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**The History of an Inferior Good:
Beer Consumption in Germany**

by

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Abstract

The question whether alcohol in general, and different types of alcoholic beverages in particular (e.g., beer) are normal or inferior goods is a heavily disputed issue within economics and health research. Based on recently developed theories of preference adjustment this paper argues that the answer to this question may not be independent of the level of income itself. It therefore applies a gradual switching regression approach to aggregate beer consumption data in Germany from 1957 to 2007. This method allows elasticities to change over time, without prior specifications of the time and speed of adjustments.
Results suggest that an important behavioral change is present in the data, as elasticities of beer demand shifted considerably between 1965 and 2004. In particular, they demonstrate that over this period beer shifted from being a normal to being an inferior good.

Keywords: Beer demand; Inferior goods; Gradual switching regression

JEL classification: D10; C22

Introduction

Like in most countries in the Western world consumption patterns for beverages in Germany changed dramatically over the past half-century. Total per capita consumption of alcohol more than doubled from 6.1 liters in 1957 to 12.7 liters in 1976, and then fell back to 9.8 liters by 2007. This implies that per capita alcohol consumption has fallen by more than 25% over the last 30 years. Most of this development is driven by changes in the demand for beer. Beer consumption started from 81.8 liters in 1957, peaking at 150.9 liters in 1976 and has since then been declining to a low 111.8 liters in 2007. This equals a 20% drop in demand, which has led to a wave of brewery closures in Germany, for which the term "Brauereisterben" has been coined (Hawley 2005).

On the other hand, even given the reduction in per capita consumption Germany still finds itself among the world's Top 4 countries in per capita beer consumption (WHO 2004).[1] The corresponding direct and indirect social costs associated with this pattern of alcohol consumption are substantial, and have been estimated to amount to €24.4 billion, or 1.16% of Germany's GDP, in 2002 (Konnopka and König 2007). Given the severe consequences to health associated with excess drinking behavior (cf. Edwards et al. 1994; Babor et al. 2003) and its impact both on productivity (Cook and Moore 2000) and social welfare (Klingemann and Gmel 2001; Konnopka and König 2007) special restrictions on commerce and consumption of alcoholic beverages have been justified in order to curb alcohol consumption.

Economists have provided the basis for and the evaluation of these alcohol policies and their tools (including, amongst others, excise taxation and restrictions on advertising) through empirical work on alcohol consumption and its consequences. Estimating elasticities of demand for alcoholic beverages, especially beer, has been a frequent activity by economists since the seminal work of Niksanen (1962). An impressive amount of studies have estimated elasticities for beer demand in various countries with an emphasis on the U.S., the UK, and Australia. However, the point estimates reported vary dramatically (cf. the surveys by Fogarty 2004; Gallet 2007; Wagenaar et al. 2009). Using the example of excise taxation, demand for alcohol might be expected to be inelastic to price changes, due to its potentially addictive nature. Literature, however, reports both inelastic and elastic estimates of price elasticities for beer (cf. Fogarty 2004).

Additionally, most of the studies conducted on the beer market assume elasticities to be constant over the respective period of observation, which usually covers between 20 and 50 years.[2] Yet, there is increasing theoretical work that questions the validity of assuming time-invariant sensitivity to price and income changes. Given the increasing emphasis on and awareness of health risks associated with alcohol consumption since the early 1970s health-state dependent utility models as developed by Viscusi and Evans (1990) predict that rational consumers should adjust their response to changes in price and income depending on the available information. Throughout the 1950s and 1960s risk thresholds for maximum daily alcohol intake were defined within the medical literature but rarely communicated to the wid-

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[1] According to the same report, Germany ranks 9th in per capita alcohol consumption (WHO 2004).
[2] The most notable exceptions are Horowitz and Horowitz (1965), and Gallet and List (1998).

er public.[3] Only starting in the mid-1970s public health authorities in Germany began to systematically disseminate information on the detrimental consequences of excessive alcohol intake. Over this time, the maximum amount of daily pure alcohol intake that was considered low-in-risk dropped continuously from 160g per day for both sexes (Bühringer et al. 2000) to 12g and 24g per day (Pabst and Kraus 2008) for females and males, respectively. Accordingly, one would also expect continuous behavioral adjustments and thus time-variant elasticities for this observation period.

Yet, adjustments to changing information may not be the only reason why elasticities vary over time. More recently, the interest of economics in the nature and causes of preference dynamics has increased markedly. Witt (2001), for instance, proposes a motivational based explanation to the massive restructuring that has been witnessed for consumption patterns since the onset of the industrial revolution (cf. Pasinetti 1981; Matsuyama 2002).[4] Arguing that the satiation of needs is the basic motivation for consumption, he holds that differential satiation characteristics of those needs are likely to translate into differential developments in income or expenditure elasticities as per capita income rises. As some needs (particularly those whose basis is physiological, like hunger or thirst) can be satiated at comparatively low income levels, income developments above this satiation-guaranteeing level are likely to leave the demand for goods serving these needs unaffected. In this sense, absolute expenditure on these goods is likely to stagnate, leading to a drop in expenditure shares and thus income elasticities as income rises. Indeed, cross-sectional evidence suggests that among goods like clothing, food, or alcohol, income elasticities are substantially higher among poorer segments of the population than among wealthier segments (Blundell et al. 1993). Hence, continuously rising income, as evidenced for Germany over the past 50 years (cf. STABU 2008: 626), may contribute to an ongoing adjustment of elasticities over this period.

Moreover, historical research suggests that in Germany alcoholic beverages (and particularly beer) were functionally reduced from aliments to stimulants as income rose in the wake of World War II (Tappe 1994; 2002), indicating that consumers may have increasingly come to abstain from alcoholic beverages as an everyday mean to satiate their need for calories or liquids. Simultaneously, a new awareness for health and body, also evidenced by Ruprecht (2005), may have induced a shift of preferences unfavorable to alcoholic beverages.

In empirical work using time-series data, shifts in preferences are traditionally modeled using (intercept) dummy variables, allowing for one or multiple breaks (Maddala and Kim 1998). The (implicit) assumption inherent in the dummy variable approach is that such changes occur due to an external shock, leading to an immediate adjustment of response parameters. In the face of both theoretical approaches introduced above this may not be appropriate for the case of beer. The addictive nature of alcohol, the credibility attributed to the health information, and the learning time associated with processing new information in order to change long-standing behaviors, may all account for a lag in consumer response to health information, as evidenced by Schneider et al. (1981) for the case of cigarettes. Hence, a less strict estimation

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[3] These thresholds were commonly based on the incidence of organ damages from drinking over extended periods (10 to 20 years). Accordingly, they are moderate by present standards and exceed currently accepted thresholds by roughly a factor 10 (cf. Bühringer et al. 2000).

[4] In accordance with Witt (2001) we will refer to this approach as "Learning to Consume" (henceforth: LTC).

technique is warranted for the case of beer. We therefore apply a gradually switching regression approach (Ohtani and Katayama 1985; Ohtani et al. 1990) to the aggregate demand for beer in Germany in the time between 1957 and 2007. Using a similar approach, Gallet and List (1998), and Gallet (1999) show a gradual shift in U.S. demand elasticities for beer and distilled spirits over the period from 1964 to 1992. Income elasticities for beer, for instance, drop significantly from -0.26 in the period from 1964 to 1973 to -0.83 in the period from 1983 to 1992. However, the number of additional controls used in their study is limited to the price of wine, such that doubts may be raised concerning their sensitivity to omitted variables. We will therefore extend their analysis taking into account the effects of other beverage prices and of demographic variables like the age and sex distribution of the German drinking population, whose importance for the explanation of consumption trends of alcoholic beverages has repeatedly been emphasized by epidemiological research (cf. Edwards et al. 1994; Bühringer et al. 2000; Babor et al. 2003) and economic analysis (e.g., Heien and Pompelli 1989; Selvanathan and Selvanathan 2004).

Moreover, by estimating the elasticity of beer demand in Germany data, we fill an existing 50-year lacuna in empirical economic research. While a number of studies have appeared in recent years analyzing cross-country alcohol consumption (Selvanathan 1991; 2006; Clements et al. 1997; Selvanathan and Selvanathan 2005; 2007; Nelson 2010),[5] none of these studies included Germany. Thus, the only elasticity estimations that we are aware of, and which explicitly deal with the beer demand in Germany stem from research conducted in the late 1950s and early 1960s (DBB 1967: 15). Table 1 summarizes these results by time period. Note that on a first glance these elasticities seem to roughly counter-trend the development of per-capita expenditure over the period from 1860 to 1960.

Table 1: Income elasticity estimates for Germany, 1860 - 1960

Period	Income elasticity estimate
Germany (Empire and Weimar Republic)	
1860 - 1879	1.68
1870 - 1889	1.36
1880 - 1899	1.01
1890 - 1913	0.68
1850 - 1913	1.10
1927 - 1928	1.00
Federal Republic of Germany	
1950 - 1951	1.00
1950 - 1954	1.34
1950 - 1959	1.15
1955 - 1957	1.14
1950 - 1960	1.05

Source: 8. Statistischer Bericht des Deutschen Brauer-Bundes e.V., 1967, p. 15.

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[5] Most of them report beer consumption to be positive and income inelastic (mean elasticity: 0.67), and responsive to price (mean elasticity: -0.27) for most countries (cf. Selvanathan and Selvanathan 2007).

The German beer consumption data

This section summarizes the basic beer consumption data for Germany for the years from 1957 to 2007. All data were obtained from various issues of the Statistical Bulletin (Statistischer Bericht) of the German Brewing Association (Deutscher Brauer-Bund e.V.). Until 1990 only information on former Western Germany is included. From 1991 onwards the data refer to the unified Germany.

Table 2 presents per capita consumption of beer, wine,[6] distilled spirits, and non-alcoholic soft drinks [7] at the beginning (1957) and the end (2007) of the sampling period and a middle year (1976) in liters as well as in pure alcohol terms consumed annually per person. In order to see whether reunification had any effect on average consumption we included the values for the two years before (1990) and after (1991) this major demographic shift found its way into official statistics.

Table 2: Beverage Consumption Data for Germany, 1957 – 2007[a],[b]

Beverage type	Year				
	1957	1976	1990	1991	2007
	Alcoholic Beverages				
Beer	81.8 (3.93)	150.9 (7.24)	142.7 (6.85)	141.9 (6.81)	111.8 (5.37)
Wine	8.2 (0.90)	23.6 (2.60)	27.1 (2.98)	26 (2.86)	24.4 (2.68)
Distilled Spirits	4.4 (1.45)	8.8 (2.90)	6.2 (2.05)	7.5 (2.48)	5.5 (1.82)
Total	94.4 (6.28)	183.3 (12.74)	176 (11.88)	175.4 (12.15)	141.7 (9.87)
	Non-alcoholic Beverages				
Soft drinks	31.3	115.5	209.6	203	298.2

[a] , scale: liters per capita for persons aged 18+ (liters of pure alcohol per capita in parentheses).
[b] ,The conversion to pure alcohol was achieved using specific volume percentage for beer (4.8%), wine (11%) and distilled spirits (33%) as recommended for Germany by Bühringer et al. (2000).

As can be seen from row 1 of Table 1, per capita beer consumption increased from 81.8 liters in 1957 to its peak of 150.9 liters in 1976 and then declined to 111.8 liters by 2007. Per capita wine consumption has increased three-fold in the period from 1957 to 2007 from 8.2 liters to 24.4 liters. It, however, reached its peak of 27.1 liters by 1990, dropped by 17.3% until 1993 and has been growing slightly but steadily since then. The per capita consumption of distilled spirits doubled to 8.8 liters from 1957 to 1976, and then decreased to 5.5 liters by 2007. Per capita consumption of non-alcoholic beverages has increased almost linearly from 31.3 liters in 1957 to 298.2 liters in 2007, and has thus seen a 10-fold increase over the observation period.

Whereas per capita consumption of beer and non-alcoholic beverages appear to be largely unaffected by the German reunification, per capita consumption of wine drops by 17.3% from 1990 to 1993 and consumption of distilled spirits increases by 20.1% in the same period. This strongly suggests that while per capita consumption of beer and non-alcoholic beverages were similar in Eastern and Western Germany, Eastern Germans had a much higher per capita con-

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[6] Including: sparkling wine.
[7] Including: mineral waters, caffeinated and non-caffeinated soft drinks and juices.

sumption of distilled spirits and a much lower consumption of wine compared to their Western counterparts.

Figure 1 presents the consumption of the three alcoholic beverages and the total alcohol consumption measured in terms of pure alcohol. It can be seen that pure alcohol consumption fell over the last three decades to its early 1960s level. Both beer and spirits contribute to this fall, whereas wine stabilizes around 2.6 liters from the mid-1970s onwards.
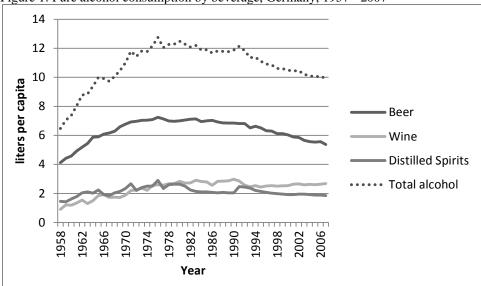
Figure 1: Pure alcohol consumption by beverage, Germany, 1957 - 2007

Source: Statistical Bulletin (Statistischer Bericht) of the German Brewing Association (Deutscher Brauer-Bund e.V.), various issues.

Assume q_{it} to be the per capita consumption and p_{it} the undeflated price chained to 1957 = 100 per unit of beverage i in period t, where $i = 1$ for beer, $i = 2$ for wine, $i = 3$ for distilled spirits, and $i = 4$ for non-alcoholic soft drinks. The log-change in per capita consumption is then defined as $Dq_{it} = \log Dq_{it} - \log Dq_{it-1}$. When multiplied by 100, the mean values of these log-changes $D\bar{q}_i = (1/T - 1) \sum_{t=2}^{T} Dq_{it}$ can be interpreted as annual average growth rates (Selvanathan and Selvanathan 2005). Similarly, the change in price per unit is given by $Dp_{it} = p_{it} - p_{it-1}$. Relative prices p'_{it} are given by $p'_{it} = p_{it}/P_t$, where P_t is the consumer price index for all beverages.[8] Thus $Dp'_{it} = p'_{it} - p'_{it-1}$ represents the annual growth rate of relative prices in the beverage market with an average annual growth rate of $D\bar{p}'_i = (1/T - 1) \times \sum_{t=2}^{T} Dp'_{it}$.

Figure 2 plots the relative price indices of beer, wine, spirits and non-alcoholic soft drinks. There is a lot of fluctuation in the relative prices of all four beverages without a clear trend for distilled spirits and non-alcoholic soft drinks. Beer prices exhibit a distinct growth starting in the mid-1980s. Wine has the lowest relative prices over the whole sample period.[9]

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[8] P_t is given by the sum of indexed prices for each beverage i, weighted by the corresponding consumption share $P_t = \sum_{i=1}^{4} w'_{it} p_{it}$, where $w'_{it} = q_{it}/Q_{gt}$, $i = 1,2,3,4$, within the whole beverage market and $Q_{gt} = \sum_{i=1}^{4} q_{it}$.
[9] Note that prices for all beverages have increased significantly less than the overall consumer price index (CPI).
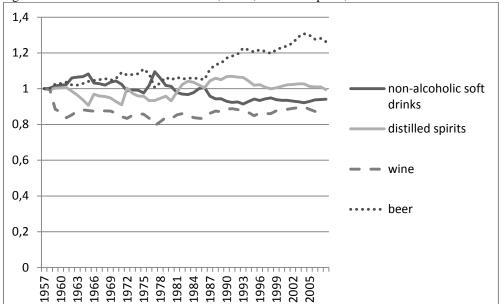
Figure 2: Relative Price Indices for Beer, Wine, Distilled Spirits, and Non-alcoholic Soft Drinks

Source: Federal Statistical Office (Statistisches Bundesamt).

Table 3 presents the average log-change in consumption Dq_i' and the average annual growth rate in relative price for beer, wine, distilled spirits and non-alcoholic beverages over the entire sample period. It can be seen that average beer consumption rose by 0.6% per annum and distilled spirits and wine consumption increased by 0.78% and 2.11% per year, respectively. Most notably is the rise of non-alcoholic soft drink consumption that amounts to 4.26% per annum. All relative prices, except the one for beer, decrease on average, whereas the average decline in relative price for distilled spirits is marginal. Overall, non-alcoholic soft drinks and wine have seen a rapid growth in consumption and a sizeable drop in prices over the observation period compared to the other two beverages. These findings are consistent with the results of Selvanathan and Selvanathan (2004; 2005) for other developed countries.

Table 3: Average per capita consumption and relative price growth of beverages

Beverage	Consumption $D\bar{q}_i$	Relative Price $D\bar{p}_i'$
	Alcoholic Beverages	
Beer	0.6	0.52
Wine	2.11	-0.26
Distilled spirits	0.78	-0.01
	Non-alcoholic Beverages	
Soft drinks	4.26	-0.12

However, Table 3 also provides a first indication for an anomaly in beer demand. On average, beer consumption rose despite rising relative prices. To investigate this phenomenon further Table 4 presents the frequency distribution (in percentage points) of joint signs of consumption and relative price changes for beer. It compares the signs of the first differences in prices

and demand over three periods of observation.[10] From the law of demand one would expect that increases in relative prices are accompanied by a reduction in demand and decreasing relative prices coincide with an increase in consumption. The percentage of the total number of observations which obey this regularity are given in columns (2) (positive consumption and negative price development) and (3) (negative consumption and positive price development). For the entire period of observation, they add-up to 54% of all observations. Hence, in 46% of the time relative prices and per capita intake moved in the same direction.[11] Again this underscores the surprising result found in Table 3.

In a next step the available time series was therefore split into two sub-segments of equal length. Results for the sub-segment covering the earlier period from 1958 to 1982 are presented in row (2) and results for the sub-segment covering the ensuing, later period from 1983 to 2007 are given in row (3) of Table 4. Clearly, the relationship between relative prices and demand differs between these periods. Relative prices and consumption move in opposite directions in only 44% of the times in the earlier half of the time series, whereas such developments can be observed in 64% of the time in the latter half.[12] These results provide a first indication for the presence of a substantial structural shift in the demand for beer.

Table 4: Frequency distributions of joint signs of relative price and consumption changes for beer, Germany, 1958 – 2007

	Signs of relative consumption and price changes in percent (absolute values in parentheses).			
	Positive consumption change		Negative consumption change	
Period	Positive price change (1)	Negative price change (2)	Positive price change (3)	Negative price change (4)
	Entire period			
1958-2007	40 (20)	18 (9)	36 (18)	6 (3)
	Temporal sub-segments			
1958-1982	52 (13)	32 (8)	12 (3)	4 (1)
1983-2007	28 (7)	4 (1)	60 (15)	8 (2)

Empirical strategy

Similar to the preceding descriptive exercise, traditional approaches to testing temporal changes in demand equations usually assume that parameter adjustments are instantaneous and that there are distinct regimes before and after these adjustments (cf. Maddala and Kim 1998: Chap. 13). Such approaches hypothesize that structural breaks are exogenously determined and that individuals instantaneously adjust their behavior according to these shocks.

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[10] The table, thus, basically presents the results from three two-by-two tables (one for each observation period) comparing the joint changes of relative beer prices (i.e., Dq_t) and per capita consumption (i.e., Dp'_t).

[11] A simple test of proportions against the null of a completely random relationship provides no evidence for such a systematic deviation.

[12] Tests of proportions against the null of a completely random relationship provide evidence for such a systematic deviation only for the latter sub-segment.

However, as argued in the introduction, several strings of research suggest that consumers may adjust their behavior gradually rather than abrupt when supplied with new information, or when adjusting their expenditure to behavior to rising income levels. Thus, an estimation technique less strict in its presumptions is warranted.

Comparable to other studies, we will therefore model the demand for beer by assuming the log of per capita consumption in period t (LBC_t) to depend upon the log of per capita real expenditure (TEX_t), the log of the price of beer (LPB_t), the log of the price of wine (LPW_t) and the price of distilled spirits (LPD_t) all measured at the same point in time.[13] According to historical (Tappe 1994; 2002) and economic (Lee and Tremblay 1992) research non-alcoholic beverages have increasingly been substituting alcoholic ones. We therefore also include the logs of the price of non-alcoholic soft drinks in period t (LPN_t).

Unlike most other studies, however, we will allow for a gradual change in the demand coefficients following an endogenously determined transition path. This is achieved estimating a gradually switching regression model as proposed by Ohtani and Katayama (1985) and Ohtani et al. (1990) and given by:

$$y_t = (\beta_i + \theta_t \gamma_i) X_{it} + \varepsilon_t, \quad t = 1, 2, \dots, T. \tag{1}$$

X_{it} is the tth observation of the ith independent variable, as described above. θ_t describes the gradual path of adjustment which equals zero before the adjustment and one afterwards. β_i and γ_i are the coefficients of interest, and $\varepsilon_t \sim N(0, \sigma^2)$. The model estimated is specified as:

$$\begin{aligned} \text{LBC}_t = (\beta_1 + \theta_t \gamma_1) TEX_t + (\beta_2 + \theta_t \gamma_2) LPB_t + (\beta_3 + \\ \theta_t \gamma_3) LPW_t + (\beta_4 + \theta_t \gamma_4) LPD_t + (\beta_5 + \theta_t \gamma_5) LPN_t + \\ (\beta_k + \theta_t \gamma_k) \boldsymbol{C}_t + \varepsilon_t, \end{aligned} \tag{2}$$

where $\boldsymbol{C}_t$ is a $(k \times 1)$ vector of controls, which will be defined below.[14]

The gradual adjustment of the parameters is achieved by allowing them to shift from β_i to $\beta_i + \gamma_i$ along a linear transition path, defined by:

$$\theta_t = \begin{cases} 0, & for\ t \leq t_2^*, \\ a_0 + a_1 t, & for\ t_1^* < t < t_2^*, \\ 1, & for\ t \geq t_2^*, \end{cases} \tag{3}$$

where t_1^* is the end point of the first regime and t_2^* is the starting point of the second regime.[15] They can therefore be interpreted as the starting and the end point of a gradual switching process. Given the values of these two points and the linearity of the transition path it can be shown that:

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[13] Given that $\frac{d\ log f(x)}{d\ log x} = \frac{1}{f(x)} \times \frac{df(x)}{dx} \cong \frac{[f(x+\Delta) - f(x)]/f(x)}{[(x+\Delta) - x]}$ is interpreted as the elasticity of $f(x)$ with respect to x, i.e., the percentage change in $f(x)$ resulting from a 1% increase in x (Hamilton 1994: 717).

[14] Given the limited number of cases we decided to drop the intercept from the estimation in order to safe two degrees of freedom.

[15] Note that the traditional dummy variable model is nested in the gradually switching approach, in which case $t_2^* = t_1^* + 1$.

$$\theta_t = \frac{t - t_1^*}{t_2^* - t_1^*}.$$

(4)

We obtain the starting and end points of the transition path by a grid search over a two-dimensional region of (t_1^*, t_2^*), based on the principle of minimization of Akaike's (1974) An Information Criterion (henceforth: AIC) and Schwarz's (1978) Bayesian Information Criterion (henceforth: SBC).

To account for socio-demographic, economic and environmental influences on beer demand we include average annual temperature, average annual unemployment rate and the share of males aged between 16 and 29 as controls into the estimation.

Both alcohol consumption and its consequences follow a seasonal rhythm, largely triggered by environmental factors like temperature, precipitation, and radiation via the circannual calendar (Poikolainen 1982; Lemmens and Knibbe 1993; Uitenbroek 1996). Econometric modeling usually accounts for this factor by including the average temperature per period (cf. Franses 1991; Bratina and Faganel 2008). We will follow the same path by including the log of average annual temperatures for Germany. Data were obtained from the website of Deutscher Wetterdienst.

How macro-economic conditions influence alcohol consumption is still a matter of debate. Whereas conventional economic literature holds that alcohol is a pro-cyclical, normal good (cf. Freeman 1999; 2000), the prevailing view from the investment side is that alcohol, and especially beer, is a recession-proof, counter-cyclical good (Ahrens 2004). While this discussion might be futile in the case of obvious luxury goods like champagne, both strings of argument are reasonable for the case of beer. On the one hand economic up-swings are accompanied by a rise in disposable income, which as long as income elasticities are non-negative should result in an increase of per capita consumption. Using Canadian data Khan et al. (2002) indeed show that a higher degree of employment is accompanied by a higher the use of alcohol.[16] On the other hand psychological theory suggests that alcohol is acyclical, as economic downturns cause stress-induced drinking. Brenner and Mooney (1983) find an increase in the frequency of a number of self- and other-destructive activities, including alcohol abuse, during periods of unemployment. To control for possible influences of economic conditions we additionally include the annually averaged unemployment rate as a further control into the estimation. Data were provided by the Bundesanstalt für Arbeit.

In contrast to the influence of unemployment, there is broad agreement by economic (Heien and Pompelli 1989; Selvanathan and Selvanathan 2004) and epidemiological research (cf. Edwards et al. 1994; Bühringer et al. 2000; Babor et al. 2003) on the role demographic effects play in alcoholic beverages demand. Numerous studies evidence a significant influence of sex, age and certain household characteristics on market demand for alcoholic beverages. Changes in the distribution of these factors in a population are thus likely to influence the amount of alcohol consumed. Due to the limited number of observations we follow the example of Nelson (2010) and control for these changes by inserting the share of males aged be-

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[16] The WHO (2004) also reports a link between economic prosperity and rising alcohol consumption for most developing and northern European countries.

tween 16 and 29 into the estimation. As this age-sex-group is the segment of the population with the highest per capita alcohol intake in Germany (Bühringer et al. 2000), changes in the segment-share should control for most of the changes in average per-capita consumption.

Results

Table 5 provides the results from the estimation, given equation (2) where C_t are the population share of males between 16 and 29, the average annual temperature, and the average annual unemployment rate. The time-series of per capita beer consumption and average annual temperature are integrated of order 1, as a series of augmented Dickey-Fuller-Tests (1981) shows. To avoid spurious results we therefore include an additional linear trend (Durlauf and Philips 1988).

Table 5: Gradually switching regression estimates

Variable	Initial elasticities (β_i)	Post-adjustment elasticities $(\beta_i + \gamma_i)$	Homogeneous $(\gamma_i = 0)$
	Variables of Interest		
Total expenditure	0.62***	-0.59***	0.91***
	(4.53)	(-2.88)	(6.81)
Beer price	0.51**	-1.09***	-0.08
	(1.95)	(-2.48)	(-0.15)
Wine price	-0.21**	1.46***	-0.37
	(-2.03)	(3.08)	(-1.45)
Distilled spirits price	0.23**	-1.21***	0.08
	(2.04)	(-2.87)	(0.32)
Price of non-alcoholic Beverages	0.17*	-0.26	0.10
	(1.52)	(-1.09)	(0.56)
	Controls		
Temperature	-0.01	0.09	0.002
	(-0.23)	(1.21)	(0.028)
Share of males, aged 16 to 29	-10.96***	17.26***	-3.23*
	(-6.54)	(5.68)	(-1.69)
Unemployment rate	0.007*	0.004	-0.0008
	(1.51)	(0.49)	(-0.11)
Linear trend	0.03***	-0.02**	-0.02***
	(3.43)	(-2.26)	(-5.91)
AIC	-346.258		-166.5896
SBC	-344.3262		-141.4758
Points of transition	$t_1^* = 1965; t_2^* = 2004$		
Coefficients of transition path	$a_0 = 0; a_1 = .0244$		

[a], the dependent variable is the log of annual per capita beer consumption (t-values in parentheses).
***, Significant at the 1% level; **, Significant at the 5% level; *, Significant at the 10% level.

A glance at AIC and SBC values reveals that allowing for time-variant responses within a gradually switching regression framework outcompetes an alternative model assuming response homogeneity in two standard measures of the goodness-of-fit. That is, assuming stable response patterns to price and income changes is not advisable for the case of beer demand in

Germany. This finding is consistent with earlier results from Horowitz and Horowitz (1965), and Gallet and List (1998) for the U.S., who also find price and income sensitivity to change over time.

The results obtained from the gradual switching regression estimation suggest that almost all elasticity estimates changed significantly from 1965 to 2004. Columns 1 and 2 of Table 5 illustrate the parameter variation before and after the transition phase. Except for the cases of non-alcoholic soft drinks, temperature and unemployment rate, all parameters estimated are different from zero at standard levels of significance, both before and after the transition phase.

In accordance with both state-dependent utility and LTC, expenditure elasticity of beer demand dropped over the period from 1957 to 2007. The results obtained do not allow testing directly between the two theories, as the period was characterized by a decrease in the perceived low-risk amount of daily alcohol-intake as well as an almost linear increase in real total expenditure. However, recall that the first systematic dissemination of information on the detrimental effects of alcohol by public health authorities in Germany dates to mid-1970s (Bühringer et al. 2000: Chap. 5). Hence, the estimated starting point of the transition process in 1965 actually predates this public discussion by almost a decade, suggesting that a growing awareness on the detrimental effects of alcohol is unlikely to explain the observed phenomenon in its entirety.

As the estimates reveal, expenditure elasticity of beer demand is positive and inelastic in the period before 1965, but after that slowly turns negative until it reaches -0.59 in 2004. That is, between 1990 and 1991 beer turned from an expenditure inelastic to an inferior good in Germany. These results are similar to the ones obtained by Gallet and List (1998) for the U.S. but correspond to a minority of results estimated assuming response homogeneity (e.g., Nelson 2003).[17] They, however, contradict the results of most other studies (cf. Selvanathan and Selvanathan 2007). Numerous factors might explain these differences. Gallet (2007) has shown that the range of existing estimates can be explained partially by differences in the specification of the estimated model, estimation techniques, underlying data structure and control variables included in the estimation. Yet, while controlling for the year of publication (which has a very small but significant, positive coefficient) he fails to control for the time period covered by the data. Our results suggest that the more recent the data used in estimation, the smaller the estimated expenditure elasticity for beer, pointing towards a shift of preferences away from beer.

The development of the own-price elasticity for beer demand supports this conjecture of changing preferences. While beer demand is price inelastic, with a positive sign in the period before 1965, it is -1.09 after 2004, and thus both negative and price elastic, implying that consumers have become more sensitive to price changes in beer. From policy standpoint, this result has significant implications, especially when compared to the estimated own-price elasticity of the homogenous model (which is slightly negative but insignificantly different from zero). Increased excise taxation on beer may have only slowly turned into an effective tool to

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[17] It is interesting to observe that Nelson (2003) uses comparatively recent data ranging from 1975 to 2000.

curb per capita beer consumption during the 1970s. Notably, at the expense of lower tax revenue. On the other hand, the coefficient obtained from the homogenous model suggests that excise taxation would have no effect on the amount of beer consumed.

Beer and Wine have been complements before 1965 ($\epsilon^{BW}_{t<1965} = -0.21$) but become substitutes after 2004 ($\epsilon^{BW}_{t>2004} = 1.46$). Beer and distilled spirits, on the other hand, are substitutes before the transition phase ($\epsilon^{BD}_{t<1965} = 0.23$) and complements after that ($\epsilon^{BD}_{t>2004} = -1.21$). Prior to 1965 non-alcoholic soft drinks were considered a substitute for beer ($\epsilon^{BN}_{t<1965} = 0.17$). During the transition phase, however, these product categories become increasingly unrelated and the parameter for the post-2004 regime ($\epsilon^{BN}_{t>2004} = -0.26$) is not significantly different from zero. Thus, if any, there is only weak support for the claim that beer and non-alcoholic soft drinks can be considered substitutes in Germany. Especially there is no indication that there has been an increasing substitution from beer to non-alcoholic alternatives, as claimed by Tappe (1994; 2002).

Another intriguing result obtained from the gradually switching approach concerns the demographic variable in the model. Whereas after 2004 an increase in the population share of males aged between 16 and 29 leads to an increase in per capita beer consumption, as predicted from the results of Bühringer et al. (2000), the relationship is inversed before 1965. This implies that this segment of the population has massively gained in importance in determining per capita consumption over the past 50 years. Thus not only the distribution of demographic parameters changed, but also the distribution of per capita consumption within the population and between certain segments of the population. These results remain robust when inserting other age-sex-segments into the estimation. For future economic and epidemiological research this result has important consequences, as assuming time-invariant distribution of consumption patterns over a population is not a feasible strategy. Yet, the fact that older segments of the population seem to have reacted stronger to the increasing information on the adverse health effects of alcohol consumption is not so surprising if one takes into consideration that many diseases caused by alcohol develop only after long-term heavy drinking (Edwards et al. 1994: 81) and that health generally deteriorates with age, leading to an increasing awareness of health information (Svedberg 2006). Other control parameters stay more or less constant.

Given that the start and end points of the transition phase are very close to the start and end points of the period of observation it must be assumed that the estimated stable regimes for the demand of beer are an artifact of measurement rather than a real life fact or at least that stable market equilibria in the demand for beer have been scarce and short in Germany over the past 50 years.

Conclusions

We employ a gradually switching regression approach as proposed by Ohtani and Katayama (1985), and Ohtani et al. (1990) to allow parameter heterogeneity over time for the case of beer demand in Germany. AIC and SBC values reveal that such an specification is better suited to describe the demand for beer in Germany than an alternative model assuming parameter

constancy over the whole period of observation. Primarily, this result suggests that there has been an economically meaningful and statistically measureable structural change in German beer demand between 1965 and 2004. As the traditional dummy variable approach is nested in the switching regression framework, we may further conclude that assuming a slow and step-wise adjustment of parameters is superior to presuming an instantaneous and immediate change of coefficients following an external shock. Thus, the gradually shifting regression approach is well suited for identifying the nature of this structural change.

The estimated elasticities illustrate the presence of important dynamics in the responses to changes in prices and total expenditure. Clearly these dynamics have resulted in a shift away from beer, partially explaining the reduction in alcohol consumption in Germany over the past 30 years. Future work might concentrate on the dynamics underlying the demand for wine and distilled spirits. Considering that unlike beer and distilled spirits, there is no excise taxation on wine in Germany, these results should have considerable impact on future tax or health policies concerning alcoholic beverages.

When evaluating the efficacy of proposed policy alternatives, understanding coefficient dynamics is fundamental. For the case of setting tax rates, estimated elasticities indicate that a naïve policymaker, ignoring temporal heterogeneity, would have incorrectly assessed their effects over the 1957–2007 period. Whether these changes were primarily fueled by an increasing public awareness of the dangers of alcohol consumption, as state-dependent utility theory suggests, or by a general income-driven shift of preferences towards a healthier lifestyle, as LTC proposes, might be a focal point for future research. Estimated transition points strongly suggest that changing information sets are unlikely to account for the entire phenomenon.

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