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AGGREGATE EMPLOYMENT AND INTERTEMPORAL SUBSTITUTION IN THE UK*

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It is now more than fifteen years since Lucas and Rapping (LR) first published their influential paper on intertemporal substitution and labour supply. Their approach, although at first intended as the microfoundations of *Keynesian* labour market theories, was very soon seen to be a radically *classical* explanation of employment fluctuations (e.g. Rees, 1970).

When coupled with a demand for labour function by competitive firms, the intertemporal substitution hypothesis (ISH) implies that the only way in which aggregate demand policies can systematically effect employment is through the real interest rate, and temporary deviations of real wages from their long-run path.[1]

ISH is a rather elegant theory, but theories are ultimately judged by the realism of their predictions. Although many aspects of actual labour markets seem to be unexplained by ISH (see Hall, 1980), its proponents claim that the most important aspects of aggregate labour markets in business cycles are consistently accounted for. To quote Lucas (1980):

> 'Employment and nominal wages are, in an immediate sense, determined by some very complicated labor market interactions involving employees and employers. It is possible, we know, to mimic the aggregate outcome of this interaction fairly well in a competitive equilibrium way, in which wages and manhours are generated by the interaction of "representative" households and firms.'

At around the same time, Solow (1980) claimed:

> 'It is astonishing that believers have made essentially no effort to verify this central hypothesis. I know of no convincing evidence in its favor, and I am not sure why it has any claim to be taken seriously.'

What both Lucas and Solow were implicitly referring to was the type of evidence associated with formal econometric tests, and which predominantly is based on testing the *implications* of alternative theories for the problem at hand. More time series evidence has appeared since 1980. Hall (1980), Altonji (1982) and Mankiw *et al.* (1985) have presented new direct estimates for the United States while Andrews and Nickell (1982) and Andrews (1983) presented UK evidence. Indirect tests of the intertemporal substitution hypothesis have also

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[1] Macro-models that are based, either implicitly or explicitly on ISH have been presented by Lucas (1972), Barro (1976), Grossman and Weiss (1982), Alogoskoufis (1983) and others.

been presented by Barro (1977, 1981), Altonji and Ashenfelter (1980), Ashenfelter and Card (1982) and others.

This more recent evidence seems to justify Solow rather than Lucas. Although Hall (1980), Andrews and Nickell (1982) and Andrews (1983) report that the hypothesis of intertemporal substitution cannot be easily rejected on its own grounds, Altonji (1982) and Mankiw *et al.* (1985) decisively reject it. The reduced form and indirect tests are also on balance unfavourable.

In this paper I set out to re-examine the time series evidence for the United Kingdom. The evidence presented by Andrews and Nickell (1982) and Andrews (1983) is rather favourable to the hypothesis. This is in contrast to recent US evidence which, with the exception of Hall (1980), is entirely unfavourable.

There are several differences from the previous UK investigations. The first difference is that I derive the short run labour supply function from an explicit problem of intertemporal optimisation. Thus, in principle, the estimated parameters could be related back to the assumed preferences of the *representative* household. The penalty one pays for this is that in order to obtain a solution one has to assume a restrictive functional form for the intertemporal utility function. My choice of a generalised CES utility function imposes time separable preferences, and constant, although not necessarily equal, elasticities of substitution between consumption and leisure in each period, and consumption/leisure bundles across periods. On the other hand, this explicit specification has the advantage that one does not have to cope with rational expectations of unobservables, for example *normal* or *permanent* variables. All variables are observed by the econometrician, or are assumed to be rational expectations of observables, which simplifies the estimation problem significantly. It also has to be noted that specifications with time separable preferences are common in cross-section and panel studies of labour supply.[2]

The above notwithstanding, one can always claim that tests based on my approach cannot be interpreted as rejecting intertemporal substitution *theory*, but only an intertemporal substitution *model*. Such a criticism can always be made about econometric testing. I will just note that alternative models of ISH have been tested by Andrews (1983), and that I discuss his results in relation to mine.

The second difference from the previous UK studies is that I use two alternative measures of labour supply, the one based on the total number of employees in employment, and the other on aggregate employee-hours. A priori, there are various reasons as to why the extensive margin of labour supply decisions is perhaps more suitable for an investigation with aggregate data. These include the observation that fluctuations in employee-hours are mainly due to fluctuations in the number of employees rather than in average hours, the fact that average hourly earnings are nowhere near marginal hourly earnings, whereas average and marginal weekly earnings are closer, problems of time aggregation, and other reasons. Nevertheless, the above arguments are not entirely compelling, and I therefore choose to investigate fluctuations both

[2] See Killingsworth (1983).

in the number of employees in employment (the *extensive* margin), and aggregate employee-hours (the *intensive* margin).

Another feature of the paper is that I present a check on the consistency of the findings for labour supply, with estimates for consumption demand, for which the underlying theoretical model also makes predictions. In fact, I find that if one adopts the number of employees as a measure of aggregate labour supply, the estimates do not appear to be inconsistent. The within period elasticity of substitution between consumption and leisure and the intertemporal elasticity of substitution are not significantly different. Their estimated value is around 0·20.

This paper is not an attempt to provide a full market clearing *aggregate* model. In fact, it is not even an attempt to test fully a market clearing *labour market* model. I simply estimate the Euler equations suggested by a version of ISH with time separable preferences, and test the implied overidentifying restrictions. The estimates for the number of employees are reasonably favourable to the model, but the estimates for aggregate employee-hours are entirely unfavourable. Deeper probing into the statistical properties of the *favourable* estimates suggests a number of problems even for these. Thus, on the basis of the results of this paper, theories that rest on intertemporal substitution *and* continuous market clearing do not appear to be supported by the evidence. The features of the estimates for the total number of employees do however suggest that maybe an extension of the theory to account for serial persistence, or the possibility of rationing in the labour market, might result in a role for intertemporal substitution in macroeconomic modelling.

The rest of the paper is as follows. In section I I present the theoretical model. Time series estimates and tests are in section II. In section III, an attempt is made to compare the estimates to alternative labour market models. I argue that, in principle, intertemporal substitution models predict similar correlations between employment and wage and price inflation as for example Sargan (1964)-type wage equations, and that it is not too surprising that they fit reasonably well to UK time series. There is an observational equivalence problem, which, nevertheless, should be possible to resolve. This and other conclusions are summed up in the final section.

I. A MODEL OF INTERTEMPORAL SUBSTITUTION

In accordance with a long tradition in macroeconomics, I assume that aggregate labour supply can be analysed as the optimal decision rule of the representative household.[3]

[3] If one were to apply the model to individual data, one would have to allow for corner solutions, or model the participation decision as choice among discrete alternatives. For aggregate data we do not however worry too much about the experience of individual households. The fiction of the representative household allows us to ignore corner solutions, and treat the participation decision as a continuous variable. This is standard practice in macroeconomics, and potentially dangerous, especially since the CES in general does not aggregate, but this paper does not address the aggregation issue at all. For some of the dangers of the assumption of the representative household see among others, Geweke (1985) and Stoker (1986).

Assume that the representative household maximises the following intertemporal CES utility function.[4]

$$U_t = \sum_{i=0}^{\infty} \left(\frac{1}{1+\delta}\right)^i (c_{\tau+i}^{1-\alpha} + d(l_0 - l_{t+i})^{1-\alpha})^{(1-\epsilon)/(1-\alpha)} \quad (\alpha, \epsilon > 0) \qquad (1)$$

subject to

$$\sum_{i=0}^{\infty} \rho_{ti}(p_{t+i}\, c_{t+i} - w_{t+i}\, l_{t+i}) = A_t. \qquad (2)$$

c, l, p, and w are consumption demand, labour supply, the price level and the nominal wage respectively. l_0 is the full labour endowment of the household each period, assumed to be a parameter, and d, ϵ and α are the other parameters of the utility function. $1/\alpha$ is the elasticity of substitution of consumption for leisure, and $1/\epsilon$ is the intertemporal elasticity of substitution. A is the predetermined set of assets, δ is the utility rate of time preference, and ρ_{ti} is defined as,

$$\rho_{ti} \equiv 1/[(1+r_t)(1+r_{t+1}) \dots (1+r_{t+i-1})] \quad \text{for} \quad i > 0;\ \rho_{t0} = 1$$

where r is the nominal interest rate.

There are several characteristics of the above formulation that deserve a brief comment. First, the direct consequence of time separability of preferences in (1), that the utility of the consumption-leisure choice in any period is independent of past and future choices. This is an important restriction on preferences, and many of its implications in the present context have been examined by Barro and King (1984). Second, the assumption that households are infinitely lived. This is not strictly required for our purposes, and could in fact be relaxed. However, since there is no clear point at which to terminate the planning horizon for households in which parents care about their descendants, I nevertheless stick to the infinite horizon formulation. Third, the household is a price taker in product, labour and asset markets. However, the anticipated path of wages, prices and interest rates is not restricted in any way. The final point concerns the assumption of certainty equivalence. One could in fact specify (1) in terms of expected utility, as for example in MaCurdy (1983), Blundell *et al.* (1985), or Mankiw *et al.* (1985). The final specification would be equivalent to the specification we arrive at with the formulation in (1), only that one would have to rely on a few more approximations, to take account of Jensen's inequality, in the transition from the logarithm of the expectation of ratios, to the ratio of the expectations of the logs. In the interests of notational economy, we stick to (1) which gives the essential insights, and would, for all practical purposes, be observationally equivalent to the expected utility formulation.

From the first order conditions for a maximum of (1) subject to (2), the

[4] All the results derived in this section hold if we assume that the household has *certain* expectations about future variables.

following relations must hold at all times between planned consumption and leisure, and expected prices, wages and interest rates:

$$\left(\frac{c_{t+i}}{d(l_0-l_{t+i})}\right)^{-\alpha} = \frac{p_{t+i}}{w_{t+i}} \quad (i = 1, 2, \ldots), \tag{3}$$

$$\frac{1}{1+\delta}\left(\frac{c_{t+i+1}}{c_{t+i}}\right)^{-\alpha}\left[\frac{c_{t+i+1}^{1-\alpha}+d(l_0-l_{t+i+1})^{1-\alpha}}{c_{t+i}^{1-\alpha}+d(l_0-l_{t+i})^{1-\alpha}}\right]^{(\alpha-\epsilon)/(1-\alpha)} = \frac{p_{t+i+1}}{(1+r_{t+i})\,p_{t+i}}, \tag{4}$$

$$\frac{1}{1+\delta}\left(\frac{l_0-l_{t+i+1}}{l_0-l_{t+i}}\right)^{-\alpha}\left[\frac{c_{t+i+1}^{1-\alpha}+d(l_0-l_{t+i+1})^{1-\alpha}}{c_{t+i}^{1-\alpha}+d(l_0-l_{t+i})^{1-\alpha}}\right]^{(\alpha-\epsilon)/(1-\alpha)} = \frac{w_{t+i+1}}{(1+r_{t+i})\,w_{t+i}}. \tag{5}$$

Equations (3), (4) and (5) are equivalent to what Mankiw *et al.* (1985) call the static first order condition (S), the Euler equation for consumption (EC), and the Euler equation for leisure (EL), respectively. (3) implies that at the optimum, the household cannot be made better off by trading consumption for leisure within periods at the expected real wage for the period. (4) implies that at the optimum the household cannot be made better of by trading consumption across periods at the relevant real interest rate, and (5) is an analogous condition for leisure.

If we take (4) for $i = 0$, and use (3) to eliminate c_t and c_{t+1} from it, after some re-arrangement we end up with:

$$\left(\frac{l_0-l_t}{l_0-l_{t+1}}\right)^{-\epsilon} = \frac{1}{1+\delta}\,\frac{w_t/p_t}{w_{t+1}/p_{t+1}}\left[\frac{1+d^{-\alpha}(w_{t+1}/p_{t+1})^{(1-\alpha)/\alpha}}{1+d^{-\alpha}(w_t/p_t)^{(1-\alpha)/\alpha}}\right]^{(\alpha-\epsilon)/(1-\alpha)}\frac{p_t(1+r_t)}{p_{t+1}}. \tag{6}$$

Equation (6) is only in terms of planned current and future leisure, the expected current and future real wages and the (exponential of) ex ante real interest rate.

Taking the logarithm of (6), and using the Taylor approximations

$$\log l_0 \simeq \phi_0+\phi\log(l_0-l_{t+i})+(1-\phi)\log l_{t+i} \quad (0 \leqslant \phi \leqslant 1),$$

$$\log[1+d^{-\alpha}(w/p)_{t+i}^{(1-\alpha)/\alpha}] \simeq \pi_0+\pi\log[d^{-\alpha}(w/p)_{t+i}^{(1-\alpha)/\alpha}] \quad (0 \leqslant \pi \leqslant 1)$$

we end up with the following log-linear equation for labour supply:

$$\log l_t = \log l_{t+1}+\gamma_1[\log(w_t/p_t)-\log(w_{t+1}/p_{t+1})]+\gamma_2 R_t+\gamma_0, \tag{7}$$

where, $R_t \simeq \log(1+r_t)-\log(p_{t+1}/p_t)$, is the *ex ante* real interest rate, and

$$\gamma_1 = \frac{(1-\phi)\,[\alpha(1-\pi)+\epsilon\pi]}{\phi\alpha\epsilon}, \tag{7a}$$

$$\gamma_2 = \frac{1-\phi}{\phi}\,\frac{1}{\epsilon}. \tag{7b}$$

γ_0 is a function of various parameters such as the log of the utility rate of time preference, and the π's and ϕ's in the approximations. In estimation it will be captured by a constant and trend.

It is worth noting the differences of (7) from the Lucas–Rapping supply function: First, where they have permanent variables, our specification implies anticipations of next period's variables. Second, assets do not appear in (7), because initial wealth affects l_t and l_{t+1} in the same way. Third, note that in the case where $\alpha = \epsilon$, i.e. when the within period and intertemporal substitution elasticities are the same, $\gamma_1 = \gamma_2$. Thus, a common elasticity of substitution implies that the coefficient of real wage deviations is the same as the coefficient of the real interest rate. In fact, this means that deviations in labour supply from next period's labour supply depend only on $\log(1+r_t) - \log(w_{t+1}/w_t)$, i.e. the real interest rate defined in terms of wage inflation. By testing the restriction $\gamma_1 = \gamma_2$, we can therefore test for a common elasticity of substitution.[5]

We can now turn to estimation and testing.

II. TIME SERIES ESTIMATES AND TESTS

In order to estimate and test (7), all future variables are replaced by rational expectations denoted by ˆ, and we assume that households make random errors in implementing their optimal labour supply plans. (7) can be rewritten as:

$$\log l_t = \omega_0 + \omega_1 \log \hat{l}_{t+1} + \omega_2 \log (w/p)_t + \omega_3 \log (\hat{w}/\hat{p})_{t+1} + \omega_4 \hat{R}_t + v_t \quad (8)$$

where $v_t \sim NI(0, \sigma_v^2)$. The restrictions of the 'theory', summarised in (7), are that $\omega_1 = 1$, and that $\omega_2 = -\omega_3$. The additional restriction that stems from imposing a common elasticity of substitution is that $\omega_2 = -\omega_3 = \omega_4$.

To obtain consistent estimates we use the method of McCallum (1976). The unobservable rational expectations of future variables are replaced for the purposes of estimation by the future variables themselves, and estimates are obtained by III. This procedure is very useful if one is interested in a sub-system or a single equation, as it does not require the complete specification of a system of simultaneous equations.

Estimates of (8), without and with the additional theoretical restrictions, appear in Table 1. Equations indexed by *A* refer to estimates based on the number of employees in employment and average weekly earnings, whereas those indexed by *B* are based on total employee-hours and average hourly earnings. In both cases aggregate employment has been divided by an index of working population adjusted for age and sex composition, as suggested by Lucas and Rapping (1969). Data definitions and sources are in the appendix.

*A*1 and *B*1 are estimates of the unrestricted equation (8). *A*2 and *B*2 embody the restrictions implied by (7), whereas *A*3 and *B*3 embody the additional restriction of a common elasticity of substitution.[6]

The estimates based on the number of employees seem to be consistent with

[5] This last restriction is implicit in Hall's (1980) model. See also Barro's (1980) comments.

[6] The equations in Table 1 were estimated with a constant and trend which are not reported for economy of space. The trend coefficient was insignificant for the unrestricted equations, but significant once the theoretical restrictions were imposed. Estimates were 0·00066 (SE = 0·00021) for *A*3 and 0·00083 (SE = 0·00028) for *B*3. The significant trend could reflect shifts in γ_0.

Table 1

Estimates of Aggregate Labour Supply Functions

(Data: UK, annual, 1950–82. Method of estimation: two-stage least squares. Dependent variable: $\log l_t$.)

	RHS Variables				Diagnostics			
	$\log l_{t+1}$	$\log (w/p)_t$	$\log (w/p)_{t+1}$	R_t	$\bar{R}^2$	s	DW	F
*A*1	0·858 (0·098)	0·370 (0·138)	−0·310 (0·126)	0·213 (0·088)	0·849	0·0108	2·10	2·20 (8, 19)
*A*2	1·000	0·359 (0·125)	−0·359 (0·125)	0·192 (0·063)	0·838	0·0112	1·84	2·03 (2, 27)
*A*3	1·000	0·198 (0·064)	−0·198 (0·064)	0·198 (0·064)	0·831	0·0114	1·78	2·20 (1, 29)
*B*1	0·847 (0·125)	0·038 (0·174)	0·088 (0·179)	0·181 (0·144)	0·921	0·0159	1·44	4·63 (8, 19)
*B*2	1·000	0·030 (0·150)	−0·030 (0·150)	0·063 (0·082)	0·923	0·0156	1·67	0·57 (2, 27)
*B*3	1·000	0·059 (0·078)	−0·059 (0·078)	0·059 (0·078)	0·925	0·0154	1·66	0·05 (1, 29)

NOTES: *A*1, *A*2, *A*3 are the estimates for the number of employees and average weekly earnings, whereas *B*1, *B*2, *B*3 those for aggregate employee hours and hourly earnings. All equations were estimated with a constant and a linear trend. All current and future variables are treated as endogenous. The instruments used are two lags of employment, real wages, the nominal interest rate, inflation, money growth, and real government expenditure. The diagnostics reported are the adjusted coefficient of determination, the standard error of estimate, the Durbin–Watson statistic, and F tests, in obvious notation. The F-tests for *A*1 and *B*1 are Basmann tests of the overidentifying restrictions, whereas for the other equations they test the linear restrictions that each equation implies for the one above it. Numbers in parentheses are standard errors for the coefficients, and degrees of freedom for the F-tests. Exact data definitions and sources are in the appendix.

the predictions of the theory but this is not the case with the estimates based on employee-hours.

The parameters of *A*1 have the predicted signs, are statistically significant at conventional significance levels, and the reported diagnostics do not provide evidence of serious mis-specification. The Basmann test for the overidentifying restrictions is below its critical value at 5% ($F_{0.95}(8, 19) = 2{\cdot}48$), although it is somewhat close to it. The linear restrictions that the theory implies for the estimates (i.e. $\omega_1 = 1, \omega_2 = -\omega_3$) cannot be rejected either. Finally, the extra restriction implied by a common atemporal and intertemporal elasticity of substitution also seems to be satisfied.

For the *B* equations the overidentifying restrictions are comfortably rejected, and none of the estimated parameters of interest is statistically significant at conventional significance levels. Furthermore, the unrestricted point estimate of ω_3 has the *wrong* sign.

For the rest of the paper I concentrate on the estimates for the number of employees, to determine whether the evidence presented by these estimates is as favourable to ISH as appears at first sight. I shall concentrate in particular on the estimates with equal atemporal and intertemporal elasticities of substitution, since this restriction cannot be rejected, and results in a more parsimonious model.

A Chow test for a structural break at mid-sample (i.e. 1966) gives a statistic of 1·03, with $F_{0\cdot95}(3, 27) = 2\cdot96$. Thus no evidence of a structural break appears before and after 1966. This is a rather stringent test as the dependent variable exhibited a markedly different behaviour before and after 1966. Despite this there is no evidence of a structural break in the estimated aggregate employment relationship. In fact, the estimated labour supply elasticity is 0·210 for 1950–66, and 0·191 for 1967–82. Recall that for the full sample it is 0·198 (Table 1, *A*3). As a further check on the robustness of the estimated relationship I present in Table 2 estimates for (the slightly smaller sample of) 1955–82, with both gross and net of income tax earnings and interest rate. The net of income tax measures

Table 2

Estimates with Gross and Net of Tax Earnings and Interest Rate

(Data: UK, annual, 1955–82. Method of Estimation: two stage least squares. Dependent variable: $\log l_t$.)

	RHS Variables				Diagnostics		
	$\log l_{t+1}$	$\log (w/p)_t$	$\log (w/p)_{t+1}$	R_t	$\bar{R}^2$	s	DW
		Gross earnings and interest rate					
(1)	0·806	0·217	−0·189	0·123	0·806	0·0116	1·77
	(0·125)	(0·156)	(0·101)	(0·154)			
(2)	1·000	0·196	−0·196	0·196	0·794	0·0120	1·97
		(0·067)	(0·067)	(0·067)			
		Net of income tax earnings and interest rate					
(3)	0·816	0·262	−0·241	0·152	0·831	0·0109	1·90
	(0·122)	(0·124)	(0·090)	(0·120)			
(4)	1·000	0·242	−0·242	0·242	0·815	0·0113	2·08
		(0·069)	(0·069)	(0·069)			

NOTES: See Table 1. Estimates are only for the number of employees. The income tax rate is from Layard and Nickell (1985).

are in fact more appropriate. If anything, the estimates for net measures suggest a better fit, and a higher estimated elasticity. The differences however are not significant.

Another question is whether the estimates are consistent with the implied Euler equation for consumption demand. Note that even under the assumption that $\alpha = \epsilon$, we cannot identify the elasticity of substitution solely from our estimates of the labour supply function. In fact, the estimated labour supply elasticity of 0·198 is equal to $(1-\phi)/\phi\epsilon$, where ϕ is the share of 'leisure' (non-work activities) to the full labour endowment of the household.

Fortunately we can get an estimate of the elasticity of substitution $1/\epsilon$, by estimating the first order conditions for consumption demand. These imply that:

$$\log c_t = \log \hat{c}_{t+1} - (1/\epsilon)\, \hat{R}_t + \text{random errors, constant and possibly trend.} \quad (9)$$

Estimation of (9) by instrumental variables gives us (1950–82)

$$\log c_t = \log \hat{c}_{t+1} - \underset{(0.100)}{0.231} \hat{R}_t - \underset{(0.008)}{0.029} + \underset{(0.3\times 10^{-3})}{0.4\times 10^{-3}} t \qquad (9')$$

$$\bar{R}^2 = 0.991,\ s = 0.019,\ DW = 1.452.$$

The estimate of the elasticity of substitution implied by (9′) is equal to 0·231, therefore $\epsilon = 4.329$. Substituting this in our estimates of the labour supply function, gives an estimate of ϕ, the share of non-work activities in potential labour supply, equal to 0·462. The estimates of the labour supply and consumption functions would be consistent if employment had been, on average, about 50% of potential labour supply. Since the average participation rate in the United Kingdom has been around 48% for the years 1950–80, the estimates of the labour supply and consumption demand functions do not appear to be inconsistent. The model does not fare badly on this criterion, and the constant elasticity of substitution is estimated at round 0·2.[7]

Table 3

Tests of Overidentifying Restrictions

	Set of additional RHS variables	F-statistic	Degrees of freedom
(*A*)	One lag of the interest rate, inflation, monetary growth and the logs of employment, real wages and government expenditure	2·41	6, 21
(*B*)	Two lags of monetary growth and the log of government expenditure	0·25	4, 23
(*C*)	Two lags of the interest rate, inflation, and the logs of employment and real wages	2·44	8, 19
(*D*)	Two lags of the log of real wages and employment	4·65	4, 23

NOTES: See Table 1. The tests refer to equation *A*1.

Another set of criteria relates to the question of the overidentifying restrictions. The Basmann test reported in *A*1, tests the hypothesis that all the instruments affect employment through expected future employment, current and expected future real wages, and the real interest rate. This general hypothesis cannot be rejected, but the resulting statistic is quite near to its critical value. As a general Basmann test is expected to have low power, I present, in Table 3, F-statistics that test for the exclusion of various subsets of the instruments as independent regressors in the employment equation.

In row *A* I test for the joint significance of one lag of all the instruments. In row *B* for the significance of lags of the aggregate demand variables, real government expenditure and monetary growth. In row *C* I test for the significance of two lags of the 'endogenous' variables employment, real wages and the real interest rate, and in row *D* for two lags of employment and real

[7] Note that the coefficient of the time trend is not statistically significant in the consumption equation and significant in the employment equations. This pattern is not inconsistent with the model as the trend in the employment equations could reflect either l_0 or the terms in the approximations, which do not enter the consumption equation.

wages, i.e. the two main labour market variables. The overidentifying restrictions tested in rows *A–C* cannot be rejected, although in two cases the F statistics are just below their 5 % critical values. The exclusion of the two lags of employment and real wages is however easily rejected.

Overall, the results in this paper suggest that although ISH is easily rejected as a theory of fluctuations in aggregate employee hours, for fluctuations in the number of employees in employment, the theory does not fare too badly. This pattern of the results suggests that the hypothesis of equilibrium in labour markets does not receive much support. Nevertheless, for the number of employees in employment the estimated relationship appears consistent with ISH, robust, and the aggregate demand variables seem to exert no independent influence on aggregate employment, apart from their indirect influence through real wages and the real interest rate. The rejection of the exclusion restrictions on two lags of employment and real wages is certainly the fatal blow for an explicit model with time separable preferences. However, it is not necessarily a rejection of the *theory* of intertemporal substitution, as this is more general than such model. The fact that the exclusion restrictions that are rejected are those on lagged employment and real wages alerts one to the possibility that these may be proxying for *normal*, or *permanent* employment and real wages. This possibility can in principle be investigated. In fact it would lead us directly to the test procedure of Andrews (1983). In the next section I compare the present estimates with those of Andrews, and other evidence on the cyclical behaviour of employment and real wages in the United Kingdom.

III. RECONCILIATION WITH OTHER STUDIES

The question I want to investigate in this section is whether the results in section II are surprising in the light of previous findings for the United Kingdom.

There has been a flurry of recent research on the cyclical behaviour of employment (unemployment) and real wages in the United Kingdom. Apart from the two studies that explicitly test ISH (Andrews and Nickell (1982) and Andrews (1983)), there is a number of wage equation studies, either inspired by Sargan's (1964) specification, or derived from union models (Grubb *et al.* (1982); Nickell and Andrews, 1983; Minford, 1983; Layard and Nickell (1985), Newell and Symons, 1985, and others).

Comparison of my estimates with the other studies on ISH does not present too many problems. The estimated transitory real wage elasticity is the same (around 0·2). Both Andrews and Nickell (1982) and Andrews (1983) do find, however, significantly lower and not as well determined real interest rate semi-elasticities.

Detailed comparisons with other studies are impossible without a major additional research effort. Most of the estimated wage equations examine unemployment and not aggregate employment as in this paper, and there is no role for the interest rate. Broadly interpreted, however, my findings do not seem to contradict the other studies.

Let us look at the UK wage equation of Grubb *et al.* (1982). This is a

Sargan-type wage equation where, ignoring constants and some additional variables, it turns out that:

$$\dot{w}-\dot{w}_{-1} = \underset{(2\cdot9)}{0\cdot92}(\dot{p}_{-1}-\dot{w}_{-1}) - \underset{(2\cdot3)}{2\cdot01}\, U$$

where t-statistics are in parentheses, dots denote rates of change and U is the unemployment rate. Since 0·92 is not significantly different from unity, the equation can be re-written as:

$$\dot{w} = \dot{p}_{-1} - 2\cdot01\, U.$$

On the other hand my short-run labour supply function can be reparametrized as:

$$\dot{w} = r_{-1} + 5\dot{l}.$$

Since the unemployment rate is negatively related to the rate of change of employment, and the nominal interest rate positively related to inflation, my reparametrised labour supply function is observationally equivalent to the Sargan-type wage equation. Similar arguments can be made about the wage equations of Nickell and Andrews (1983), Layard and Nickell (1985), Minford (1983), Newell and Symons (1985) and others, all of whom estimate a negative effect of unemployment on real wages. What ISH does, is to substitute a labour supply function for the 'Phillips curve', but otherwise it is meant to explain the same correlations as the other wage equations. This is an argument about *observational equivalence*, although I am not suggesting that this problem cannot in principle be solved. In fact by specifying sufficiently detailed structural models of the labour market, we should be able to test the alternatives against a *statistical model* that encompasses them. This task goes beyond the scope of the present paper, and it is left for future work.

IV. CONCLUSIONS

In this paper I have set out to re-examine the explanatory power of the intertemporal substitution hypothesis for employment fluctuations in the United Kingdom.

The model that is estimated and tested is derived as the optimal decision rule of an infinitely living household, with time separable preferences, and an intertemporal CES utility function. For the total number of employees in employment the temporary elasticity of real wages, which in this model turns out to be almost equal to the elasticity of substitution, is estimated at around 0·2, and this is consistent with estimates from a similarly specified consumption function. This elasticity is a lot lower than for the US economy, where it was found to be in excess of unity (see Alogoskoufis, 1986).

Some of the overidentifying restrictions implied by this version of ISH seem to be rejected, but overall the model does not fare too badly on statistical grounds. In fact, it turns out to be almost *observationally equivalent* to other estimated wage equations and 'Phillips curves'. Directly comparing it to those alternatives is not a task undertaken in this paper. It should be noted, however, that there is nothing in the nature of ISH that would not admit a labour demand curve shifting about with the level of aggregate demand, as for example in the model of Layard and Nickell (1985). Therefore, the implications of ISH about aggregate demand policies need not differ from those of the latter model. Everything hinges on the pricing rules followed by firms, which determine whether the level of aggregate demand shifts the demand for labour curve or not.

I shall finish with an account of two of the empirical failures of the intertemporal substitution hypothesis that have been found in this investigation. The first is that it does not seem able to account for fluctuations in *employee-hours*, contrary to the assertion of Lucas quoted in the introduction. It can nevertheless account for fluctuations in the number of employees. The second is that, even in the latter case, some of the overidentifying restrictions implied by a version of ISH with time separable preferences, seem to be rejected. The variables for which the restrictions are rejected seem to suggest that maybe a version of ISH that does not rest on time separability should be specified. The results of Andrews (1983), as well as some preliminary results of my own, suggest that the overidentifying restrictions are rejected even for more generally specified equilibrium labour market models that rest on ISH.

In principle we should reject any theory that fails on such grounds, especially as it has such an unpalatable explanation for unemployment. I nevertheless feel that the positive points in the results of the present paper suggest that although theories that rely on ISH *and* continuous market clearing are decisively rejected, ISH itself might have some role to play in macroeconomic modelling. To play such a role it would have to be extended to account for the possibility of rationing. Such an extension, coupled with an adequate theory of imperfectly indexed nominal wage contracts, might result in better microfoundations of macroeconomic models.

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APPENDIX

In estimation current and future employment real wages and the real interest rate are treated as endogenous. l is employees in employment divided by an index of working population corrected for age and sex composition as in Lucas and Rapping (1969). w is average weekly earnings, manual workers, p is the retail price index, r the Treasury Bill rate. The instruments used were two lags of $\log l$, $\log (w/p)$, nominal interest rate, inflation, money growth (M3), and the log of real government expenditure. For the estimates with aggregate employee hours, l is multiplied and w is divided by average weekly hours of manual workers. The average income tax rate used in the estimates of Table 2 is taken from Layard and Nickell (1985).

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[Footnotes]

[1] **Heterogeneous Information and the Theory of the Business Cycle**
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