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SILVIA TIEZZI

Addiction and Smoking Behaviour in Italy

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Abstract - Since the end of the eighties the Becker and Murphy model of rational addiction has been the dominant approach to estimate addiction e ects. The main implication of the model is that public policy, in principle, should not interfere with a fully rational behaviour. However, the additional public health care costs smokers impose on non smokers could be internalised using price mechanisms, as the long run price elasticity of demand is supposed to be, according to this model, significantly higher than the short run one and higher than that obtained from alternative models of addiction, such as the habit persistence model. In this paper we estimate the demand for Tobacco and related products in Italy using PANEL data supplied by ISTAT for the twenty Italian regions. The rational addiction model is used to estimate addiction e ects following the methodological approach suggested by Baltagi and Levin (2001). The myopic addiction model is also estimated as an alternative way of modelling addiction e ects. These data seem to support the rational addiction model, although the results are not clearcut. We have thus estimated the same models using Time Series of per-capita Households Tobacco expenditures from the Italian National Accounts. In this case, the data strongly support the Rational Addiction model and produce elasticities in line with similar case studies.

Keywords: Tobacco demand; rational addiction; habit persistence

JEL Classification: D12; C23

Silvia Tiezzi, Dipartimento di Economia Politica, Università degli Studi di Siena

1   Introduction

Since the end of the eighties the Becker and Murphy model of rational addiction has been the dominant approach to estimate addiction effects. A rational addictive consumer, a smoker for instance, is supposed to maximize over the life cycle a stable utility function and to be fully aware of the future consequences of his or her addiction and chooses to be an addicted because he or she evaluates the benefits of addiction to be greater than its full costs. It follows that public policy should not interfere with such fully rational behaviour. However, the additional public health care costs smokers impose on non smokers could be internalised using price mechanisms, as the long run price elasticity of demand is supposed to be significantly higher than the short run one and higher than elasticities obtained from the myopic model of addiction, for instance.

In this paper we try to estimate the demand for Tobacco in Italy using the myopic and the rational model of addiction. Previous Italian studies on Tobacco demand have been developed in the context of a demand system approach without trying to model the dynamics of Tobacco demand (Jones and Giannoni-Mazzi, 1996; Caiumi, 1992; Rizzi 2000; Rizzi-Balli 2002)[1].

We use a balanced panel of annual data on Tobacco and related products supplied by ISTAT from 1972 to 2000 for the twenty Italian regions and estimate a single equation model. The same exercise is carried out using time series of per-capita Households Tobacco expenditures from 1960 to 2002 also supplied by ISTAT. While with the first data set we do not obtain clearcut results, the second data set strongly supports the Becker model of addiction.

The paper is structured as follows. Economic theories of addiction are briefly summarised in paragraph 2 which also reviews empirical work on the rational addiction model. Paragraph 3 gives an outline of recent trends in smoking behaviour and smoking regulation in Italy. In paragraph 4 we present the results obtained from the panel data, whereas paragraph 5 shows results obtained when using time series. Paragraph 6 draws some final considerations.

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[1]an exception is Rizzi, 2000.

2 Theories of Addiction and Empirical Evidence

There is now a significant body of research on the demand for cigarettes and the effects of prices on Tobacco consumption. Two different groups of studies can be singled out: conventional studies on cigarettes demand and those that explicitly take into account the addictive nature of smoking (Chaloupka and Warner, 2000). Conventional studies on cigarettes demand estimate the effect of prices on consumption without taking into account the addictive nature of cigarettes consumption, i.e. they use static demand equations. According to a survey on the "Economics of Smoking" by Chaloupka and Warner (2000), the price elasticity estimates from recent studies of this kind fall within the range -0.14 to -1.23. In Italy conventional estimates of Tobacco demand, in the context of a demand system, that allows for substitution among goods after a change in the price of one of the goods, have been carried out by Jones and Giannoni-Mazzi (1996), Caiumi (1992), Rizzi (2000), Rizzi-Balli (2002). Jones and Giannoni-Mazzi (1996) estimate a static demand equation for Tobacco in the context of a demand system approach. The own price elasticity for Tobacco, evaluated at the sample mean is, on average, -0.33, in line with the study by Caiumi. Caiumi (1992) included Tobacco as a separate good in an extensive analysis of the demand for food, that follows a two-stages budgeting allocation mechanism, based on the linear AIDS model. She reports, for the year 1990, a non compensated, non conditional, direct price elasticity of demand for Tobacco of -0.34. Rizzi (2000) analyses the relationship between the structure of private final consumption expenditures in Italy and the recent demographic trends to see how changes in the age structure of the Italian population affect the level and the composition of final expenditures. He uses a QAIDS demand model that follows a 4 stages budgeting allocation process where the expenditure on Tobacco is decided at the first stage. He finds a mean (over the period 1961-1996) non compensated, non conditional, direct price elasticity of demand for Tobacco of -0.75. In this study the demand function also includes a dynamic effect due to habit formation. The habit formation coefficient for Tobacco is quite high and amounts to 0.595. Rizzi and Balli (2002) estimate short-run price elasticities of demand for a complete system of demand for non durables, including Tobacco, that incorporates the effects of demographic variables and rationing. Their mean monthly compensated direct price elasticity of demand for Tobacco (over the period 1985(1)-2001(6)) is -0.879. Table 1 summarises the main results of previous italian studies on Tobacco demand. Except for the habit formation effect included in the study by Rizzi (2000) we do not know of

other Italian studies that take into account the addictive nature of smoking.

Psychological studies of harmful addiction have introduced the three basic dimensions of: gradual adaptation (tolerance); irreversibility (withdrawal) and positive effects of habits (reinforcement) that are now part of the formal economic models of addictive behaviour. Tolerance means that a given level of consumption is less satisfying when past consumption has been greater. Withdrawal denotes the loss of satisfaction following consumption cessation. Reinforcement means that greater current consumption of a good causes its future consumption to rise (Grossman, 1995, p. 157). Starting from the end of the 50ies, most studies on cigarettes demand have explicitly addressed the addictive nature of smoking; this has led to the introduction of some sort of dynamics in the empirical specification. Economic models of addiction can be divided into three groups: imperfectly rational models of addictive behaviour; models of myopic addiction and rational addiction models (Chalopuka and Warner, 2000, p. 1556). Imperfectly rational addiction models assume stable but inconsistent short-run and long-run preferences. Chaloupka and Warner point out (2000, p. 1557) that, although these models foster interesting discussions of some aspects of addictive behaviour, they have not been applied empirically to cigarette smoking. In myopic addiction models individuals recognize the dependence of current consumption (of an addictive good) on past consumption, but ignore the impact of current and past choices on future consumption decisions when making current choices. Empirical application of myopic addiction models are based on the work of Houthakker and Taylor (1970) and Pollack (1970). In these works the stock of a commodity[2] has a positive impact on its current consumption in the presence of habit formation if the commodity is non durable. Current consumption positively depends on past consumption according to a fixed propensity to habituation or addiction. More recent examples of habit formation models for cigarette consumption are Baltagi and Levin (1986 and 1992). In these models, the lagged dependent variable has a habit interpretation as the speed of adjustment to the equilibrium level of consumption in a partial adjustment model (Cameron, 1998, p. 53). Other references for the application of this dynamic specification to cigarettes consumption can be found in the survey by Cameron (1998).

The rational addiction theory was formally developed by Becker and Murphy (1988) (B&M henceforth). Becker objected to the habit persistence or myopic model observing that rational individuals will notice that they have an addiction and will try to adjust

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[2]Or last period consumption, if we assume a 100% rate of decay for the stock of habits.

their intertemporal consumption trajectory in an optimal way. The Becker model of addiction assumes a stable lifetime utility function over time, perfect foresight, discounting of the future at the market interest rate and that smoking has no influence on future earnings. Becker's theoretical model gives rise to a linear difference demand equation in which current consumption of an addictive good positively depends, not only on past consumption, but also on the future expected consumption levels. An important implication of the model is that the long run price elasticity of demand for an addictive good should be higher than that obtained from the myopic model, as a rational addicts takes also into account his future behavior when facing current prices for the addictive good. This last point has very strong policy implications, because it means that, legalization of drugs use, for instance, and the following price fall, could cause a significant rise in the demand for those goods (Becker, Grossman and Murphy, 1994, BGM henceforth), if the price fall is not flanked by an appropriate dissuasive campaign; it also implies that an increase in the price of Tobacco, for instance, could lead to a significant fall in consumption in the long run, thus contradicting the common belief according to which the demand for addictive goods is not sensitive to price changes.

Another implication of the rational addiction model is that *announcements* of future price changes could strongly affect the demand for addictive goods, because smoking in different years are assumed to be complements.

In principle, one could choose between the two models (myopic and rational) through a test of the statistical significance of the coefficient on the lead consumption term and the plausibility of the implied discount rate. However results from the existing empirical literature are not clearcut.

2.1   Price Elasticities of Demand and Addiction Models

One implication of addiction models, in terms of their consequences for economic policy, is that the long run price elasticity of demand (LRE) exceeds the short run one (SRE) and also exceeds responses derived from a static demand function. Moreover, among addiction models, the long run response obtained from a rational addiction model is higher than the one obtained from myopic models.

2.1.1 Static Demand Functions

In a static demand function (where no addiction is considered) the short and long run price elasticities of demand coincide as the equilibrium adjustment to a price change is immediate. Given the linear demand function $C_t = \alpha + \theta_1 P_t + \eta_t$, where C_t is Tobacco consumption at time t, P_t is Tobacco price and η_t is the stochastic error term, the price elasticity of demand, calculated at the sample mean, is

$$LRE_S = SRE_S = \theta_1 \frac{\overline{P_t}}{\overline{C_t}}$$

2.1.2 Myopic Demand Functions

A myopic demand function for an addictive good follows a partial adjustment model where the lagged dependent variable represents a fixed propensity to addiction which is carried over from period to period and its coefficient can be interpreted as the speed of adjustment to the steady state level of consumption. In this case, following a price change, we would have an immediate reponse given by the impact multiplier, whereas the adjustment to the new steady state level of consumption will take place in more than one period. As a consequence, the long run multiplier (or equilibrium multiplier) will be greater than the short run one. Following Verbeek (2000, pp. 278-281) let C_t^* denote the optimal or desired level of C_t and assume that

$$C_t^* = \alpha + \theta_1 P_t + \eta_t \tag{1}$$

The actual value of C_t differs from C_t^* because adjustment to its optimal level corresponding to P_t is not immediate. The adjustment is only partial in the sense that $C_t - C_{t-1} = (1 - \gamma)(C_t^* - C_{t-1})$ where $0 < \gamma < 1$. Substitution gives:

$$C_t = \delta + \gamma C_{t-1} + \phi P_t + \epsilon_t \tag{2}$$

where: $\delta = (1 - \gamma)\alpha$; $\phi = (1 - \gamma)\theta_1$; $\epsilon_t = (1 - \gamma)\eta_t$

The short run price elasticity of demand, calculated at the sample mean, is thus:

$$SRE_M = \phi \frac{\overline{P_t}}{\overline{C_t}} = (1 - \gamma)\theta_1 \frac{\overline{P_t}}{\overline{C_t}}$$

The long run price elasticitiy of demand, obtained letting $C_t = C_{t-1}$ is, instead,

$$LRE_M = \frac{\phi}{(1 - \gamma)} \frac{\overline{P}}{\overline{C}} = \theta_1 \frac{\overline{P}}{\overline{C}}$$

so that for $\gamma < 1$, $LRE_M > SRE_M$.

The partial adjustment model is a special case of an Error Correction Model (ECM) which says that the change in C_t is due to the change in P_t plus an error correction term. Subtracting C_{t-1} from both sides of (2) and adding and subtracting from the RHS ϕP_{t-1} gives:

$$\Delta C_t = \phi \Delta P_t - (1 - \gamma) \left[C_{t-1} - \alpha - \theta_1 P_t - \eta_t \right] \tag{3}$$

This is an example of ECM where the change in C_t is due to the impact of a change in P_t, $\phi \Delta P_t$, plus the equilibrium error in square brackets. When the business cycle effect is $\phi \Delta P_t = 0$, the ECM gives exactly the partial adjustment model in (2). If $C_{t-1} > C^*$ the error correction term works to push C back towards its equilibrium level.

2.1.3 Rational Demand Functions

In the Rational Model of Addiction the short and the long run price elasticity of demand are obtained from the solution of the following second order linear non homogeneous difference equation that results from the intertemporal utility maximization problem of a rational addictive consumer with stable preferences over time (see BGM, appendix A for details):

$$C_t = \alpha + \theta C_{t-1} + \theta_1 P_t + \theta \beta C_{t+1} + \eta_t \tag{4}$$

where β is the discount factor $\frac{1}{1+\sigma}$ and σ is the rate of time preference assumed to be equal to the interest rate in the rational addiction model. The resulting elasticities, calculated at the sample mean, are:

$$SRE_R = \frac{dC_t}{dP_t} \frac{\overline{P}}{\overline{C}} = \left[\frac{2\theta_1}{1 - 2\theta\beta + \left[1 - 4\theta^2\beta \right]^{1/2}} \right] \frac{\overline{P}}{\overline{C}}$$

$$LRE_R = \frac{dC_\infty}{dP} \frac{\overline{P}}{\overline{C}} = \frac{\theta_1}{1 - \theta(1 + \beta)} \frac{\overline{P}}{\overline{C}}$$

In the rational addiction model the short run price elasticity of demand gives the percentage variation in the consumption of an addictive good in the first year after a

permanent change in the current price and all future prices, with past consumption held constant. The long run price elasticity gives, instead, the percentage change in consumption following a permanent price change in *all* time periods (Becker, Grossman and Murphy, 1991, p. 240).

In the rational addiction model $LRE_R > SRE_R$, but, from what has been said, it is also: $LRE_R > LRE_M > LRE_S$: the long run response is higher than the short run one and higher than long run responses obtained from alternative models of Tobacco demand.

2.2   Tests of the Rational Addiction Theory

Rational addiction is pausible when the data accept the hypothesis of forward looking behaviour, i.e. when the coefficient of the lead consumption term is positive and significant, and when the discount factor has a reasonable value. The results of some empirical tests of the rational addiction theory, however, cast doubts over the explicative power of model. Even when the coefficient of the lead consumption term has the right sign and magnitude, the discount rate, for instance, has unreasonable values in almost any case, although this is attributed by some (BGM and Baltagi and Griffin, 2001) to the type of data used. More specifically, according to Baltagi and Griffin (2001, p. 454) "...aggregate panel data do not seem likely to provide sharp estimates of the discount rate". Laux (2000, p. 428) claims that this result signals a failure of the rationality hypothesis. Should the consumers be rational with stable preferences in their smoking decisions, for instance, the discount rates revealed relative to addictive consumption should approximate those revealed in their saving or investment decisions. A gap between these two should be taken as either a signal of time inconsistency or of bounded rationality.

Further, the long run price elasticity of demand is greater than one, in absolute value (and the demand is thus elastic), only in a few cases, whereas in at least two cases, it has not been reported because its values turn out to be meaningless (Cameron, 1999 and Olekalns and Bardsley, 1996).

Lastly, there are at least a few cases (BGM, Grossman and Chaloupka, 1998, and Cameron, 1999) where the rational addiction model produces uncertain results and the data seem to fit the habit formation model better.

The first empirical tests of the rational addiction model have been produced by BGM and Chaloupka (1991). BGM estimate a linear demand function for cigarettes where current consumption depends on past consumption, on the actual value of future consumption of the addictive good, on the current price of cigarettes and on the unobservables

e_t and e_{t+1} that incorporates the impact on utility of unobserved variables that have an influence on the life cycle[3].

$$C_t = \theta C_{t-1} + \beta\theta C_{t+1} + \theta_1 P_t + \theta_2 e_t + \theta_3 e_{t+1} \qquad (5)$$

Instrumental Variables (IV) methods are often used to estimate this kind of model because of the endogeneity problem implied by the presence of the lagged and lead dependent variable among the regressors.

In BGM the coefficient associated to future cigarette consumption is positive and significant and the long run price elasticites of demand are, on average, -0,75. The estimated value of the discount factor[4] is implausible in all of the estimates produced[5]. On the other hand, the myopic model estimation produces consistent estimates for any instruments' set used. A similar data set is used by Baltagi and Griffin (2001) to estimate equation 5. They use two additional estimators: the Foward-Filter first difference 2SLS (FD2SLS) and the Generalised Method of Moments (GMM), besides the traditional FE2SLS, to overcome the econometric problems caused by the presence of predetermined or endogenous variables when using panel data. Baltagi and Griffin's results strongly support the Rational Addiction hypothesis. Chaloupka (1991) obtains coefficients for future consumption that are not always significant; the long run price elasticity of demand is rather low (-0,37 on average, for the full sample) and the discount factor is very high. Similar studies have been carried out by Keeler, Hu, Barnett and Manning (1993), Waters and Sloan (1995), Olekalns and Bardsley (1996), Duffy (1996), Grossman and Chaloupka (1998), Grossman, Chaloupka and Sirtalan (1998), Cameron (1997 e 1999), Labeaga (1999), Bask and Melkersson (2000), Escario and Molina (2001), Gruber and Köszegi (2001), Gardes and Starzec (2002) and Baltagi and Griffin (2002), among others. In many of them one gets evidence of forward looking behaviour, but the other results are not fully consistent with the theory. Gruber and Köszegi (2001) estimate a demand function where the demand for Tobacco depends on excise rates rather than prices. They notice that the assumption according to which consumers can forecast future prices a long

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[3]The e terms are arguments of the utility function and are an intrinsic part of the model. They are not to be confused with the u_t which is the stochastic error term to measure all omitted factors.

[4]In the Rational Addiction theory, the coefficients associated to past and future consumption are the same save for the discount factor $\beta = \frac{1}{1+\sigma}$ so that the intertemporal rate of time preference is $\sigma = \frac{1}{\beta} - 1$.

[5]BGM produce two instrumental variables estimates using two different sets of instruments: the first includes future prices and future taxes as instruments, the second one excludes them. Their preferred specification appears to be the latter. See pages 407 and following for details.

time in advance is rarely verified, whereas it is more likely that they will be informed well in advance of a future increase in the excise rates. Moreover, prices could be endogenous. It is often the case that these models include fixed-effects to capture the variability in demand due to structural differences among states included in the panel. However, it can be that these effects are not truly fixed in the long run and that a reduction in cigarettes consumption is wrongly attributed to price variations over time. If, for any reason, prices increase the most in those states where demand is decreasing the most, one can get to the wrong conclusion that future prices are correlated to current consumption[6]. Gruber and Köszegi (2001) analyse smoking behaviour in the time intervals between the announcement of a variation in excise rates on cigarettes and the time when the new excise rate becomes effective. Thus only announced variations in excises are taken into account. They obtain strong evidence of forward looking behaviour. The coefficients associated to past and future excise rates are positive and significant[7].

Despite the high number of empirical tests realised so far, making comparisons is very hard due to the heterogeneity of the works relative to data (individual or aggregated, time series, cross section or panel) and estimators used. Even when the estimator used is the same, for instance 2SLS, the results seem to change dramatically according to the instruments' set used. In the first exercise we carry out we replicate the empirical strategy followed by Baltagi and Griffin (2001). This should allow direct comparisons of our results to theirs. Moreover, Baltagi and Griffin adopt consistent and efficient estimators capable of dealing with the econometric problems faced when using panel data in presence of endogenous or predetermined variables.

3   Smoking behaviour in Italy

Italy is, according to recent OECD data (2002), one of the OECD countries with a very high percentage of daily smokers over the population. According to the Italian National Statistical Office (ISTAT, 2002b) in the year 2000 smokers in Italy were 12.330.000, about 24,9% of the population over 14 years of age. Among those, the abitual smokers (those that smoke every day) are about 22,9%, whereas heavy smokers (those declaring to smoke

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[6]The most widely used example in the literature is that of a State monopolist who faces a decreasing demand and thus decides to rise the prices in order to keep fiscal revenues constant. In this case, using prices as regressors would lead to the wrong conclusion that smokers are forward looking.

[7]The values associated to C_{t+1} for Gruber and Köszegi correspond to past and future excise rates and not to past and future consumption, as for the other empirical works under consideration, becasue the authors choose a different empirical strategy to test for forward looking behaviour.

more than 20 cigarettes per day) are about 40,9%. Smoking in Italy is highly influenced by sex, age, location and the level of education attained. There are more male smokers than females (32% of males smoke against about 18% of females). The highest share of smokers is registered in the North-West and in Central Italy (26,2%), followed by the Islands (24,5%), the South (23,8%) and the North-East (23,5%). Smoking is more widespread in urban areas and the share of smokers seems to decrease as we go from big to small towns. The smoking habit also appears to be strictly linked to schooling, but with different impacts according to the gender. Among males, the number of smokers is negatively related to the number of years of education. Among women, the relationship between smoking and the educational level varies with age. Young women (aged 25 to 44) exhibit a negative relationship between smoking and the educational level. Elder women (aged more than 65) show a positive relationship between the smoking habit and the level of education.

Precocious smokers (those who start smoking before reaching 14 years of age) are more frequent among men: 6,9% of male smokers are precocious smokers against 3,4% of women. Among women, the share of precocious smokers decreases with age: precocious smokers are 7,3% of young female smokers; 4% among female smokers aged 25 to 44 and 1,5% of elder female smokers. Men show an opposite relationship between precocious smoking and age.

A relevant health risk factor is the daily amount of Tobacco smoked. The majority of Italian smokers (91,9%) declares to smoke daily, i.e. to be an abitual smoker (Lega Italiana per la Lotta contro i Tumori, 2002). Among daily smokers we can distinguish between: heavy smokers (more than 20 cigarettes per day) which account for 40,9% of daily smokers; mean smokers (10 to 20 cigarettes per day) which are 40,1% of daily smokers and moderate smokers (1 to 9 cigarettes per day), about 19% of daily smokers. Heavy smokers are concentrated in Southern Italy and the Islands (46,2% in the South and 45,2% in the Islands).

In Italy, in the year 2000, 22,2% of young people aged 14 to 24 (about 1.600.000 people) have declared to smoke. Young smokers are concentrated in Northern and Central Italy. 80,5% of young smokers have begun smoking between 14 and 18. The smoking habit of the parents is believed to affect heavily the smoking habit of the children: only 17,1% of children with non-smoking parents are smokers. The smoking behaviour of the mother seems to affect more heavily the smoking attitude of the children: 31,3% of smoking children have the mother as the only smoking parent, against 22,2% of cases where the

father is the only smoking parent.

Second hand smokers (i.e. non smokers that live with at least one smoker and are therefore exposed to smoke) in Italy are about 12.500.000. Three quarters of them (73,1%) live with one smoker and 23,4% is exposed to two smokers. Among second hand smokers the children are more than 4 millions; 1.552.000 of them is less than 6 years old; 2.405.000 is aged between 6 and 13. About half of the children aged between 0 and 13 lives with at least one smoker (Lega Italiana per la Lotta contro i Tumori, 2002).

3.1 Tobacco consumption

According to ISTAT data (2002a), households expenditure on Tobacco, at constant 1995 prices, has grown between 1982 and 1986 from 20.627 billions Lire to 21.361 billions Lire and has decreased steadily between 1987 and 1995 from 19.923 billions Lire to 17.935 billions Lire. Since then aggregate households expenditure on Tobacco has almost remained stable (up to 1999) at 18.000 billions Lire. However, this decrease is likely to be due, at least partly, to the rapid increase in cigarette smuggling, estimated to have grown by about 800% between 1985 and 1993 and to account for about 13% of all cigarettes consumed.

3.2 Tobacco Control Measures

The advertisement of Tobacco products has been banned in Italy since 1962 (L. 10 April 1962 n. 165). A 1991 decree (D.M. 30 November 1991 n. 425) has implemented an E.U. directive on television advertising and prohibits both direct and indirect advertising of Tobacco products on television. This decree includes a ban on television sponsorship. A sentence of the European Court of Justice of 5 October 2000 has repealed the E.U. Directive 98/43 aimed at banning all advertising and sponsorship of Tobacco products, although this measure does not interfere with related laws implemented by member countries.

Smoking is banned in the following areas (L. 11 November 1975 n. 584): hospital wards, school classrooms, closed premises used for public meetings, cinemas and theatres, museums, libraries and reading rooms open to the public, art galleries open to the public. The D.M. 18 May 1976 has extended the ban to public administration areas open to the public and to Universities, and the D.P.R. 11 July 1980 n. 753 has further extended it to train coaches and waiting rooms. The circular of the Ministry of Health dated 28 March

2001 n. 4 furtherly widens the number of areas where smoking is banned.

As to working environments, the D.P.R. 19 March 1956 n. 303 bounds employers to guarantee their employees a sufficient supply of clean air at the work place even with the help of purifying plants. The D.Lgs. 19 September 1994 n. 626 compels employers to adopt any precautionary measures to preserve employees from health or safety risks related to their working environment. Finally the Constitutional Court sentence of 20 December 1996 n. 399 establishes a link between the D.Legs. 626 and smoking behaviour: the employer must adopt any precautionary measure to avoid health damages arising to employees from second hand smoking. Since 26 June 2002 the D.Legs 626 has been further reinforced by the inclusion of second hand smoke among carcinogenic substances that cause health risks in working environments. Moreover, Tobacco smoke has been included among those substances from which employees should be preserved in their working environment.

A new ban on smoking in public places has been recently approved by the Italian Parliament with the Law of 16 January 2003 n. 3, which forbids smoking in every public place including bars and restaurants. Transgressors can be charged with a fine of up to 2000 Euros and local authorities can introduce inspectors in charge of monitoring the enforcement of the Law. The Law will come into force after one and a half years since its publication in the Official Gazette.

This overview of the Italian smoking regulation reveals that public policy strongly relies on command and control measures, rather than on economic incentives, to affect smoking behaviour. More specifically, there seems to be an attempt at associating smoking behaviour with some kind of social discomfort. It is true that the financial law approved for the year 2003 (L. 27 December 2002 n. 289) has introduced increases in the excise rates on cigarettes, but this measure is justified on revenues' grounds, as a source of additional public revenues to finance research, which relies on a supposed unelastic demand response to Tobacco price changes. When public health is at stake, the preferred economic policy measure is regulation, as it has been just shown. This observation seems to point out that individual smoking behaviour in Italy is believed to be rather insensitive to price changes. Should this not be the case a stronger reliance on price mechanisms that affect smoking behaviour could perhaps be observed.

Tobacco control measures in Italy

Bans on smoking

- L. 584-1975: it bans smoking in hospital wards, school classrooms, cinemas and theatres
libraries and reading rooms, art galleries;
- D.M. 18 May 1976: the ban is extended to public administration areas and Universities;
- D.P.R. 753-1980: it further extends the ban on smoking to train coaches and waiting rooms;
- L. 3-2003: it forbids smoking in every public place including bars and restaurants;

Advertising

- L. 165-1962: ban on advertising of Tobacco products;
- D.M. 425-1991: ban on both direct and indirect advertising and sponsorship of Tobacco products on television;

Work place

- D.P.R. 303-1956: employers must guarantee a sufficient supply of clean air at the work place;
- D.L. 626-1994: employers must preserve employees from health or safety risks related to working environments;
- C.C.S. 399-1996: employers must avoid health damages arising to employees from second hand smoking;
- T.A.R. sentence 723-1997: it establishes a direct link between some pathologies onset and second hand smoking;

4 Estimating Tobacco Demand with Panel Data

4.1 Data

To estimate the demand model we use annual data from 1972 to 2000 on Tobacco sales from the State Monopoly supplied by ISTAT, the Italian National Statistical Institute, for the twenty Italian regions. The data made available in this Survey include the quantity (in quintals) of Tobacco products, both national and non national, sold by the State Monopoly to the retailers in each region; the quantity of non national Tobacco products sold; the revenues of the State Monopoly in Lire and the average per-capita expenditure in Lire. The Tobacco products included are: cigarettes, cigars, smoking Tobacco, snuff and cut Tobacco.

Additional variables used are: final consumption expenditures (including expenditure in durable goods) of Italian families, per region, supplied by ISTAT, as a proxy of disposable income; the total regional population calculated in the middle of each year; the regional polulation aged 14 or more, calculated in the middle of each year, and the

quantity of foreign Tobacco consumption, in inverse ratio, used as a proxy of smuggling Tobacco. Finally, we use a regional consumer price index (CPI) normalised in 1995, also supplied by ISTAT.

The real per-capita sales of Tobacco (quantity per head per year) to a person of 14 years or older is our dependent variable, $C_{i,t}$, where $i = 1, .., 20$ denotes the Italian region and $t = 1972, .., 2000$ denotes the year. To take account of differences in the consumption profile across regions we have also introduced dummy variables, $N1 - N20$, associated to the regions. Inclusion of an intercept term brings to the exclusion of one space dummy to avoid the dummy variable trap.

Our pseudo panel covers 20 regions over 29 years; we thus have 580 observations (29 years times 20 regions) for each variable. These data can be organised in two different ways. If r is the region and t the year considered, one way is to line up annual data (y=1-29) on each region (r=1-20) so that the slowest varying index is the space dimension. This is the so called "pooled" data format used, in general, when we assume that observations are independent across both the time and the space dimension. When using complex lag structures or the GMM estimator, the "panel" data format is used, where we have the data one observation per region. In this case, we will line up observations on each region (r=1-20) for each year (y=1-29) so that the slowest varying index is the time dimension[8].

A summary of variables definitions, means and standard deviations of the main variables is presented in table 2.

4.2   Estimation

We estimate the following model:

$$C_{i,t} = \alpha + \beta_1 C_{i,t-1} + \beta_2 P_{i,t} + \beta_3 C_{i,t+1} + \beta_4 Y_{i,t} + \beta_5 FC_{i,t} + u_{i,t} \tag{6}$$

with $i = 1, .., 20$; $t = 1, .., 29$ and where:

$C_{i,t}$ is the real per-capita sales of Tobacco of individual i (aged 14 or older), in year t, expressed in kg per person; $P_{i,t}$ is the real price of Tobacco at time t in region i deflated by the CPI; $Y_{i,t}$ is the real per-capita final consumption expenditure used as a proxy of disposable income and $FC_{i,t}$ is the per-capita consumption of foreign Tobacco, in inverse ratio, of a person i (aged 14 or older), in year t, expressed in Kg per person.

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[8] See TSP 4.5 user's guide, chapter 15, for details.

The disturbance term $u_{i,t}$ is specified as a one-way error-component model: $u_{i,t} = \mu_i + v_{i,t}$, where the μ_i denotes the region specific effect that captures all those aspects that are not considered explicitly as explanatory variables in the model and $v_{i,t}$ is a remainder disturbance. The regional effects can be assumed either fixed or random. The OLS estimator produces consistent estimates of the coefficients and of their standard errors only when the regressors in equation (6) are exogenous and the error term is homoscedastic and serially uncorrelated. When the error terms are correlated across time for each spatial unit the OLS estimator produces consistent but inefficient estimates of the parameters of interest. In this case one can use the methodology proposed by Balestra and Nerlove and known as the Random Effects (RE) estimator. This implies quasi-demeaning of the equation to be estimated so that the possibility of correlation across time of the error term is phased out and the parameters' estimates are both consistent and efficient, provided that the individual effect is random with respect to the observed explanatory variables. However, when the individual effect is correlated with the explanatory variables the OLS nor the RE estimators produce consistent estimates. In this case, as long as the regressors are strictly exogenous with respect to the time varying error component, consistent parameters estimates can be obtained by taking individual deviations from individual means, which leads to interpreting the individual effects as individual constants. This is called the Fixed Effects estimator (FE). The FE or *within* model assumes that there are common slopes, but each cross section unit has its own intercept term modeled introducing dummy variables. What distinguishes the RE from the FE model is that the time-invariant region specific effect μ_i is uncorrelated with the explanatory variables in the RE model, whereas it is correlated with the explanatory variables in the FE model.

These estimators are valid when the regressors are stictly exogenous, but when some of the regressors could be endogenous, as in our case, 2SLS and an appropriate set of instruments should be used, i.e instruments that are uncorrelated with the time varying error component. In our case, prices and income could be used as instruments. If P_t is uncorrelated with u_t for all t, then, in principle, all prices could be used as instruments for each time period exploiting the numerous orthogonality conditions between P_t and u_t. With the FE and RE estimator this implies that a very strict exogeneity condition must hold, i.e. that the time varying error component is uncorrelated with the instruments used *for all time periods considered*. Unfortunately there are many cases in which such a strict exogeneity condition does not hold. If the set of instruments we want to

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use is predetermined, but not strictly exogenous, as in our case, equation 6 cannot be estimated using FE2SLS[9], because the FE2SLS will be inefficient unless T (the number of time periods) tends to infinity. To overcome this problem one may use transformations of the regression equation that leave predetermined variables valid as instruments. This is the methodology followed by Arellano and Bond (1991) that prescribed a GMM estimator. This estimator utilizes the orthogonality conditions that exist between the lagged values of the dependent variable and the error term in a dynamic panel data model. In this case one first differences the equation to be estimated. The GMM estimator is then obtained by performing generalised least squares (GLS) on the differenced equation, after pre-multiplying it by W', where W is a block diagonal matrix with $[P_{i,1}, P_{i,2}, ..., P_{i,T}]$ in each block. An alternative estimator is the one suggested by Keane e Runkle (1992) who describe a forward-filtering transformation that also leaves predetermined variables as valid instruments. This estimator, like the GMM estimator, produces both consistent and efficient estimates of the parameters of interest. It is based on insights obtained by applying time series models to panel data. If a time series equation has serially correlated errors and predetermined instruments, serial correlation can be eliminated by a transformation that makes the transformed dependent variable for time t a linear combination of the values of the original dependent variable for time periods t and later (Keane and Runkle, 1992, p. 4). This transformation preserves the orthogonality conditions implied by the time series model and yields consistent and potentially more efficient estimates of the parameters.

4.3   Results

For our empirical implementation we estimate equation (6) where Tobacco consumption at time t depends on its price, on the lagged and lead consumption, on disposable income, on a proxy of smuggling and where the error term is modeled as a one-way error component. The PANEL procedure in TSP4.5 produces OLS as well as Fixed-Effects and Random Effects estimates, allowing to choose between the last two. The results are shown in table 3. All standard errors are heteroskedastic-consistent. We then perform instrumental variables estimation using two sets of instruments: the first uses P_t, Y_t, FC_t and two lags of them, as well as the regional dummies; the second set of instruments

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[9]A variable $x_{i,t}$ is said to be strictly exogenous if $E[x_{i,t}\epsilon_{i,s}] = 0$ for all t and s. If $E[x_{i,t}\epsilon_{i,s}] \neq 0$ for $s < t$ but $E[x_{i,t}\epsilon_{i,s}] = 0$ for $s \geq t$ the variable is said to be predetermined. Intuitively, if the error term at time t has some feedback on the subsequent realizations of x then $x_{i,t}$ is a predetermined variable.

adds future prices (P_{t+1} P_{t+2}). The results are printed in table 4. When using the OLS estimator, both the lagged and lead consumption term are positive and statistically significant, but the lead consumption term coefficient is slightly higher than the lagged one giving rise to a negative discount rate. The price coefficient is also negative and statistically significant. A Hausman test for the choice between the FE and the RE estimator accepts the null that the RE model is the one that better captures the relation between the explanatory variables and the individual effects. The parameters' values are very similar in the three cases.

Estimating equation (6) using Fixed Effects Two Stages Least Squares (FE2SLS), produces statistically significant results for all the variables except for the lagged consumption term (table 4, panel A) which also takes a negative sign. Moreover, the lead consumption term coefficient becomes much larger than the lagged one, thus contradicting the theory. The set of instruments used at the first stage includes: the regional dummies, two lags of prices, income and the proxy of smuggling plus their levels. When two leads of the price are included in the instruments' set, the results do not change much except for the lagged consumption coefficient which now takes a positive sign (table 4, panel B)[10].

The FE2SLS results give rise to a negative interest rate, but we can calculate the price elasticities of demand at the sample mean. Their values are -0.43 for the short run elasticity and -0.45 for the long run one.

Parameters' estimates produced by the GMM estimator are all statistically significant and have the right sign, both when the price lead is excluded from the instruments' set and when it is included. However, the lead consumption coefficient is slightly larger than the lagged consumption coefficient and the price elasticities of demand calculated at the sample mean are exceedingly high.

As to the Forward-Filter First Difference 2SLS Estimator, when the future price is included in the instruments and when using instruments in first differences (table 4, panel B) all the coefficients have the right sign and are statistically significant. However, the

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[10]BGM (1994) found that excluding the lead price of the dependent variable from the set of instruments led to negative interest rates and also that future prices were not legitimate instruments. Nevertheless they opted for the inclusion of this variable in the set of instruments. They justify this choice on several grounds. First of all, excluding this variable may lead to poor instrumentation; moreover, consumers may have relevant information to forecast future cigarette prices: if a tax increase is announced in advance, consumers may anticipate the price change well in advance. Moreover, they found that models that use future prices as instruments are much less sensitive to changes in the specification of the structural demand equation than those that exclude these instruments (BGM, p. 409).

lead consumption term is higher than the lagged one. Even in this case, however, we are unable to obtain sensible price elasticities of demand. These results do not change much when we use instruments in levels.

This first set of results allows us to make some considerations. In the OLS, FE and the RE models, both consumption coefficients are statistically significant and have the right sign, but the lead consumption coefficient is slightly higher than the lagged one. When using consistent and efficient estimators (table 4) and when the price leads are included in the instruments' set, the lead and lagged consumption coefficients are always significant, but even in this case the lead consumption term is higher than the lagged one giving rise to a negative interest rate. The lead consumption term coefficient is positive and significant in all cases. Therefore we cannot accept the null hypothesis that the lead consumption variable's coefficient is zero, implying that the representative consumer behind our data is forward looking. However, the results are not fully consistent with the theory, because we do not obtain reasonable values for the subjective rate of time preference. We can calculate price elasticities of demand only in one case and the long run price elasticity of demand is slightly higher (in absolute value) than the short run one. Baltagi and Griffin (2001, p. 454) suggest that before the rational addiction model can be widely accepted plausible and reasonable estimates of the implied discount rate are needed. They also suggest that the implausible discount rates may be obtained due to the use of aggregate rather than individual data and that the use of microdata seems the most promising approach. This first set of results does not allow a clear acceptance of the theory, although we do reject the null hypothesis that the lead consumption coefficient is zero. We believe that this outcome is not to be attributed to methodological pitfalls, but rather to the poor informative content of the data. The idea that our data reflect the consumer's choice does not seem fully convincing, as our dependent variable is the quantity sold by the State Monopoly to the tobacconists. Therefore it does not reflect the true Tobacco demand which is the result of an individual maximization process, but simply what the retailers consider to be the likely future Tobacco demand they will face.

4.4   Estimate of the Myopic demand function

Non-rational or myopic models of addiction fail to consider the impact of future consumption on current consumption, i.e. they are entirely backward looking. Current consumption depends only on current price, lagged consumption, disposable income and current events. The pioneering empirical work is by Houthakker and Taylor (1970) who

estimated single equation dynamic demand functions for many goods including Tobacco. The source of dynamic behaviour is the stock of habits: $S_t = (1 - \delta)S_{t-1} + C_t$ where δ is the rate at which habits decay. Assuming a 100% rate of decay ($\delta = 1$) of the stock of habits produces a linear equation to be estimated of the form:

$$C_{i,t} = \alpha + \beta_1 C_{i,t-1} + \beta_2 P_{i,t} + \beta_3 Y_{i,t} + FC_{i,t} + u_{i,t} \tag{7}$$

where the subscript i denotes the ith region

($i = 1, .., 20$) and the subscript t denotes the time.

The coefficient on the lagged dependent variable, in this restricted model, can also be interpreted as the speed of adjustment to the steady state level of consumption in a partial adjustment model, as Baltagi and Levin (1986 and 1992) for instance do. However Cameron (1998, p. 53) finds that the habit persistence interpretation of the coefficient on the lagged dependent variable is more plausible than the adjustment costs interpretation (underlying the partial adjustment model) when the good in question is an addictive good.

The partial adjustment model can be estimated by OLS, because it assumes that the lagged dependent variable can be treated as given, that is, as being uncorrelated with the equations' error terms. In this case OLS estimation is consistent (Verbeek, 2000, p. 280).

Table 5 shows the results obtained from estimation of the myopic model of addiction. The lagged consumption term is statistically significant and has the right sign. However, the price coefficient takes a positive sign. The Hausman test supports the Fixed Effects model, but even in this case, the price coefficient has a positive sign.

5   Estimating Tobacco Demand with Time Series

5.1   Data

In this paragraph we estimate the rational addiction model using times series rather than panel data. We use annual aggregate data on households final consumption expenditure on Tobacco products from 1960 to 2002 which have been obtained from the ISTAT Italian National Accounts. Additional variables used are: the consumer price index (IPC) excluding Tobacco; the Tobacco price is a price index obtained by dividing the index of Tobacco price normalised in 1995 by the CPI normalised in 1995; the total population

calculated in the middle of each year and population aged 14 or older calculated in the middle of each year[11].

The real per capita expenditure of Tobacco and related products (of persons aged 14 or older) is our dependent variable. We estimate the pure Becker model of rational addiction where current Tobacco consumption depends on consumption at time $t-1$ and $t+1$ and on the real price at time t and on a constant term. The equation to be estimated is thus:

$$C_t = \alpha + \beta_1 C_{t-1} + \beta_2 C_{t+1} + \beta_3 P_t + u_t \tag{8}$$

This equation is estimated with OLS as well as with 2SLS to take account of the endogeneity problem highlighted in paragraph 2.2.

5.2   Results

The results of this second attempt are shown in table 6. In the OLS case the lead and lagged consumption coefficients are both positive and higly significant although the lead consumption term is slightly higher that the lagged one. The price coefficient has a negative sign, as expected, but it is not significant. When equation (8) is estimated using 2SLS all the coefficients are statistically significant. The lead consumption coefficient is smaller than the lagged consumption coefficient, as suggested by the theory, giving rise to a positive rate of time preference. All standard errors are heteroscedastic consistent. The instruments' set used at the first stage includes two lags and two leads of the price, besides the current price and the constant. Figure 1 shows actual and fitted values of the index of per capita Tobacco expenditure normalised in 1995. Per capita Tobacco expenditure has been growing steadily from 1960 to 1980 and has remained stable at 1980 levels until about 1985. From 1985 till about 1995 it has decreased going back to 1975 levels, while since 1995 it shows a new increasing trend, despite the strict regulation on smoking implemented recently in Italy.

Table 7 shows, instead, short and long run price elasticities of demand for Tobacco and the rate of time preference calculated from the 2SLS estimates of the rational addiction model. Elasticities are calculated at the mean point of each decade under consideration. Consistently with the theory, the short run price elasticity of demand is always lower

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[11]The population time series has been supplied by prof. Petrioli of the University of Siena.

than the long run one. The long run price elasticity of demand is greater than one only during the first decade and approximates one over the last decade under consideration. From 1972 to 1995 it is rather low ranging from -0.66 to -0.87. According to the rational addiction model, the marginal utility of income is a multiplying factor in the current price coefficient (Escario and Molina, 2001, p. 213), so that an increase in the marginal utility of income will produce a greater increase in the price coefficient. This implies that rich people, who possess a lower marginal utility of income, will be less sensitive to price changes than people with lower income and a higher marginal utility of income.

Figure 2 shows the short and long run price elasticities of demand obtained from the rational addiction model over time. The demand for Tobacco product appears to be highly sensitive to price changes over the sixties and the seventies, when the mean level of income in Italy was lower, than during the eighties for instance. From 1980 to 1990 both elasticities remain almost stable to rather low levels consistently with a higher, on average, level of income in those years. The LRE starts to increase again from 1992 onward, which coincides with a period of austerity and restrictive economic policy in Italy. The evolution over time of price elasticities of demand seems thus to be consistent with the predictions of the rational addiction model.

5.3 Simulating a Price Change

As a last exercise we have simulated the effects on consumption of permanent price changes over the period 2003-2010. We assume three different scenarios: a) the real price of Tobacco is only slightly increasing at the rate of 1% per year during the period 2003-2010; b) the price is increasing at the rate of 5% per year; c) the price is increasing at the rate of 10% per year. Time series used to estimate equation (8) are determined endogenously as follows. We fit C_t with OLS from 1962 to 2000 using two leads and two lags of the prices, besides the constant, as regressors:

$$C_t = \alpha_0 + \alpha_1 P_{t-2} + \alpha_2 P_{t-1} + \alpha_3 P_t + \alpha_4 P_{t+1} + \alpha_5 P_{t+2} + u_t$$

For the years 2001-2008, C_t is generated using as prices those simulated according to the three hypothetical scenarios described above. The values of C_t thus estimated are used, in place of the effective values, to estimate the rational addiction equation (8) from 1962 to 2008. This procedure implies that Tobacco demand ad each time period is simulated dinamically taking into account the available information on past and future prices. This seems more consistent with the theory than the common practice adopted in

empirical works on rational addiction of using effective values of C_t to estimate equation (8). The results of the simulation are shown in figure 3: the variable C represents actual values of Tobacco demand, whereas $C1$, $C2$ and $C3$ are the values of Tobacco demand simulated dinamically and where different price scenarios for the years 2001-2007 are assumed.

The effect of expected permanent price changes over a number of years appears to be rather strong. When an increase of 10% per year in the price of Tobacco is assumed, the level of per capita Tobacco expenditure goes back to levels preceding 1960. Even when smaller annual price increases are assumed, the curb in Tobacco demand appears to be relevant. The strongest implication of the rational addiction model is therefore that announcements of future price increases could achieve large demand decreases because smokers take the future into account when making their own current smoking decisions.

6   Final considerations

In this paper we test the Rational Model of Addiction on Italian data to see whether the idea of rationality in addiction is supported in Italy as it is, for instance, in the United States. Previous works of this kind have been carried out in Europe only in Spain (Escario and Molina, 2001) and in Greece (Cameron, 1997). The model is tested on panel data as well as on time series. When dealing with Panel data efficient and consistent estimators (as suggested by Baltagy and Griffin, 2001) are used to overcome the econometric problems faced in presence of endogenous or predetermined variables.

A first set of estimates, based on panel data, seems to support the rational addiction model, but the results are not clearcut. On one hand the coefficient on the lead consumption term is almost always positive and significant implying that the representative consumer behind our data is actually "forward looking". As a consequence, the long run price elasticity of demand should be higher than those obtained from alternative models of addiction and price mechanisms could be used more extensively to curb Tobacco consumption as they turn out to be effective means of reducing demand. On the other hand, however, the lead consumption term is often considerably higher than the lagged one giving rise to a negative discount rate and the value obtained for both coeffcents leads to meaningless elasticities of demand, except for one case. As already pointed out by Baltagi and Griffin (2001 p. 454) we feel that the rational addiction model may represent a significant improvement over models of myopic addiction. However plausible and sta-

tistically significant estimates of the implied discount rate and of the relevant elasticites are needed. We feel that these results can be attributed to the quality of the data used. Aggregate data, like those we use, do not seem likely to provide sharp estimates of the discount rate. Also the idea that these data should reflect the consumer's choice does not seem convincing, as our dependent variable is the quantity of Tobacco products sold by the State Monopoly to the tobacconists. Therefore it does not reflect the true Tobacco demand which is the result of an individual maximization process, but simply what the retailers consider to be the likely future Tobacco demand they will face.

In a second attempt at estimating the rational addiction model we use time series on per capita households expenditures on Tobacco products from 1960 to 2002 taken from the National Accounts. In this case the data strongly support the rational addiction model. The long run price elasticity of demand is in the range -1.95 (during the 1962-1971 decade) to -0.58 (during the 1982-1991 decade); the rate of time preference is about 23%. A simulation exercise is also carried out with these data. Three different hypothesis of price changes over the period 2003-2010 are introduced and Tobacco demand is endougenously determined through a dynamic simulation that uses past and future prices to determine Tobacco demand. The demand for Tobacco appears to be very sensitive to future price changes. *Announcements* of future permanent price changes seems to be an effective means of modifying smoking behaviour.

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Table 1: Price Elasticity of Demand for Tobacco from previous Italian Studies

Study	Elasticity type	Elasticity value
Caiumi (1992)	long run	-0.34
Jones-Giannoni Mazzi (1996)	long run	-0.33
Rizzi (2000)	long run	-0.75
Rizzi-Balli (2002)	short run	-0.88
	long run	-1.26

Table 2: Definitions, Means (M) and Standard Deviations (SD) of Variables

Variable	Definition, mean (M), Standard Deviation (SD)
$C_t = (TB/POP14)100$	Per capita (of persons aged 14 or older) Tobacco consumption per year in Kg per person (M=2.067, SD=0.338)
$P_t = (RIC/IPR)/TB$	Real price of national and foreign Tobacco expressed in Millions Lire per quintals (M=0.605, SD=0.346)
$Y_t = 1000(YD/IPR)/POP14$	Real per capita disposable income per year expressed in Millions Lire per capita (M=29850, SD=37495)
$CET_t = 1/TBE_t$	Aggregate Quantity Foreign Tobacco (in Quintals), in inverse ratio, as a proxy of smuggling (M=0.0002, SD=0.0004)
TB_t	Quantity of national + foreign Tobacco products sold by the State Monopoly to retailers (in quintals) per year (M=47692.51; SD=37406.703)
RIC_t	Proceeds of the State Monopoly from sales to the retailers (in Millions Lire) per year (M=448033.157; SD=543277.420)
YD_t	Households' final consumption expenditure per year used as a proxy of disposable income (in Billions Lire) (M=29850.430; SD=37495.442)
$POP14$	Population aged 14 or older calculated in the middle of each year
IPR	Regional consumer price index (1995=100)
TBE_t	Quantity of Foreign Tobacco products sold by the State Monopoly to retailers (in quintals) per year (M=20186.035; SD=18274.89)

Table 3: Estimates of the Rational Addiction Model
Dependent variable C_t (t-statistics in parentheses)

	$C_{i,t-1}$	$C_{i,t+1}$	$P_{i,t}$	$Y_{i,t}$	$FC_{i,t}$	Constant	R^2
OLS	0.497	0.501	-0.003	0.000	-1.067	0.030	0.98
	(25.56)	(28.00)	(-2.077)	(0.940)	(-0.145)	(1.159)	
Fixed-Effects	0.494	0.494	-0.003	0.000	-0.263	-	0.98
	(23.05)	(23.86)	(-1.708)	(0.219)	(-0.018)		
	F(19,515)=0.0916						
	p-value(1.000)						
Random-Effects	0.497	0.501	-0.003	0.000	1.105	0.023	0.98
	(25.62)	(28.41)	(-2.080)	(0.932)	(0.146)	(1.170)	
	Hausman Test						
	$\chi^2(5) = 0.700$						
	p-value(0.983)						

Number of observations:540

Table 4: Estimates of the Rational Addiction Model
Dependent variable C_t (t-statistics in parentheses)

	$C_{i,t-1}$	$C_{i,t+1}$	$P_{i,t}$	$Y_{i,t}$	$FC_{i,t}$	R^2	r	SRE	LRE
A. Future price excluded from the instruments									
1. FE2SLS	-0.146	0.918	-0.025	0.011	-112.6	0.94			
	(-1.111)	(6.828)	(-3.437)	(2.726)	(-1.845)				
2a. FD2SLS-KR*	0.372	0.653	-0.035	0.027	-11.69	0.99			
	(21.09)	(20.99)	(-8.182)	(6.941)	(1.376)				
2b.FD2SLS-KR**	0.386	0.628	-0.034	0.027	7.591	0.99			
	(47.10)	(26.27)	(-11.95)	(11.12)	(1.027)				
GMM	0.439	0.509	-0.006	0.001	-2.132				
	(584.8)	(846.9)	(-226.5)	(64.67)	(-3.206)				
B. Future price included in the instruments									
1. FE2SLS	0.057	0.553	-0.023	0.002	-144.2	0.95	-0.44	-0.43	-0.45
	(0.443)	(4.631)	(-3.754)	(0.565)	(-2.324)		(-1.920)	(-4.103)	(-6.684)
2a. FD2SLS-KR*	0.384	0.647	-0.033	0.025	7.954	0.99			
	(38.94)	(20.14)	(-9.429)	(6.877)	(0.898)				
2b.FD2SLS-KR**	0.391	0.627	-0.034	0.027	5.668	0.99			
	(67.76)	(25.21)	(-11.88)	(10.70)	(0.748)				
GMM	0.453	0.498	-0.005	0.000	-11.49				
	(729.3)	(1058)	(-225.1)	(25.10)	(-24.28)				

Note: regional dummies are included in all models, but their estimates are not reported to save space.
* Instruments in levels; ** Instruments in first differences to account for possible integrated processes;
standard errors are heteroskedastic consistent.

Table 5: Estimates of the Myopic Model.
Dependent variable C_t (t-statistics in parentheses)

	$C_{i,t-1}$	$P_{i,t}$	$Y_{i,t}$	$FC_{i,t}$	Constant	R^2
OLS	0.979	0.003	-0.004	30.05	0.076	0.94
	(67.71)	(1.756)	(-3.482)	(2.525)	(1.905)	
Fixed-Effects	0.892	0.008	-0.014	22.69	-	0.94
	(42.54)	(3.326)	(-6.972)	(1.043)		
Random-Effects	0.950	0.005	-0.007	43.68	0.173	0.94
	(54.45)	(2.346)	(-4.809)	(2.691)	(3.509)	

Hausman Test
$\chi^2(4) = 41.263$
p-value(0.000)

Table 6: Estimates of the Rational Addiction Model with Time Series. Dependent variable C_t (t-statistics in parentheses)

	C_{t-1}	C_{t+1}	P_t	C	R^2
OLS	0.476	0.483	-0.046	0.085	0.99
	(7.458)	(6.673)	(-1.374)	(1.305)	
$2SLS$	0.500	0.404	-0.91	0.181	0.99
	(9.047)	(3.697)	(-1.817)	(1.628)	

All standard errors are heteroscedastic consistent.

Table 7: Short and Long Price Elasticities of demand rational addiction model (t-statistics in parentheses)*

	SRE	LRE	r
$1962 - 1971$	-0.59	-1.96	0.24
	(-4.665)	(-5.522)	(0.515)
$1972 - 1981$	-0.20	-0.66	
	(-4.665)	(-5.522)	
$1982 - 1991$	-0.18	-0.58	
	(-4.665)	(-5.522)	
$1992 - 1996$	-0.27	-0.87	
	(-4.665)	(-5.522)	
$1997 - 2000$	-0.30	-0.99	
	(-4.665)	(-5.522)	

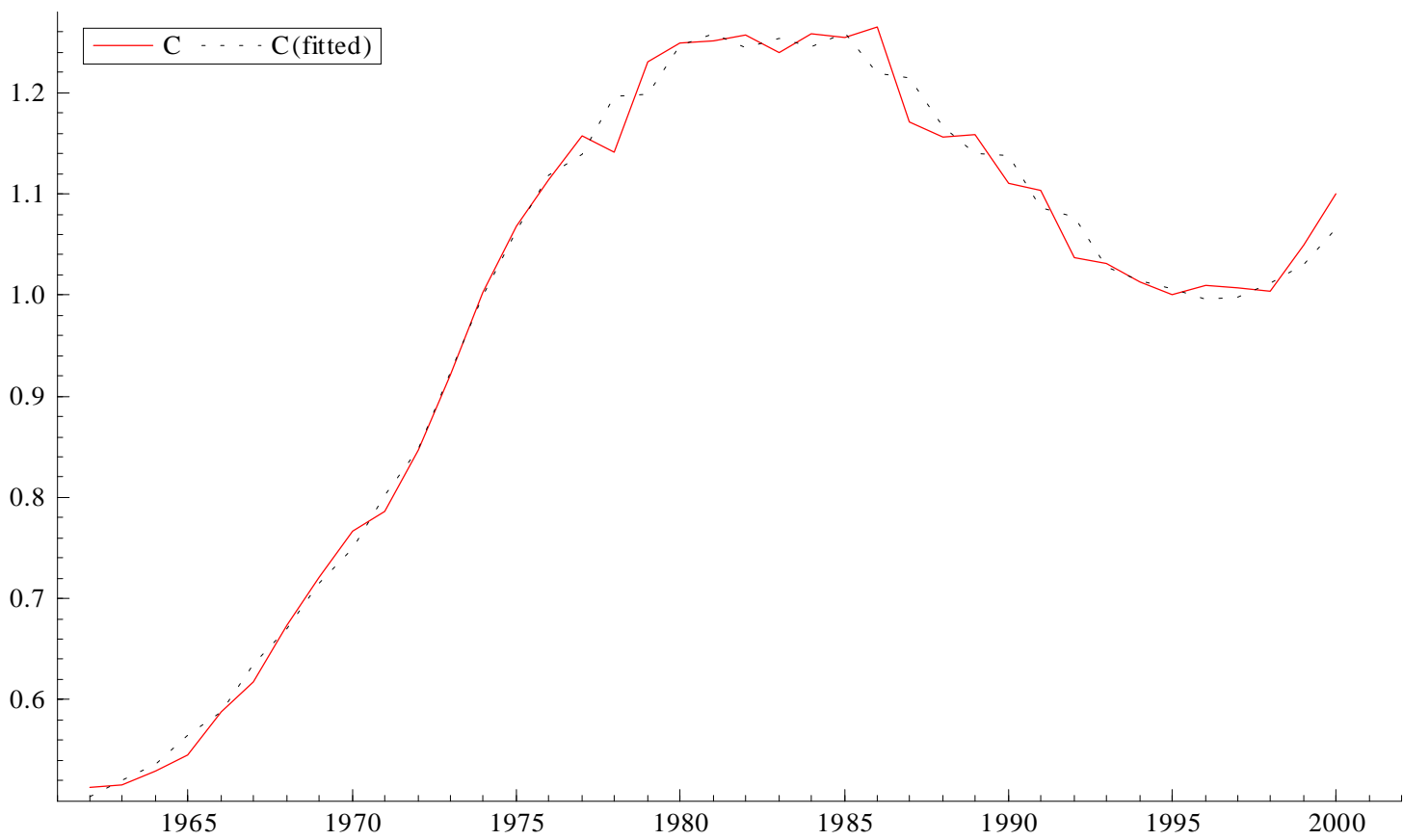* Standard errors for elasticities have been computed using ANALYZ in TSP45.

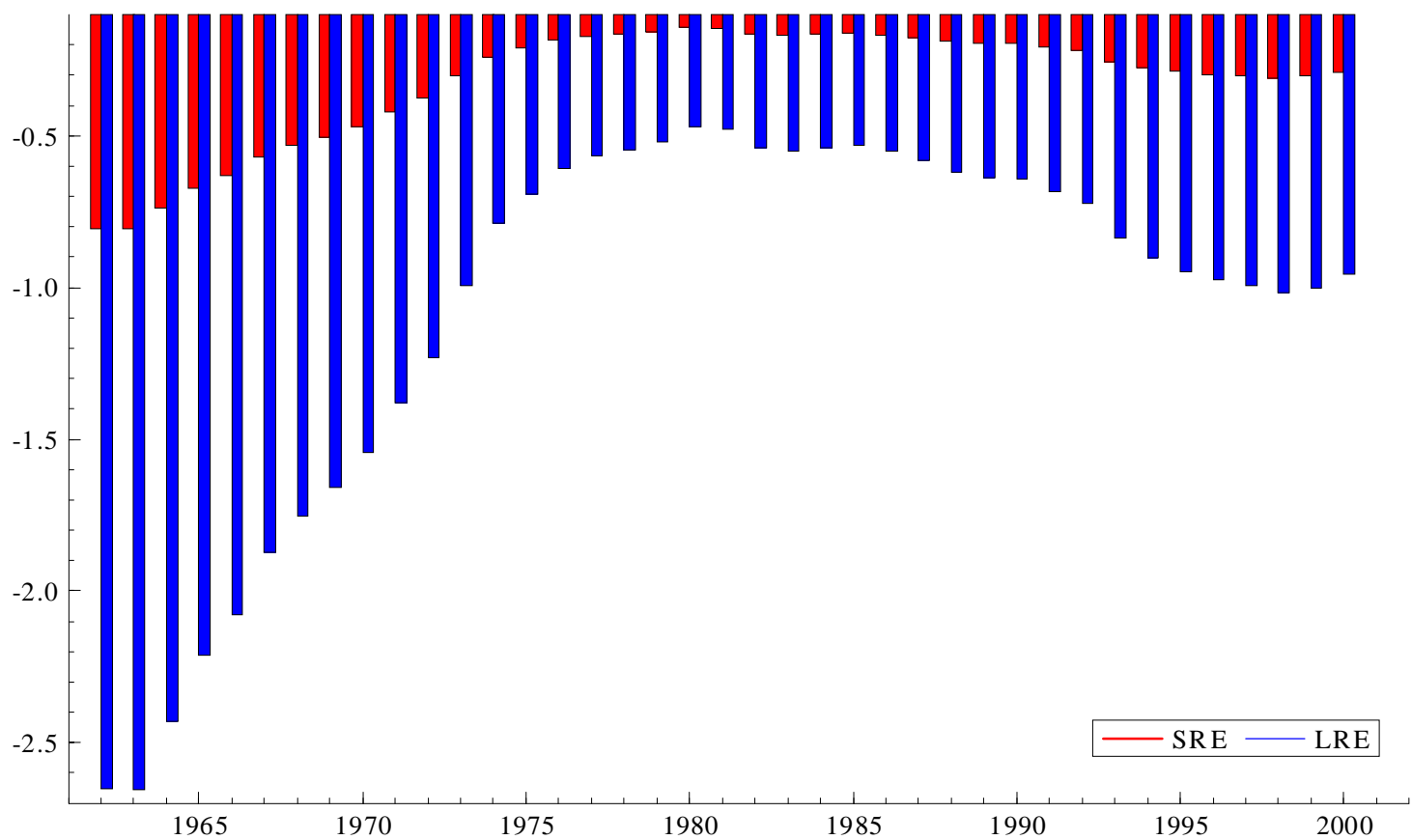Figure 1: Real and Fitted values of per capita Tobacco Expenditure (ra model, 2SLS)

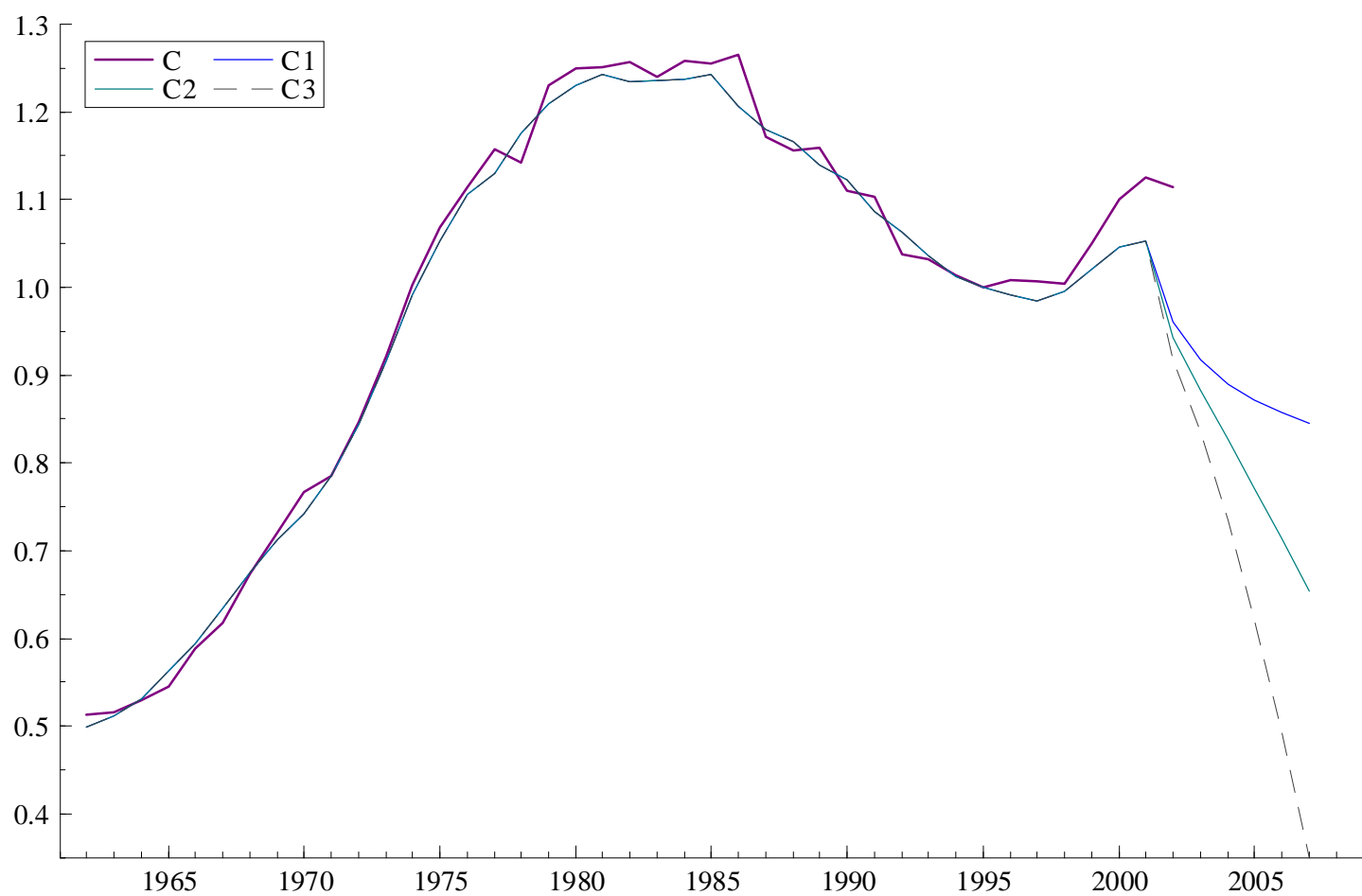Figure 2: Short (SRE) and Long (LRE) run Price Elasticities of Demand (RA model, 2SLS)

Figure 3: The Effects of Announced, Permanent Price Changes on Tobacco Demand