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CYCLICALITY AND DURABILITY: EVIDENCE FROM U.S. CONSUMERS' EXPENDITURE

Steven Cook*

Coventry Business School

In this paper three hypotheses concerning the cyclicality of U.S. consumers' expenditure are proposed. These hypotheses are based upon the distinction between expenditure on durable and non-durable goods. It is argued that durability will lead to increased cyclical sensitivity and that this increased cyclicality will be of an asymmetric nature. The asymmetric adjustment will be of the form of decreases in expenditure on durable goods being more extensive and more rapid during recessionary phases of the business cycle than corresponding increases during expansionary periods. These hypotheses are evaluated using U.S. data on consumer durables and non-durables over the period 1959-1998. Via the use of the Hodrick-Prescott (1997) filter the cyclical elements of these series are derived and subjected to Sichel's (1993) univariate tests of business cycle asymmetry. Overwhelming support is found for all of the hypotheses proposed.

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I. Introduction

Interest in the possibility of macroeconomic variables displaying some form of asymmetry or non-linearity has increased rapidly in recent years, both in terms of general applications and in relation to the business cycle (see Mills, 1991; Mullineux and Peng, 1993 for surveys of the literature). In this paper the adjustment of U.S. consumers' expenditure over the business cycle will be examined. In contrast to numerous studies which examine

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consumption at the aggregate level, consumption is disaggregated into its durable and non-durable components. This separation is employed as it is expected that durability will induce a degree of asymmetry into the adjustment of consumption over the business cycle, an issue that will obviously be masked in an analysis of the aggregate series. It will be argued that in comparison to non-durables, expenditure on durables will display significant cyclicality and that this will possess asymmetry of two forms. The asymmetry corresponds to expenditure falling faster and further during recessions than increases during expansionary periods. To test these predictions Sichel's (1993) tests of business cycle asymmetry will be employed.

In the next section the relationship between cyclicality and durability will be discussed, and the hypotheses to be tested will be proposed. Section III will present the two tests of asymmetry introduced by Sichel (1993), allowing these predictions to be directly evaluated. Section IV presents the results of applying these tests to U.S. data on durable and non-durable consumption, with Section V concluding.

II. Durability and Cyclicality

In this section the relationship between the durability of consumers' expenditure and its adjustment over the business cycle will be discussed. Rather than present a formal economic model, a series of plausible assumptions will be made which will lead to three hypotheses being proposed. It is the formal empirical evaluation of these hypotheses which is the focus of this paper.

The distinction between consumers' expenditure and consumption itself has long been recognised (see Darby, 1972). Consequently, expenditure on durables is sometimes suggested to be more closely related to investment decisions than standard consumer theory, with durable goods yielding a stream of utility over a given period. Expenditure on durables will therefore be more dependent upon the business cycle as, for example, during recessionary periods it is easier to defer the replacement of durables than reduce expenditure on non-durables which typically represent goods of a more necessary nature. The notion that durables are more cyclically sensitive than other goods can be referred to as Proposition I.

Following on from Proposition I, the next issue to be addressed is whether the proposed excessive cyclicality in consumer durables displays any form of asymmetry. It is typically assumed in economics that adjustment is smooth and symmetric. This is a highly restrictive assumption and it can be questioned whether durables adjust to a similar extent and at a similar speed during expansionary and recessionary periods. When the possibility of cyclical asymmetry is considered, the most plausible assumption to make is that in the presence of financial constraints, it will be easier to defer expenditure on durables goods during recessions, than increase it during economic upswings. As this adjustment refers to the cycle, it is thus relative to an underlying trend, and does not refer to the overall level of the series. Therefore it is hypothesised that expenditure on durables will be cut further during recessions than it is increased during expansions (Proposition II), and that the speed of adjustment will be greater during recessions as expenditure can be quickly decreased whereas increases may be subject to delay (Proposition III). Alternatively this rapid downward adjustment may be interpreted as implying that upswings are slow and steady. It is in this form that Gale (1996) proposed predictions for the adjustment of investment expenditure.

The empirical work conducted here can also be related to the theoretical analysis of Caballero (1993). Caballero (1993) considers the sluggish adjustment of durables and proposes a model in which transactions costs lead to the consumption of durables deviating from the level predicted by the permanent income hypothesis. Adjustment back to this desired path occurs when the deviation from it becomes so large that some upper and lower trigger points are reached. In the present context the asymmetric behaviour presented later can be explained by these trigger points being asymmetrically distributed about the permanent income path.

III. Testing for Asymmetric Behaviour

In Section IV each of the propositions presented above will be empirically evaluated. However, before the results of this analysis are presented, the methods to be employed will be discussed. Evaluation of Proposition I is relatively straightforward, requiring only that the cycle is isolated for each series and then compared. To examine Propositions II and III the deepness and steepness tests of Sichel (1993) will be applied to the cyclical elements of the durables and non-durables series[1]. The two tests of asymmetric behaviour presented by Sichel are based upon the skewness present in the level and the first difference of the cyclical element of a time series. While the deepness test considers the skewness of the level of this component and can therefore detect any peaks or troughs, the steepness test considers the difference, or change in this series and can therefore detect any differences in speed of adjustment towards these peaks or troughs. More precisely, the deepness test relates to the relative depth of the recessionary troughs below trend compared to height of the recovery booms above it. A negative statistic indicates that troughs are deeper than booms are high, while a positive statistic indicates the opposite. It is the former which is suggested by Prediction II. The second test of asymmetry, steepness, relates to the speed at which booms and troughs are approached. Again the statistic can be positive, indicating booms are approached more rapidly than troughs, or negative, indicating troughs are approached more rapidly. Prediction III suggests a negative steepness statistic for expenditure on durables. Before formally presenting the construction of these tests, an important feature to note is that they apply to the cyclical element of a time series. Therefore if we consider a time series x_t (expressed in natural logarithms):

$$x_t = \tau_t + c_t + \xi_t \tag{1}$$

[1] An initial application of these tests can be found in the examination of *aggregate* U.K. consumers' expenditure by Holly and Stannett (1995).

where τ_t is the non-stationary trend component, c_t is the stationary cyclical component and ξ_t is the irregular component which is $\mathrm{NID}\left(0,\sigma_\xi^2\right)$, the tests of asymmetry are performed upon the cyclical component c_t. Isolation of this cyclical element requires the use of a method of trend extraction, with the choice of an appropriate method being a far from uncontroversial issue (see Harvey and Jaeger, 1993; Cogley and Nason, 1995). As will be seen in the following section, the variables under consideration here are stochastically trending, or I(1), variables and the detrending method employed is the familiar Hodrick and Prescott (1997) (HP) filter. The HP filter has several factors in its favour. As it is a linear filter, it can not induce asymmetry, and although it may accentuate booms and troughs, this would be of benefit in the present study as it will allow any asymmetry present to be more easily detected. The HP filter also has some advantages over alternative approaches such as the structural time series model approach of Harvey and Jaeger (1993) and the closely related exponential smoothing filter (see King and Rebelo, 1993). More precisely, the HP filter proposes a trend which is the solution to the minimization problem:

$$min\sum_{t=1}^{T}\left\{\left(x_t-\tau_t\right)^2+\lambda\left[\left(1-\mathrm{L}\right)^2\tau_t\right]^2\right\} \tag{2}$$

where L is the lag operator and λ is the smoothing parameter. In theory λ can be set at any value, with the extreme values of $\{0,\infty\}$ leading to the HP trend coinciding with the original series and a linear trend respectively. Values of λ other than zero cause the last term in (2) to smooth out the trend by penalizing the rate at which the slope of the trend changes. Conventionally a value of $\lambda = 1600$ is imposed for quarterly data to remove low frequency components with a periodicity of more than 32 quarters. This value, which is the optimal value according to the transfer function derived by Harvey and Jaeger (1993), will be adopted here.

Having detrended the data and isolated the cyclical element c_t, the tests of asymmetry can be constructed. The test of deepness is provided by the coefficient of skewness:

$$D(c) = \frac{\left[T^{-1} \sum_{t=1}^{T} (c_t - \bar{c})^3 \right]}{\sigma(c)^3} \tag{3}$$

where $\bar{c}$ is the mean of c_t, σ(c) is the standard deviation of c_t, and T is the sample size. The significance of this statistic is tested using the constructed variable z_t:

$$z_t = \frac{(c_t - \bar{c})^3}{\sigma(c)^3} \tag{4}$$

which is regressed upon a constant, with the significance of the constant showing the significance of D(c).

The steepness statistic, relating to the speed of adjustment, is calculated using the first differences of the cyclical element:

$$ST(\Delta c) = \frac{\left[T^{-1} \sum \left(\Delta c_t - \overline{\Delta c} \right)^3 \right]}{\sigma(\Delta c)^3} \tag{5}$$

where $\overline{\Delta c}$ is the mean of Δc_t, $\sigma(\Delta c)$ is the standard deviation of Δc_t, and T is the sample size. The significance of this statistic is again found by means of a constructed variable, z_t^{Δ}, which is regressed upon a constant, with the significance of the constant showing the significance of ST(Δc):

$$z_t^{\Delta} = \frac{\left(\Delta c_t - \overline{\Delta c} \right)^3}{\sigma(\Delta c)^3} \tag{6}$$

Predictions II and III state that the deepness and steepness statistics should both be negative. It is obviously also required that these statistics be significant. To test the significance of D(Δc) and ST(Δc) we examine the significance of the constant terms in the regressions of the constructed variables z_t and z_t^{Δ}. Due to the presence of serial correlation, conventional OLS standard errors will be invalid, so a serial correlation consistent variance-covariance matrix estimator is required. The results presented here employ Newey-West (1987) standard errors, which use a correction based upon estimated autocovariances[2]. The use of these corrected standard errors means that decisions then have to be made over the appropriate kernels and bandwidths to employ. With regard to the choice of kernel, there is no overwhelming evidence in the literature suggesting any particular kernel to be 'best'. As a consequence results will be reported here for three alternative kernels. These kernels are the Parzen, Bartlett and Tukey kernels, which use quadratic, declining and trigonometric weights, respectively, for the autocovariances. With regard to the choice of an appropriate bandwidth, this is again not well defined as it is dependent upon the degree of autocorrelation present in the series under investigation, which is typically unknown. Here the bandwidths corresponding to approximately one third and one quarter of the sample size, giving alternative bandwidths of 39 and 52 for the present sample of 157 observations will be employed. The choice of three kernels and two bandwidths means that six standard errors will be presented for each of the deepness and steepness statistics.

IV. Results

The results presented in this section have been derived using quarterly observations covering the period 1959(1) to 1998(1) on U.S. real consumers' expenditure on durables and non-durables[3]. The natural logarithms of these series will be denoted as *cd* (durables) and *cnd* (non-durables). Preliminary

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[2] For a more complete discussion of consistent variance-covariance matrix estimators see Andrews (1991), Andrews and Monahan (1992), Newey and West (1987,1994), and Pesaran and Pesaran (1997). In this paper the Newey-West standard errors were calculated using *Microfit 4.0* (Pesaran and Pesaran, 1997).

[3] The data are seasonally adjusted quarterly observations in 1992 dollars from 1959(1) to 1998(1). The Datastream codes for these series are USCNNONDD and USCNDURBD.

unit root tests showed both *cd* and *cnd* to be I (1) series. More precisely the application of fifth order Augmented Dickey-Fuller (ADF) tests[4] applied to *cd* and *cnd* gave calculated values of -3.045 and -1.650, failing to reject the unit root null hypothesis against a 5% critical value of -3.44. Conversely the application of fifth order ADF tests to the first differences of these series Δcd and Δcnd rejected the null, with calculated values of -4.103 and -4.748 against a 5% critical value of -2.88.

Before discussing the asymmetric properties *cd* and *cnd*, Proposition I, that *cd* is more cyclical than *cnd*, can be examined via analysis of the cyclical elements presented in Figure 1. The increased volatility present in the cycle of *cd* clearly supports this hypothesis. This distinction in volatility reflects the findings of Christodoulakis *et al*. (1995) where a difference in volatility was observed in a number of EC countries when consumption was disaggregated into its government and private sector components.

The results of the deepness and steepness tests, with which to evaluate Propositions II and III are presented in Table 1. Along with the calculated values of the deepness and steepness statistics, asymptotic standard errors and asymptotic marginal significance levels (p-values) are presented. The results are striking, showing both of the predictions to be strongly supported. Not only are both statistics negative as required, but they are also highly significant. This clearly supports the predictions that durables will display asymmetric behaviour in the form of reductions in expenditure being greater than increases (deepness) and the speed of reductions in expenditure being faster than increases (steepness). The results for non-durable expenditure are in stark contrast with both tests highly insignificant.

[4] To improve the power of the ADF tests a linear time trend was included when examining the levels of the series *cd* and *cnd*, but not their differences.

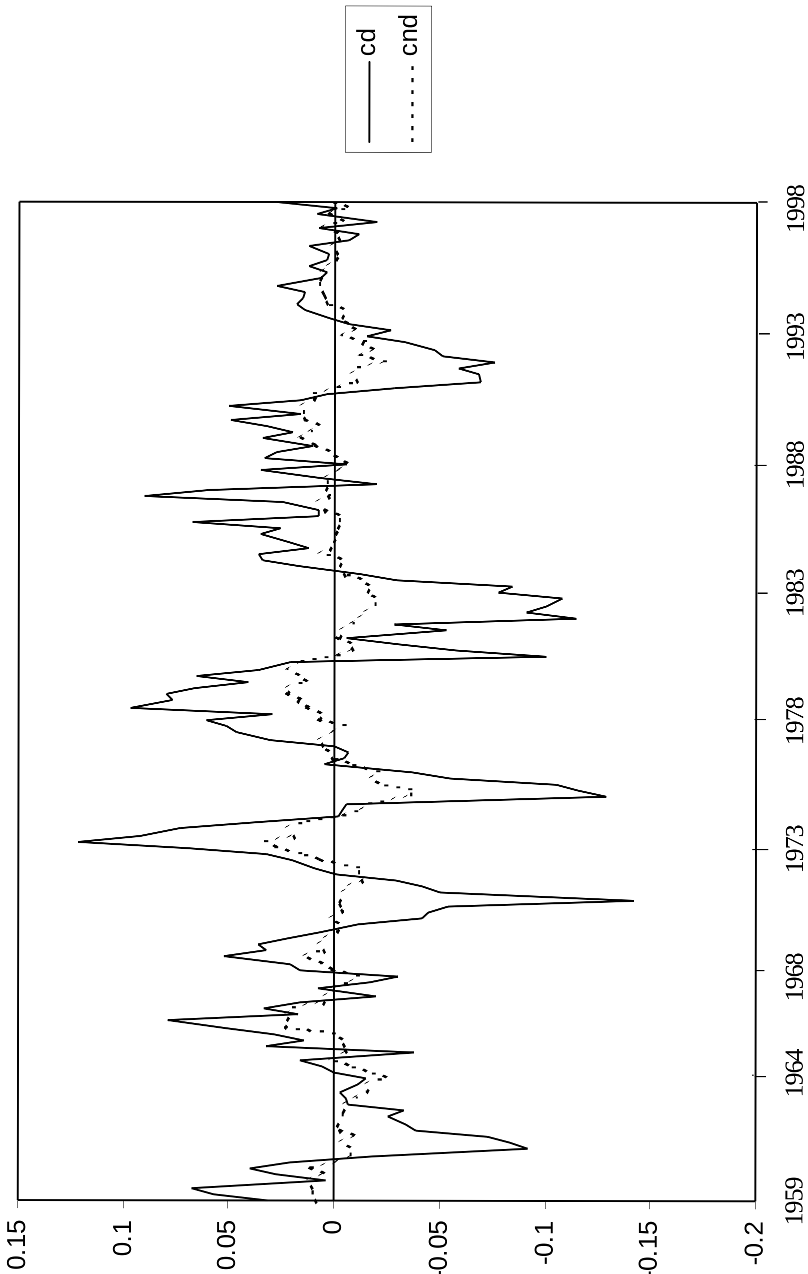

Figure 1. The Cyclical Components

Table 1. Deepness and Steepness Tests

	Coefficient			
	D (*cnd*)	D (*cd*)	ST (Δ*cnd*)	ST (Δ*cd*)
	-.0605	-.5314	.1503	-.8272
Kernel & Bandwidth	Asymptotic Standard Error (p-value)			
	D (*cnd*)	D (*cd*)	ST (Δ*cnd*)	ST (Δ*cd*)
Parzen				
52	.2827 (.831)	.2568 (.040)*	.3213(.641)	.3735(.028)*
39	.2111 (.775)	.1998 (.009)**	.3127 (.632)	.3811 (.031)*
Bartlett				
52	.2890 (.834)	.2540 (.038)*	.3290 (.648)	.4134 (.047)*
39	.2397 (.801)	.2344 (.025)*	.3061 (.624)	.3817 (.032)*
Tukey				
52	.1977 (.760)	.1802 (.004)**	.3185 (.638)	.3861 (.034)*
39	.1455 (.678)	.1593 (.001)**	.2968 (.613)	.3845 (.033)*

* denotes significance at the 5% level.
** denotes significance at the 1% level.

V. Conclusions

In this paper three hypotheses have been proposed concerning the cyclicality of U.S. consumers' expenditure on durables and non-durables. These hypotheses, derived as the result of a series of plausible assumptions, had clearly testable implications. Using data for the period 1959-1998 overwhelmingly supportive evidence was found for each of these propositions. The implications of these findings of asymmetric adjustment are particularly important given the usual assumptions of symmetry and linearity incorporated in most econometric models. An example of the impact of incorporating significant asymmetries within econometric models is provided by the analysis of a large scale macroeconomic model of Arden *et al.* (1999). Arden *et al.* show that not only do asymmetric specifications dominate symmetric alternatives in a number of sectors, but this also leads to very different model simulations being derived with significantly different policy implications.

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