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The Market Share of Wine in Denmark*

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Abstract

This paper analyzes the position of wine in the Danish alcohol market from 1978 to 2008. During this time period the market share of wine has doubled, assumingly due to a tax-induced change in relative prices as well as behavioral changes. This paper models the yearly observed market share of wine by unobserved component models which allow for adaptive trends including regressions with time varying coefficients. I find that the market share of wine has a steady upward trend even if it was temporarily broken by a tax reduction for liquor in 2001. (JEL Classification: C22, D11, L66)

I. The Danish Alcohol Market

After a steady increase until the late 1970s, Danish overall alcohol sales have been flat for the last 30 years – in spite of rising population, incomes and wealth. Figure 1 reports recent consumption trends for pure alcohol equivalents. Accordingly, while the overall alcohol consumption as well as the consumption of liquor has been fairly constant wine has gained substantial market share at the expense of beer.

Figure 2 shows price index series, defined as yearly averages of monthly consumer prices including all taxes. To some extent, the growing market share of wine is explained by changes in the price relations of wine to beer and liquor. By using price ratios all irrelevant common factors like inflation and economic growth are divided out. The major jumps in the price indices as reported in Figure 2 and therefore also in the price relations are mainly due to changes in the taxation of alcohol in 1992–1993 and again in 2003. The tax reduction in the 1990s was due to a relaxation on the restrictions on the border trade with wine and beer (but not liquor), which was feared to increase the private import dramatically. In 2001, the restrictions on border trade with liquor had to be relaxed due to directives from the European Union and the taxation of liquor was similarly reduced

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Figure 1

Sales of Alcohol in Denmark

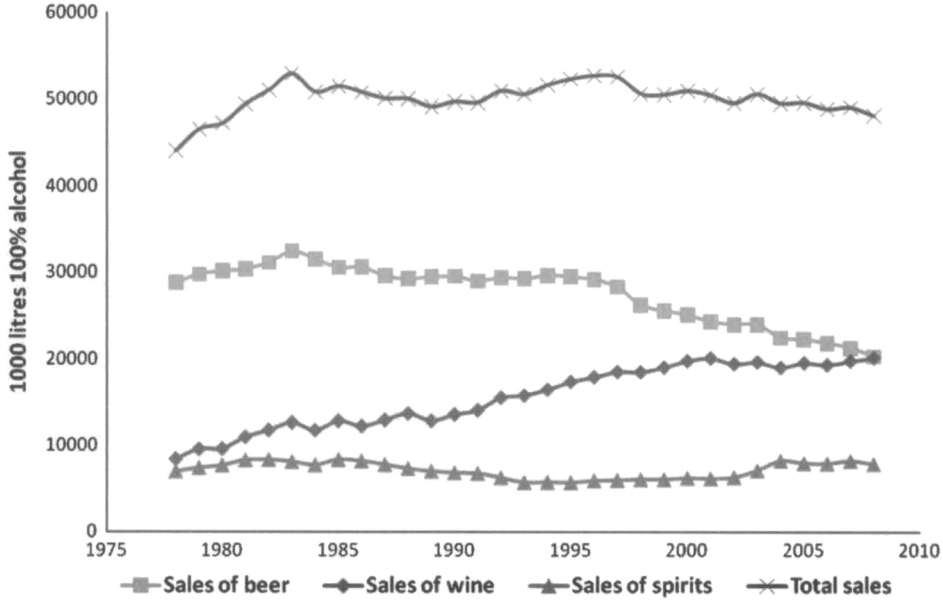
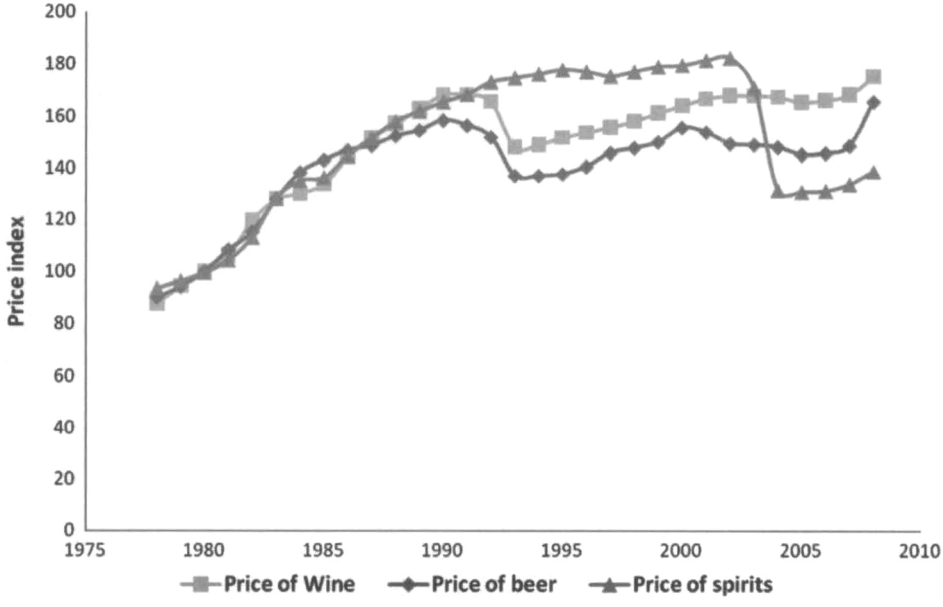


Figure 2

Price Indices for Beer, Wine and Liquor in Denmark



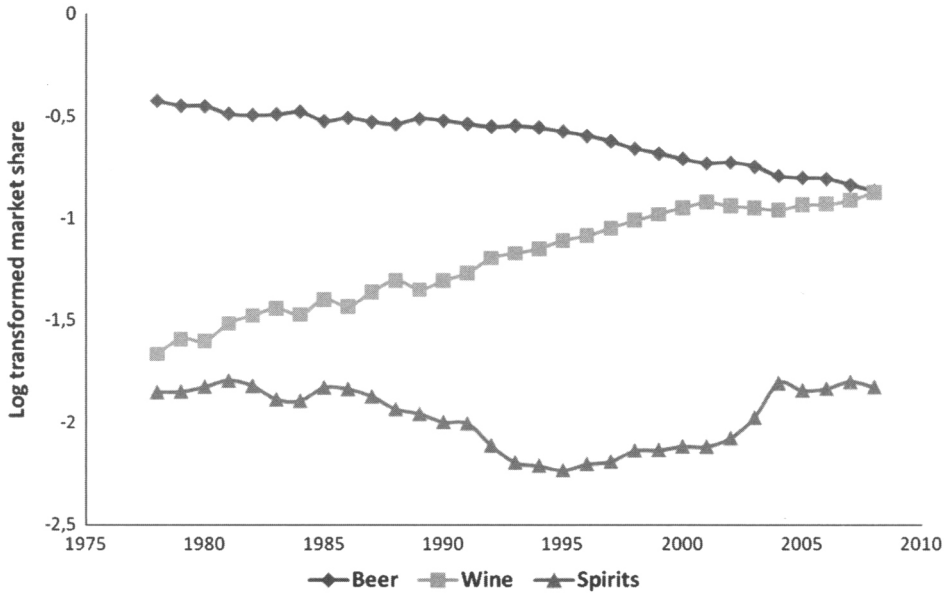
in order to prevent a dramatically increasing private import. Historically Danish alcohol taxes favoured domestic production with a higher taxation on wine than beer and moreover with a specific taxation on liquor such that imported liquor were more heavily taxed than the traditional Danish products. Now, the tax rates refer mainly to the alcohol content of wine and beer; only liquor is subject to a higher tax.

Figure 3 shows the log transformed market shares of wine, beer and liquor. Note that the market share in this paper is defined as the quantitative market share, i.e., when all types of alcohol are converted to 100% alcohol. This definition is of course controversial as it suggests that the desired Danish alcohol intake is independent of its source. However, the fact that total alcohol sales in terms of pure alcohol have virtually been constant, even if the market shares of the three types of alcohol have changed significantly, supports this point of view. This argument finds additional support since many restrictions and recommendations regarding the consumption of alcohol (e.g., alcohol limits for drivers and pregnant women), refer to the alcohol content independent of its origin.

The market share of wine has increased almost linearly for many years up to 2001. Since then, the trend appears to decline. The market share of liquor is U-shaped, declining for many years but rising recently. This could be due to the tax regulations which in the 90s reduced the tax on wine and beer but not on liquor. Conversely, the tax on liquor was reduced in 2001 while the tax on wine and beer has been unchanged.

Figure 3

Log-Transformed Market Shares of Wine and Liquor



When studying these market shares over several decades one should take into account socio-economic and cultural factors such as changing eating habits or changes in income and population level and structure. Especially non-drinking immigrants may have had a major impact on per capita alcohol consumption. When studying alcohol consumption in Denmark, one also needs to consider the cross-border trade as Danes could save money by buying their alcohol in Germany while Swedes and Norwegians could save by buying in Denmark. The private cross-border trade is assumed to account for approximately 10% in either direction, in and out of Denmark leading to a zero net effect. Since data on the petty net cross-border trade are not readily available, this analysis considers the Danish alcohol market simply as the market for alcohol sold according to the Danish tax statistics. That is, it includes alcohol bought by Norwegians and Swedes in Denmark and excludes alcohol bought by Danes in Germany.

All these considerations lead to the conclusion that a formal statistical model with constant parameter values is impossible to formulate as important independent variables are not at hand and the dynamics might possibly have changed during the period under study. For these reasons models using the idea of adaptive unobserved components are appealing.

II. Models with Unobserved Components

In this paper the time series of yearly observed market shares for wine is modeled using unobserved components. Unobserved component models (see e.g. Harvey, 1989) provide a rich and flexible class of models for data series. They are especially relevant for the present study since they allow for time varying structures, which can properly describe the market share of wine in a changing market environment. In its simplest form the series of yearly observed market shares, called y_t, is decomposed into a level term and a remainder term of the form

$$y_t = \mu_t + \varepsilon_t,\ \varepsilon_t \sim N\left(0,\ \sigma_\varepsilon^2\right) \tag{1}$$

In this expression the remainder term ε_t, called the irregular component, expresses a stochastic component, which is unexplained by the model. That is, a small variance σ_ε^2 indicates a close fit by the model. The level series μ_t in (1) includes a trend defined as follows:

$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t,\ \eta_t \sim N\left(0,\ \sigma_\eta^2\right) \quad \beta_t = \beta_{t-1} + \xi_t,\ \xi_t \sim N\left(0,\ \sigma_\xi^2\right) \tag{2}$$

The slope variable β_t is allowed to vary with time. The residual series η_t, ε_t and ξ_t are all assumed to be mutually independent white noise series, meaning that they each consist of identically distributed independent stochastic terms. Their variances give an idea of the stability of the components. For instance, while $\sigma_\xi^2 = 0$ results in a model with a constant trend, larger values of σ_ξ^2 allow the trend to fluctuate.

In Section IV and V this basic model is extended by regression terms in order to study the influence of the relative prices of wine to beer and liquor on the market share of wine. In the case of only one regressor this is done by simply adding regression terms to y_t:

$$y_t = \mu_t + \gamma_t x_t + \varepsilon_t \tag{3}$$

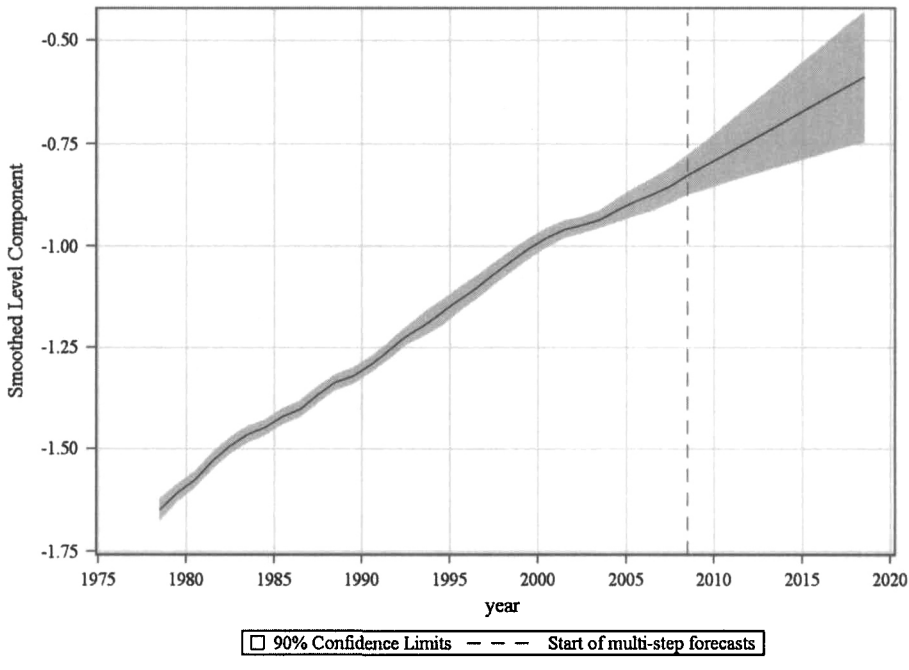
$$\gamma_t = \gamma_{t-1} + \zeta_t,\ \zeta_t \sim N\left(0,\ \sigma_\zeta^2\right) \tag{4}$$

using the above model (1) for the level series μ_t and the slope component (2) and introducing yet another residual series ζ_t assumed to be independently, identically distributed and also independent of all the previously introduced residual series in the model. Again, the value $\sigma_\zeta^2 = 0$ of the variance corresponds to a constant regression coefficient while positive values of the variance σ_ζ^2 allow for time varying regression coefficients.

Such models are special formulations of state space models (e.g., Durbin and Koopman, 2001) and are estimated by versions of the Kalman filtering algorithm (de Jong and Chu-Chun-Lin, 2003). In this paper all models are estimated by Proc UCM in SAS®. All reported values are estimated based on the full sample. Readers are referred to the SAS documentation for further details.

Figure 4

The Smoothed Level Component



III. Analysis of the Market Share of Wine Using Unobserved Components

In this section, the model given by (1) and (2), which only include a level term and a slope term, is applied to the log transformed market share of wine.

As shown in Figure 4, the level term exhibits steady growth until 2001 and has levelled off since then. The graph provides 90% confidence limits, and not the commonly used 95% limits, because all of the implicit testing in this analysis is for a one sided alternative, which is then easily done looking only at the relevant side of the confidence band.

Figure 5 depicts the smoothed slope component. In accordance with the results shown in Figure 4, the slope is almost constant at approximately 0.03 up to the late 1990s, suggesting an annual increase in market share by approximately 3%. From the year 2000 on, however, this value has dropped to about 0.015.

Table 1 reports the values of the level and slope components for 2008, i.e. the last observation year. The estimated value 0.017 of the slope parameter is much smaller than the value 0.03 in the 90's but it is still significant at a 5% level when tested against a one sided alternative. The idea behind models with unobserved components is that the estimated level and slope parameters could capture a new behaviour after a few observations; in this case, with a much flatter upward trend.

Figure 5

The Smoothed Slope Component

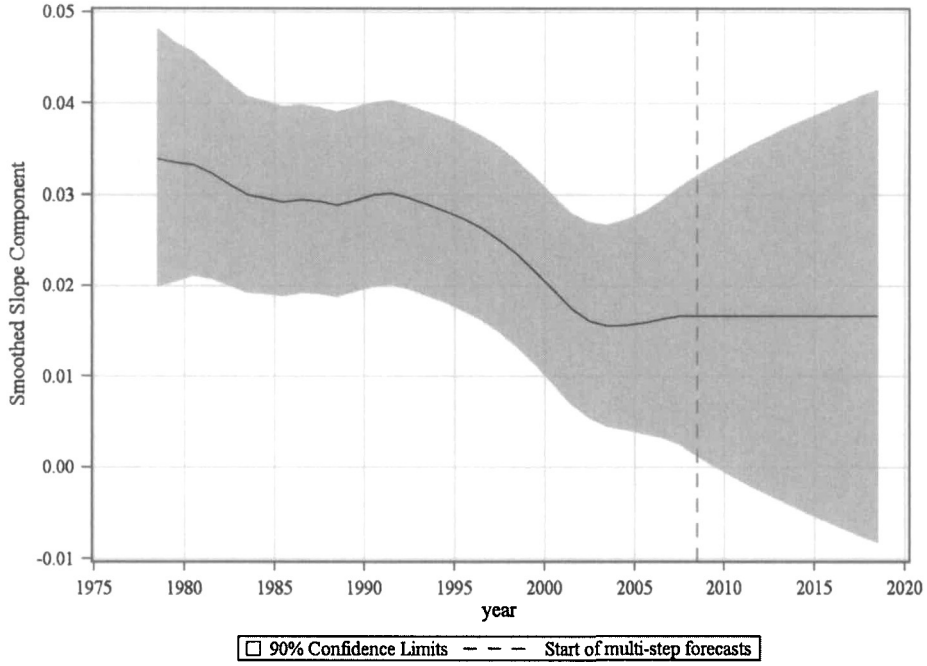


Table 1
Parameter Estimates

Parameter	*Estimate*	*Standard Error*
Level for last observation	−0.8806	0.0150
Slope for last observation	0.01663	0.0094
Variance of irregular component	0.0003136	0.0001980
Variance of level component	0.0004003	0.0003668
Variance of slope component	0.00001407	0.00002759

The forecasts, also given in Figure 4, are derived using the latest observed values of the level and the slope components and assuming a value of zero for the irregular component. The forecasts indicate a slight upward trend but the confidence limits are broad for longer horizons although the confidence level is specified to 90% instead of the commonly applied default value of 95%.

The irregular component, as shown in Figure 6, seems to be more volatile in the first years of the study but has exhibited a smaller variance and a reduced level since

Figure 6
The Smoothed Irregular Component

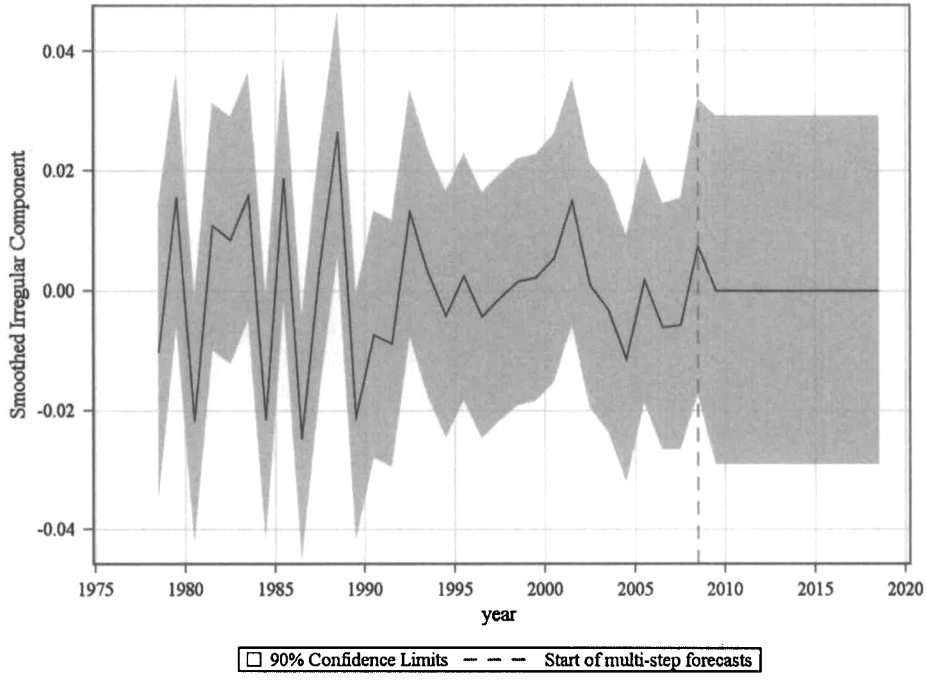
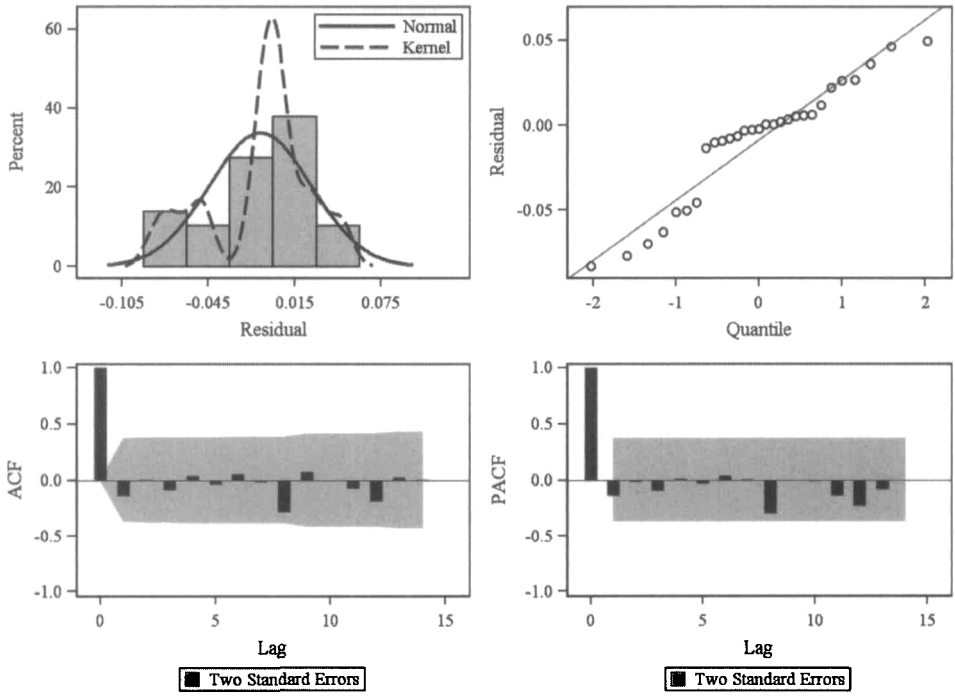


Figure 7

Model Fit Diagnostics



the early 1990s. In the residual plots of Figure 7 neither the histogram nor the Gaussian probability plot indicate any problems with the normality assumption in the model. Figure 7 also suggests that the independency assumption for the irregular series is met, as all estimated autocorrelations and partial autocorrelations are inside the confidence bands.

IV. The Effect of Relative Prices on the Market Share of Wine – Fixed Coefficients

In this section the model is extended by including price ratios as explanatory variables. More precisely, the model has the log-transformed market share of wine as the dependent variable and the log-transformed price ratios of wine compared to liquor and beer, x_t and z_t respectively, as independent variables using a fixed regression coefficient.

$$y_t = \mu_t + \gamma x_t + \delta z_t + \varepsilon_t \tag{5}$$

The level terms, μ_t, are modeled by the dynamic unobserved component model (1) and (2) as shown in Section III.

Table 2
Final Estimates of the Free Parameters

Regression coefficient	*Estimate*	*Approx Std Error*	*T Value*	*Approx Pr > |t|*
Price ratio of wine to beer	0.0163	0.1989	0.08	0.93
Price ratio of wine to liquor	−0.1639	0.0903	−1.82	0.07

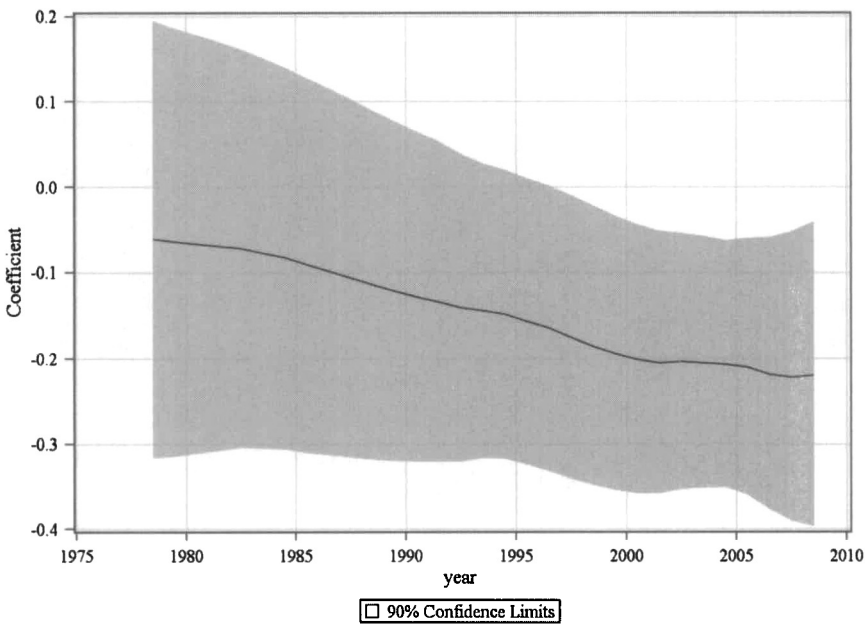
The results, reported in Table 2, show that, while the estimated coefficient of the wine to beer price ratio is statistically insignificant even at the 10% level, the price ratio of wine to liquor is significant at the 7% level; a one-sided test is significant at the 3.5% level. If the price ratio of wine to beer is dropped as an independent variable, the numerical value of the estimated regression coefficient is unaltered and the significance of the wine to liquor price ratio increases to p = 2.7%.

V. The Effect of Relative Prices on the Market Share of Wine – Adaptive Coefficients

In this section, I consider the inclusion of random coefficient regressors. Due to insignificance of the wine-beer price ratio as shown in Section IV, I only keep the wine-liquor price ratio as explanatory variable:

$$y_t = \mu_t + \gamma_t x_t + \varepsilon_t \tag{6}$$

Figure 8
Adaptive Estimation of the Regression Coefficient to the Wine-Spirits Price Ratio



$$\gamma_t = \gamma_{t-1} + \zeta_t,\ \zeta_t \sim N\left(0,\ \sigma_\zeta^2\right) \tag{7}$$

The model for the level component, μ_t, includes a level and a slope parameter (1) and (2). The time varying regression coefficient, γ_t, which could be interpreted as the cross price elasticity of wine with respect to liquor, is plotted in Figure 8. The diagram shows that the regression coefficient has changed from −0.10 before 1985 to around −0.20 in the years after 2005. The estimated fixed coefficient regression parameter in Section IV, −0.16 (see Table 2), can be interpreted as an average of these time varying regression parameter values.

As shown in Figure 9, the estimate of the slope parameter exhibits a value of 0.030 for the first years, but declines to values of approximately 0.025 in the last years of the considered time period. This is in contrast to the results in Section III where the estimated slope decreases to 0.017 for the last observation as reported in Table 1. This suggests that the underlying positive trend is constant and has not changed. The fact that the observed market share of wine has remained constant or even declined in recent years is mainly due to the increasing market share of spirits – caused by liquor tax reductions.

Table 3 reports the estimated variances corresponding to the stochastic components in the model. Compared to the similarly estimated values in Section III (see Table 1), the estimated variances for the level and slope components are substantially smaller. This

Figure 9

Smoothed Slope Estimate

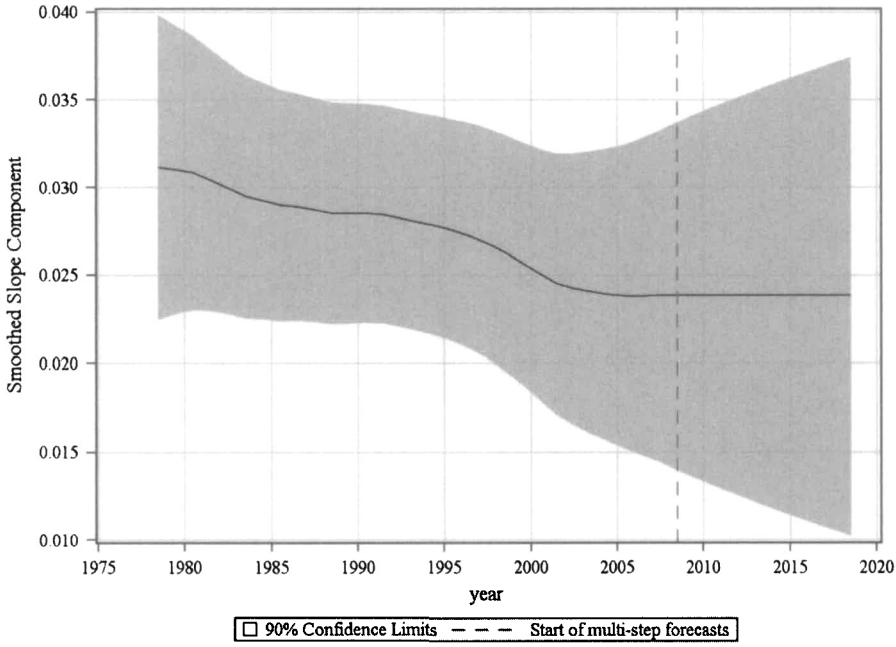


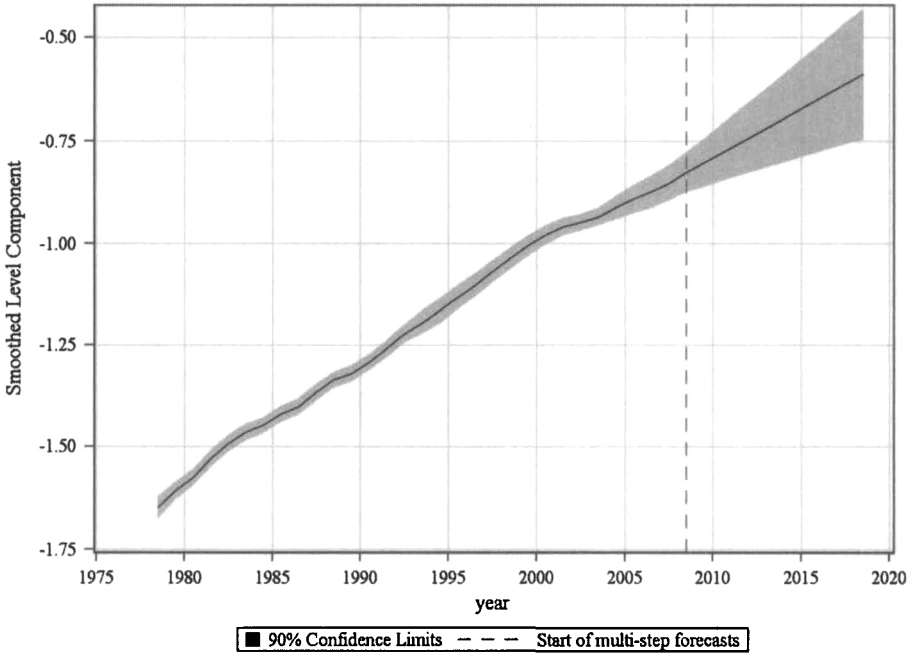
Table 3
Estimates of the Variances in the Adaptive Model

Component	*Estimate*	*Approx Std Error*
Irregular	0.000429	0.000245
Level	0.000214	0.000327
Slope	0.00000322	0.00001183
Wine to liquor price ratio	0.00123	0.00495

again indicates that the overall trend is almost constant, which suggests that the visible break in the direction of the trend in 2001 is solely due to the change in the taxation of liquor. While changes in price ratios may offset or dominate the trend variable temporarily, the trend toward an increasing market share of wine in Denmark is likely to remain unchanged for the near future.

This development is depicted in the forecasts of the level component, including the trend, in Figure 10. Note that Figure 10 reports narrower confidence limits than shown for the similar forecast of the model without price information (Figure 4). This is because the level and trend components are more precisely determined since the variances are

Figure 10
Level Component and Forecasts



much smaller in Table 3 than was the case in Table 1. This leads to more precise forecasts even if the estimated variance of the error component is somewhat larger in the model using the price ratio as an explanatory variable.

VI. Conclusion

Alcohol consumption in Denmark has been constant for many years. However, this does not implicate that the market situation is static. By employing models for unobserved components I demonstrated that the market share of wine increased by nearly 3% per year until 2001. The observed reduction in the market share of wine since 2001 is entirely due to changes in the taxation of alcohol favouring liquor over beer and wine.

References

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Durbin, J. and Koopman, S.J. (2001). *Time Series Analysis by State Space Methods.* Oxford: Oxford University Press.

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