathbf{X}_{t-1}\right\} + \beta_1\Delta\mathbf{X}_t + \varepsilon_t$$

The results obtained are as below;

Table 7.3 Results for the estimation of the ARDL model

Explanatory Variable	Coefficient
CPI _{t-1}	-.1525* (.04666)
Raw tobacco prices _{t-1}	.026* (.009947)
Private Consumption _{t-1}	.00668* (.02849)
Tariff _{t-1}	.04482 (.03055)
Excise rate _{t-1}	.08905* (.03746)
ΔRaw tobacco prices	-.01333 (.02281)
ΔPrivate Consumption	-.3149 (.2824)
ΔTariff	-.03036 (.02336)
ΔExcise rate	.1561* (.03013)
Constant	-1.1152* (.4046)
R ²	.5107
N	91

**p-value is significant at 5% level*

All variables are in natural logarithms except the constant

Looking at the first difference terms in our model, only the coefficient of the first difference of the excise rate is statistically significant at the 5% level. There is hence a positive short run relationship between the excise rate and the CPI of tobacco products.

The coefficients on the lagged terms give an indicator of the long run relationship between the explanatory variables and the CPI of the tobacco products. From our specification, the coefficient on the lagged terms of our explanatory variables should be recalculated as the beta coefficient of each lagged explanatory variable divided by the beta coefficient of the lagged CPI variable. Table 7.4 below hence has the recalculated coefficients as well as the percentage change in the logarithmic CPI of the tobacco products due to each explanatory variable. The percentage change in the CPI of the tobacco products due to each explanatory variable is obtained for the period 1990 to 2012 by finding the percentage change between the average CPI in 2012 and the average CPI in 1990.

Table 7.4 Recalculated beta coefficients and percentage share of explanatory variable in change of logarithmic CPI variable

Variable	Coefficient	Percentage share of variable in change of log of CPI
Raw tobacco price	0.1705	8.6%
Private Consumption	0.4381	11.5%
Tariff	0.2939	1.3%
Excise rate	0.584	71.5%
Unexplained variation		7.1%

All variables are in natural logarithms

Based on the table above, the most important variable in explaining the long run changes in the CPI of tobacco prices is the excise rate. It explains approximately 71.5% of the long run variation in the logarithmic change of the dependent variable. There is however 7.1% of the long run variation that remains unexplained.

8.0 Implications and Discussion

The results from both the cointegration test and the ARDL model indicate that indeed the excise rate, private consumption and the tariff are associated to changes in the CPI of tobacco products. Specifically, there is a both a short and long run relationship between the CPI and the excise rate. This implies that a change in the excise tax rate will result in a permanent change in the price of cigarettes. There is also a long run relationship between the raw tobacco price, private consumption and the tariff however these relationships are secondary in importance to that of excise rates and CPI.

The main objective of this paper was to determine what caused the real NOT cigarette price increases. Results obtained indicate that a 1% increase in tobacco excise taxes lead to a less than 1% increase in the price of cigarettes in both the short run and the long run. This does not explain the increase in the real NOT cigarette price increases. From the results obtained in section 7.0 above, the preliminary data analysis, and the graphical analysis; the real NOT price increase could possibly have been driven by a combination of the other explanatory variables (consumption, tariffs and raw tobacco) as well as the exchange rate (prior to 2000). In light of this possibility, and the fact that the Johansen's test of cointegration determined that there were two cointegrating vectors in the series data, the modelling of an ARDL model without accounting for the second cointegrating vector may give an incomplete picture of how the series interact with each other over time. It is also worth noting that the model used a logarithmic excise tax term as an explanatory variable and hence indirectly assumed that the excise tax is levied ad valorem which is not the case in reality. This could have possibly biased the results.

Lastly, the model used also does not account for the effect that the market concentration of the cigarette industry would have on the price of cigarettes. It is hence possible that this is the missing variable in explaining the increase in the real NOT cigarette prices.

Conclusively, as a preliminary data analysis tool, the model used has served the purpose of showing that the relationships that are modelled theoretically do exist empirically. Furthermore, the preliminary analysis through the Johansen's test of cointegration has showed that in order to completely understand the short and long run relationships associated with cigarette prices, and hence thoroughly explain the rise in real NOT prices in the cigarette market, a model that accounts for the existence of 2 cointegrating vectors must be used. Based on the preliminary analysis, future research could extend the model used to account for the presence of 2 cointegrating factors, as well as the high market concentration

9.0 References

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10.0 Appendix

10.1 Derivation of theoretical model

Demand for the domestically produced cigarettes, $q_1 = a_1 - b_{11}p_1 + b_{12}p_2$

Demand for the imported cigarettes, $q_2 = a_2 - b_{22}p_2 + b_{21}p_1$

Elasticity of demand for the domestically produced cigarettes is dependent on b_{11} since

$$\frac{\partial q_1}{\partial p_1} \frac{p_1}{q_1} = -b_{11} \frac{p_1}{q_1}$$

Similarly, Elasticity of demand for the imported cigarettes is dependent on b_{22} since

$$\frac{\partial q_2}{\partial p_2} \frac{p_2}{q_2} = -b_{22} \frac{p_2}{q_2}$$

Cross price elasticity of demand for the domestically produced cigarettes is dependent on b_{12} since

$$\frac{\partial q_1}{\partial p_2} \frac{p_2}{q_1} = b_{12} \frac{p_2}{q_1}$$

Similarly, Cross price elasticity of demand for the imported cigarettes is dependent on b_{21} since

$$\frac{\partial q_2}{\partial p_1} \frac{p_1}{q_2} = b_{21} \frac{p_1}{q_2}$$

It is assumed that both firms face constant marginal costs (c) and that both firms maximize their profits taking the other firm's behavior as given. Prices are hence set simultaneously without the firm's knowing each other's price choice. The profit equations are hence as below;

$$\pi_1 = p_1 q_1 - c q_1$$

$$\pi_1 = (p_1 - c) q_1$$

$$\pi_1 = (p_1 - c) (a_1 - b_{11} p_1 + b_{12} p_2)$$

$$\pi_2 = p_2 q_2 - c q_2$$

$$\pi_2 = (p_2 - c) q_2$$

$$\pi_2 = (p_2 - c) (a_2 - b_{22} p_2 + b_{21} p_1)$$

First Order Conditions (Profit maximization)

$$\frac{\partial \pi_1}{\partial p_1} = (p_1 - c) (-b_{11}) + (a_1 - b_{11}p_1 + b_{12}p_2) = 0$$

$$-b_{11}p_1 + cb_{11} + a_1 - b_{11}p_1 + b_{12}p_2 = 0$$

$$a_1 + b_{12}p_2 = 2b_{11}p_1 - cb_{11}$$

$$a_1 + b_{12}p_2 = b_{11}(2p_1 - c)$$

$$\frac{a_1 + b_{12}p_2}{b_{11}} = 2p_1 - c$$

$$2p_1 = \frac{a_1 + b_{12}p_2}{b_{11}} + c$$

$$p_1 = \frac{a_1 + b_{12}p_2}{2b_{11}} + c/2 \tag{1}$$

Similarly

$$\frac{\partial \pi_2}{\partial p_2} = (p_2 - c) (-b_{22}) + (a_2 - b_{22}p_2 + b_{21}p_1) = 0$$

$$-b_{22}p_2 + cb_{22} + a_2 - b_{22}p_2 + b_{21}p_1 = 0$$

$$a_2 + b_{21}p_1 = 2b_{22}p_2 - cb_{22}$$

$$a_2 + b_{21}p_1 = b_{22}(2p_2 - c)$$

$$\frac{a_2 + b_{21}p_1}{b_{22}} = 2p_2 - c$$

$$2p_2 = \frac{a_2 + b_{21}p_1}{b_{22}} + c$$

$$p_2 = \frac{a_2 + b_{21}p_1}{2b_{22}} + c/2 \tag{2}$$

If symmetric prices are assumed, the price at A can be calculated using equations (1) and (2).

$$p_1 = \frac{a_1 + b_{12}p_2}{2b_{11}} + c/2 \tag{1}$$

$$p_2 = \frac{a_2 + b_{21}p_1}{2b_{22}} + c/2 \tag{2}$$

Replacing (2) in (1)

$$p_1 = \frac{a_1 + b_{12} \left\{ \frac{a_2 + b_{21} p_1 + c/2}{2b_{22}} \right\}}{2b_{11}} + c/2$$

$$p_1 = \left\{ \frac{2b_{22} a_1 + b_{12} a_2 + b_{12} b_{21} p_1 + b_{12} b_{22} c}{2b_{22}} \right\} \left\{ \frac{1}{2b_{11}} \right\} + c/2$$

$$p_1 = \left\{ \frac{2b_{22} a_1 + b_{12} a_2 + b_{12} b_{21} p_1 + b_{12} b_{22} c}{4b_{22} b_{11}} \right\} + c/2$$

$$p_1 = \frac{2b_{22} a_1 + b_{12} a_2 + b_{12} b_{21} p_1 + b_{12} b_{22} c + 2b_{22} b_{11} c}{4b_{22} b_{11}}$$

$$p_1 - \frac{b_{12} b_{21} p_1}{4b_{22} b_{11}} = \frac{2b_{22} a_1 + b_{12} a_2 + b_{12} b_{22} c + 2b_{22} b_{11} c}{4b_{22} b_{11}}$$

$$p_1 \left\{ 1 - \frac{b_{12} b_{21}}{4b_{22} b_{11}} \right\} = \frac{2b_{22} a_1 + b_{12} a_2 + b_{12} b_{22} c + 2b_{22} b_{11} c}{4b_{22} b_{11}}$$

$$p_1 \left\{ \frac{4b_{22} b_{11} - b_{12} b_{21}}{4b_{22} b_{11}} \right\} = \frac{2b_{22} a_1 + b_{12} a_2 + b_{12} b_{22} c + 2b_{22} b_{11} c}{4b_{22} b_{11}}$$

$$p_1 = \left\{ \frac{2b_{22} a_1 + b_{12} a_2 + b_{12} b_{22} c + 2b_{22} b_{11} c}{4b_{22} b_{11}} \right\} \left\{ \frac{4b_{22} b_{11}}{4b_{22} b_{11} - b_{12} b_{21}} \right\}$$

$$p_1 = \frac{2b_{22} a_1 + b_{12} a_2 + b_{12} b_{22} c + 2b_{22} b_{11} c}{4b_{22} b_{11} - b_{12} b_{21}} = p_2$$

$$\text{Therefore } p^* = \frac{2b_{22} a_1 + b_{12} a_2 + b_{12} b_{22} c + 2b_{22} b_{11} c}{4b_{22} b_{11} - b_{12} b_{21}}$$

Because of the symmetric nature of the demand functions and the prices, it can be assumed that;

$$a_1 = a_2 = a$$

$$b_{11} = b_{22} = b$$

$$b_{12} = b_{21} = d$$

This can be used to simplify the equilibrium price as below;

$$p^* = \frac{2ba + da + 2dbc + 2b^2c}{4b^2 - d^2}$$

$$p^* = \frac{a(2b+d) + bc(d+2b)}{(2b-d)(2b+d)}$$

$$p^* = \frac{a+bc}{2b-d}$$

The inclusion of excise taxes

$$\pi_1 = p_1 q_1 - c q_1 - e q_1$$

$$\pi_1 = (p_1 - c - e)q_1$$

$$\pi_1 = (p_1 - c - e)(a_1 - b_{11}p_1 + b_{12}p_2)$$

$$\pi_2 = p_2q_2 - cq_2 - eq_2$$

$$\pi_2 = (p_2 - c - e)q_2$$

$$\pi_2 = (p_2 - c - e)(a_2 - b_{22}p_2 + b_{21}p_1)$$

First Order Conditions (Profit maximization)

$$\frac{\partial \pi_1}{\partial p_1} = (p_1 - c - e)(-b_{11}) + (a_1 - b_{11}p_1 + b_{12}p_2) = 0$$

$$-b_{11}p_1 + cb_{11} + eb_{11} + a_1 - b_{11}p_1 + b_{12}p_2 = 0$$

$$a_1 + b_{12}p_2 = 2b_{11}p_1 - cb_{11} - eb_{11}$$

$$a_1 + b_{12}p_2 = b_{11}(2p_1 - c - e)$$

$$\frac{a_1 + b_{12}p_2}{b_{11}} = 2p_1 - c - e$$

$$2p_1 = \frac{a_1 + b_{12}p_2}{b_{11}} + c + e$$

$$p_1 = \frac{a_1 + b_{12}p_2}{2b_{11}} + c/2 + e/2 \quad (3)$$

Similarly

$$\frac{\partial \pi_2}{\partial p_2} = (p_2 - c - e)(-b_{22}) + (a_2 - b_{22}p_2 + b_{21}p_1) = 0$$

$$-b_{22}p_2 + cb_{22} + eb_{22} + a_2 - b_{22}p_2 + b_{21}p_1 = 0$$

$$a_2 + b_{21}p_1 = 2b_{22}p_2 - cb_{22} - eb_{22}$$

$$a_2 + b_{21}p_1 = b_{22}(2p_2 - c - e)$$

$$\frac{a_2 + b_{21}p_1}{b_{22}} = 2p_2 - c - e$$

$$2p_2 = \frac{a_2 + b_{21}p_1}{b_{22}} + c + e$$

$$p_2 = \frac{a_2 + b_{21}p_1}{2b_{22}} + c/2 + e/2 \quad (4)$$

Again, assuming symmetric prices, the new equilibrium price after the imposition of the excise tax can be calculated from equations (3) and (4) as below;

$$p_1 = \frac{a_1 + b_{12}p_2}{2b_{11}} + c/2 + e/2 \quad (3)$$

$$p_2 = \frac{a_2 + b_{21}p_1}{2b_{22}} + c/2 + e/2 \quad (4)$$

Replacing (4) in (3)

$$p_1 = \frac{a_1 + b_{12} \left\{ \frac{a_2 + b_{21}p_1}{2b_{22}} + c/2 + e/2 \right\}}{2b_{11}} + c/2 + e/2$$

$$p_1 = \left\{ \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{21}p_1 + b_{12}b_{22}c + b_{12}b_{22}e}{2b_{22}} \right\} \left\{ \frac{1}{2b_{11}} \right\} + c/2 + e/2$$

$$p_1 = \left\{ \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{21}p_1 + b_{12}b_{22}c + b_{12}b_{22}e}{4b_{22}b_{11}} \right\} + c/2 + e/2$$

$$p_1 = \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{21}p_1 + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11}}$$

$$p_1 - \frac{b_{12}b_{21}p_1}{4b_{22}b_{11}} = \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11}}$$

$$p_1 \left\{ 1 - \frac{b_{12}b_{21}}{4b_{22}b_{11}} \right\} = \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11}}$$

$$p_1 \left\{ \frac{4b_{22}b_{11} - b_{12}b_{21}}{4b_{22}b_{11}} \right\} = \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11}}$$

$$p_1 = \left\{ \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11}} \right\} \left\{ \frac{4b_{22}b_{11}}{4b_{22}b_{11} - b_{12}b_{21}} \right\}$$

$$p_1 = \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11} - b_{12}b_{21}} = p_2$$

$$\text{Therefore } p^{**} = \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11} - b_{12}b_{21}}$$

Because of the symmetric nature of the demand functions and the prices, it can be assumed that;

$$a_1 = a_2 = a$$

$$b_{11} = b_{22} = b$$

$$b_{12} = b_{21} = d$$

This can be used to simplify the equilibrium price as below;

$$p^{**} = \frac{2ba + da + dbc + dbe + 2b^2c + 2b^2e}{4b^2 - d^2}$$

$$p^{**} = \frac{a(2b+d) + bc(d+2b) + be(d+2b)}{(2b-d)(2b+d)}$$

$$p^{**} = \frac{a+bc+be}{2b-d}$$

$$\frac{\partial p^{**}}{\partial e} = \frac{b}{2b-d}$$

The inclusion of tariffs

Assuming that $p_2 = p_3 + \tau$, where τ represents the tariff and p_3 is the tariff exclusive foreign price, the reaction function of the importing firm can be recalculated as below. For the sake of simplicity, it is assumed that the tariff is levied as a specific tariff. The reaction firm of the domestic firm will stay the same as in the case where excise taxes were included.

$$\pi_2 = p_2 q_2 - \tau q_2 - c q_2 - e q_2$$

$$\pi_2 = (p_2 - \tau - c - e) q_2$$

$$\pi_2 = (p_2 - \tau - c - e) \{a_2 - b_{22}(p_2 - \tau) + b_{21}p_1\}$$

First Order Conditions (Profit maximization)

$$\frac{\partial \pi_2}{\partial p_2} = (p_2 - \tau - c - e) (-b_{22}) + \{a_2 - b_{22}(p_2 - \tau) + b_{21}p_1\} = 0$$

$$-b_{22}p_2 + b_{22}\tau + b_{22}c + b_{22}e + a_2 - b_{22}p_2 + b_{22}\tau + b_{21}p_1 = 0$$

$$b_{22}\tau + b_{22}c + b_{22}e + a_2 + b_{22}\tau + b_{21}p_1 = b_{22}p_2 + b_{22}p_2$$

$$2b_{22}p_2 - 2b_{22}\tau - b_{22}c - b_{22}e = a_2 + b_{21}p_1$$

$$b_{22}(2p_2 - 2\tau - c - e) = a_2 + b_{21}p_1$$

$$2p_2 = \frac{a_2 + b_{21}p_1}{b_{22}}$$

$$2p_2 = \frac{a_2 + b_{21}p_1}{b_{22}} + 2\tau + c + e$$

$$p_2 = \frac{a_2 + b_{21}p_1}{2b_{22}} + \tau + \frac{c}{2} + \frac{e}{2} \tag{5}$$

From the previous derivation in the presence of excise taxes

$$p_1 = \frac{a_1 + b_{12}p_2}{2b_{11}} + c/2 + e/2 \quad (3)$$

Again, assuming symmetric prices, the new equilibrium price after the imposition of the tariff in the presence of the excise tax can be calculated from equations (3) and (5) as below;

$$p_1 = \frac{a_1 + b_{12}p_2}{2b_{11}} + c/2 + e/2 \quad (3)$$

$$p_2 = \frac{a_2 + b_{21}p_1}{2b_{22}} + \tau + c/2 + e/2 \quad (5)$$

Replacing (5) in (3)

$$p_1 = \frac{a_1 + b_{12} \left\{ \frac{a_2 + b_{21}p_1}{2b_{22}} + \tau + c/2 + e/2 \right\}}{2b_{11}} + c/2 + e/2$$

$$p_1 = \left\{ \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{21}p_1 + 2b_{12}\tau + b_{12}b_{22}c + b_{12}b_{22}e}{2b_{22}} \right\} \left\{ \frac{1}{2b_{11}} \right\} + c/2 + e/2$$

$$p_1 = \left\{ \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{21}p_1 + 2b_{12}\tau + b_{12}b_{22}c + b_{12}b_{22}e}{4b_{22}b_{11}} \right\} + c/2 + e/2$$

$$p_1 = \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{21}p_1 + 2b_{12}\tau + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11}}$$

$$p_1 - \frac{b_{12}b_{21}p_1}{4b_{22}b_{11}} = \frac{2b_{22}a_1 + b_{12}a_2 + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11}}$$

$$p_1 \left\{ 1 - \frac{b_{12}b_{21}}{4b_{22}b_{11}} \right\} = \frac{2b_{22}a_1 + b_{12}a_2 + 2b_{12}\tau + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11}}$$

$$p_1 \left\{ \frac{4b_{22}b_{11} - b_{12}b_{21}}{4b_{22}b_{11}} \right\} = \frac{2b_{22}a_1 + b_{12}a_2 + 2b_{12}\tau + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11}}$$

$$p_1 = \left\{ \frac{2b_{22}a_1 + b_{12}a_2 + 2b_{12}\tau + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11}} \right\} \left\{ \frac{4b_{22}b_{11}}{4b_{22}b_{11} - b_{12}b_{21}} \right\}$$

$$p_1 = \frac{2b_{22}a_1 + b_{12}a_2 + 2b_{12}\tau + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11} - b_{12}b_{21}} = p_2$$

$$\text{Therefore } p^{***} = \frac{2b_{22}a_1 + b_{12}a_2 + 2b_{12}\tau + b_{12}b_{22}c + b_{12}b_{22}e + 2b_{22}b_{11}c + 2b_{22}b_{11}e}{4b_{22}b_{11} - b_{12}b_{21}}$$

Because of the symmetric nature of the demand functions and the prices, it can be assumed that;

$$a_1 = a_2 = a$$

$$b_{11} = b_{22} = b$$

$$b_{12} = b_{21} = d$$

This can be used to simplify the equilibrium price as below;

$$p^{***} = \frac{2ba+da+2d\tau+dbc+dbe+2b^2c+2b^2e}{4b^2-d^2}$$

$$p^{***} = \frac{a(2b+d)+bc(d+2b)+be(d+2b)}{(2b-d)(2b+d)} + \frac{2d\tau}{4b^2-d^2}$$

$$p^{***} = \frac{a+bc+be}{2b-d} + \frac{2d\tau}{4b^2-d^2}$$

$$\frac{\partial p^{***}}{\partial \tau} = \frac{2d}{4b^2-d^2}$$

10.2 Table showing results of Lag Selection Order Criteria

Lag	LL	LR	FPE	AIC	HQIC	SBIC
0	279.559		1.3×10^{-9}	-6.2399	-6.1833	-6.0992
1	993.973	1428.8	1.3×10^{-16}	-21.9085	-21.5682	-21.0639*
2	1015.69	43.43	1.3×10^{-16}	-21.8338	-21.21	-20.2855
3	1041.73	52.083	1.3×10^{-16}	-21.8575	-20.9502	-19.6054
4	1108.73	134.1*	1.3×10^{-17} *	-22.8132*	-21.6223*	-19.8573

*denotes appropriate number of lags as determined by selection criteria

10.3 Table showing results of Johansen normalization

	Variable	Coefficient
Cointegrating equation 1	CPI	1
	Raw tobacco prices	0
	Private consumption	-.3167
	Tariff	-.0001992
	Excise rate	-.7729
	Constant	4.8789
Cointegrating equation 2	CPI	0
	Raw tobacco prices	1
	Private consumption	.7681
	Tariff	-.5444
	Excise rate	-.6588
	Constant	-16.2659