Economics of Tobacco: An Analysis of Cigarette Demand in Ireland

Economics of Tobacco: An Analysis of Cigarette Demand in Ireland

The authors, Seán Kennedy (skennedy@revenue.ie), Victor Pigott (vpigott0@revenue.ie) and Keith Walsh (keithw@revenue.ie), are economists in the Statistics and Economic Research Branch of the Office of the Revenue Commissioners and are members of the Irish Government Economic and Evaluation Service ("IGEES"). Any opinions expressed in this paper are the views of the authors and do not necessarily reflect the views of the Office of the Revenue Commissioners. The authors alone are responsible for the conclusions.

Table of Contents

List of Tables

List of Figures

Executive Summary

Over the past decade consumption of Irish taxed cigarettes has halved. For most of this period, the evidence suggests that smoking had declined only marginally as smokers increasingly substituted to alternative products. However, recent data indicate that smoking prevalence has reduced substantially in the last two years.

A set of rigorous econometric models are employed to estimate the price elasticity of demand for taxed cigarette consumption in Ireland. According to the modelling results, the elasticity ranges from -1.6 to -2.0, averaging at -1.8. The interpretation is that a 10 per cent *increase* in the price of cigarettes is associated with a *decline* in the consumption of taxed cigarettes of 18 per cent on average.

High elasticity is indicative of a strong response by consumers of taxed cigarettes to price changes. The evidence suggests that this high responsiveness in Ireland was largely driven by a substitution to alternative tobacco products, including legitimate cross border purchases and untaxed cigarettes. However, recent falls in prevalence rates indicate that a major part of the responsiveness now driving the elasticity may be from smokers quitting (or reducing smoking) rather than substitution to other products.

The elasticity results have policy implications. They suggest that a tobacco tax increase could lead to an overall reduction in the Exchequer receipts associated with cigarettes. Taken together with more traditional inelastic estimates, the elasticities in this analysis offer a potential range for estimating the impact of tax changes on receipts.

Independent research by Ipsos MRBI estimates that non-Irish duty paid cigarettes account for 17 per cent of the market in 2014, with a potential tax loss €214 million. This remains the most accurate and robust measure of the tax loss in the cigarette market but an alternative approach based on the results in this paper suggests it could be considered as a possible upper bound or ceiling.

The focus of this paper is the likely effects of tax changes on cigarette consumption and the associated tax revenues. There are established adverse effects of tobacco and cigarette smoking on public health and Government may wish to continue to use fiscal policies such as taxation in the pursuit of health goals rather than solely securing tax receipts. The prevention and detection of illegal smuggling and trading of cigarettes remains an operational imperative for Revenue in the coming years.

1 Introduction

Tobacco is traditionally seen as "an old reliable" from a taxation perspective, in that higher rates of tax are expected to deliver increased receipts of VAT and Excise Duty. Higher rates are also often seen as discouraging smoking and therefore deliver health benefits.

The economic argument centres on the elasticity of demand – the responsiveness of smokers to price changes. Cigarette demand tends to be inelastic because of the addictive nature of the product.

Ireland has an illicit cigarette market that has remained relatively consistent in recent years. The implication of illicit cigarette consumption is that a substitute is available for Irish taxed cigarettes, namely non-Irish duty paid cigarettes. In addition, smoking prevalence has declined in recent years. These factors may contribute to a high responsiveness among consumers to price changes.

The main objectives of this paper are as follows:
1. To improve Revenue's understanding of the tobacco market in Ireland, which represents an important source of tax revenue;
2. To determine the degree of consumer responsiveness to cigarette price changes;
3. To consider the implications of this responsiveness for Exchequer receipts; and
4. To understand the scale of the illicit market for cigarettes.

The paper is structured as follows. Section 2 details the Irish market for cigarettes in an international context and examines recent developments. It also assesses the structure of the cigarette market in Ireland including smoking prevalence rates, substitution to alternative tobacco products and the Non-Irish Duty Paid (NIDP) element. Section 3 shows the results of the econometric modelling, including a discussion of the findings and implications. The results are then extended to simulate the likely effects of cigarette tax increases on Exchequer receipts. Section 4 presents an quantitative framework and an analysis is undertaken of the potential tax loss to the Exchequer from the illicit market. Finally, Section 5 concludes.

2 The Cigarette Market in Ireland

By its nature, cigarette (and other tobacco product) demand tends to be inelastic because of the addictive nature of the product. Tax *increases* on inelastic products lead to *higher* tax revenues because the reduction in consumption is proportionately smaller than the rate increase. Conversely, tax *increases* on elastic products lead to *lower* receipts.

Price elasticity depends on many factors but an important factor is the availability of substitute products. If a consumer can easily switch to another product when price increases, responsiveness (elasticity) is higher.

The behavioural responses to cigarette price increases fall into two broad categories:

❑ Reduced cigarette consumption
  ➢ Some smokers will quit smoking;
  ➢ Some smokers will reduce consumption partially;
  ➢ Some former smokers who would otherwise have restarted choose not to; and
  ➢ Some new smokers who would otherwise have started choose not to do so.

❑ Substitution to alternatives
  ➢ Some smokers switch to alternative tobacco products such as roll your own (RYO) tobacco, cigars, other tobacco or electronic cigarettes;
  ➢ Some smokers switch to non-Irish taxed cigarettes that are legally brought into Ireland for personal consumption; and
  ➢ Some smokers switch to illicit cigarettes sourced from the black market or illegal cross border shopping.

2.1   International Context

The cigarette market, both legal and illegal, has a global dimension and it is instructive to consider the Irish market in an international context. The World Health Organisation estimates that 10 per cent of the global cigarette market is illicit.

It is a rule of thumb that countries with higher cigarette prices generally have greater illegal cigarette problems. Higher prices widen the differential between legitimate and illegitimate market prices. In effect, this increases margins for smugglers on the one hand, while at the same time increasing the extent of potential savings from purchasing illicit cigarettes for consumers. Figure 1 shows cigarette prices in Ireland and other European

countries. According to Eurostat's most recent *Detailed Average Prices Report 2014*, Ireland has one of the highest average cigarette prices in Europe.

Figure 1: Cigarette Prices in Europe
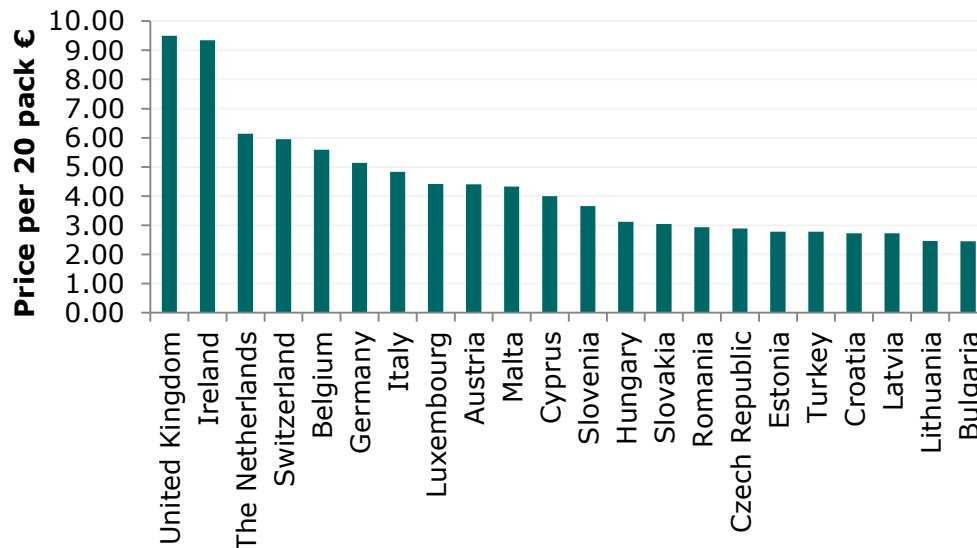
Source: Eurostat data. Note: Average Cigarette Prices in 2013 (20-pack).

2.2   Developments in Ireland

Figure 2 (A) shows a decomposition of cigarette price based on the national average retail price for a 20-pack. The green bars combined show the total tax content (specific Excise, ad valorem Excise and VAT) while the grey bars show the tax exclusive element.[1]

As shown in Figure 2(B), clearances of Irish tax paid cigarettes have steadily declined over the past decade. Over 6 billion cigarettes were cleared from tax warehouses in 2003; in comparison only 3.1 billion were cleared in 2014, a decline of about half (51 per cent). At the same time, cigarette Excise receipts have only fallen by a proportion of that figure (21 per cent). This is primarily explained by rising cigarette taxes.

Figure 2 illustrates a number of trends. First, overall cigarette prices have increased steadily over the past decade. Second, the incidence of tax per pack has remained approximately stable at just under 80 per cent of the price. Third, in addition to taxes, there have been consistent manufacturer increases every year. Fourth, there have been compositional shifts in tax whereby larger portions of tax are attributable to *specific Excise* instead of *ad valorem Excise*.

---

[1] VAT receipts from cigarettes are estimated, as tax returns do not require the yield from a particular product to be identified, and the VAT yield for cigarettes cannot be known with complete precision.

Figure 2: Cigarette Clearances, Exchequer Revenues and Price Decomposition

(A) Decomposition of Cigarette Price　　　*(B) Cigarette Clearances and Excise Receipts*
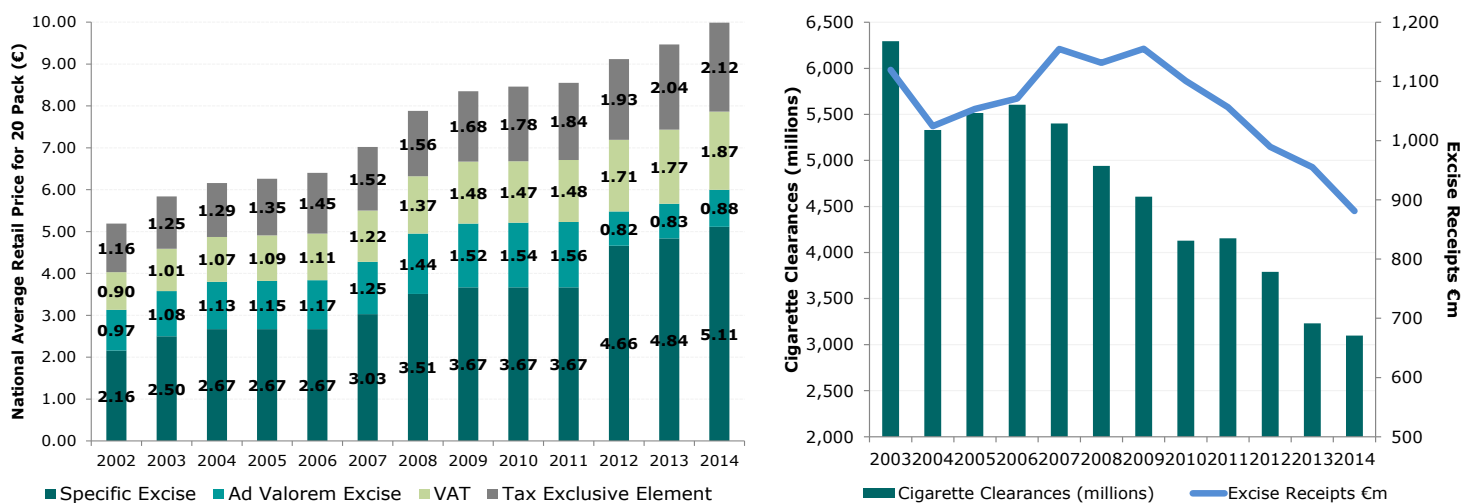
Source: Revenue and CSO data.

2.3　Smoking Prevalence in Ireland

According to Eurobarometer, smoking prevalence in Ireland was 29, 31, 29 and 21 per cent in 2006, 2009, 2012 and 2014 respectively. Eurobarometer estimate between 2012 and 2014 the number of cigarettes smoked (by smokers) per day fell by 1.8 cigarettes to 13.9 on average. Over the same period, prevalence fell by 2 percentage points in the EU overall. A HSE study (2015) also shows a declining prevalence rate in Ireland albeit at a different rate: 28, 25, 22 and 19.5 per cent in 2006, 2009, 2013 and 2014 respectively.[2]

Given the difference in Eurobarometer and HSE estimates (21 per cent and 19.5 per cent in 2014 respectively), the methodological approaches are worth reviewing (a more detailed discussion is available in Appendix I). The studies have similarities: both are based on data collected by Ipsos MRBI, adopt a quota sampling approach, interview approximately 1,000 respondents and survey only those over the age of 15. However, there are also differences. First, the questions asked are not identical. Second, the Eurobarometer estimate is based on a face-to-face survey method compared to telephone interviews in the HSE study. Third, the Eurobarometer study is completed as part of a wider sample of over 27,000 respondents across Europe.

It should be noted that the differences noted above are marginal and both surveys find sharp reductions in prevalence in recent years.

---

[2] The HSE (2015) study is available at: http://www.hse.ie/eng/about/Who/TobaccoControl/Research/.
Figures are taken for the month of December for each year so as to reflect latest available data. By comparison, the Survey of Lifestyle, Attitudes and Nutrition in Ireland (SLÁN) for the Department of Health estimates smoking prevalence to be 27 per cent in 2002 and 29 per cent in 2007 (most recent published year).

2.4   Substitution Effects

An increase in the price of cigarettes may cause consumers to switch to other tobacco products. These include cigars, roll-your-own (RYO) fine-cut tobacco for the rolling of cigarettes, other smoking tobacco and, more recently, electronic cigarettes. For Irish taxed cigarettes, smokers may switch to cigarettes on which Irish duty has not been paid.

2.4.1   Alternative Irish Taxed Tobacco Products

While the research literature is mixed, there is some evidence to suggest a substitute relationship between cigarettes and RYO tobacco. In an econometric study of cigarette consumption in the UK, Czubek and Johal (2010) find that an increase in the price of RYO leads to an (inelastic) increase in cigarette consumption. A World Bank study also finds a strong substitute relationship between cigarettes and RYO tobacco (Wilkins *et al*., 2000).

Arguably the most significant current substitute for taxed cigarettes in Ireland is RYO tobacco. Figure 3 shows Revenue clearance data for all tobacco products other than cigarettes since 2005. These remained roughly stable between 2005 and 2008 with approximately 200,000 kilograms cleared from tax warehouses annually. The trend jumped to closer to 300,000 kilograms annually between 2009 and 2011 before exceeding 400,000 kilograms in 2013 and 2014. The rising trend can almost exclusively be explained by increases in RYO tobacco.

Figure 3: Developments in Other Tobacco Products, 2005 - 2014
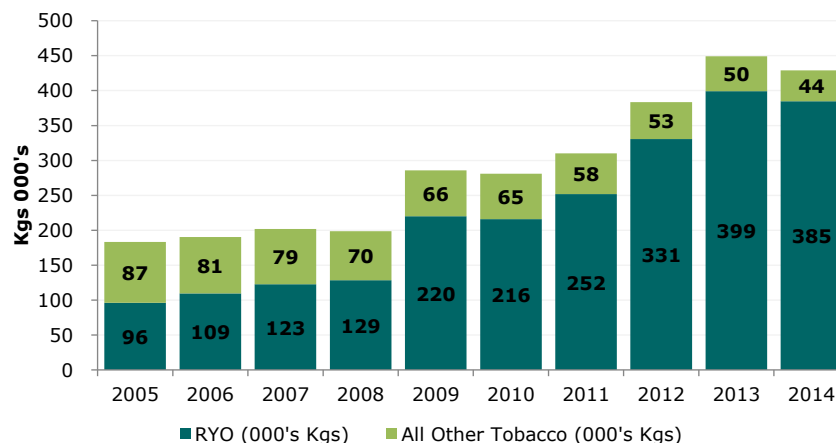
Source: Revenue Data.

2.4.2   Legally Imported Non-Irish Taxed Market

According to research conducted by Ipsos MRBI for Revenue and the HSE National Tobacco Control Office, cigarettes brought into the country legally (i.e., with appropriate taxes paid in the source country) account for 6 per cent of the total market in 2009, 7 per

cent in 2012 and 6 per cent in 2014.[3] By comparison, a Euromonitor estimate indicates that this element of the market accounts for around 10 per cent of the total cigarette market in Ireland in 2012.

2.4.3   Illicit Market

The illicit cigarette market is, by definition, not observed or registered and so producing reliable estimates is challenging. Internationally, the scale of the illicit market is often assessed using cigarette seizures and survey data.

Revenue seizures are shown in Table 1. However, seizures do not provide a useful indicator of illicit market trends as they can be a function of the quality and intensity of enforcement activity or shifts in how cigarettes are smuggled. Additionally, large seizures often substantially distort the data. It should be noted also that product seized in Ireland may not be destined for the Irish market.

Table 1: Revenue Cigarette Seizures, 2010 - 2014

Year	Revenue Seizures (millions of cigarettes)
2010	178
2011	109
2012	96
2013	41
2014	53

Source: Revenue Data.

Aside from seizures, there are two main sources for estimates of the size of the illicit cigarette market in Ireland – empty pack surveys (typically used by industry groups) and market research surveys.[4]

Figures from the Irish Tobacco Manufacturers' Advisory Committee (ITMAC) suggest non-Irish Duty Paid (NIDP) cigarettes account for about 28.3 per cent of the market in 2013, up from 27.9 in 2012.[5] ITMAC figures appear to be based on empty pack surveys by market researchers. A report on the illicit tobacco market by Japan Tobacco International (JTI) on Ireland in 2013 estimates the size of the NIDP cigarette market at 28.3 per cent. This is based on empty pack surveys conducted by KPMG.

---

[3] The results of the Ipsos MRBI surveys 2009-2014 are available on the Revenue website at http://www.revenue.ie/en/about/publications/survey-reports.html.
[4] The same methods are used to estimate legitimate cross border purchases (Section 2.4.2).
[5] The 2013 ITMAC figures were released in Q1 2014.

The above estimates combine legitimate cross border purchases of cigarettes with illicit cigarettes. As noted in Section 2.4.2, the former is relatively significant so it is preferable to separate the two where possible.

Euromonitor estimates that 1 in 10 cigarettes consumed in Ireland could be accounted for by illicit trade cigarettes and legal cross border purchases in 2007.[6] The most recent estimate for 2013 shows an increase to more than 1 in 5 cigarettes (22.7 per cent).

Independent research carried out by Ipsos MRBI, on behalf of Revenue and the National Tobacco Control Office, finds that 16 per cent of cigarettes packs surveyed in Ireland are illicit in 2009, 13 per cent in 2012 and 11 per cent in 2014. The MRBI survey is based on a quota sample of 800 in-home interviews, weighted to attempt to be representative of the total population. Figure 4 shows the MRBI estimates over the period 2009 to 2014.

Figure 4: Estimates of Cross Border Purchases and Illicit Trade, 2009 – 2014
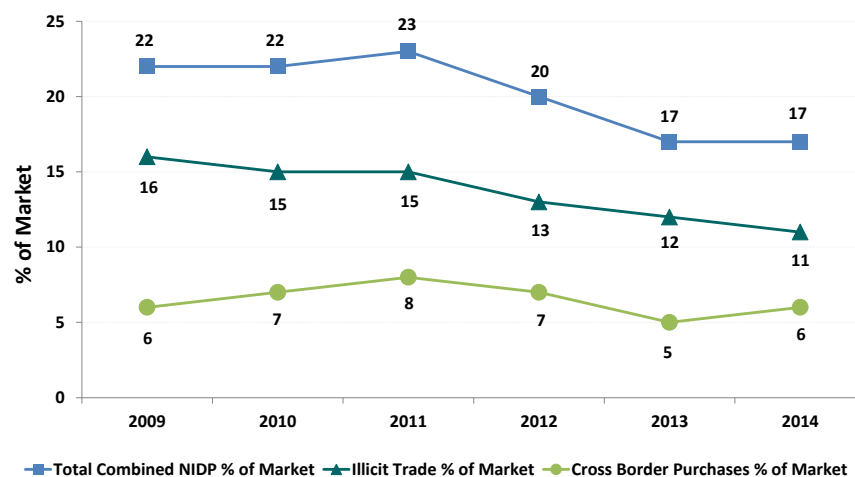
Source: Authors' analysis of Ipsos MRBI data.

Overall, cigarette seizures and empty pack surveys tend to be unrepresentative and unreliable for different reasons.[7] The Ipsos MRBI survey estimates are more likely to provide a robust assessment of the illicit market in Ireland.

---

[6] Euromonitor estimates are based on a combination of official statistics, trade association data and interviews.
[7] With empty pack surveys, it's impossible to know if a location surveyed is representative. Even if there was a representative location, discarded packs are unlikely to be representative of packs overall (people smoking outside and dropping packs will be different to those that smoke mostly at home or always dispose of their pack in the bin). However, as a counterpoint to this, the empty pack surveys do show fairly consistent results.

3 Econometric Model of Cigarette Demand

3.1 Research Review

3.1.1 Research in Ireland

For many years little or no economic analysis was conducted on cigarette demand in Ireland. Madden (2002) provides a summary of the sparse earlier literature. Most of this shows that the demand for cigarettes was inelastic (O'Riordan 1969; Walsh 1980; Conniffe, 1995) with some exceptions (Escario and Molina, 2001).

In part, this limited research reflects the fact that cigarette demand has only become topical again in recent years due to changes in the market. This is illustrated by Nguyen, Rosenqvist and Pekurinen (2012) with an econometric study spanning the period 1970 to 2009. The paper estimates the elasticity of demand for cigarettes in Ireland at -0.6. This indicates that for most of the period, elasticity of demand was in line with the usual (inelastic) expectations. In recent years the market has changed and this result (an average since 1970) does not reflect newer developments.

Using multivariate analysis and controlling for other factors beyond price, Reidy and Walsh (2011) estimate the average price elasticity of demand for taxed cigarettes in Ireland over the period 2002 to 2009. Many explanatory variables of cigarette consumption are explored but the only statistically significant factors are: price, income, the introduction of the workplace smoking ban, EU enlargement and the point of sale advertising ban. The main result of the paper is that price itself did not test significant but the lag of price did. The model suggests a price elasticity of -3.6, i.e., a 1 per cent increase in price is associated with a 3.6 per cent reduction in taxed cigarette consumption.[8]

The findings of Reidy and Walsh (2011) are the first to show elastic demand for taxed cigarettes in Ireland. Several research reports have been commissioned in response to the findings. These are discussed below and criticisms of Reidy and Walsh are addressed.

The HSE National Tobacco Control Office commissioned a report on cigarette demand produced by Chaloupka and Tauras later in 2011. Chaloupka and Tauras employ eight econometric models of taxed cigarette demand and the elasticities vary between -1.2 and -2.3 (where price is found to be statistically significant).

---

[8] Any elasticity greater than 1 (or, more accurately, more negative than -1) implies elastic rather than inelastic demand.

Chaloupka and Tauras (2011) use the same data as Reidy and Walsh (2011) and adopt a broadly similar econometric approach. However, the report disagrees with some aspects of the approach taken in Reidy and Walsh (2011). For instance, one criticism relates to the use of a backward stepwise regression model as "an atheoretic approach". Stepwise regression is a widely used data-driven approach in the research that eliminates statistically insignificant variables from the analysis.

There are also certain limitations to the approach taken by Chaloupka and Tauras. For example, the model does not appear to include lagged consumption as suggested by the research literature (see Conniffe, 1995). In addition, the model includes a measure for pre-budgetary stockpiling by tobacco companies. While this variable may have merit, it is likely already accounted for by the quarter variables used to capture seasonality. These quarter variables are adopted in the models presented in this paper.

Overall, the Chaloupka and Tauras analysis confirms the findings of Reidy and Walsh, albeit with lower magnitudes of elasticities. They note that the estimates are "*likely to be explained by increased tax avoidance and tax evasion in response to increased cigarette taxes and prices*" and that "*…further tax increases would lead to reductions in tax revenues as consumption of taxed cigarettes would fall sharply with much of the drop resulting from some smokers switching to untaxed cigarettes*".

Methodological suggestions from Chaloupka and Tauras are adopted in this present paper. Some are not found to be particularly significant (e.g., traveller numbers) and not considered further. Others variables in Chaloupka and Tauras are alternatives to those used in Reidy and Walsh. For example, an overall measure of tobacco regulation and controls is used rather than variables for the smoking ban or the easing of traveller consumption restrictions.

In October 2011, the Irish Heart Foundation published a report by consultants Landman Economics suggesting that the elasticity of tobacco consumption in Ireland is -0.5. The report also argues that the illicit market for cigarettes in Ireland is fairly constant in size over time and does not grow in response to taxation increases. However, the analysis is based on estimates for one year at a time, in this case for 1998 and for 2007. Using a single year's data is problematic as the findings may be distorted by once-off circumstances and are not representative of, or applicable to, other periods. This approach makes it challenging to fully capture the current situation in the tobacco market in Ireland. The Landman analysis is also based on self-reported (survey) expenditure data, which is known to be unreliable for products like tobacco.

3.1.2 International Research

International estimates of the price elasticity of demand for tobacco have varied widely but most range between -0.3 and -0.5 (Chaloupka *et al*., 2012; Goel *et al*., 2006; Gallet and List, 2003; Ramboll, 2014). This implies that a 10 per cent *increase* in cigarette prices is associated with a smaller *decrease* in demand of 3 to 5 per cent.

While most estimates are inelastic, some have been found to be elastic including the aforementioned paper by Reidy and Walsh. While unusual by international standards, this is consistent with the high cigarette prices, declining prevalence and significant illicit market observed in Ireland.

Research on the UK cigarette market is relevant since it has similar market characteristics to the Irish market including relatively high prices and a significant illicit market (estimated at 7 per cent in 2011/12 by HMRC). Cullum and Pissarides (2004) find a price elasticity for duty paid cigarettes of between -1.08 and -1.45. Czubek and Johal (2010) use a cointegration approach to establish the long-term relationship between price and consumption (of UK duty paid cigarettes) from the early 1980s to 2009. The elasticity varies between –0.92 and –1.17. Demand is found to be elastic in four models and inelastic in four models. However, the authors note that in their preferred specification of the model, the elasticity is –1.05 (i.e., elastic).[9]

3.2   Data

Economic theory suggests that the quantity demanded of a product depends on multiple factors including its price, the price of related goods, incomes and unemployment. This section briefly reviews the variables used in the model. Quarterly time-series data are used, covering 2002 to 2014.

3.2.1 Taxed Cigarette Consumption

The dependent variable is taxed cigarette consumption per capita based on Revenue warehouse clearance data.[10] Figure 5 shows cigarette clearances over the last decade. Taxed consumption has decreased steadily: over 7 billion cigarettes were cleared from the warehouse in 2002; only 3.1 billion were cleared in 2014 (a decline of 56 per cent).

---

[9] The analysis also confirms that long-run elasticities tend to be higher than shorter-term measures, as would be expected given the addictive nature of the product. Smokers' short-term response to a price change will be lower (more inelastic) than the change over time. This shows the value of looking at longer time periods and not focusing overly on shorter term or year-to-year changes to draw conclusions for the longer term.

[10] Per capita consumption to control for population changes over the period on cigarette consumption. Data refer to persons aged 15 years and older (CSO QNHS).

Figure 5: Cigarette Clearances, 2002 – 2014
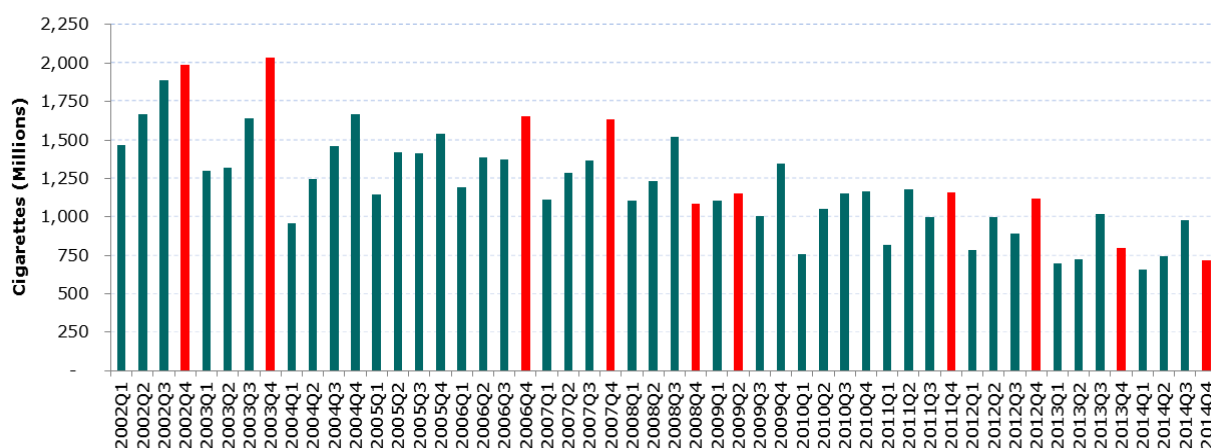
Source: Revenue data. Note: Quarters in red indicate a tobacco products tax increase in that quarter (Q2 2009 reflects the emergency budget in April 2009).

Clearances data provide a proxy for cigarette sales and the associated level of consumption but do not reflect actual cigarette consumption *per se*. First, clearances relate to *Irish duty paid cigarettes*. They do not include sales of cigarettes for which Irish taxes have not been paid (this has important implications for interpreting the results of the modelling). Second, clearances reflect the timing of withdrawals of cigarettes from warehouse by manufacturers. As can be seen in Figure 5, stockpiling can occur prior to Budget increases but there are also instances when manufacturers anticipated increases that did not materialise (e.g., Q4 2009 suggests stockpiling but the rate was unchanged in Budget 2010). Third, if consumers also engage in personal stockpiling, a further difference arises between cigarette sales and consumption.

3.2.2 Price

Figure 6 shows nominal and real prices for packs of 20 cigarettes from 2002 to 2014.[11] Both nominal and real prices have risen consistently over the period but real prices have done so at a slower rate. The real price trend tends to exhibit quite sharp increases, reflecting budgetary changes, followed by periods of relative price stability.[12]

---

[11] Real price refers to price adjusted for inflation using the CSO consumer price index.
[12] Price data for RYO tobacco are not readily available and are not included in the model.

Figure 6: Nominal and Real Prices, 2002 – 2014
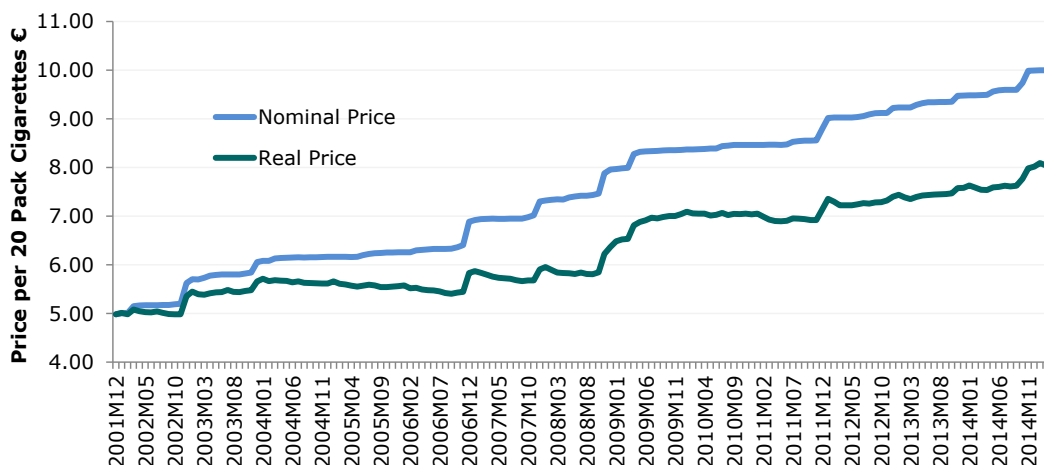
Source: Revenue and CSO data.

As mentioned, stockpiling distorts the timing of clearances and a clearer trend can be obtained by showing smoothed clearances. Figure 7 shows smoothed clearances alongside average cigarette prices. The trend shows a sharp contrast: appreciable price increases and consistently declining clearances.

Figure 7: Nominal Prices and Clearances, 2002 – 2014
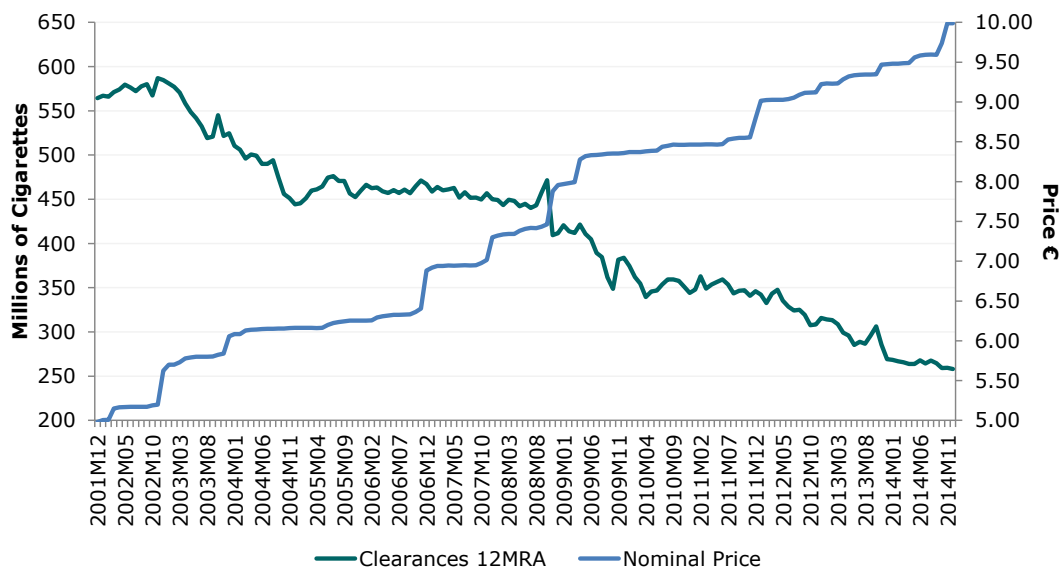
Source: Revenue data. Note: MRA represents 12 month rolling average to smooth consumption pattern.

3.2.3 Income, Unemployment and Other Variables

Disposable income represents an important determinant of cigarette consumption. Rising incomes typically lead to increases in consumption. To take account of this in the model, GDP per capita is used based on CSO data.[13] Figure 8 shows GDP per capita and

---

[13] GDP at constant prices chain linked to 2012 and population aged 15 years and older are used.

unemployment levels (the latter has also been shown to impact on cigarette consumption and therefore is also included in the model).[14]

Figure 8: GDP per capita and Unemployment, 2002 – 2014

(A) GDP per Capita *(B) Unemployment Rate*

Source: Revenue and CSO (National Accounts and QNHS) data.

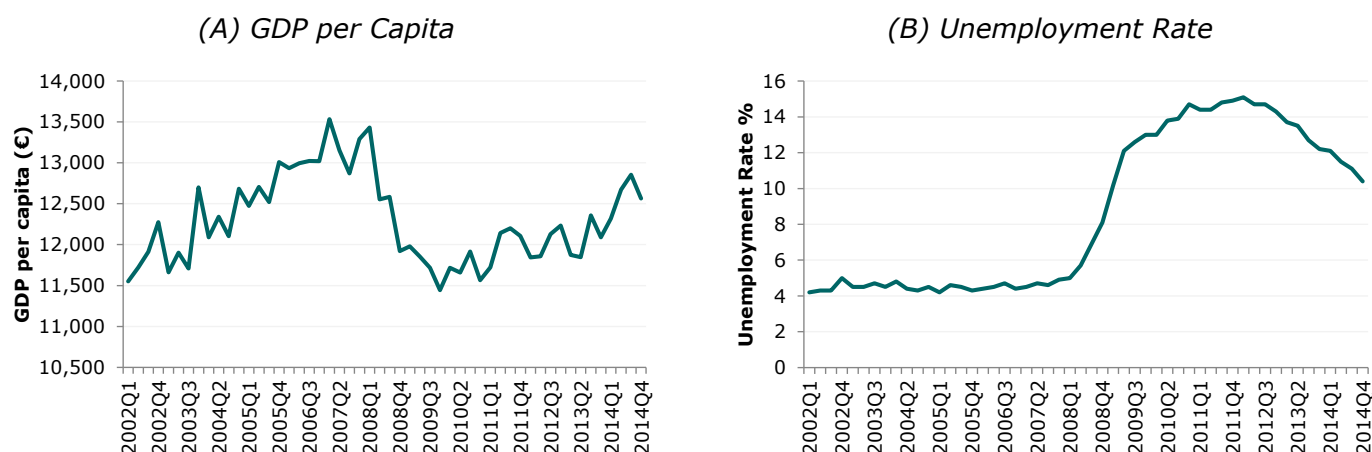The model also controls for the impact of various policy changes over the period. Five separate binary variables are added. Furthermore, to control for seasonality trends and stockpiling prior to anticipated tax increases in the Budget, binary variables are included for three of the four quarters in each year.[15]

Table 2: Policy and Event Variables

Variable	To Account for	Period
Smoking Ban	Workplace smoking ban	2004 Q1
EU Enlargement	10 new EU members May 2004	2004 Q2
Ten Pack Ban	Ban on the sale of packs of 10/15 cigarettes	2007 Q2
Travel Restriction	Easing of restrictions on transport of cigarettes for personal consumption between member states	2008 Q4
POS Advert Ban	Ban on point of sale (POS) tobacco advertising	2009 Q3

Source: Authors' analysis.

3.3   Model Estimation

Several econometric models of taxed cigarette consumption are estimated using the above data. In addition to investigating whether there is a *statistically significant* relationship in each case, the *quantitative impact* of any significant relationship is examined.

Most economic time-series data are trending and non-stationary. This can present issues leading to spurious regression. One solution is to use differencing to ensure that the series

---

[14] The CSO seasonally adjusted unemployment rate is used.
[15] Quarter 4 is excluded as the reference quarter.

has a mean and variance that are constant over time (stationary). Consumption, price and Excise are first-differenced in the model; GDP and unemployment are second differenced.[16] All models are expressed in double log format (the natural logarithm is taken of the dependent and relevant independent variables). As a result, the coefficients on price are elasticities. The one exception is unemployment, which is expressed in levels. Details on the diagnostic testing can be found in Appendix II.

3.4   Model Specification

To estimate the price elasticity of demand for taxed cigarettes, six commonly used models are adopted from the research literature.

According to economic theory, a product is addictive if increases in past consumption raise current consumption. These are known as myopic models of addiction. Lagged variables (consumption in previous quarters) are included so that the impact past consumption may be having on current consumption is measured.[17] As suggested by Conniffe (1995), adding a lagged variable of consumption makes current consumption dependent on the level already attained. Most of the international literature suggests that a lagged variable for consumption should be included in these models. At least one lagged consumption measure is included in all models. Diagnostic testing suggests that four lags (quarters) are appropriate and a model with four lags is investigated. Lead values are also included, accounting for rational addiction theory and rational foresight.

Cigarette consumption and price may be simultaneously determined by supply and demand. This may have the effect of biasing the price elasticity estimate. One solution is the instrumental variable (IV) technique. This approach involves identifying a new variable that is correlated with cigarette price but is not influenced by consumption.[18] Excise Duties are a commonly used IV for tobacco (see World Health Organisation, 2010). The basic econometric strategy is to run a regression of price on the IV (Excise) and other exogenous variables in the model, obtain predicted values of price and use these as the exogenous price value in the regression.

The policy variables (Table 2) are to an extent covering similar periods. These variables have phased effects to differing degrees and it is possible that they are explaining similar effects in the model. From an econometric perspective, this presents an issue of

---

[16] To identify the order of integration for each variable, an Augmented Dickey Fuller test for unit root is performed. A visual inspection of the autocorrelation and partial-autocorrelation functions is also conducted.
[17] Rational addiction theory also says that smokers understand the addictive nature of tobacco and foresee all the future consequences of smoking. The theoretical idea, originally proposed by Becker and Murphy (1988), says that smokers are rational in the sense that they are aware that increasing current consumption will addict them to higher levels of consumption in the future.
[18] This is an issue of simultaneity. In addition, a valid instrument must be both relevant and exogenous.

multicollinearity and it is sensible to follow the approach of Chaloupka and Tauras (2011) and drop variables where this is the case.

3.5 Model Results

Table 3 presents the results from six econometric models. According to the analysis, the price elasticity of taxed cigarette demand ranges from -1.6 to -2.0, with an average elasticity of -1.8.[19] All models are found to be elastic. The results imply that a 10 per cent *increase* in the price of cigarettes is associated with a *decline* in the consumption of taxed cigarettes of 16 to 20 per cent, with an average decline of 18 per cent. Note that the models relate to taxed (rather than total) cigarette consumption.

The model employs quarterly time series data from 2002 to 2014. Due to this relatively short period of data, a range of models are estimated to improve robustness.

Model (1) includes four lagged and one lead variables and the full set of policy variables. The price elasticity of demand is estimated at -1.4 (but is not statistically significant).

Model (2) excludes smoking ban and POS advertisement ban due to a degree of multicollinearity with EU enlargement and ten pack ban respectively.[20] This model, which is statistically significant, estimates a price elasticity of demand at -1.6.

Model (3) accounts for potential persistence in the consumption data (which would be interpreted as addiction according to economic theory) but does not take account of rational foresight.

Model (4) combines the approaches of (2) and (3). Models (3) and (4) produce elasticity estimates of -1.8 and -2.0 respectively (the former is not significant, the latter is).

Model (5) applies a more simplistic approach by allowing for persistence in only one previous period; the model produces a statistically significant estimate of -1.7.

Finally, model (6), which uses the aforementioned IV approach (the specific Excise element of price), produces a statistically significant estimate of −3.1. While the instrument is found to be relevant, in that cigarette prices and Excise taxes are positively

---

[19] Only statistically significant results are included in the average calculation. The IV estimate is also not included for the reasons explained later in this section.
[20] If EU enlargement and POS advert ban or EU enlargement and ten packs had been chosen instead the estimates do not change significantly.

correlated (0.70), there is no evidence to reject the exogeneity assumption.[21] For this reason, it is not included as part of the average estimate.

Of the policy variables, the smoking ban and EU enlargement have the most significant effects. As expected, the smoking ban is found to have the effect of reducing cigarette consumption. EU enlargement is found to increase taxed consumption. The quarter variables are significant and mostly negative, indicating higher levels of consumption in the final quarter of the year due to stockpiling prior to Budgets.

As mentioned, a positive and significant lagged consumption measure in a model would be interpreted as addiction by economic theory. A significant lead consumption variable would suggest that higher future consumption is associated with lower present consumption and would support the rational addiction theory. However, while the model results show statistically significant effects of both lagged and lead variables, the effects are negative for the lags of consumption. The results are therefore not supportive of economic theory.

The estimates for both GDP per capita and unemployment are not found to be statistically significant.[22] Therefore there is no evidence found that taxed cigarette consumption is affected by changes in income.

A graphical evaluation of the quality of the models, showing a comparison of actual and predicted values, is presented in Appendix III.

The models calculate at the average since 2002 and cannot control for all factors associated with cigarette consumption. While the general result is that a price *increase* is associated with a *decline* in taxed cigarette consumption, this is finding is not expected to hold true in every year.

---

[21] Using the Durbin-Wu-Hausman test, the null hypothesis is that the price is exogenous. The null is not rejected so exogeneity of price cannot be rejected in the model.
[22] Partially due to second differencing.

Table 3: Estimates of Price Elasticity of Taxed Cigarette Demand, 2002–2014

Dependent variable: First Difference of Log Consumption of Irish Taxed Cigarettes

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) IV
Real Price	-1.362	-1.574**	-1.826	-1.985*	-1.693*	-3.100*
	(0.857)	(0.619)	(1.282)	(1.149)	(0.900)	(1.601)
GDP per capita	-0.053	0.097	0.472	0.508	0.209	-0.018
	(0.291)	(0.259)	(0.391)	(0.393)	(0.277)	(0.241)
Consumption $_{(t-1)}$	-0.920***	-0.964***	-1.123***	-1.127***	-0.518***	-0.911***
	(0.108)	(0.123)	(0.179)	(0.146)	(0.078)	(0.083)
Consumption $_{(t-2)}$	-0.677***	-0.749***	-1.023***	-1.030***		-0.683***
	(0.142)	(0.151)	(0.262)	(0.225)		(0.111)
Consumption $_{(t-3)}$	-0.363**	-0.396***	-0.578**	-0.578**		-0.348***
	(0.133)	(0.128)	(0.250)	(0.226)		(0.097)
Consumption $_{(t-4)}$	-0.155	-0.159	-0.229	-0.228		-0.134*
	(0.096)	(0.096)	(0.198)	(0.190)		(0.077)
Consumption $_{(t+1)}$	-0.499***	-0.487***			-0.550***	-0.499***
	(0.069)	(0.068)			(0.076)	(0.055)
Unemployment	0.015	0.013	0.030	0.029	0.021	0.015
	(0.019)	(0.019)	(0.037)	(0.035)	(0.023)	(0.015)
Smoking Ban	-0.151*		-0.035		-0.242***	-0.130*
	(0.085)		(0.121)		(0.066)	(0.072)
EU Enlargement	0.212***	0.097*	0.128*	0.100	0.263***	0.176***
	(0.051)	(0.049)	(0.074)	(0.080)	(0.049)	(0.057)
Point of Sale Advert Ban	0.008		0.013		-0.058	-0.076
	(0.056)		(0.116)		(0.068)	(0.078)
Ten Pack Ban	-0.026	-0.023	0.009	0.010	-0.035	-0.025
	(0.031)	(0.031)	(0.038)	(0.038)	(0.040)	(0.027)
Travel Restriction	-0.007	-0.001	-0.041	-0.028	0.074	0.083
	(0.064)	(0.031)	(0.119)	(0.039)	(0.075)	(0.088)
Quarter 1	-0.084	-0.091	-0.310***	-0.312***	-0.104*	-0.071
	(0.072)	(0.066)	(0.095)	(0.091)	(0.057)	(0.061)
Quarter 2	0.004	-0.016	-0.247**	-0.251***	0.090	-0.024
	(0.058)	(0.064)	(0.102)	(0.092)	(0.054)	(0.053)
Quarter 3	0.088	0.062	-0.193*	-0.197**	0.283***	0.068
	(0.065)	(0.064)	(0.096)	(0.090)	(0.048)	(0.061)
Number of Observations	*46*	*46*	*47*	*47*	*49*	*46*
Adjusted R²	*0.94*	*0.94*	*0.81*	*0.82*	*0.91*	*0.93*

Source: Authors' analysis. Notes: Robust standard errors in parentheses; *significance at 10%, **5% and ***1%. The first five models are estimated using ordinary least squares and the sixth model is estimated using two-stage least squares.

3.6   Exchequer Receipts Simulation Analysis

The econometric models suggest that the price elasticity of demand is elastic: a cigarette tax *increase* will likely lead to an overall *reduction* in the Exchequer receipts associated with cigarettes. The reason is that increases in receipts associated with the higher tax are expected to be outweighed by decreases in consumption of taxed cigarettes.

As noted, while the general finding is that tax increases are associated with declines in tax receipts on average, the relationship is not expected to always hold true in a given year.

According to the average of the statistically significant results in Section 3.5 (with the IV model (6) excluded for the reasons noted above), a 10 cent tax increase on a 20-pack of cigarettes could lead to a fall in cigarette receipts of circa €6 million. A larger increase of €1 could lead to a fall in cigarette receipts of €86 million as shown in Figure 9.[23]

Figure 9: Estimated Exchequer Impacts of Selected Cigarette Tax Increases
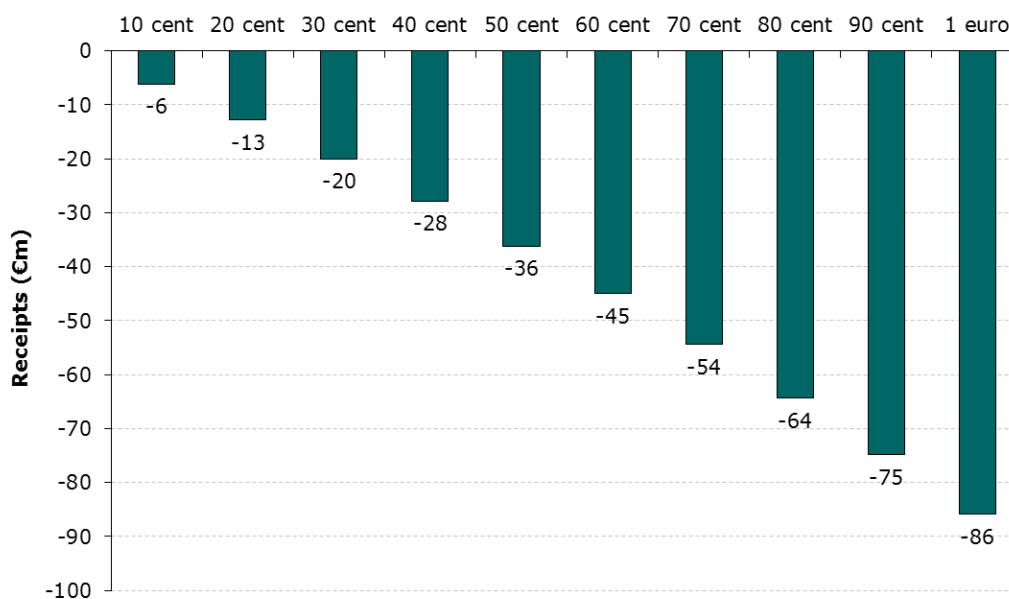
Source: Authors' analysis.

---

[23] The simulation analysis is based on a number of simplifying assumptions. Receipts are estimated by multiplying the number of 20-packs of cigarette clearances by the effective tax per pack. The effective tax rate per pack is taken from 2014 Revenue data. While there are different prices associated with different packs of cigarettes, the CSO average price for a pack of 20 cigarettes is used. The consumption level in 20-packs is calculated by taking the total number of cigarette sticks from Revenue clearance data. It is also worth emphasising that the elasticities are subject to some margin of error.

4 Quantitative Assessment of Cigarette Market

Ipsos MRBI research, commissioned by Revenue and the National Tobacco Control Office, estimates the potential tax loss on cigarettes at €214 million in 2014.[24] In this section, a complementary approach is taken to consider the share of cigarette consumption not explained through taxed consumption.

4.1   Comparing Total and Taxed Consumption

Estimates of cigarette consumption, which are based on prevalence rates and an average cigarettes smoked per day from Eurobarometer, have fallen significantly.[25] Estimated annual 20-packs consumed decline from 298 million in 2012 to 191 million in 2014.

As regards Irish taxed consumption, as discussed previously Irish taxed cigarette 20-packs cleared from tax warehouses have fallen significantly in recent years, from 190 million in 2012 to 155 million in 2014.

Irish taxed RYO tobacco is included in the analysis as an alternative form of cigarette. RYO clearances, converted to an equivalent 20-pack basis, increase from 22 million in 2012 to 27 million in 2013 but fall to 26 million in 2014.[26,27]

The analysis, as summarised in Table 4, shows the share of total consumption of 20-packs that can reasonably be attributed to taxed cigarettes and taxed substitutes. These account for 71 per cent and 95 per cent of cigarette consumption in 2012 and 2014 respectively.

Table 4: Total Cigarette Consumption and Taxed Consumption

20-Packs (Millions)	2012	2014
Estimated Total Cigarette Consumption (from Eurobarometer data)	*298*	*191*
Taxed cigarettes (warehouse clearances)	190	155
Roll Your Own Tobacco (warehouse clearances)	22	26
Total Taxed Consumption	*212*	*181*
Taxed as % of Total Consumption	*71%*	*95%*

Sources: Authors' analysis of Eurobarometer and Revenue data.

Overall, the analysis supports the view that reduced prevalence, and not the illicit trade, may be the driving force behind falling cigarette clearances in more recent years. Given

---

[24] See Section 2.4 for earlier discussion.
[25] Two methodological issues should be noted here. First, the total potential smoking population is defined as those aged 15 years and over. Second, smoking intensity is based on cigarettes and RYO but not other forms of tobacco (e.g., cigars).
[26] RYO tobacco in kilograms is converted to an equivalent in cigarette sticks using an assumption of around 0.74kgs of tobacco for every 1,000 cigarettes.
[27] Other tobacco products, notably e-cigarettes, are not included in the smoking prevalence figures and are therefore not included in the analysis. It is estimated by Eurobarometer that electronic cigarette usage in Ireland is about 3 per cent of the population aged 15 and over in 2014.

falling prevalence rates, the share of taxed consumption that can explain total cigarette consumption in Ireland has increased in 2014.

4.2   Estimates of NIDP and Tax Loss to Illicit Market

NIDP cigarettes are both cigarettes brought into Ireland legally from elsewhere for personal consumption and illicit trade cigarettes. The most reliable estimates are produced from the market research by Ipsos MRBI for Revenue and the National Tobacco Control Office, shown in Table 5.

Table 5: Ipsos MRBI NIDP and Tax Loss Estimates

	Legal Cross Border Purchases (% of Market Share)	Illicit Market (% of Market Share)	Estimated Tax Loss (€ Million)
2009	6%	16%	€285m
2010	7%	15%	€249m
2011	8%	15%	€258m
2012	7%	13%	€240m
2013	5%	12%	€212m
2014	6%	11%	€214m

Sources: Ipsos MRBI surveys for Revenue and National Tobacco Control Office.

Ipsos MRBI estimates for 2014 indicate the illicit market share is down to 11 per cent and legal cross border purchases are up to 6 per cent. The estimated tax loss is €214 million.

By contrast, based on the approach in Section 4.1, taxed cigarette consumption combined with taxed substitutes could account for just under 95 per cent of estimated total cigarette consumption. This is much less than estimates for previous years, due mainly to the significantly reduced smoking prevalence in Ireland in 2014. The shortfall of around 5 per cent of the market equates to tax lost of around €84 million in 2014.

The two methods are not expected to reconcile. The Ipsos MRBI estimate is independently produced from a robust sampling methodology and remains the most accurate estimate available of the tax loss. That the above estimate is lower suggests that the MRBI estimate may be considered as a possible upper bound of the estimated tax loss.

5 Conclusion

This paper presents an assessment of the cigarette market in Ireland. Several econometric models of taxed cigarette consumption are estimated, employing quarterly time series data from 2002 to 2014. The likely behavioural responses to price increases are then examined in addition to the possible implications for tax receipts and the potential tax loss from the illicit market.

Econometric modelling shows the price elasticity of demand for taxed cigarette consumption is elastic. A 10 per cent *increase* in the price of cigarettes is associated with a *decline* in the consumption of taxed cigarettes of 18 per cent on average. While the general finding is that a price increase is associated with a decline in taxed cigarette consumption, this is not expected to be true in every year.

The results are consistent with previous elasticity estimates in Ireland (Chaloupka and Tauras, 2011; Reidy and Walsh, 2011). The estimated elasticities are high by international standards but reasonable given the conditions in the market in Ireland and are supportive of research showing the scale of the illicit market and, more recently, reduced prevalence.

High elasticity is indicative of a strong response by consumers of taxed cigarettes to price (tax) changes. The evidence until recently suggested that this high responsiveness is driven by a substitution to alternative products, such as RYO and e-cigarettes, or NIDP cigarettes (both legitimate cross border and illicit), which the Ipsos MRBI surveys show to be significant. Smoking declined only marginally as smokers increasingly substituted to alternative products. However, the recent substantial falls in prevalence rates between 2012 and 2014 suggest that a major part of the responsiveness now driving the elasticity may be smokers quitting (or reducing smoking) rather than substitution to other products.

The elasticity results have policy implications. They suggest that cigarette tax *increases* tend to be associated with *reductions* in the Exchequer receipts associated with cigarettes. For instance, according to the analysis, a 10 cent tax increase on a 20-pack of cigarettes is associated with a fall in cigarette receipts of around €6 million on average. Taken together with more traditional (inelastic) estimates, the elasticities in this analysis offer a potential range for estimating the impact of tax changes on receipts.

Ipsos MRBI research estimates the potential tax loss in the cigarette market in Ireland to be €214 million in 2014 based on surveys showing the illicit market as 11 per cent and legal cross border market at 6 per cent.

The Ipsos MRBI estimate is independently produced from a robust sampling methodology and remains the most accurate estimate available of the tax loss. The alternative method in Section 4 of this paper indicates the share of cigarette consumption not explained through consumption of taxed cigarettes and taxed substitutes has fallen to around 5 per cent, a tax loss closer to €84 million. The two methods are not expected to reconcile. That the estimate in this paper is lower suggests that the MRBI estimate could be considered as a possible upper bound of the possible tax loss.

There are a number of areas for potential further research in the area of tobacco. The elasticities estimates may be updated over time and prevalence and illicit market estimates will continue to be monitored.

The growth of consumption of e-cigarettes (on which data are limited at present) is a further issue to be considered in future research in more detail. E-cigarettes appear to be growing in prevalence and may impact on the results discussed above.

The focus of this paper is to examine the likely effects of tax changes on cigarette consumption and the associated tax receipts. There are established adverse effects of tobacco and cigarette smoking on public health. Consequently, Government may wish to use fiscal policies to pursue health goals rather than solely securing tax revenues. Overall, the analysis underlines that Ireland continues to face significant challenges arising from high cigarette prices and the availability of NIDP product. Accordingly, the prevention and detection of illegal smuggling and trading of cigarettes remains an operational imperative for Revenue.

Appendix I – Approaches to Smoking Prevalence Estimates

There are two primary measures of smoking prevalence discussed in the paper: studies for Eurobarometer and HSE. There are a number of important distinctions in the methodologies.

First, the questions asked are not the same. The Eurobarometer study asks *'regarding smoking cigarettes, cigars or a pipe, which of the following applies to you?'* while the HSE study asks *'do you smoke one or more cigarettes each week, whether packaged or roll your own?'*. The Eurobarometer study includes cigars and pipes. However, given that Eurobarometer shows that only 2 per cent of Irish smokers used cigars or pipes, it is unlikely that this will significantly impact on the overall results. Casual smokers could respond differently to the questions if they respond positively to smoking once or twice a week on the HSE study but negatively to be smokers in general on the Eurobarometer study. This would have the effect of upwardly biasing the HSE study, which is the opposite of the observed estimate.

A second methodological distinction arises in that the Eurobarometer study is based on face-to-face surveys in people's homes whereas the HSE study is based on data from monthly landline and mobile telephone interviews. Some level of response bias on a sensitive attribute such as smoking is expected.[28]

The Eurobarometer estimate has the advantage of being consistent with a wider sample of over 27,000 respondents across Europe.

Any estimate of smoking prevalence is subject to some margin of error. It should be stressed that the differences noted above are marginal and both surveys show substantial reductions in prevalence in recent years.

---

[28] It is instructive to consider the international research on the impact of different data collection methods on results. Yeager and Krosnick (2010) examine the validity of self-reported use of nicotine in face-to-face interviews by comparing respondents' answers to the levels of serum nicotine found in the respondent's blood samples. The study finds that approximately 1 per cent of adult respondents said that they did not use a product containing nicotine but had elevated nicotine levels. The study concludes that face-to-face interviews elicit '*remarkable accuracy of self-reports of nicotine consumption*' compared with telephone interviews where '*social desirability pressure are more likely to distort answers*'.

Appendix II – Diagnostic Testing

Stationarity

Most economic time-series data are trending. They are therefore non-stationary and their properties are variant with respect to time. To ensure stationarity of the variables, a number of diagnostic tests are required.

Figure A1 shows consumption per capita after log transformation and differencing.[29] Conducting a visual inspection of both the autocorrelation and partial-autocorrelation functions is also important. If a variable is stationary, the correlogram should show autocorrelations that decay quickly. Separately, the HQIC test, which is regarded as the most appropriate for quarterly data, confirms four lags. The two most common other criteria – the Akaike Information Criterion (AIC) and the Schwarz' Bayesian Information Criterion (AIC/BIC/SBIC) – also confirm four lags.

Figure A1: Diagnostic Testing

(A) Log 1st Difference Consumption per capita
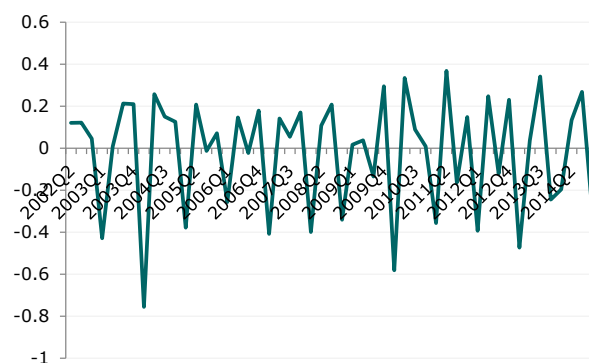
*(B) Autocorrelation Log 1st Difference Consumption 2002 – 2014*
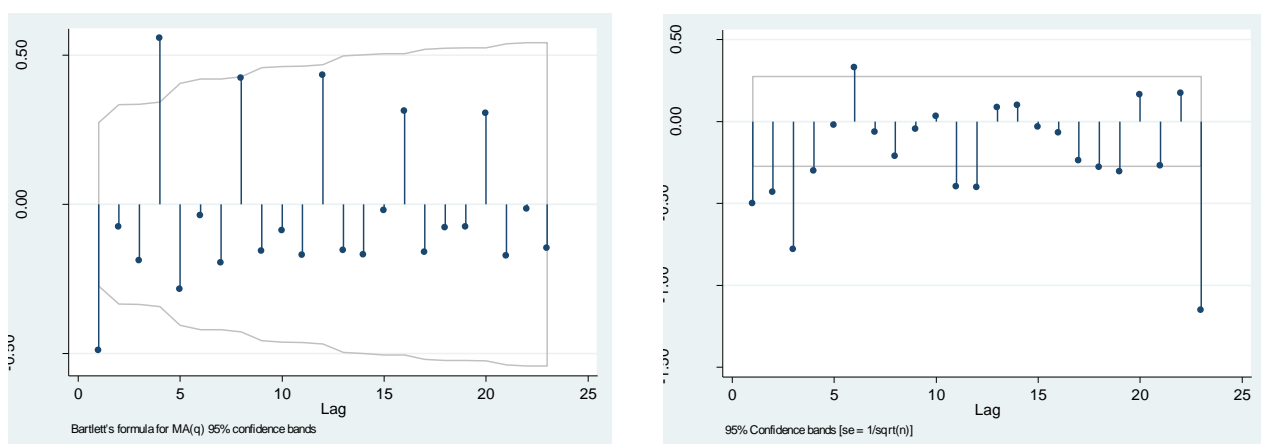
Source: Authors analysis of Revenue and CSO data.

---

[29] Stationarity confirmed with ADF tests in Stata – Ln Consumption (with 4 lags) stationary after 1st differencing; ADF test statistic of -5.21 with p value of 0.00, i.e., H_0 (unit root) is rejected.

Figure A2 shows a number of variables following transformation to logs and after differencing. Both real price and GDP per capita are shown after log transformation and differencing and unemployment after differencing only. For all variables, stationarity is confirmed after differencing with ADF tests using Stata 13 software.

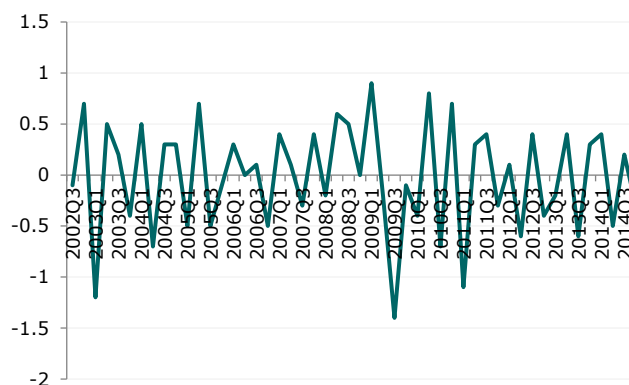**Figure A2: Real Price, GDP per capita and Unemployment**

(A) Log 1st Difference Real Price
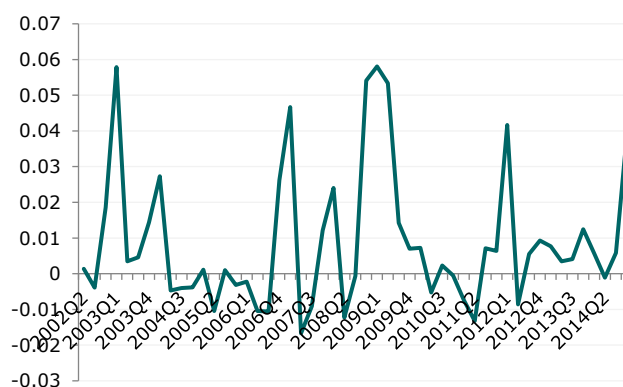
(B) Log 2nd Difference GDP per capita
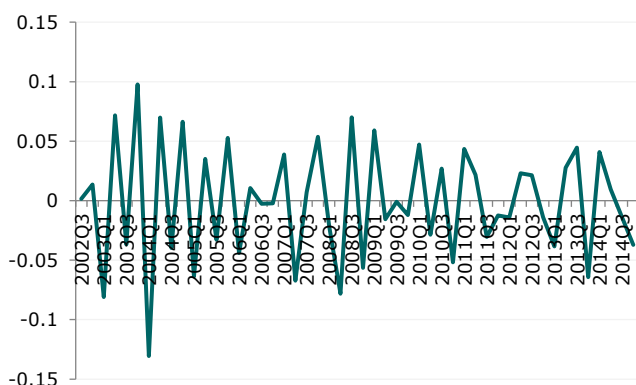
(C) 2nd Difference Unemployment

Source: Authors' analysis of Revenue and CSO data.

Multicollinearity

Testing for multicollinearity among the variables used in the model shows that there is no substantial problem with multicollinearity between the three independent continuous variables when the three are tested together (highest variance inflation factor is 1.03). When the eight dummy variables (policy/event variables and time variables) are also added to the set to be tested for multicollinearity, some do exhibit problematic VIFs, i.e., greater than 5 (POS advertising ban, travel restriction and Q2 dummy).

Appendix III – Model Evaluation

Figure A3 below provides a graphical evaluation of the quality of the model by comparing actual and predicted values. Since cigarette consumption is transformed using logs and first differencing for the purposes of modelling, practical interpretation is difficult. Instead, the purpose of graphs A and B below is to show that the regression line produced by the model performs well in predicting actual cigarette consumption (when logged and first differenced).

Figure A3: Actual and Predicted Cigarette Consumption (Logs)

(A) Actual versus Predicted   *(B) Actual versus Predicted by Quarter*
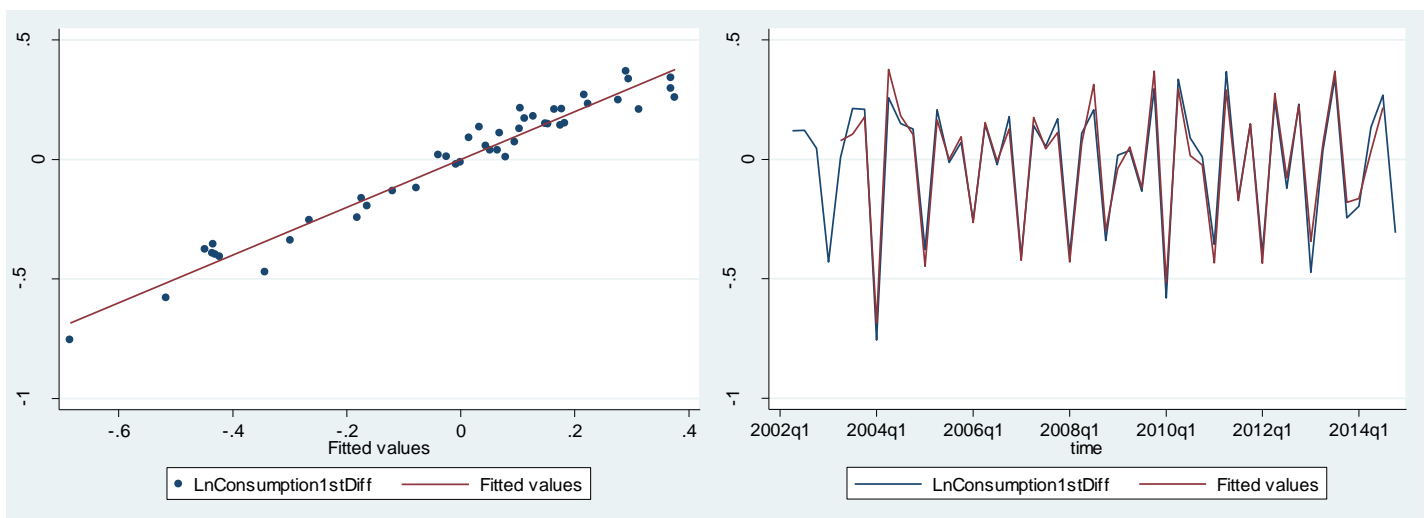
Source: Authors' analysis.

Bibliography

Becker, G. and Murphy, K., 1988, 'A Theory of Rational Addiction', The Journal of Political Economy, Vol. 964, pp. 675-700.

Chaloupka, F.J. and Tauras, J.A., 2011, 'The Demand for Cigarettes in Ireland', paper funded by the HSE National Tobacco Control Office.

Chaloupka, F.J., Yurekli, A. and Fong, G., 2012, 'Tobacco Taxes as a Tobacco Control Strategy', Tobacco Control, No. 21, pp. 172-180.

Ciecierski, C.U., and Chaloupka F.J. 2000, 'Data for Economic Analysis', Tool 2 Tobacco Data, World Bank Economics of Tobacco Toolkit, edited by Yurekli and de Beyer.

Conniffe, D., 1995, 'Models of Irish Tobacco Consumption', The Economic and Social Review, Vol. 26(4), pp. 331-347

Cullum, P., and Pissarides, C.A, 2004, 'The Demand for Tobacco Products in the UK', Government Economic Service Working Paper No. 150.

Czubek, M., and Johal, S., 2010, 'Econometric Analysis of Cigarette Consumption in the UK', HM Revenue & Customs Working Paper No. 9.

Escario, JJ. and Molina, JA., 2001, 'Why do European consumers smoke? Responses from the rational additional model', International Journal of Consumer Studies, Vol. 251.

Eurobarometer, 2014, 'Attitudes of Europeans Towards Tobacco and Electronic Cigarettes', Report 429, May 2015.

Eurobarometer, 2012, 'Attitudes of Europeans Towards Tobacco', Report 385, May 2012.

Euromonitor International, 2014, 'Tobacco in Ireland', Euromonitor Passport Report.

Euromonitor International, 2013, 'Tobacco in Ireland', Euromonitor Passport Report.

Eurostat, 2014, 'Detailed Average Prices Report', EC October 2014.

Gallet, C.A. and List, J.A., 2003, 'Cigarette Demand: A Meta-analysis of Elasticities', Health Economics, Vol. 12(10), pp. 821-835.

Goel, R. K. and Nelson, M.A., 2006, 'The Effectiveness of Anti-Smoking Legislation: a Review', Journal of Economic Surveys, Vol. 20(3), pp. 325-355.

Landman Economics, 2011, 'Tobacco Taxation, Smuggling and Smoking in Ireland', a report for the Irish Heart Foundation.

Madden, D., 2002, 'Setting the Appropriate Tax on Cigarettes in Ireland', University College Dublin, Centre for Economic Research Working Papers, WP02/25.

Nguyen, L., Rosenqvist, G. and Pekurinen, M., 2012, 'Demand for Tobacco in Europe: An Econometric Analysis of 11 Countries for the PPACTE Project', report for National Institute for Health and Welfare.

O'Riordan, W., 1969, 'Price Elasticity of Demand for Tobacco in Ireland', Economic and Social Review, Vol. 1 (1), pp. 109-115.

Ramboll, 2014, 'Study on the measuring and reducing of administrative costs for economic operators and tax authorities and obtaining in parallel a higher level of compliance and security in imposing excise duties on tobacco products', study for the EC.

Reidy, P. and Walsh, K., 2011, 'Economics of Tobacco – Modelling the Market for Cigarettes in Ireland', Office of the Revenue Commissioners, Dublin.

Walsh, B., 1980, 'Health and education and the demand for tobacco in Ireland, 1953 – 76, A Note', Economic and Social Review, Vol. 12(1), pp. 147–151.

Wilkins, N., Yurekli, A. and Hu, T., 2000, 'Economic Analysis of Tobacco Demand', Economics of Tobacco Toolkit, World Bank Washington D.C.

World Health Organisation (WHO), 2010, 'Economic Analysis of Demand Using Data from the Global Adult Tobacco Survey (GATS)' WHO Economics of Tobacco Toolkit.

Yeager, D. and Krosnick, J., 2010, 'The Validity of Self-Reported Nicotine Product use in the 2001 – 2008 National Health and Nutrition Examination Survey', Medical Care, Vol. 48(12), pp. 1128-1132.