

Cigarette consumption in The Netherlands 1970-1995

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Cigarette consumption in The Netherlands 1970 – 1995: does tax policy encourage the use of  
hand-rolling tobacco?

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**Background.** Tax rises to reduce cigarette consumption are a major feature of European tobacco control policies. In many countries, hand-rolling tobacco is much cheaper than manufactured cigarettes. We investigated whether changes in price differentials between manufactured and hand-rolled cigarettes influenced cigarette consumption in The Netherlands.

**Method.** We develop regression models to explain changes in the consumption of the two cigarette types. Price elasticities, the percentage changes in consumption for a 1% change in price, are calculated from Netherlands data for 1970-1980 and 1985-1995.

**Results.** The ratio of manufactured to hand-rolled cigarette price changed little during 1970-1980 but varied subsequently. On multivariate analysis, manufactured cigarette consumption in 1970-1980 decreased as its price rose (elasticity = -0.74). In 1985-1995, manufactured cigarette consumption fell with increases in both its own price (elasticity = -0.54) and in the price differential between manufactured and hand-rolled cigarettes (elasticity = -0.60). During 1985-1995, roll-your-own consumption fell as the price ratio of manufactured to hand-rolled cigarettes fell (elasticity = +1.0).

**Conclusion.** When the price rise for hand-rolling tobacco is greater than the price rise for manufactured cigarettes, the fall in manufactured cigarette consumption is accompanied by a fall in roll-your-own use. Cigarette smokers are deterred from switching to hand-rolled cigarettes instead of stopping smoking. This increases the health benefits of raising taxes on manufactured cigarettes, discourages the use of even more harmful forms of tobacco and may reduce inequalities in health.

**Key-words:** *elasticity, hand-rolling tobacco, manufactured cigarettes, price, tax*

## **INTRODUCTION**

Tobacco use accounted for 513,000 deaths in 1990 in the European Union,<sup>1</sup> including 121,000 in the UK and 25,000 in The Netherlands.<sup>2</sup> The health consequences from smoking hand-rolling tobacco may be worse than from manufactured cigarettes, because hand-rolled cigarettes have a higher tar content<sup>3,4</sup> and no filter. Both of these increase the relative risk of lung cancer,<sup>5-7</sup> oral cancer,<sup>8</sup> respiratory disease and ischaemic heart disease.<sup>9</sup>

The economist would predict that the consumption of tobacco would be inversely affected by price; indeed, the finding has been confirmed in many countries.<sup>10-13</sup> Government policy in a number of European countries is to increase excise duties on manufactured cigarettes in real terms, in order to reduce both cigarette consumption and smoking prevalence. In countries such as the UK and The Netherlands, manufactured cigarettes are significantly more expensive per item than those hand-rolled from loose tobacco and cigarette paper. In the UK in particular, this gap is widening due to differential policies on taxation. In such a case, it is likely that the lower prices for hand-rolling tobacco will undermine the health impact of tobacco taxation,<sup>14</sup> because some cigarette smokers will switch to hand-rolled cigarettes in preference to stopping smoking in response to price rises.<sup>15</sup> Evidence suggests that just such a result was observable in Finland in the 1970s and early 1980s.<sup>11</sup> However, the tobacco industry is campaigning for a freeze on all tobacco taxes<sup>16</sup> or even a reduction in tax on hand-rolling tobacco in the UK because of its much higher price than elsewhere in Europe. They claim that there is loss of sales through illegal imports<sup>17</sup> although Joossens and Raw<sup>18</sup> showed that the tobacco industry is the main beneficiary of sales of contraband.

The prevalence of smoking fell substantially in The Netherlands in the 1970s but this trend has slowed more recently (*figure 1*). Hand-rolled cigarettes accounted for 46% of cigarette consumption in 1995. Using Dutch consumption and price data, we tested the hypothesis that widening differences in price between manufactured and hand-rolled cigarettes influences differential cigarette consumption. Responsiveness to price or income change is conventionally assessed as elasticity, defined as the percentage change in consumption associated with a 1% change in price or income.

## **METHOD**

Data on population, annual consumption of manufactured and hand-rolled cigarettes and prices were supplied by STIVORO, the Netherlands Foundation on Health and Smoking. Per capita consumption was calculated from the annual sales of cigarettes and hand-rolling tobacco in The Netherlands divided by the population aged 15 years and over. When prices changed during the year, the average price for the year was calculated from the number of months at each price. The Netherlands Central Bureau of Statistics provided the retail price index (RPI, which we used to calculate real prices in 1970 guilders), unemployment rates and average disposable income. Two additional variables were calculated from the data, namely the ratio of the real price of manufactured to hand-rolled cigarettes and the difference between the real prices.

Average disposable income data were not available annually until 1987. Values for missing years were calculated in line with changes in average hourly manufacturing wage adjusted for inflation (as multiple linear regression showed no relationship between income and gross

domestic product (GDP) but a close relationship with the average hourly manufacturing wage/RPI). It was impossible to calculate a value for 1984 as the two variables moved in opposite directions. Unemployment was used as a measure of the distribution of purchasing power, on the basis that unemployment benefit was considerably below the mean income of employed persons. In consequence, a higher level of unemployment for a given average disposable income would indicate a greater disparity in capacity to pay between employed and unemployed.

We should have liked to have included advertising as an independent variable, although the econometric evidence for its effect on tobacco consumption is disputed.<sup>12,19-21</sup> However, published data on tobacco advertising expenditure were available for too few years to include them and the tobacco industry declined to furnish us with their marketing expenditure. We used STIVORO's annual budget, available from 1981 onward, as a proxy for health promotion expenditure. It is likely that health promotion spending has an investment or carry-over effect, i.e. the impact lasts longer than the immediate period of spending. Accordingly, two further variables were calculated to capture this impact, namely  $HP_{50}$ , which added 50% of the previous year's budget to that year's to calculate the 'effective expenditure', and  $HP_{5025}$ , which added 50% of the previous year's 'effective expenditure' to that year's budget.

The consumption figures provided by STIVORO came from the Dutch Customs and Excise Office and represent the amount of manufactured cigarettes and 'cut tobacco' taxed and sold in The Netherlands each year. Cut tobacco includes both roll-your-own and pipe tobacco. However, STIVORO estimates that only 3% of cut tobacco is used in pipes and that this has not changed (B. De Blij, personal communication), so we have assumed that all such tobacco

was used in hand-rolled cigarettes. The same approach was taken in a Finnish study.<sup>11</sup>

Consumption data also exclude black market tobacco products, which appear to account for 5-10% of cigarettes smoked in The Netherlands.<sup>18</sup>

The analyses were conducted in accordance with the theory of the single model of demand<sup>22</sup> and the methods proposed by Maynard and Jones<sup>23</sup> (except that only numbers of cigarettes were used, not cost or weight of tobacco). We performed linear regression for each independent variable for which the scatter-plot demonstrated a linear relationship with the dependent variable. Log-log equations were used throughout. We tested for collinearity of independent variables, then performed stepwise multiple linear regression with listwise deletion. A single demand equation model was used for each dependent variable and time period. The general form of the equation involved the per capita consumption of cigarette product as the dependent variable with, as independents, real and relative prices, real disposable income, unemployment and measures of health promotion. Only statistically significant models which conformed with the assumptions of linearity, normality, equality of variance and randomness of error are presented below.

## **RESULTS**

Tests for linearity demonstrated apparently random patterns for many independent variables when plotted against total or hand-rolled cigarette consumption. In most cases, we perceived that the 'random' pattern was the result of one linear relationship from 1970 until some time in the early or mid-1980s and a second, different, linear relationship from the late 1970s or early or mid-1980s until 1995. To enable analyses of data with linear relationships, we

accordingly divided the data into earlier and later time periods. The 1984 calculated income value is missing. To enable comparisons between different dependent variables, we wished to use periods of the same duration. We therefore elected to analyse over the periods 1970-1980 and 1985-1995.

With the univariate models, the ratio of manufactured to hand-rolled cigarette price changed little during 1970-1980 but varied subsequently. All linear relationships with  $p < 0.05$  are listed in *table 1*; with multiple testing, only results where  $p < 0.01$  should be considered statistically significant. As expected, own-price increases reduced the consumption of manufactured (*figure 2*) and hand-rolled cigarettes in each decade. Three of the four cross-price elasticities were also negative ( $p < 0.01$ ), probably due to correlation between prices. During 1985-1995, decreasing the price ratio of manufactured to hand-rolled cigarettes decreased the consumption of hand-rolled (*figure 3*) and all cigarettes. For 1970-1980, a rise in average disposable income had the expected effect of increasing consumption, although more for hand-rolled than for manufactured cigarettes. However, in 1985-1995, rising income was associated with reduced consumption of hand-rolled cigarettes. Unemployment demonstrated some collinearity with income, so the multivariate analyses were performed both including and excluding unemployment.

With the multivariate models (*table 2*), that for consumption of manufactured cigarettes in 1970-1980 contained only the own-price variable. For 1985-1995, there were three valid models to explain the consumption of manufactured cigarettes. The best model included the price of manufactured cigarettes and the difference between the price of manufactured and hand-rolled cigarettes (*figure 4*). The prices of manufactured and hand-rolled cigarettes

formed a second model and the price of manufactured cigarettes plus the ratio of prices of manufactured and hand-rolled prices the third; these two were a less good fit.

The best model for explaining the consumption of hand-rolled cigarettes during 1970-1980 included unemployment, which increased consumption, and price of hand-rolled cigarettes, which decreased consumption. When unemployment was excluded, the replacement model became average disposable income (elasticity = +1.2,  $p = 0.005$  and adjusted  $r^2 = 0.81$ ) and price of hand-rolled cigarettes (elasticity = -0.49,  $p = 0.0095$  and adjusted  $r^2$  became 0.91). In 1985-1995, when relative prices fluctuated more, consumption of hand-rolled cigarettes was determined by the ratio of prices of manufactured to hand-rolled cigarettes (*figure 3*).

Price of manufactured cigarettes explained 86% of the variation in total cigarette consumption per capita for each decade. The elasticity was larger in the later decade (-1.0 for 1985-1995 compared with -0.83 for 1970-1980) when the price ratio of manufactured to hand-rolled cigarettes was falling.

## **DISCUSSION**

The distinct patterns we found for each of the earlier and later periods are unlikely to be mere artefact, despite the use of only 11 observations in each period, because the two decades were very different in terms of both their supply and demand characteristics. The 1970s were economically volatile, with rapidly rising unemployment rates after a protracted period of high and stable employment. The more recent period was something of the reverse, with unemployment initially high but falling gradually. Smoking prevalence fell substantially in the first decade but changed slowly thereafter. The consumption of manufactured cigarettes in 1970-1980 was explained solely by own-price, in the classic demand equation. However, for



1985-1995 substitution was evidently occurring, with consumption depending both on own-price and the difference between own-price and that of an alternative.

It is interesting to note that unemployment was a more powerful explanatory variable in the models than was income. Within the analysis, it is impossible to determine whether unemployment was reflecting the country's economic situation (a 'feel bad' factor) or if we are directly identifying a potent influence associated with continuing smoking, namely being unemployed. Income was an important determinant of cigarette consumption in earlier studies<sup>22-24</sup> but a recent analysis found the effects of personal income almost disappeared when gender, age and education were also included in the model (L. Ramstrom, personal communication). Perhaps, average disposable income has become a less adequate measure of smokers' income in recent years as smoking prevalence has become more polarised towards the socioeconomically disadvantaged.<sup>25,26</sup>

Alternatively, we may have identified an extreme example of the reduction in elasticities found by others.<sup>12</sup> Price, income and advertising elasticities for manufactured cigarettes in the UK and the USA were larger before 1964, smaller after 1970 and intermediate in between.

It was postulated that this arose because smokers both responsive to health education and sensitive to price and income changes stopped smoking, leaving a pool of smokers who were less responsive to these effects. In the Dutch case, however, there were no significant changes in own-price elasticities between our two 11-year periods, both of which were post-1970.

In goods markets generally, demand varies inversely with own-price and positively with income. When income falls, for example as a result of unemployment, the desired product may be unaffordable. Consumers will thus demand an 'inferior' good as a substitute for the

more desirable but too expensive commodity. Our results suggest that hand-rolled tobacco has become perceived as an inferior good in relation to manufactured cigarettes. During 1985-1995, the prices of the two types of cigarette converged, then diverged. On multivariate analysis, a 10% increase in the price difference between manufactured and hand-rolled cigarettes decreased the consumption of manufactured cigarettes by 6%. This accounted for one-quarter of the total variation in consumption. In the same period, the consumption of hand-rolled cigarettes fell by 10.3% for every 10% decrease in the ratio of price of manufactured to price of hand-rolled cigarettes, explaining 71% of the variation in the consumption of hand-rolled cigarettes. The only previous study to have examined cross-elasticities, in Finland, found that a 10% increase in cigarette price resulted in a 5% decrease in cigarette consumption and a 22% increase in demand for pipe tobacco. The price of manufactured cigarettes was the most important factor influencing demand for pipe tobacco, which is used in hand-rolling cigarettes in Finland. The authors concluded that If the price of cigarettes and pipe tobacco is increased by the same percentage, about half of the fall in per capita consumption of cigarettes will be taken up by the increase in consumption of hand-rolled cigarettes. Increasing the price of pipe tobacco about three times as much as the price of manufactured cigarettes would prevent the substitution effect.<sup>11</sup> There is some evidence that such substitution reoccurred in Finland, during an economic recession in the early 1990s (M. Hara, personal communication).

Although derived from Dutch data, our results are relevant to countries throughout Europe in which hand-rolling tobacco is widely used. Perhaps more importantly, there is evidently a very considerable potential for a transfer of consumption from manufactured to hand-rolled

cigarettes in countries where the share of roll-your-own cigarettes remains small as yet. The UK is a case in point. Although only 18% of male cigarette smokers smoked mainly hand-rolled cigarettes in 1992, the proportion had risen to 23% by 1996. The most dramatic increase in hand-rolling tobacco use has been amongst the youngest smokers, from 7% of male cigarette smokers aged 16-19 years and 11% of those aged 20-24 years in 1994<sup>25</sup> to 13% in both these agegroups. Use of hand-rolling tobacco is most common in older male cigarette smokers (27% for 35-49 years, 29% for 50-59 years, and 24% for 60+ years) but, as a higher proportion of younger adults smoke, most users of hand-rolling tobacco in Britain are aged 25-59.<sup>27</sup>

Roll-your-own use is also more common in men in less favourable socio-economic circumstances. Amongst male cigarette smokers, 26% of UK skilled manual workers, 34% of unskilled manual workers and 37% of those who have never worked smoke mainly hand-rolled cigarettes (M. Jarvis, personal communication). Smokers with lower incomes are naturally more sensitive to rises in cigarette prices.<sup>10</sup> The continuation of current policies which lead to increasing divergence in the prices of manufactured and hand-rolled cigarettes are thus likely to encourage further substitution of hand-rolling tobacco.

It is evident from our analysis that, unless the price of hand-rolling tobacco is on a par with that of manufactured cigarettes in The Netherlands and, by implication, in all European countries, substitution of a different form of tobacco will, in effect, reduce the impact of tax-induced price rises. Arguably, this different form is also more dangerous. Usage will particularly be taken up by the poorer sections of society, groups which already have worse health and higher mortality. Where the retail price gap between one country and its

neighbours is much smaller for manufactured than for hand-rolled cigarettes, as is the case for the UK, incentives for smuggling would be reduced. Indeed, this result with respect to tax harmonisation has already been demonstrated in the case of the prevention of cross-border shopping in the US.<sup>13, 28, 29</sup>

Many European governments are committed to regular, real prices in cigarette excise duties, because this powerful disincentive to smoke results in major benefits for the health of the population. However, unless these duties are distributed in an even-handed fashion, maintaining parity between manufactured and roll-your-own cigarettes, our evidence suggests that substitution will occur and the health benefits expected from a given duty increase will not be realised.

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Table 1. Per capita cigarette consumption in The Netherlands, 1970-1980 and 1985-1995:  
results of univariate linear regression by time period, significant at 5%<sup>a</sup>.

YEAR	DEPENDENT VARIABLE	INDEPENDENT VARIABLE	ELASTICITY	95% CI	p (T-test)	Adjusted R <sup>2</sup>
1970 - 1980	Manufactured cigarette consumption	Ln P <sub>M</sub>	-0.74	-0.37, -1.1	0.0013	0.67
		Ln P <sub>R</sub>	-0.67	-0.33, -1.0	0.0015	0.66
		Ln P <sub>M</sub> -P <sub>R</sub>	-0.70	-0.29, -1.1	0.004	0.59
		Ln Y	+0.91	0.03, 1.8	0.045	0.31
	Hand-rolled cigarette consumption	Ln P <sub>M</sub>	-1.00	-0.63, -1.4	0.0002	0.79
		Ln P <sub>R</sub>	-0.91	-0.56, -1.3	0.0002	0.78
		Ln P <sub>M</sub> -P <sub>R</sub>	-0.95	-0.51, -1.4	0.0009	0.69
		Ln Y	+1.70	1.1, 2.3	0.0001	0.81
		Ln N <sub>U</sub>	+0.18	0.12, 0.23	<0.00005	0.84
	Total cigarette consumption	Ln P <sub>M</sub>	-0.83	-0.59, -1.1	<0.00005	0.86
		Ln P <sub>R</sub>	-0.75	-0.52, -0.98	<0.00005	0.84
		Ln Y	+1.20	0.51, 1.9	0.0034	0.59
		Ln N <sub>U</sub>	+0.12	0.05, 0.19	0.0034	0.59

# Cigarette consumption in The Netherlands 1970-1995

1985 - 1995	Manufactured cigarette consumption	Ln $P_M$	-0.50	-0.16, -0.84	0.0087	0.50
		Hand-rolled cigarette consumption	-1.26	-0.50, -2.0	0.0046	0.57
		Ln $P_R$	-0.61	-0.33, -0.88	0.0008	0.70
		Ln $P_M/P_R$	+1.00	0.57, 1.5	0.0007	0.71
		Ln Y	-1.60	-0.37, -2.8	0.016	0.43
		Ln HP	-0.21	-0.00, -0.41	0.047	0.30
		Ln $HP_{5025}$	-0.25	-0.02, -0.48	0.037	0.33
	Total cigarette consumption	Ln $P_M$	-1.03	-0.74, -1.3	<0.00005	0.86
		Ln $P_R$	-0.45	-0.32, -0.58	<0.00005	0.86
		Ln $P_M/P_R$	+0.72	0.43, 1.0	0.0003	0.75

a: There were 45 possible comparisons, so results where  $0.01 < p < 0.05$  should be viewed with caution.

Ln, natural logarithm

$P_M$ , price of manufactured cigarettes

$P_R$ , price of roll-your-own cigarettes

Y, average disposable income

$N_U$ , unemployment

HP, health promotion expenditure

$HP_{5025}$ , health promotion expenditure with two year carry-over effect.

Table II. Best econometric models to explain per capita cigarette consumption in The Netherlands 1970-1980 and 1985-1995, by type of cigarette smoked.

Dependent variable	1970 - 1980	1985 - 1995						
	Explanatory variable(s) in best model	Elasticity (95% CL)	p	Adjusted R <sup>2</sup>	Explanatory variable(s) in best model	Elasticity (95% CL)	p	Adjusted R <sup>2</sup>
Manufactured cigarette consumption	$\propto F(P_M)$	-0.74 (-0.37, -1.1)	0.0013	0.67	$\propto F(P_M, P_M-P_R)$	P <sub>M</sub> : -0.54 (-0.29, -0.79) P <sub>M</sub> -P <sub>R</sub> : -0.60 (-0.15, -1.1)	0.001 0.016	0.50 →0.74
Hand-rolled cigarette consumption	$\propto F(N_U, P_R)$	N <sub>U</sub> : +0.11 (0.03, 0.19) P <sub>R</sub> : -0.43 (-0.01, -0.85)	0.012 0.047	0.84 →0.89	$\propto F(P_M/P_R)$	+1.0 (0.57, 1.5)	0.0007	0.71
Total cigarette consumption	$\propto F(P_M)$	-0.83 (-0.59, -1.1)	<0.00005	0.86	$\propto F(P_M)$	-1.0 (-0.74, -1.3)	<0.00005	0.86

$P_M$ , Price of manufactured cigarettes ;

$P_R$ , Price of hand-rolled cigarettes;

$N_U$ , Unemployment.

Stepwise log-log linear regression with listwise deletion of missing values.

*Figure 1*      Smoking prevalence in The Netherlands, 1970-1995

*Figure 2* Price and per capita annual consumption of manufactured cigarettes in The Netherlands, 1970-1 995

*Figure 3* Per capita annual consumption of hand-rolled cigarettes and the ratio of real prices of manufactured to hand-rolled cigarettes in The Netherlands, 1970-1995

*Figure 4*      Per capita annual consumption of manufactured cigarettes and the real difference in prices between manufactured to hand-rolled cigarettes in The Netherlands, 1985-1995