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ON THE ROLE OF INFLATION IN CONSUMPTION FUNCTION

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ON THE ROLE OF INFLATION

IN CONSUMPTION FUNCTION*

by

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Abstract

The purpose of this paper is to re-examine the role of inflation in household consumption behavior both in terms of the observed rate of inflation and inflation uncertainty. First, we show what is 'exactly' the relationship between the Deaton story of involuntary saving and the consumption function specification of Davidson, Hendry, Srba and Yeo. Second, we present a way of deriving the latter specification from an explicit intertemporal model of consumer choice. Third, we compare these two consumption function specifications using quarterly U.K. data. This comparison gives support to the latter specification, furthermore suggesting that inflation uncertainty does, in fact, influence household consumption behavior negatively.

1. INTRODUCTION

In the 1970's a considerable amount of effort was made in analyzing the relationship between inflation and household consumption and saving. Most empirical analyses suggested that inflation does have a significant positive (negative) effect on household saving (consumption) (see e.g. Deaton (1977), Howard (1978) and Davidson et al (1978)). In contrast with such a consensus on empirical evidence the theoretical issues have remained almost totally unsolved. With a notable exception of Deaton (1977) inflation variables have been mostly introduced into household consumption and saving functions in an ad hoc fashion. A typical example is the influental study by Davidson et al (1978), which displays good empirical performance but is vague about the justification of inflation variables.

In this paper we re-examine the role of inflation in the consumption function in the following respects: First, we examine what is 'exactly' the relationship between the Deaton story of involuntary saving - due to inability on the part of households to distinguish between relative and absolute price changes - and the consumption function specification of Davidson et al (1978). Second, we present a way of deriving the consumption function specification of Davidson et al (1978) from an explicit inter-temporal model of consumer choice and discuss the role of inflation uncertainty for consumption behaviour. Finally, we compare the Deaton and Davidson et al specifications of consumption function with each other and look at the question of whether also inflation uncertainty matters or not by using up-dated UK quarterly data over the period 1956.2-1982.1.[1)] Theoretical considerations are presented in section 2, while section 3 is devoted to empirical results.

2. THEORETICAL CONSIDERATIONS

We start by presenting the consumption function specification proposed by Davidson et al (1978), subsequently referred as the DHSY specification,

$$(1) \qquad \Delta_4 \log c_t = b_0 \Delta_4 \log y_t + b_1 \Delta_4 \Delta_1 \log y_t + b_2 \log(c/y)_{t-4} + b_3 \Delta_4 \log p_t + b_4 \Delta_4 \Delta_1 \log p_t$$

where c denotes the volume of consumption expenditure, y the real disposable income of households, p the implicit deflator of c and $\Delta_i x_t = x_t - x_{t-i}$. When this specification was fitted into UK quarterly data the inflation terms turned out to be negative, even though their coefficient estimates were rather unprecise. But how is this related to the saving function suggested by Deaton? This specification with the additional hypothesis of constant expectations with respect to real income growth and inflation rate can be expressed as follows[2)]

$$(2) \qquad (s/y)_t = d_0 + d_1 \Delta_1 \log y_t + d_2 \Delta_1 \log p_t + d_3 (s/y)_{t-1}$$

where the coefficients d_1, d_2 and d_3 should be between one and zero, and where s denotes household saving (in real terms). As mentioned earlier, the saving function (2) can be justified in terms of inability on the part of households to distinguish between relative and absolute price changes in such a way that the inflation variable represents unanticipated inflation. By taking the fourth differences of (2) and using the approximation $(s/y) \approx \log y - \log c$ leads up to the following consumption function specification

$$(3) \qquad \Delta_4 \log c_t = \Delta_4 \log y_t - d_1 \Delta_4 \Delta_1 \log y_t - d_2 \Delta_4 \Delta_1 \log p_t - d_3 \Delta_4 (s/y)_{t-1}$$

where the coefficient of $\Delta_4 \log y_t$ should be equal to one. Comparing (1) and (3) reveals two further differences between them. First, the DHSY specification has an error correction term of type $\log c_{t-4} - \log y_{t-4}$, while the 'corresponding' term in the Deaton specification (3) is $\Delta_4(s/y)_{t-1}$. Second, and more importantly, the Deaton specification expressed in (3) does not contain the inflation term $\Delta_4 \log p_t$ in contrast with the DHSY specification. But there is no explicit justification in Davidson et al (1978) for the inflation term $\Delta_4 \log p_t$; the "error correction" framework brings not only $\Delta_4 \Delta_1 \log p_t$, but 'automatically' also $\Delta_4 \log p_t$ into the consumption function.

In trying to find out a coherent explanation for the role of the $\Delta_4 \log p_t$-term in the consumption function it seems tempting to argue that in one way or another it reflects the deflation of households' liquid assets.[3)] The role of assets in this sense becomes readily obvious when analyzing consumer choice in an intertemporal setting. In fact, by using a simple intertemporal model with binding labour supply constraints one can end up with the consumption function specification which is practically indistinguishable from the DHSY specification (see Appendix for details). The inflation term $\Delta_4 \log p_t$ appears as an explanatory variable via its effect on households' real resources, which consist of real income, anticipated real income and employment growth and the inflation adjusted asset endowment from the previous period. Thus in terms of inflation rate variables a more general specification than what is presented in Deaton (1977) can be justified. In what follows we consider whether this more general specification gets support or not by comparing the performance of the DHSY and Deaton specifications.

But the inflation rate variables may have impacts on household consumption and saving behaviour also via some other channels. In particular, it has been suggested that as the rate of inflation becomes more variable, it becomes more difficult to forecast future inflation thus creating greater uncertainty (see e.g. Logue and Willett (1976) for evidence about the positive relationship between average inflation and its variability). To the extent that nominal incomes and/or nominal interest rates are not fully indexed with respect to inflation rate, a rise in future inflation rate uncertainty gives rise to an increase in "income risk" - uncertainty about future non-capital income - and/or "capital risk" - uncertainty about the rate of return on saving. The questions of how "income risk" and "capital risk" affect consumption and saving have been recently analyzed in a number of articles (for a survey of the literature, see Lippman and McCall (1982)). It turns out that under fairly natural assumptions a rise in "income risk" affects consumption (saving) negatively (positively), while the effect of "capital risk" is ambiguous.[4)] Thus the question of how uncertainty about future inflation rate affects consumption and saving depends not only on the strength of risk aversion of households, but also on the degree of indexation (hedging) of nominal incomes and interest rates with respect to inflation rate. In what follows we introduce a proxy for future inflation rate uncertainty as an additional explanatory variable into the consumption function as a sort of black box way to model inflation rate uncertainty.

3. EMPIRICAL RESULTS

Before going to empirical results it is worthwhile to note that modelling consumer intertemporal choice under binding labour supply constraints implies not only that the anticipated real rate of interest should be included into the consumption function, but also that in general a consumption function where the income variable alone reflects labour supply rationing cannot be derived from microeconomic considerations. Only in the case of unitary intertemporal elasticity of substitution the employment terms due to labour supply rationing vanish from consumption functions (see Koskela and Virén (1983) for details). Therefore we also introduced the employment variables (h) both into the DHSY and Deaton specification. In the former case we used both the $\Delta_4 \log h_t$ and $\Delta_4 \Delta_1 \log h_t$ terms in order to take account of the implied "error correction" mechanism.

The specifications (1) and (3) with and without employment terms was just fitted into seasonally unadjusted UK data over the period 1956.2-1982.1.[5)] The corresponding OLS estimation results in an unrestricted form are presented in Table 1.[6)]

The results can be briefly summarized as follows: First, the coefficient estimates of the inflation terms are of 'expected' sign and highly significant, moreover so that the inflation term $\Delta_4 \log p_t$ should also be included as an explanatory variable in contrast to the Deaton (constant expectations) specification (3).[7)] All other coefficient estimates are of 'expected' sign and precisely estimated with the exception of the employment terms in the DHSY-specification, which have rather low t-

Table 1: Estimation results of the Deaton and DHSY consumption function specifications.

	$\Delta_4\bar{y}_t$	$\Delta_4\Delta_1\bar{y}_t$	$\Delta_4\Delta_1\bar{p}_t$	$\Delta_4\Delta_1\bar{h}_t$	$\Delta_4(s/y)_{t-1}$	$\Delta_4\bar{p}_t$	$\Delta_4\bar{h}_t$	$(s/y)_{t-4}$	R^2	D-W	AIC
(1)	.846	-.602	-.635	.367	-.478				.913	1.860	-951
	(23.47)	(9.46)	(9.37)	(2.24)	(6.31)						
(2)	.840	-.578	-.615		-.459				.908	1.927	-953
	(22.91)	(9.03)	(8.98)		(5.98)						
(3)	.501	-.230	-.379	.255		-.143	.041	.105	.928	1.556	-967
	(15.43)	(4.84)	(6.20)	(1.64)		(6.01)	(0.54)	(7.60)			
(4)	.511	-.220	-.362			-.145		.103	.926	1.619	-967
	(17.80)	(4.65)	(5.97)			(6.13)		(7.84)			

	$\hat{a}_1$	$\hat{a}_2$	$\hat{a}_3$	$\hat{a}_4$	χ^2_4	Chow	F_e	J
(1)	.112	.107	.055	-.373	19.431	.903	8.840	.786
	(0.80)	(1.07)	(0.55)	(3.82)				(5.18)
(2)	.061	.085	.078	-.366	17.847	1.063	8.924	.812
	(0.42)	(0.85)	(0.78)	(3.71)				(5.20)
(3)	.320	-.140	.095	-.380	19.737	.854	5.057	.417
	(2.88)	(1.31)	(0.91)	(3.43)				(2.24)
(4)	.277	-.126	.099	-.385	18.261	.864	3.577	.366
	(2.54)	(1.22)	(0.96)	(3.50)				(1.89)

All variables denoted by upper bars are expressed in natural logs, AIC denotes the Akaike Information Criterion, a_i´s denote the estimates of the residual AR-parameters in the Breusch (1978) test procedure, χ^2_4 the corresponding LM test statistic, Chow the F-statistic for parameter stability, F_e the F-statistic for the non-overlapping variables of the alternative hypothesis (in the Mizon-Richard (1983) encompassing framework), and finally J denotes the Davidson-McKinnon J-statistic for the predicted value of the alternative hypothesis. Significant values of F_e and J indicate that the alternative hypothesis is superior.

ratios. Second, the unrestricted estimations of (3) suggest that the coefficient restriction for the $\Delta_4 \log y_t$-term implied by the Deaton specification can be rejected. The t-values for the hypothesis that the coefficient estimate of $\Delta_4 \log y_t$ is different from one are 4.29 and 4.37 for equations (1) and (2) respectively.[8)] Finally, in conformity with the findings reported above, various nested and non-nested test statistics suggest that the DHSY specification slightly outperforms the Deaton specification. The superiority of the DHSY specification results largely from its inclusion of the inflation rate term which can be justified, as referred earlier, in terms of the inflation adjusted asset variable.

But as pointed out earlier, inflation rate uncertainty may affect household consumption and saving behaviour under the imperfect indexation (hedging) of nominal incomes and/or nominal interest rates with respect to inflation rate. Therefore, we introduced a proxy for inflation rate uncertainty as an additional explanatory variable into the DHSY consumption function specification in order to see whether this channel of influence matters and whether it provides an alternative or complementary impact on consumption and saving. We used the twelve-term moving variance from the twelve-term moving mean of the quarterly rate of change of prices as a rough operational measure of inflation rate uncertainty (for a similar approach, see Klein (1977)).[9)] Estimation results are presented in Table 2.

Several features of results merit note. First, inflation uncertainty, proxied by the 12-term moving variance from the 12-term moving mean of quarterly rate of change of prices, affects consumption (saving)

Table 2: Estimation results of the DHSY consumption function specificaton with inflation rate uncertainty.

	$\Delta_4\bar{y}_t$	$\Delta_4\Delta_1\bar{y}_t$	$\Delta_4\bar{p}_t$	$\Delta_4\Delta_1\bar{p}_t$	$(s/y)_{t-4}$	v_t	$\Delta_4 v_t$	R^2	D-W	AIC
(5)	.511	-.234	-.090	-.424	.091	-1.890		.928	1.643	-970
	(18.19)	(4.98)	(2.54)	(6.39)	(6.35)	(2.09)				
(6)	.519	-.235	-.082	-.425	.086	-1.584	-1.229	.931	1.684	-971
	(18.46)	(5.05)	(2.33)	(6.45)	(5.89)	(1.74)	(1.74)			

	$\hat{a}_1$	$\hat{a}_2$	$\hat{a}_3$	$\hat{a}_4$	χ^2_4	Chow
(5)	.271	-.184	.113	-.409	19.209	.538
	(2.52)	(1.77)	(1.11)	(3.75)		
(6)	.240	-.191	.099	-.402	18.374	.455
	(2.21)	(1.83)	(0.96)	(3.66)		

$F(v_t, \Delta_4 v_t = 0) = 3.755 > 3.07 = \hat{F}_{.05,2,97}$

The variable v_t is a proxy for inflation uncertainty and is defined $v_t =$

$(1/n) \sum_{i=1}^{n} (\Delta_1\bar{p}_{t-i} - \Delta_1\hat{\bar{p}}_{t-i})^2$, where $\Delta_1\hat{\bar{p}}_t = (1/n) \sum_{i=1}^{n} \Delta_1\bar{p}_{t-i}$ and $n = 12$. For other symbols, see Table 1.

negatively (positively). Second, introducing inflation uncertainty does not eliminate the significance of the inflation rate variable thus suggesting that inflation rate uncertainty provides not an alternative, but a complementary channel of influence on consumption and saving.[10)]

FOOTNOTES:

1) The period of estimation in Deaton (1977) was 1955.3-1974.3 while in Davidson et al (1978) 1958.1-1975.2.

2) The Deaton specification says that household saving ratio is positively related to unanticipated rates of change in real income and inflation rate so that its form depends on expectations hypotheses to be used. There is some empirical evidence in favour of the constant expectations specification of the Deaton story (see e.g. Koskela and Virén (1982)).

3) A step in this direction is taken in Hendry and von Ungern-Sternberg (1981) under the so-called 'mismeasurement hypothesis'.

4) There are two conflicting tendencies in this connection: on the one hand an increase in "capital risk" reduces the incentive to save because the more one saves, the more one stands to to loose; on the other hand, higher riskness makes it necessary to save more in order to protect oneself against very low level of future consumption.

5) The data are described in Davidson et al (1978). The employment variables to be used correspond to the number of employees.

6) Various proxies for the real interest rate variable $\bar{r}_t$ were also tried in the context of equations (1) and (3). Without exceptions the respective coefficient estimates were far from significant. As the consumption function, presented in expression (6) of Appendix, indicates consumption in period t depends on future values of employment, prices and real income, i.e. on h_{t+1}, p_{t+1}, and y_{t+1}. We experimented also with some proxies for these future variables by predicting them with least squares regressions from some sets of variables for period t, t-1, t-2 and t-3. The results obtained were very similar to those presented in Table 1 with the exception that the goodness of fit statistics showed a bit lower values. A full set of results is available from the authors upon request.

7) When equations (1) and (3) are fitted into the data samples of 1956.2-1969.1 and 1969.2-1982.1, the coefficient estimates of the inflation terms display striking similarity over time (which is something to be expected, given the Chow-test statistics) as the following numbers indicate:

	1956.2-1969.1		1969.2-1982.1	
	$\Delta_4 \log p_t$	$\Delta_4 \Delta_1 \log p_t$	$\Delta_4 \log p_t$	$\Delta_4 \Delta_1 \log p_t$
(i)		-.580 (3.70)		-.603 (6.33)
(ii)	-.140 (1.71)	-.256 (1.87)	-.159 (4.03)	-.369 (4.01)

where (i) and (ii) correspond to the equations (1) and (3) in Table 1.

8) The neglect of assets may explain why Deaton ends up with the parameter value $d_1 = 1$ in his theoretical derivation. This is, however, clearly at the variance with data, which Deaton tries to explain by referring to a sort of weighted average expectations mechanism. When the Deaton specification (3) was estimated in the restricted form so that the coefficient of $\Delta_4 \log y_t$ was forced to unity, the following results were obtained:

(1') $$\Delta_4 \log c_t = 1.000\Delta_4 \log y_t - \underset{(14.55)}{.775}\Delta_4\Delta_1 \log y_t - \underset{(10.42)}{.726}\Delta_4\Delta_1 \log p_t + \underset{(2.35)}{.417}\Delta_4\Delta_1 \log h_t - \underset{(14.06)}{.729}\Delta_4 (s/y)_{t-1} \quad R^2 = .896,\ D\text{-}W = 2.064$$

(2') $$\Delta_4 \log c_t = 1.000\Delta_4 \log y_t - \underset{(14.04)}{.755}\Delta_4\Delta_1 \log y_t - \underset{(9.99)}{.707}\Delta_4\Delta_1 \log p_t - \underset{(13.61)}{.719}\Delta_4 (s/y)_{t-1} \quad R^2 = .891,\ D\text{-}W = 2.146$$

9) Of course, this is not the only possibility. Alternatively, one might experiment with explicit models of formation of inflation rate expectations by estimating the time-series process of inflation rates using Box-Jenkins methods and producing then forecast error variances for inflation rates (for this kind of approach in another context, see Rosen and Rosen and Holtz-Eakin (1983)).

10) We also estimated a simple "Keynesian" consumption function in a difference form with inflation uncertainty variable. This gave the following results

(i) $$\Delta_4 \log c_t = \underset{(22.18)}{.636}\Delta_4 \log y_t - \underset{(2.58)}{2.493}\Delta_4 v_p \quad R^2 = .834,\ D\text{-}W = 1.612$$

(ii) $$\Delta_4 \log c_t = \underset{(4.78)}{.007} + \underset{(18.11)}{.558}\Delta_4 \log y_t - \underset{(3.17)}{2.785}\Delta_4 v_p \quad R^2 = .852,\ D\text{-}W = 2.018$$

Moreover, introducing both inflation uncertainty and employment terms ($\Delta_4 \bar{h}_t$ and $\Delta_4\Delta_1 \bar{h}_t$) into the "Keynesian" consumption function suggested that the hypothesis according to which they have no effect on household consumption and saving can be rejected at the 5 per cent significance level ($F(\Delta_4\bar{h}_t, \Delta_4\Delta_1\bar{h}_t, v_t, \Delta_4 v_t = 0) = 3.038 > \hat{F}_{.05,4,100} = 2.46$).

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APPENDIX

Consider the following two-period maximization problem:

(4) $$\max_{\{c_1, c_2\}} U = (\phi_1(c_1^z(1-h_1)^{1-z})^{-x} + \phi_2(c_2^z(1-h_2)^{1-z})^{-x})^{-1/x}$$

$$\text{subject to: } A_0 + W_1h_1 + R_2W_2h_2 = p_1c_1 + R_2p_2c_2$$

where ϕ, z and x refer to the parameters of the underlying CES and CD utility functions. p_i refers to prices, W_i to nominal wage rates, A_0 to nominal amount of assets at the beginning of the current period (i.e. 1), h_i to labor supply, which is here assumed to be exogeneous, and R_i to nominal discount rate factor $(1/(1+r)^{i-1})$. We assume for simplicity that the real rate of interest, $R_2p_2p_1^{-1}$, is equal to the time preference factor $\phi_2\phi_1^{-1}$.

Assumptions that intra-period and intertemporal preferences can be described by Cobb-Douglas and CES-utility functions respectively are dictated both by tractability and by the desire to allow for enough flexibility for the labour supply rationing to affect current consumption.

The following 'consumption function' can derived from (5):

(5) $$\log c_t = \log y_t + \log(A_{t-1}/Y_t) + 1 + (1+\bar{r}_t)^{-1}(y_{t+1}/y_t)) + \log(1 + (1+\bar{r}_t)^{-1}(h_{t+1}/h_t)^{\theta})$$

where $Y_t = W_th_t$, $y_t = Y_t/p_t$ and $1 + \bar{r}_t = (1+r_t)(p_t/p_{t+1})$.

By approximating the log sum and the multiplicative interest rate term by the respective additive linear terms we end up with the following equation:

$$(6) \qquad \log c_t = \log y_t + b_1(A_{t-1}/Y_t) + b_2\Delta_1\log y_{t+1} + b_3\Delta_1\log h_{t+1} + b_4\bar{r}_t$$

Now, by taking the fourth differences and using the following approximations $Y_t \approx Y_{t-1}(1+\Delta_1\log y_t)(1+\Delta_1\log p_t)$, $\Delta_4 A_{t-1}/Y_{t-1} \approx (s/y)_{t-4}$, $A_{t-1}/Y_{t-1} \approx (\frac{s}{y})_{t-4}$ + some constant, using static expectations with respect to the expected future rates of change of real income and employment and finally rearranging terms we end up with

$$(7) \qquad \Delta_4\log c_t = b_0\Delta_4\log y_t + b_1\Delta_4\Delta_1\log y_t + b_2(s/y)_{t-4} + b_3\Delta_4\log p_t + b_4\Delta_4\Delta_1\log p_t + b_5\Delta_4\Delta_1\log h_t + b_6\Delta_4\bar{r}_t$$

where $b_0 > 0$, $b_1 < 0$, $b_2 > 0$, $b_3 < 0$, $b_4 < 0$, $b_5 > 0$ and $b_6 \gtrless 0$.

If we assume the unitary intertemporal elasticity of substitution so that $\theta = 0$ (see Koskela and Virén (1983) for details) and $b_5 = 0$ and, furthermore, neglect the real interest rate term, we arrive with the specification which is practically identical to that of Davidson et al (1978).