ADDITION AND ALCOHOL CONSUMPTION:
EVIDENCE FROM ITALIAN DATA

ABSTRACT

In this paper we estimate the demand for alcoholic beverages in Italy following the rational addiction framework by Becker and Murphy (1988) and using a GMM estimator. To increase confidence in the reliability of this framework we use two different data sets: (i) a time series of annual aggregate alcohol consumption from 1960 to 2002 supplied by ISTAT; (ii) a time series of household data on wine, beer and liquor consumption recorded on a four-week basis from 1999:3 to 2004:4 and supplied by ISMEA-Nielsen. Both data sets support the hypothesis that alcohol consumers are actually forward-looking. Past consumption is significant in explaining current consumption thus detecting the addictive nature of alcohol. Short and long run price elasticities and the income elasticity of demand are also calculated. Interestingly, the long run income elasticity of demand, as derived from the rational addiction model, is higher than one both for aggregate and specific products so alcoholic beverages turn out to be luxury goods.

Key words: rational addiction; alcohol consumption.
JEL Classification: D12, C23.

I - INTRODUCTION

Consumption of alcoholic beverages has features and consequences that make this class of commodities different from traditional consumer goods (Cook - Moore, 2000). Alcohol is an intoxicant: consumed in sufficient quantity in a single session it impairs mental and physical functioning and it is potentially toxic, generating important social costs such as: alcohol related violence and crime, road accidents and extra costs to the health and social security system. Alcohol consumption also has direct intertemporal consequences: past consumption generates habit formation and addiction. Moreover, chronic alcohol use affects physical and mental health over the course of years or decades. For these reasons alcoholic beverages are subject to restrictions in most western societies. Regulation, rather than economic incentives, is the preferred policy measure to reduce consumption in most countries. This is because demand is typically assumed to be price inelastic. Rational addiction models, however, assign an important role to price changes in reducing consumption of addictive goods (Becker - Grossman - Murphy, 1991).

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In this paper we estimate the demand for alcoholic beverages in Italy, testing the rational addiction model developed by Becker - Murphy (1988). Its popularity is due to both its important policy implications and the fact that, under a quadratic utility function, it leads to a simple linear specification with testable hypotheses (Picone, 2005). More specifically, the model implies that, contrary to common sense beliefs, the demand for addictive goods is relatively sensitive to price changes in the long run.

Our study is primarily concerned with contributing towards this strand of literature, as well as investigating the demand for alcoholic beverages in Italy. To the best of our knowledge, this is the first attempt to provide such evidence within the rational addiction framework. To strengthen our results we compare GMM estimations on two different data sets: (i) a time series of annual aggregate alcohol consumption supplied by ISTAT over the investigation period 1960 to 2002; (ii) a time series of household data on wine, beer and liquor consumption recorded on a four-week basis from 1999:3 to 2004:4 and supplied by ISMEA-Nielsen. The purpose is to compare model estimates based on aggregate and product-specific data. Given the differences in the investigation period, the data frequency and variable definitions, obtaining reasonably homogenous findings in both data sets prompts confidence in the reliability of such framework. The paper is structured as follows. An overview of alcohol consumption and policies in Italy is given in section II. In section III we introduce the analytical framework and review the existing empirical evidence on rational addiction to alcohol. Section IV sets out the econometric strategy and the results. Section V concludes.

II - OVERVIEW OF ALCOHOL CONSUMPTION AND POLICIES IN ITALY

2.1. Consumption

In the year 2000 the average per capita consumption of pure alcohol in Italy was about 7.5 litres (Ministero della Salute, 2003, p. 12). According to the WHO for the European Region such level of consumption should be cut to 6 litres per capita by the year 2015. In the same year 75% of Italians over the age of 14 consumed alcoholic beverages: 87% of males and 63% of females (table 1) (Scafato et al., 2004, p. 14).

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Share of Alcohol Consumers in Italy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1998</td>
</tr>
<tr>
<td>Male</td>
<td>83.4</td>
</tr>
<tr>
<td>Female</td>
<td>58.6</td>
</tr>
</tbody>
</table>

Source: Scafato - Ghirini - Russo, 2004

Alcohol consumption in Italy has followed a negative trend decreasing by 51.25% between 1970 and 2001 (figure 1).
However, such a sharp reduction in aggregate consumption is the result of contrasting figures (table 2) for wine (-40.8%), spirits (-65.7%) and beer (+57%).

<table>
<thead>
<tr>
<th></th>
<th>1981</th>
<th>1991</th>
<th>2000</th>
<th>% Var. 81-00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquor</td>
<td>3.5</td>
<td>2.5</td>
<td>1.2</td>
<td>-65.7</td>
</tr>
<tr>
<td>Wine</td>
<td>86.2</td>
<td>62.1</td>
<td>51</td>
<td>-40.8</td>
</tr>
<tr>
<td>Beer</td>
<td>17.9</td>
<td>24.9</td>
<td>28.1</td>
<td>+57</td>
</tr>
<tr>
<td>Pure Alcohol</td>
<td>11.7</td>
<td>9.1</td>
<td>7.5</td>
<td>-35.9</td>
</tr>
</tbody>
</table>

Source: Scafato - Russo, 2004

A rather different picture emerges from the study of Bentzen et al. (1999) on Scandinavian countries where the consumption of spirits almost halved between 1960 and 1992. Beer and wine consumption have increased in Finland, Norway and Sweden, whereas beer consumption has decreased in Denmark, where it has traditionally been very high. Overall, the consumption of pure alcohol in the four Nordic countries shows a positive trend, because the decrease in consumption of spirits is more than compensated by the increase in wine and beer consumption. Italy seems to show an opposite trend: the increase in beer consumption does not compensate for the decrease in wine and spirits also because beer has the lowest alcohol content among the three types of beverages.
In figure 2 we have plotted an index \((1995 = 1)\) of real per capita (14 years and over) consumption of all alcoholic beverages and the real alcohol price over the years 1960-2002\(^1\), to check whether this profile in alcohol consumption has some relationship with the evolution in the real price, as would be expected when studying the trend of a traditional good. A quick glance reveals that consumption of alcoholic beverages does not seem alike that of traditional commodities. The relationship between real price and consumption seems to be as expected only from around 1977 onwards when the real price decreases sharply towards a minimum in 1985, whereas consumption remains almost stable at 1977 levels. From 1985 onwards the price starts to increase again and, as expected, consumption decreases continuously to reach a minimum in 2002. The correlation coefficient between these two variables, over the sample period, is indeed rather low: \(-0.29\). The graph therefore seems to suggest that alcohol consumption before 1977 was driven by variables other than price, whereas later on the role of the real price became more relevant in explaining real consumption trends. The correlation coefficient, calculated over this subperiod, is equal to \(-0.54\).

**FIG. 2 - Index \((1995 = 1)\) of per capita consumption and real alcohol price**

\[ 1.7 \quad 1.6 \quad 1.5 \quad 1.4 \quad 1.3 \quad 1.2 \quad 1.1 \quad 1.0 \]

\[ 1960 \quad 1965 \quad 1970 \quad 1975 \quad 1980 \quad 1985 \quad 1990 \quad 1995 \quad 2000 \]

Source: Italian National Accounts

\(^1\) The variable ALC is given by the ratio between per capita alcohol expenditure at 1995 prices \((q_t p_{95})\) and per capita alcohol expenditure in 1995 \((q_{95} p_{95})\). The real alcohol price \(P\) is, instead, given by the ratio between the implicit deflator \(\left(\frac{p_t q_t}{p_{95} q_t}\right)\) and the consumer price index \((1995 = 1)\).
Survey data on the life styles and health conditions of individuals available for the years 1993-2001 (Indagine Multiscopo sulle famiglie – stili di vita e condizioni di salute) and supplied by ISTAT (the Italian National Statistical Institute) may help clarify which are the variables, other than the price, that influence alcohol consumption.

During the nineties a remarkable change in drinking habits occurred in the form of: a) an increase in the number of female consumers; b) an increase in the number of young consumers (teenagers and people aged 18 to 24); c) an increase in the number of people consuming alcohol outside the main meals (again higher for females and the young).

Italy is a wine producing country in which, in general, wine has traditionally always been consumed in moderate quantities and by all members of the household, to accompany meals.

The increase in the number of consumers on the one hand and the sharp decrease in per capita levels of consumption, on the other, reveal a change in consumption habits and suggest a transition from a Mediterranean approach to a northern European one characterized by binge drinking and by the use of alcohol as a way to ease personal relationships and social discomfort or as a means of female emancipation and cultural homologation. If this is true, then the comforting picture of a continuously decreasing level of alcohol consumption could hide an increase in the number of people actually at risk, especially among the most fragile groups in society.

2.2. Policy

Between 1994 and 1999 Italy, together with other European countries, introduced policy changes aimed at controlling alcohol consumption. Such policies seemed to rely mainly on command and control measures – such as restrictions and prohibitions – and on voluntary agreements. Changes have occurred in two main areas: drink driving legislation and alcohol promotion. Random Breath Testing (RBT) has been introduced to reinforce drink driving controls. The police need to have a justified suspicion to breath test drivers and the penalties for drink driving are suspension of the driving licence for between 15 days and 3 months, a fine or imprisonment for up to one month. The maximum legal blood alcohol concentration (BAC) when driving is 50 mg%. The increased risk for young and professional drivers is recognized and a lower BAC limit is set up for them. However, the overall level of enforcement of drink driving legislation is regarded as low. To counter alcohol promotion, more restrictions regarding the sale and advertisments of alcohol have been introduced: an age limit of 16 for purchasing alcohol and restrictions on the hours for the sale of spirits. Advertising of all types of alcohol is restricted on TV, radio, in the press and on billboards with two exceptions: the advertising of spirits on billboards and of beer on the radio is only subject to a voluntary code. A fine is imposed if advertising regulations are breached.

Concerning strategies aimed at limiting the availability of alcohol, there is a licen-
sing system for the import, export, production, wholesale and retail of all types of drinks. A formal procedure for obtaining a licence for retail outlets does exist, but all applicants get a licence, thus rendering the procedure almost meaningless. Restrictions on the sale of alcoholic beverages relate only to sales at specific events: children’s festivals, sporting events and demonstrations. During these events, the restriction is partial for beer, voluntary for wine and total for spirits.

The most recent public measure concerning alcohol consumption is law 125/2001 which introduces measures aimed at the prevention and treatment of alcohol related problems in line with the recommendations of the European Alcohol Action Plan.

While these command and control strategies are important in controlling alcohol consumption and related problems, monitoring and enforcement are crucial in order to determine their effectiveness. Moreover, the implementation of legal provisions requires an extra expenditure of 2.130 millions Euros per year.

The use of economic incentives, such as taxes, to reduce alcohol consumption is not provided for in Italy. The majority of countries have a system of two taxes on alcoholic beverages: a value added tax (VAT) and a specific alcohol tax based on the volume of alcohol (the stronger the beverage the higher the tax), but this kind of taxation is not provided for in Italy where only a VAT is used to raise revenues to finance public expenditure. Moreover, wine is not taxed.

The use of economic incentives should be contemplated among the measures aimed at reducing alcohol related social costs. In this respect, economic models of demand and, in particular, habit formation and addiction models may be useful to highlight the effectiveness of price mechanisms in reaching such targets.

III - CONCEPTUAL FRAMEWORK

The usual way of modeling alcohol consumption nowadays is the rational addiction (RA) framework developed by Becker - Murphy (1988). Previous empirical research introduced the notion of dependency via models of habit formation, otherwise known as the myopic models of addiction, or else, it ignored the addictive nature of alcohol and modeled alcohol demand as a traditional consumer good.

In the RA framework the behavior of an addicted consumer is characterized by reinforcement and tolerance. Tolerance implies that the marginal utility of the stock of past consumption is negative while reinforcement requires that an increase in past consumption raises the marginal utility of current consumption. An implication of reinforcement is that levels of consumption in adjacent time periods are complements. In addition, the RA framework implies that consumers also take into account the future negative consequences of their behavior so that, for reinforcement to occur, the increase in the marginal utility of current consumption following an increase in past consumption must be greater than the reduction in the present value of future consumption due to the harmful consequences of addiction. Underlying the RA theory are several assumptions that have led to extensions and to a bulk of critical literature: i) initiation in consumption is not explained: the individual consumes positive
amounts of the addictive good; ii) s/he can accurately predict future prices and other demand shifters; iii) s/he is not only rational and forward looking, but also time consistent; iv) s/he does not have self control problems. The model fails to explain important aspects of addictive behavior, such as temptation (Gul - Pesendorfer, 2001); projection bias (Lowenstein - O’Donoghue - Rabin, 2003); cue-contingent utility (Laibson, 2001); cue-triggered mistakes (Bernheim-Rangel, 2004).

Nevertheless, the model is still rather popular among practitioners, because it leads to a simple linear specification with testable hypotheses. Following Becker - Grossman - Murphy (1994) (BGM henceforth), we assume that the addicted consumer’s problem is to maximize, over his/her life cycle, the following function:

\[ V = \max \sum_{t=1}^{\infty} \beta^{-1} U(Y_t, C_t, S_t, e_t) \]  \hspace{1cm} (1)

where \( Y_t \) is consumption of a non addictive good (used as numeraire) at time \( t \) \((t = 1, \ldots, \infty)\), \( C_t \) is consumption of the addictive good (in this case alcohol), at time \( t \), \( S_t \) is the stock of the addictive good at time \( t \), \( e_t \) reflects unmeasured life cycle variables that affect utility in each period (i.e. demand shifters) and \( \beta \) is the discount factor \( 1/(1 + r) \), with \( r \) being the inter temporal rate of time preference which is assumed to be constant over time.

The instantaneous utility function has the following properties: \( U_C > 0; U_{CC} < 0; U_{SS} < 0 \). Moreover, the standard properties of addiction: tolerance, \( U_S < 0 \), and reinforcement, \( U_{CS} > 0 \), are assumed to hold. Consumption of the addictive good is assumed to have no effect on the marginal utility derived from consuming the composite good \( Y \) and vice versa: \( U_{CY} = 0 \). We assume that \( S_t \) evolves according to the following law of motion:

\[ S_t = (1 - \delta)S_{t-1} + C_{t-1} \]  \hspace{1cm} (2)

where \( \delta \) is the rate of depreciation on the stock of the addictive good. \( S_t = C_{t-1} \) for \( \delta = 1 \).

The consumer maximizes equation (1) subject to a lifetime budget constraint:

\[ W_0 = \sum_{t=1}^{\infty} \beta^{-1} \left( P_tC_t + Y_t \right) \]  \hspace{1cm} (3)

Where \( W_0 \) is the present value of wealth and where \( P_t \) is the price of the addictive good at time \( t \).

When the instantaneous utility function is quadratic and the intertemporal rate of time preference is equal to the market interest rate equation (1) generates a structural demand equation for alcohol consumption at time \( t \) of the following form:

\[ C_t = \beta_1 C_{t-1} + \beta_2 C_{t+1} + \beta_3 P_t + \beta_4 e_t + \beta_5 e_{t+1} \]  \hspace{1cm} (4)

Whereby, current consumption is positively related to past and future consumption and negatively related to the current price. In particular, \( \beta_1 \) measures the effect of past consumption and, by symmetry, it also measures the effect of current con-
sumption on future consumption of the addictive good. The larger the value of $\beta_1$
the greater is the degree of reinforcement or addiction. BGM recognize that the $e_t$
may be serially correlated. Even when they are not, they may affect utility in each
period and affect consumption at all dates through the optimizing behavior implied
by equation (1). Therefore BGM treat $C_{t-1}$ and $C_{t+1}$ as endogenous and use lagged
and forward prices as instruments. The statistical significance of the coefficient of fu-
ture consumption, together with a reasonable value of the inter temporal rate of time
preference$^2$, provides a direct test of the rational addiction theory. Rational addicts
will increase their consumption when future prices are expected to fall.

Equation (4) has some important implications. First, complementarity between ad-

djacent periods of consumption and negative cross-price elasticities between alcohol
consumption at different points in time, holding prices in all other periods constant.

Secondly, there are important differences between long and short run responses to
permanent price changes. The short run effect describes the impact on consumption
of a price change at time $t$ and in all future time periods that is not anticipated until
time $t$. The long run price effect pertains to a price change in all time periods. Since
$C_{t-1}$ remains the same if a price change is not anticipated until period $t$, the long run
price effect must exceed the short run price effect.

The RA model mainly has been applied to cigarettes consumption, whereas inves-
tigations concerning alcohol are not as numerous. One reason for this is that alcohol
is not supposed to be as addictive as tobacco. Another reason, put forward by Bentzen
et al. (1999) is probably the lack of long and consistent time series or panel data
available at the individual level.

Empirical tests of RA to alcohol have been carried out by Waters - Sloan (1995);
Grossman - Chaloupka - Sirtalan (1998); Bentzen - Eriksson - Smith (1999); Baltagi
- Griffin (2002); Baltagi - Geishecker (2006). Grossman et al. (1998) use surveys of
high school seniors as part of the monitoring of the future results to test the RA theo-
ry and find a long run price elasticity which is approximately 60% larger than the
short run elasticity. Waters - Sloan (1995) use individual data to test the RA model
applied to alcohol consumption. Their estimations provide relatively strong support
for the RA model. Bentzen et al. (1999) use aggregate time series data over the peri-
od 1960-1994 to test the RA model for alcohol consumption across four northern
European countries and find support for the RA hypothesis mainly for wine and spir-
its whereas evidence for beer is more controversial. Using aggregate consumption
data on distilled spirits for 42 US states over the period 1959-1994 Baltagi - Griffin
(2002) obtain results that are in general supportive of the RA hypothesis. However

$^2$ The inter temporal rate of time preference is by far the most difficult parameter to evaluate
because, according to theory, this is: $r = \frac{F}{F} - 1$. In practice the available estimates are charac-
terised by a large heterogeneity both in sign and magnitude irrespective of the type of data (indi-

dual versus aggregate, time series versus panel). Nevertheless, this awkward variability of the inter

temporal discount rate has never been considered a sufficient reason to contradict the RA model,


instead it has led many researchers to fix it exogenously, rather than obtaining it as a derived pa-


terometer.
their results are sensitive to the assumption of homogeneity across states or over time (Baltagi - Griffin, 2002, p. 486). Finally, Baltagi - Geishecker (2006) use eight rounds of a Russian survey covering the period 1994-2003. They find support for the RA hypothesis for men but not for women in Russia.

To summarize we report, in the following table 3, on the extreme variability of the estimated discount rate. Only Baltagi - Geishecker (2006) calculated standard errors of the implied discount rate.

<table>
<thead>
<tr>
<th>Study</th>
<th>Data</th>
<th>Discount rate range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waters - Sloan (1995)</td>
<td>panel of individuals</td>
<td>fixed at 5%</td>
</tr>
<tr>
<td>Grossman et al. (1998)</td>
<td>panel of individuals</td>
<td>-20% ÷ -60%</td>
</tr>
<tr>
<td>Bentzen et al. (1999)</td>
<td>time series</td>
<td>fixed at 10%</td>
</tr>
<tr>
<td>Baltagi - Griffin (2002)</td>
<td>panel of aggregates</td>
<td>-15% ÷ +150%</td>
</tr>
<tr>
<td>Baltagi - Geishecker (2006)</td>
<td>panel of individuals</td>
<td>-14% ÷ +175%</td>
</tr>
</tbody>
</table>

IV - ESTIMATING THE ADDICTION MODEL

4.1. Econometric strategy

The following transformation in first-differences of equation (4) is a suitable transformation of the data to eliminate the problems of spurious regression:

\[ \Delta C_t = \beta_0 + \beta_1 \Delta C_{t-1} + \beta_2 \Delta C_{t+1} + \beta_3 \Delta P_t + \beta_4 \Delta Y_t + \Delta \varepsilon_t \]  

(5)

where \( t = 2, ..., T - 1 \); \( \Delta \varepsilon_t = \beta_4 \Delta \varepsilon_{t-1} + \beta_5 \Delta \varepsilon_{t+1} \) is the idiosyncratic error term; \( \Delta Y_t \), which represents an empirical modification of the theoretical model, is an exogenous determinant that influences alcohol demand, namely the real per capita expenditure used as a proxy for disposable income.

There are two problems that prevent the linear expression (5) from being estimated by ordinary least squares. First, there is an omitted variable bias due to uncounted demand shifters that may also be serially correlated (Becker et al., 1991). Second, there is measurement error when we use actual values as they do not fully anticipate planned future consumption of the addictive good, leading to an error-in-variable model (Picone, 2005).

In the attempt to correct for this endogeneity bias we use a \( k \times 1 \) vector of instruments, \( Z_t \), which may include some or all covariates, and apply generalized method of moments\(^3\) (GMM). The vector of instrumental variables is uncorrelated with the

\(^3\) A comprehensive discussion on generalized method of moments can be found in Davidson and MacKinnon (1993, chapter 17), Hall (2005), Hansen (2005, chapter 5), Hayashi (2000, chapter 3 and 4), Matyas (2003), to cite a few.
disturbance but correlated with the explanatory variables and satisfies the set of $l$
orthogonality conditions $E(Z_i \Delta \varepsilon_i) = 0$. If the model is overidentified, i.e., the
umber of independent moment conditions is greater than the number of estimated para-
parameters ($l > k$), the GMM estimator of the linear equation (5) is obtained by minimiz-
ing a quadratic form in the sample moments and has the form:

$$
\tilde{\beta}_{GMM} = (X'ZW^{-1}Z'X)^{-1}X'ZW^{-1}Z' \Delta C
$$

(6)

where, $X = [1; \Delta C_{-1}; \Delta C_{+1}; \Delta \rho; \Delta Y]$ is the $(nxk)$ matrix of explanatory variables,
$Z$ is a $(nxl)$ instrument matrix and $W$ is a $(lxl)$ weight matrix. In practice we need a
two step procedure in order to estimate consistently $W$. In the first step, we use the
fact that a consistent yet not efficient estimate of the parameter vector may be obtained
with an arbitrary positive definite and symmetric matrix which does not depend on $\beta$. In the second step, any such preliminary estimate $\hat{\beta}$ is used to form the optimal
weighting matrix and obtain $\tilde{\beta}_{GMM}$.

In fact, the method used to estimate $W$ depends on the time series properties of the
population moment conditions. If the error term of the regression (5) is serially
 correlated and possibly conditionally heteroskedastic a consistent (HAC) estimate of $W$
is given by the kernel based Newey-West estimator.

Finally, the relevant question is what the most plausible instruments in this in-
stance are. If we assume that actual values of consumption in period $t + 1$ are error
ridden variables, it can be shown that the disturbance in equation (4) is given by:

$$
\varepsilon_t = \beta_0 e_t + \beta_3 \varepsilon_{t+1} + \beta_2 m_{t+1}
$$

(7)

where $e$ is a comprehensive demand shifter, $m$ is the measurement error in the planned
future consumption of alcohol and $\beta$'s are structural parameters. By definition, $e_{t+1}$
and $C_{t+1}$ are correlated; in addition, we expect the measurement error to be zero
mean, uncorrelated with planned future consumption and correlated with actual
values of the addictive good in period $t + 1$, which in turn implies that measured fu-
ture consumption become endogenous in equation (4):

$$
E(C_{t+1} \varepsilon_t) = \beta_3 E(C_{t+1} e_{t+1}) - \beta_2 \sigma_m^2
$$

(8)

Whether or not $C_{t-1}$ can be considered as a predetermined variable depends upon
the potential serial correlation of the disturbance $\varepsilon_t$ and the first difference transfor-

4 Note that while the GMM estimator depends on $W$ the dependence is only up to a scalar.
The two step procedure can be repeated to obtain the iterated efficient GMM estimator. Although
the two step and the iterated efficient estimators share the same asymptotic distributions, their
finite sample properties may differ (Hall, 2004).

5 The KERNEL option of TSP's GMM procedure provides two choices for the kernel, Bartlett
and Parzen; both weights ensure positive semi-definiteness of the sample covariance matrix of the
orthogonality conditions. For an overview on the kernel-based estimators and bandwidth selection
procedures see Hayashi (2000, chapter 6). The NMA option of TSP's GMM procedure sets
the number of autocorrelation terms to be considered.

6 After transforming the model in first differences, we have $\Delta \varepsilon_t = \beta_4 \Delta e_t + \beta_5 \Delta \varepsilon_{t+1} + \beta_2 \Delta m_{t+1}$. 
mation (5) used in estimation, which makes the error term $\Delta \varepsilon_t$ follow a MA(2) process. After some diagnostic test on the time series properties of the explanatory variables (see table 4), we confidently assume that the price of alcohol and the expenditure variable are strictly exogenous and tentatively use the following matrix of instruments in both levels and first differences:

$$Z = [1, \Delta Y, Y, \Delta P, P]$$  \hspace{1cm} (9)

where each term is a submatrix whose columns contain two lags and two leads.

4.2. Data

The first data set we use is a time series of alcoholic beverages (in billions of Euros) in Italy for the period 1960-2002 taken from ISTAT National Accounts. Per capita values are obtained by dividing aggregate expenditures by population over 14 years old (calculated in the middle of each year). Our dependent variable is per capita alcohol consumption calculated as the ratio between per capita expenditure at 1995 prices ($q_t P_{95}$) and per capita expenditure in 1995 ($q_{95} P_{95}$). The real price of alcohol is obtained by dividing the implicit deflator, calculated as the ratio between current expenditure and expenditure at 1995 prices, by the consumer price index (1995 = 1). Figure 2 shows the index (1995 = 1) of per capita alcohol consumption and the real price. We have also added to the set of explanatory variables the real expenditure on non durables as a proxy for disposable income.

The advantage of this data set is that, in contrast to many studies on rational addiction, past and future consumption levels used are actual consumption levels and not constructed from the data. Moreover a long and consistent time series is more appropriate to model dynamic behavior such as that depicted in this paper. However, there are also some disadvantages in using aggregate data. First, the total expenditure on alcohol in National Accounts aggregates the expenditure on alcohol of all Italians. These data may be dominated by the behavior of light and moderate drinkers and a decrease in aggregate consumption of alcohol could hide a rather different picture. A second problem lies in the level of detail of the commodity structure in the National Accounts as beer, wine and spirits are mixed in this type of data\(^7\). In fact addictive behavior could be better captured by disaggregated data for wine, beer and spirits.

For this purpose we use a second data set supplied by ISMEA (Italian Institute for Agricultural and Food Market Services). In order to monitor household food consumption patterns, ISMEA maintains an extensive data collection system, called Panel famiglie, in partnership with AC Nielsen. The Panel famiglie is based on records of purchases in a sample of about 6,000 Italian households. This sample is meant to be representative and is stratified according to socio-demographic and geographic variables. Data are recorded using the home scanning technology: every household

\(^7\) This second problem may also apply to micro data.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ISTAT data</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_t = (ALQ_t/N14)100$</td>
<td>Per capita (age &gt; 14) alcohol expenditure</td>
<td>1.351</td>
<td>0.241</td>
</tr>
<tr>
<td>$P_t = (ALV_t/ALQ_t)/PG_t$</td>
<td>Real price of alcoholic beverages (1995 = 1)</td>
<td>1.139</td>
<td>0.161</td>
</tr>
<tr>
<td>$Y_t = Y95_t/N14$</td>
<td>Real per capita disposable income per year (1995 = 1)</td>
<td>0.783</td>
<td>0.234</td>
</tr>
<tr>
<td>$ALQ_t$</td>
<td>Aggregate alcohol expenditure, 1995 prices (millions Euros)</td>
<td>5417.678</td>
<td>837.055</td>
</tr>
<tr>
<td>$ALV_t$</td>
<td>Aggregate alcohol expenditure (millions Euros)</td>
<td>2577.546</td>
<td>1882.417</td>
</tr>
<tr>
<td>$PG_t$</td>
<td>Consumer Price Index (CPI) (1995 = 1)</td>
<td>0.481</td>
<td>0.406</td>
</tr>
<tr>
<td>$Y95_t$</td>
<td>Household annual final consump. expend., 1995 prices (millions Euros)</td>
<td>391066.923</td>
<td>145025.636</td>
</tr>
<tr>
<td>$N14$</td>
<td>Population &gt; 14 (millions units)</td>
<td>44.050</td>
<td>3.751</td>
</tr>
<tr>
<td><strong>ISMEA-Nielsen data</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_{L_t}$</td>
<td>Liquor purchased per household per month (Litres)</td>
<td>0.067</td>
<td>0.028</td>
</tr>
<tr>
<td>$C_{W,t}$</td>
<td>Wine purchased per household per month (Litres)</td>
<td>3.179</td>
<td>0.481</td>
</tr>
<tr>
<td>$C_{B,t}$</td>
<td>Beer purchased per household per month (Litres)</td>
<td>1.194</td>
<td>0.346</td>
</tr>
<tr>
<td>$P_{L,t} = (LV_t/C_{L,t})/IPCT_t$</td>
<td>Real price of liquor (1999:3 = 1)</td>
<td>8.955</td>
<td>0.566</td>
</tr>
<tr>
<td>$P_{W,t} = (WV_t/C_{W,t})/IPCT_t$</td>
<td>Real price of wine (1999:3 = 1)</td>
<td>1.543</td>
<td>0.209</td>
</tr>
<tr>
<td>$P_{B,t} = (BV_t/C_{B,t})/IPCT_t$</td>
<td>Real price of beer (1999:3 = 1)</td>
<td>1.143</td>
<td>0.034</td>
</tr>
<tr>
<td>$Y_t$</td>
<td>Mean monthly household expenditure (Euros)</td>
<td>2191.611</td>
<td>70.073</td>
</tr>
<tr>
<td>$LV_t$</td>
<td>Liquors expenditure per household (Euros)</td>
<td>0.711</td>
<td>0.348</td>
</tr>
<tr>
<td>$WV_t$</td>
<td>Wine expenditure per household (Euros)</td>
<td>5.784</td>
<td>1.553</td>
</tr>
<tr>
<td>$BV_t$</td>
<td>Beer expenditure per household (Euros)</td>
<td>1.591</td>
<td>0.473</td>
</tr>
<tr>
<td>$IPCT_t$</td>
<td>Monthly Consumer Price Index (CPI) (1995 = 100)</td>
<td>111.6</td>
<td>4.508</td>
</tr>
</tbody>
</table>
in the sample is provided with a computer equipped with an optical scanner, which is used to record consumption information as soon as the purchased product enters the home. These data are supplemented by additional information concerning the purchase from a computer-guided questionnaire, and a procedure exists to record comparable information for items without a bar code. These elementary data are electronically retrieved from each household on a weekly basis and are then aggregated for four-week intervals.

This information includes beverages (both alcoholic and non-alcoholic) aggregated at the national level for the period March 1999 to April 2004, amounting to 276 observations for each variable. For each type of beverage we observe total expenditure (measured in '000 euros) and quantity (measured in '000 litres). The very detailed list of individual beverage items was then aggregated into the following four products: (1) wine, (2) beer, (3) spirits and (4) non-alcoholic beverages.

These data do not exhaust the total consumption of alcoholic beverages by Italian households as only home purchases are recorded. Drinks away from home, for instance, are not recorded here. We presume that this is the reason why per-capita alcohol consumption turns out to be so low. Additional data used in this study include the national population aged 14 or more, calculated in the middle of each year. For each of the three alcohol products, the real price is calculated as the ratio between the implicit price (the ratio between current expenditure per household and litres purchased per household) and the consumer price index (1999:3 = 1). Summary statistics of data are presented in table 4.

Auld and Grootendorst (2004) dispute that aggregate data are appropriate to deal with rational addiction models under specific conditions. We have however tested against the stated conditions.

First, we tested for stationarity of the time series using two different types of unit root tests: the Dickey-Fuller and the Weighted Symmetric. For the ISTAT data (table 5a), we found a unit root for all the variables used: $P C$ and $Y$. Therefore all estimations were made with the variables in first differences. On the other hand, all variables in the ISMEA data set turn out to be stationary (table 5b) and in this case estimations were performed in levels.

Finally we tested for autocorrelation of the differenced variables using two different tests: a Durbin's alternative and a Breusch-Godfrey LM test. For ISTAT data we reject the null of no autocorrelation and accept the hypothesis of serial correlation.

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8 We thank Letizia Fini and Antonella Finizia of ISMEA for having supplied the data. Additional information on the structure of the data used can be found on the ISMEA web site (http://www.ismea.it) by downloading the document «Panel famiglie Ismea/ACNielsen: Struttura dell'indagine, metodologia di rilevazione e dettaglio informativo».

9 Population data were supplied by professor Petrioli of the University of Siena.

10 The Durbin's alternative follows a normal distribution and it is a valid test for autocorrelation when more than one lagged dependent variable is included among the regressors. The Breusch-Godfrey LM test for autocorrelation of order $x$ follows a $\chi^2$ distribution with $DF = x + k - 1$, where $x$ is the number of lags and $k$ is the number of identified coefficients in the model, including the intercept.
TABLE 5a
Diagnostic Tests on ISTAT Time Series (p-values in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>Unit Root</th>
<th>Autocorrelation (differenced model)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P C Y</td>
<td></td>
</tr>
<tr>
<td>Wtd. Sym.</td>
<td>-1.515 -0.798 -1.166</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.887) (0.985) (0.957)</td>
<td></td>
</tr>
<tr>
<td>Dickey-Fuller</td>
<td>-1.233 -2.251 -0.567</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.903) (0.461) (0.997)</td>
<td></td>
</tr>
<tr>
<td>Durbin's h Alt.</td>
<td></td>
<td>-2.327</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.020)</td>
</tr>
<tr>
<td>Breusch-Godfrey</td>
<td></td>
<td>5.767</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.056)</td>
</tr>
</tbody>
</table>

TABLE 5b
Unit Root Tests on ISMEA Time Series (p-values in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>PW PL PB CW CL CB Y</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(0.000) (0.000) (0.000) (0.068) (0.045) (0.000) (0.422)</td>
</tr>
<tr>
<td></td>
<td>(0.000) (0.000) (0.000) (0.045) (0.000) (0.002) (0.626)</td>
</tr>
</tbody>
</table>

of order 2 in the error terms, thus setting the number of moving average disturbances in GMM estimation equal to 2. We did not find autocorrelation in ISMEA data and the number of moving average disturbances was set to zero in this case.

Although we acknowledge the limitations of each data set, for the reasons just outlined, we are confident that estimating the RA model on two data sets may reasonably increase the reliability of our empirical results.

V - RESULTS

Table 6 shows the results of GMM estimations of the rational addiction model. All estimated parameters have the expected sign and are statistically significant at the

11 As an alternative way of modeling addictive behavior, a myopic demand function was also estimated in which the impact of future consumption was not considered. This function results from the solution of a static one period utility maximization problem where utility at time t depends on past consumption of the addictive good, as well as on current consumption, income and current events. The source of dynamic behavior is the stock of habits: St = (1 - δ)St-1 + Ct-1
Table 6
GMM Estimates of the Rational Addiction Model
Dependent variable $CT$ (standard errors in parentheses)

<table>
<thead>
<tr>
<th>ISTAT (first differences)</th>
<th>ISMEA-Nielsen (levels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol aggregate</td>
<td>Liquor</td>
</tr>
<tr>
<td>$Ct-1$</td>
<td>0.392</td>
</tr>
<tr>
<td></td>
<td>(0.083)</td>
</tr>
<tr>
<td>$Ct+1$</td>
<td>0.322</td>
</tr>
<tr>
<td></td>
<td>(0.113)</td>
</tr>
<tr>
<td>$P_t$</td>
<td>-0.161</td>
</tr>
<tr>
<td></td>
<td>(0.089)</td>
</tr>
<tr>
<td>$Y_t$</td>
<td>1.073</td>
</tr>
<tr>
<td></td>
<td>(0.336)</td>
</tr>
<tr>
<td>Trend</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.025</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
</tr>
<tr>
<td>Test overid. restr.</td>
<td>8.379</td>
</tr>
<tr>
<td>p-value</td>
<td>[0.592]</td>
</tr>
<tr>
<td>$R^2$ (adj.)</td>
<td>0.314</td>
</tr>
<tr>
<td>$n$</td>
<td>37</td>
</tr>
</tbody>
</table>

Standard errors are both heteroskedastic consistent and also robust to autocorrelation.

5% level. Consistently with the theory, for both data sets the lagged consumption coefficient is positive and larger than the lead consumption coefficient thus giving rise to a positive rate of time preference. Habit formation is strong for spirits ($\beta_1 = 0.655$) and beer ($\beta_1 = 0.460$), weaker for wine ($\beta_1 = 0.258$) and also quite strong for the aggregate of alcoholic beverages ($\beta_1 = 0.392$). Consumers seem to be forward looking in their choices, although this attitude, measured by the value of the lead consumption coefficient, is much higher when measured on aggregate data.

where $\delta$ is the rate at which consumption habits decay. Assuming a 100% rate of decay ($\delta = 1$) reduces the stock of habits to last period consumption and the solution to the static maximization problem produces a linear equation to be estimated of the form:

$$CT = \alpha + \beta_1 CT_{t-1} + \beta_2 P_t + \beta_3 Y_t + \beta_4 T + u_t$$

where the subscript $t$ denotes time and where disposable income $Y$ and a time trend $T$ have been added. The coefficient on the lagged dependent variable can also be interpreted as habit persistence when the good in question is an addictive good. This model can be estimated by OLS, because it takes the lagged dependent variable as being uncorrelated with the error terms of the equations. OLS estimation is consistent in this case (Verbeek, 2000, p. 280). Estimation of this model both in levels and in differences produced no statistically significant results which we omit to save space.
than on spirits ($\beta_2 = 0.128$), wine ($\beta_2 = 0.185$) or beer ($\beta_2 = 0.280$). The test for over identifying restrictions is distributed as a $\chi^2$ with degrees of freedom equal to the number of exceeding instruments. Since the critical value of the $\chi^2$ at the 5% level of significance with 10 degrees of freedom is 18.31, we accept the null of no over identification for both aggregate data and each good separately.

Short run (SRE) and long run (LRE) price elasticities at the sample mean, are (Becker - Grossman - Murphy, 1991, p. 240; Baltagi - Griffin, 2001, p. 452):

$$SRE = \frac{dC}{dP} \frac{\bar{P}}{\bar{C}} = \frac{2\theta_1}{1 - 2\theta \beta + (1 - 4\theta^2 \beta)^{1/2}} \frac{\bar{P}}{\bar{C}} \quad (10)$$

$$LRE = \frac{dC_{\infty}}{dP} \frac{\bar{P}}{\bar{C}} = \frac{\theta_1}{1 - \theta(1 + \beta)} \frac{\bar{P}}{\bar{C}} \quad (11)$$

The short run price elasticity of demand gives the percentage variation in consumption of an addictive good in the first year after a permanent change in current 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.

Consistently with the theory, $SRE \leq LRE$ in both data sets although demand is rather unelastic in the long run for all goods. The only exception is beer ($LRE = -0.861$) where the elasticity nonetheless remains lower than one in absolute terms. The implied intertemporal rates of time preference are very high. This may signal a rather high level of impatience in alcohol consumers and, at the same time, low consideration for the future consequences of current consumption. We have also calculated short and long run income elasticities of demand (table 7).

### Table 7

<table>
<thead>
<tr>
<th></th>
<th>SRE</th>
<th>LRE</th>
<th>r(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Price</td>
<td>Income</td>
<td>Price</td>
</tr>
<tr>
<td>Alcoholic beverages</td>
<td>-0.256</td>
<td>1.173</td>
<td>-0.474</td>
</tr>
<tr>
<td></td>
<td>(0.190)</td>
<td>(0.205)</td>
<td>(0.385)</td>
</tr>
<tr>
<td>Liquor</td>
<td>-0.178</td>
<td>0.477</td>
<td>-0.640</td>
</tr>
<tr>
<td></td>
<td>(0.407)</td>
<td>(0.380)</td>
<td>(1.749)</td>
</tr>
<tr>
<td>Wine</td>
<td>-0.371</td>
<td>1.379</td>
<td>-0.510</td>
</tr>
<tr>
<td></td>
<td>(0.172)</td>
<td>(0.439)</td>
<td>(0.201)</td>
</tr>
<tr>
<td>Beer</td>
<td>-0.394</td>
<td>0.870</td>
<td>-0.861</td>
</tr>
<tr>
<td></td>
<td>(0.375)</td>
<td>(0.403)</td>
<td>(0.846)</td>
</tr>
</tbody>
</table>

Standard errors were computed using the Delta method.
form of these elasticities is the same as the price elasticities. Long run income elasticities are higher than one for each good and in the aggregate.

In the rational addiction model, the marginal utility of income is a multiplying factor in the current price coefficient (Escario - 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 wealthy people, who have a lower marginal utility of income, will be less sensitive to price changes than people with lower incomes and a higher marginal utility of income. Thus, we expect that price elasticities of demand will be higher in periods of lower income and lower in periods of higher income.

Table 8 shows short and long run price elasticities of demand (obtained from (5)) estimated from ISTAT aggregate data at the sample mean of each decade. Alcohol demand appears to be more sensitive to price changes during the sixties, when Italy experienced a lower mean level of income, than during the eighties for instance. From 1973 to 1992 both elasticities are quite low consistently with a higher average level of income in those years. The LRE starts to increase again from 1992 onwards, in a period of austerity and restrictive economic policy in Italy. The evolution in time of the price elasticities of demand thus seems to be consistent with the predictions of the rational addiction model. These measures should, however, be considered with some caution given their high standard errors which may be due to the method of estimation. While the elasticities are calculated as a highly non linear combination of the parameters, standard errors are estimated with the Delta method which linearizes the non linear functions around the estimated parameter values.

VI - CONCLUSIONS

This study is mainly concerned with confronting the rational addiction hypothesis with Italian data. The RA model has policy implications (for instance a higher long

<table>
<thead>
<tr>
<th></th>
<th>SRE</th>
<th>LRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1963 - 1972</td>
<td>-0.27</td>
<td>-0.52</td>
</tr>
<tr>
<td></td>
<td>(0.207)</td>
<td>(0.419)</td>
</tr>
<tr>
<td>1973 - 1982</td>
<td>-0.22</td>
<td>-0.42</td>
</tr>
<tr>
<td></td>
<td>(0.165)</td>
<td>(0.334)</td>
</tr>
<tr>
<td>1983 - 1992</td>
<td>-0.21</td>
<td>-0.38</td>
</tr>
<tr>
<td></td>
<td>(0.154)</td>
<td>(0.311)</td>
</tr>
<tr>
<td>1993 - 1999</td>
<td>-0.31</td>
<td>-0.58</td>
</tr>
<tr>
<td></td>
<td>(0.232)</td>
<td>(0.470)</td>
</tr>
</tbody>
</table>

Standard errors were computed using the Delta method
Elasticities calculated from ISTAT data and model (5)
run price elasticity of demand than alternative models of addiction) that could be of use when choosing policy measures aimed at reducing alcohol consumption. Reducing consumption is a desired outcome since according to WHO standards an average level of 6 litres of pure alcohol per capita per year in Italy should be reached by the year 2015.

In order to increase confidence in the reliability of our results, we produce GMM estimations of the demand for alcohol using two data sets: a time series of annual aggregate alcohol consumption from 1960 to 2002 supplied by ISTAT and a time series of household data on wine, spirits and beer recorded on a four-week basis from 1999:3 to 2004:4 supplied by ISMEA-Nielsen. The results of the two empirical exercises are consistent and we therefore believe that they provide reasonable evidence of the hypotheses stated. There is a strong habit formation component in all types of alcohol consumption and, as predicted by theory, alcohol consumers also seem to be forward looking in their decisions as the future consumption coefficient is positive, statistically significant and lower than the past consumption coefficient. These results suggest that alcohol demand may be sensitive to both current and future economic incentives.

We also calculate short and long run price elasticities of demand as well as the income elasticity of demand. Although the long run price elasticity of demand is substantially higher than the short run one, as predicted by the RA model, the demand for alcoholic beverages, in both data sets, is rather unelastic. Thus, even though alcohol consumers turn out to be forward looking, a price increase would not be particularly effective in reducing alcohol demand even in the long run. Surprisingly, the long run income elasticity of demand at the sample mean is higher than one for each individual good and for the aggregate of alcoholic beverages implying that a permanent income change of 1% in all time periods causes demand to increase by more than 1%. Alcoholic beverages could therefore be considered as luxury goods the demand for which increases more than proportionally following an increase in income. However, the distribution of income is not taken into account here. Thus, alcohol could be a luxury at low levels of income, but a necessary or inferior good at high levels of income.

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REFERENCES


