Why do European consumers smoke? Responses from the rational addiction model

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Abstract

In this paper, we test whether European consumers are addictive smokers and, if this is the case, then whether such addictions can be explained by the rational addiction theory. To this end, we start from a non-separable intertemporal utility function, which allows us to derive a demand function that is estimated using tobacco time-series. The results are in accordance with the model of rational addiction for all European smokers. Thus, we observe the addictive character of tobacco consumption and, secondly, we note that the addiction is not the result of myopic consumer behaviour, but rather of the maximization of total utility, implying that consumers consider the future effects of their current decisions.

Keywords European consumers, addiction, smoking, model.

Introduction

Although the first works that analysed the consumption of addictive goods assumed that such consumption was derived from irrational behaviour,[1,2] subsequent studies have raised the possibility that the behaviour of agents who consume addictive goods could be considered as rational, in the sense of involving forward-looking maximization with stable preferences.[3–10] In this context, the rational addiction model is based on a behaviour that maximizes the utility obtained during the total lifetime of individuals. This model incorporates the dependence between the current and the past consumption of addictive goods, which implies that recognition is given to the existence of notions of tolerance, reinforcement and withdrawal. Tolerance suggests that a given level of consumption yields less satisfaction, as past cumulative consumption is higher; reinforcement implies a learned response to past consumption; and finally, withdrawal refers to a negative physical reaction and other reductions in utility, associated with the cessation or interruption of consumption.

In this paper, we explain why European consumers smoke, through the use of the intertemporal model of rational addiction. Thus, we test whether tobacco consumption generates addiction in European people and, if this is the case, then whether such addiction can be explained in the context of rational addiction theory. In other words, we examine whether the consumer falls into addiction after a maximization process of the utility that was obtained during his total lifetime, taking into account the future consequences of current decisions or, in contrast, whether the consumer becomes addicted because he does not evaluate the future consequences of current choices. In this context, we consider a non-separable intertemporal utility function in which tobacco addiction incorporates the dependence between current and past decisions, thus permitting the inclusion of the earlier cited notions of tolerance, reinforcement and withdrawal. The maximization of such a utility function, subject to the corresponding budget restriction, allows us to obtain a demand function in which current consumption depends on lag and lead consumption and on current price. This demand function is then estimated using time-series data of per capita consumption and prices for 13 European countries, specifically Germany, Belgium, France, the Netherlands, Italy, Denmark, Ireland, the United Kingdom, Greece, Spain, Austria, Finland and Sweden.

The organization of the paper is as follows. In the next section, we develop the theoretical framework of rational addiction, deriving an expression of the demand function; thereafter, we present the data and the empirical results; and finally, we summarize the main conclusions.

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Theoretical framework

The rational addiction model for tobacco considers a utility function for consumers, which incorporates the addiction that is given by the dependence between the current utility and the past consumption of the addictive good. Moreover, we assume that individuals are rational, because their objective is to maximize the utility obtained during all their lifetime. In this context, at any given moment in time, consumers' utility is assumed to be a function of health, H(t), the relaxation produced by addictive consumption, R(t), and a composite of other consumption goods, Z(t), that is to say, U(t) = U[H(t), R(t), Z(t)]. We assume that this utility function is concave, and has positive first derivatives and negative second derivatives.

The first variable, health, is assumed to be a function of some market goods, such as medical care, and the individual's own time spent, for example, on exercise, M(t). These inputs have positive but diminishing effects on health, which is also affected by the cumulative past consumption of the addictive stock, S(t). The stock accumulation process is described by a simple investment function, $\dot{S}(t) = C(t) - \delta S(t)$, where $\dot{S}$ is the rate of change over time in S, C is the consumption of the addictive good and δ is the constant depreciation rate. Cigarette consumption at time t can be thought of as a gross investment in the addictive stock. Therefore, the health production function can be expressed as H(t) = H[M(t), S(t)]. Relaxation, that is to say the psychological benefits of smoking, is produced by the addictive good, C(t), and the addictive stock, S(t). Therefore, R(t) = [C(t), S(t)]. Increased consumption has a positive effect on the production of relaxation, whereas higher past consumption has a negative effect. This assumption incorporates the notion of tolerance into the model. To capture reinforcement effects in consumption, the marginal productivity of cigarette consumption in the production of relaxation is assumed to be increasing with the level of the addictive stock. Finally, the composite good is produced using inputs, X(t), which include market goods and the individual's own time, with each of these assumed to have positive but diminishing marginal productivity, that is to say Z(t) = Z[X(t)]. In summary, we derive an instantaneous utility function, U(t) = U[C(t), S(t), Y(t)], where Y(t) is a vector that includes inputs into the production of the composite good and health.

On the basis of the above theoretical framework, we derive a demand function for the addictive good using a quadratic utility function in the difference between present consumption and addiction stock as an indicator of past consumption.[11] We assume that first derivatives are positive and that the utility function is concave with negative second derivatives:

$$U(t) = [U_{CC}/2][C(t) - S(t)]^2 + [U_{YY}/2][Y(t)]^2 + u_C[C(t) - S(t)] + u_Y[Y(t)] + u_{CY}[C(t) - S(t)][Y(t)]$$

Therefore, the maximization of this utility function, subject to the lifetime budget constraint and the simple investment function, and assuming that the addiction stock constitutes the consumption of the past period, allows us to derive the following demand function:[5,6,9]

$$C(t) = c_0 + c_1C(t-1) + c_2C(t+1) + c_3P_C(t)$$

with $P_C(t)$ being the money price of the addictive good.

On the basis of such a function, we can easily test whether consumers' behaviour is addictive and, if this is the case, then whether it is rational or myopic. Therefore, a good will be addictive if its consumption is complementary in several periods, that is to say if its consumption in different periods is positive and significantly related. Moreover, the test of rational addiction, compared with myopic addiction, consists in proving whether consumers take the future into account when making their own current decisions. Thus, myopic demand is only backward looking, whereas rational demand is both backward looking and forward looking. Finally, the rational model implies that the past period has more influence over current consumption than the future period.

Data and results

With respect to data, in this paper we have used tobacco time-series for 13 European countries, which have been obtained from several issues of the *National Accounts*, Vol. II, OECD. In particular, we have homogeneous data for Germany (1964–94), Belgium (1964–94), France (1964–94), the Netherlands (1969–94), Italy (1970–94), Denmark (1966–94), Ireland (1970–94), the United Kingdom (1964–94), Greece (1964–94), Spain

(1964–94), Austria (1964–94), Finland (1964–94) and Sweden (1964–94). Per capita consumption is obtained by dividing consumption between that part of the population older than 15 years. The real price of tobacco is obtained by dividing the nominal price by the national consumer price index.

Before estimating the demand equation for each country, we provide a descriptive analysis for the budget shares of tobacco. Thus, Table 1 shows the mean, standard deviation, maximum and minimum values and the evolution of the budget shares of tobacco for each of the sample countries. We note first that Ireland exhibits the highest mean value, 4.62%, with three other countries showing values higher than 3%, namely Denmark (3.68%), the UK (3.64%) and Greece (3.28%). In contrast, the lowest average budget shares correspond to France and Spain, 1.26% and 1.44% respectively. The standard deviations, which show for each country the variations in the different values with respect to the mean, reveal that Denmark exhibits the highest indicator (0.97), whereas Spain shows the lowest (0.18). With respect to the time evolution of the budget shares, we note that all the countries, except for Greece and Spain, present a decreasing trend. Thus, from 1964 to 1994, the rates of increase for Greece and Spain are 28.1% and 17.7% respectively; in contrast, the highest rates of decrease correspond to the UK (51.5%) and Denmark (58.2%), whereas the lowest corresponds to France (17.3%).

Given that the intertemporal demand equations imply the endogeneity of past and future consumption, the 13 demand equations are individually estimated by the 2SLS method, with the OLS procedure implying, in this particular case, inconsistent estimations. Moreover,

Table 1 Tobacco budget shares (%)

Country	Mean	SD	Minimum	Maximum
Germany	2.29	0.42	1.65	3.08
Belgium	1.77	0.24	1.37	2.18
France	1.26	0.22	1.04	1.73
Netherlands	1.93	0.45	1.42	3.11
Italy	1.90	0.40	1.40	2.86
Denmark	3.68	0.97	2.46	5.87
Ireland	4.62	0.83	3.74	7.00
UK	3.64	0.89	2.49	5.33
Greece	3.28	0.51	2.48	4.41
Spain	1.44	0.18	0.98	1.79
Austria	2.53	0.40	1.78	3.22
Finland	2.37	0.45	1.94	3.35
Sweden	2.30	0.47	1.72	3.12

Country	1964	1970	1975	1980	1985	1990	1994
Germany	3.05	2.68	2.21	2.08	2.13	2.05	1.68
Belgium	2.08	1.99	1.80	1.62	1.68	1.39	1.42
France	1.73	1.49	1.13	1.06	1.12	1.11	1.43
Netherlands	–	2.79	2.14	1.86	1.68	1.46	1.47
Italy	–	2.86	2.12	1.62	1.79	1.45	1.70
Denmark	–	4.75	3.66	3.41	3.14	2.72	2.46
Ireland	–	7.00	5.30	3.88	4.88	3.80	3.93
UK	5.33	4.63	3.62	3.49	3.24	2.49	2.58
Greece	3.44	3.53	2.86	2.48	3.02	3.74	4.41
Spain	1.52	1.64	1.29	1.21	1.66	1.49	1.79
Austria	3.05	3.03	2.46	2.38	2.46	2.02	1.79
Finland	3.06	2.74	2.04	2.05	1.94	2.00	1.97
Sweden	2.85	2.94	2.48	2.12	1.95	1.81	1.90

the independent variables of the demand equations suggest that the lead and lag prices are plausible instruments and, therefore, we have used the independent variables, as well as four lead and lag prices, as instruments. We have used these lead prices, although they could result in biased estimates, because the solution proposed in the literature, that is to say using only the lag prices as instruments, exhibits more general limitations.[5–9]

Given the time horizon, 32 years, we have also included several time dummy variables in the demand equation of each country in order to take into account the impact of government regulatory policies on tobacco consumption that have been implemented in these countries. Thus, we first introduced two dummy variables common to each European country: (i) T87 (= 0 until 1986; = 1 from 1987), which is derived from the 'Europe Against Cancer Program' implemented in 1987' and (ii) T89 (= 0 until 1988; = 1 from 1989), which incorporates the effect of several measures adopted by the European Union in 1989, in particular the 89/552/CEE measure, which limits tobacco advertising, the 89/622/CEE measure, which incorporates improvements in the presentation of the good and, finally, the Resolution of the Council and the Ministers for Health of the Member States, meeting on 18 July 1989, on banning smoking in places open to the public. Moreover, we have included other specific dummy variables for several countries, with the purpose of taking into account particular government measures that limit tobacco consumption.

Table 2 shows the results of the estimation. We show first that European smokers are indeed rational addicts. Thus, we note that consumption in different periods is complementary for every country. All the estimated parameters of consumption are individually significant at the 5% level, with five intercepts and price coefficients also being significant at the same level. The parameters of past consumption are positive, which implies the addictive character of tobacco, whereas the coefficients of future consumption are also positive, which reflects the rationality of individual behaviour. Moreover, the current prices have the expected negative sign in all countries. Finally, we observe that the past consumption parameter is always higher than the future consumption coefficient, as the rational addiction model predicts. Therefore, we can affirm that our estimations support the rational addiction hypothesis of tobacco consumption in the 13 different European countries that make up our sample.

With respect to the dummy variables, we can observe that the majority of parameters are not significant at the 5% level, with two possible reasons for this being considered. First, the imposition of these regulatory measures is normally accompanied by increases in the price of tobacco and, therefore, an important component of the effect of the time dummy variables could appear as being included in the prices. Secondly, given that the majority of the time variables refer to the final years of the estimation period (after eliminating some observations resulting from the instruments), and also bearing in mind the addictive character of tobacco, which implies that smokers need some time in order to adapt to the new situation derived from the regulatory changes and therefore in order to give up tobacco consumption, the effects of the regulatory measures could reveal themselves at times that will fall outside our sample period.[12]

After presenting the estimated parameters, we show the degrees of fit, from which we note the excellent fit, as revealed by the high R^2-values, higher than 0.87 in all cases, except for Italy, Denmark, Finland and Sweden.

Summary and conclusions

In this paper, we have tested whether European consumers are addictive smokers and, if this is the case, then whether such addiction can be explained by the rational addiction theory. To that end, we have started from a non-separable intertemporal utility function, which includes the notions of tolerance, reinforcement and withdrawal. The restricted maximization of this utility function has allowed us to derive a demand function that expresses current consumption in terms of past and future consumption, as well as current, past and future prices.

The descriptive results show that Ireland exhibits the highest mean budget share, with a further three countries, namely Denmark, the UK and Greece, showing values higher than 3%. In contrast, the lowest average

Table 2 Results from the model of rational addiction

Country	Intercept	C(t – 1)	C(t + 1)	$P_C(t)$	T	T_{87}	T_{89}	R^2	Are smokers rational addicts?
Germany	0.8284*	0.1767**	0.1606**	–0.4161*	–0.0214[1]	0.0054	0.0078	0.87	Yes
	(4.28)	(1.87)	(1.87)	(–4.50)	(–1.38)	(0.35)	(0.50)		
Belgium	4.7569	0.4288*	0.3898*	–3.0374	0.0775[2]	–0.5047	–0.2018	0.95	Yes
	(0.69)	(3.51)	(3.51)	(–0.78)	(0.16)	(–0.99)	(–0.38)		
France	0.1629	0.4963*	0.4512*	–0.1157	–	0.0155	0.0095	0.98	Yes
	(1.21)	(18.1)	(18.1)	(–1.25)		(0.65)	(0.37)		
Netherlands	0.8427*	0.3293*	0.2994*	–0.7516*	–0.0060[8]	0.0014	–0.0095	0.98	Yes
	(3.65)	(5.58)	(5.58)	(–3.69)	(–0.27)	(0.07)	(–0.44)		
Italy	0.3223*	0.4144*	0.3768*	–0.2875*	–	0.0005	0.0198	0.63	Yes
	(2.45)	(3.15)	(3.15)	(–2.86)		(0.02)	(1.11)		
Denmark	1.6940	0.3692*	0.3356*	–0.5058	–	–0.1671	–0.2546	0.61	Yes
	(1.27)	(2.35)	(2.35)	(–1.48)		(–1.12)	(–1.46)		
Ireland	3.8257*	0.2539*	0.2308*	–2.2339*	–	–0.9978	–0.7498	0.95	Yes
	(2.65)	(2.46)	(2.46)	(–2.61)		(–0.06)	(–0.42)		
UK	–0.0138	0.5694*	0.5176*	–0.0252	0.0042[7]	0.0057	0.0087	0.89	Yes
	(–0.14)	(6.24)	(6.24)	(–0.49)	(0.25)	(0.33)	(0.49)		
Greece	4.9458	0.5046*	0.4587*	–3.4755	–1.1009[5]	2.0652	0.2543	0.99	Yes
	(1.20)	(29.1)	(29.1)	(–1.18)	(–0.33)	(1.29)	(0.20)		
Spain	2.9485	0.4961*	0.4510*	–2.2830*	–0.2686[8]	–0.5865[3]	0.0536[6]	0.98	Yes
	(1.54)	(17.1)	(17.1)	(–1.97)	(–0.45)	(–1.01)	(0.09)		
Austria	1.4017**	0.4551*	0.4138*	–0.8320**	0.1077[4]	0.0971	–0.0427	0.91	Yes
	(1.94)	(10.0)	(10.0)	(–1.71)	(1.12)	(0.99)	(–0.43)		
Finland	1.5085*	0.2786*	0.2533*	–0.7133*	–0.203*[2]	0.1513	0.2212	0.57	Yes
	(2.73)	(2.62)	(2.62)	(–2.01)	(–2.07)	(1.47)	(1.01)		
Sweden	2.6563*	0.1117*	0.1015*	–0.1493*	–	–0.1644	–0.1176	0.40	Yes
	(2.51)	(2.11)	(2.11)	(–1.99)		(–0.93)	(–0.68)		

Values within parentheses are t-rates.
*Means significant at the 5% level.
**Means significant at the 10% level.
Superscripts in time dummies: 1 refers to 1975, 2 to 1976, 3 to 1978, 4 to 1979, 5 to 1980, 6 to 1982, 7 to 1986 and 8 to 1988.

budget shares correspond to France and Spain. With respect to the time evolution, we note that all the countries, except for Greece and Spain, present a decreasing trend.

Moreover, the results derived from the estimation of the demand equation are in accordance with the model of rational addiction for all European smokers. Thus, we have observed the addictive character of tobacco consumption, deriving the positive effect that past consumption has on current consumption; secondly, we have noted that the addiction is not the result of myopic consumer behaviour, but rather of the maximization of total utility, implying that consumers consider the future effects of their current decisions.

Acknowledgements

The participants at the 12th Annual Conference of the European Society for Population Economics (Amsterdam, Holland), the 47th International Atlantic Economic Conference (Vienna, Austria), as well as an anonymous referee, have all provided very valuable comments and suggestions on an earlier version of this paper. The usual disclaimer applies.

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