Time patterns in UK demand for alcohol and tobacco: an application of the EM algorithm

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Abstract

Capturing the pattern of structural change is a relevant task in applied demand analysis, as consumer preferences may vary significantly over time. Filtering and smoothing techniques have recently played an increasingly relevant role. A dynamic Almost Ideal Demand System with random walk parameters is estimated in order to detect modifications in consumer habits and preferences, as well as changes in the behavioural response to prices and income. Systemwise estimation, consistent with the underlying constraints from economic theory, is achieved through the EM algorithm. The proposed model is applied to UK aggregate consumption of alcohol and tobacco, using quarterly data from 1963 to 2003. Increased alcohol consumption is explained by a preference shift, addictive behaviour and a lower price elasticity. The dynamic and time-varying specification is consistent with the theoretical requirements imposed at each sample point.
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1. Introduction

The use of Kalman filtering and smoothing techniques for estimating a dynamic and random walk coefficient version of the Almost Ideal Demand System is explored. The model is applied to UK alcohol and tobacco demand through the last four decades (1963–2003).

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Demand analysis is a relevant research field within economics and the issue of structural change is a major one throughout the literature. The Nobel laureate Richard Stone is acknowledged as one of the pioneers of modern demand analysis, as he was the first economist to promote a direct confrontation between economic theory and empirical evidence (Deaton, 1987). In his seminal paper on the Linear Expenditure System (LES), Stone (1954) estimated a complete system of demand equations, where the demand for each commodity is expressed as a function of income and the prices of all goods in the consumer bundle. The LES was estimated on UK time series data. In his further research on demand, Stone addressed two major time series issues still subject to scientific debate: the generalisation of demand systems to allow for (i) dynamic behaviours and (ii) time-varying parameters (TVP) to capture structural change in tastes and preferences. When a long time series is considered, the assumption of fixed parameters within a demand model becomes implausible because of the rise in income and living standards. Furthermore, demand equations are often derived as first-order local approximations of the true underlying demand functions. Thus, estimates from time-series data are only locally valid. Usually, the reference point is the sample mean, which is an undesirable limitation given that data are likely to be trending and non-stationary. In addition, theoretical constraints are also imposed and tested only locally and there is no guarantee that they hold throughout the whole time span.

Different approaches exist in the economic literature for modelling TVP. Stone (1964) provides a TVP version of the LES, where the coefficients are allowed to vary with a vector of lagged moving averages of expenditure. After the road-opening article by Kalman (1960), very few studies adopted the Kalman filtering (KF) techniques to estimate demand equations with TVP. The exponential growth in computing power has led to a wider use of the Kalman-based procedures to allow for changing parameters within demand systems. To our knowledge, Chavas (1983) was the first to exploit the KF to estimate a time-varying demand system. Recent research has focused on the Almost Ideal Demand System (AIDS) by Deaton and Muellbauer (1980), which is the most widely applied demand model in the literature. Leybourne (1993a,b) estimates a time-varying coefficient version of the AIDS (TVC/AIDS) on an equation-by-equation basis. Moosa and Baxter (2002) suggest systemwise estimation, but their stochastic specification is limited to a time-varying intercept (local linear trend) and a stochastic seasonal component. Deschamps (2002) also estimates a state–space dynamic AIDS with time-varying intercept by a Markov chain Monte Carlo method, using a Bayesian hierarchical prior. None of the above models allows for time-varying cross-equation constraints, such as the symmetry restrictions required by the economic theory. This issue is addressed within a different model specification by Doran and Rambaldi (1997), while Mazzocchi (2003) explores the TVC/AIDS model with full implementation of the time-varying homogeneity and symmetry constraints. The statistical implications of testing time-varying constraints within the AIDS framework are discussed in Leybourne (1993b). The estimation of the TVC/AIDS model through procedures based on the KF has proven to successfully investigate two key patterns of consumption behaviour, changes in tastes and in seasonal variations. These are essential explanatory factors of the demand dynamics for food and other frequently purchased goods. The consumption of alcoholic drinks and tobacco is especially interesting, for several reasons. First, these goods are subject to heavy government taxation, due to their relatively low price elasticity and the need for safeguarding public health. Under a policy perspective, changing behaviours