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DOES THE LABOR MARKET CLEAR?: LUCAS-RAPPING MODEL RECONSIDERED*

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DOES THE LABOR MARKET CLEAR?: LUCAS-RAPPING MODEL RECONSIDERED

by

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Abstract

This paper concerns the problem of testing for the labor market equilibrium hypothesis. Using a Lucas-Rapping- type model as a point of reference three testing procedures are carried out so that the stability of parameters of an equilibrium model are analyzed, a disequilibrium labor market model is estimated, and finally the relationship between the residuals of the labor supply and unemployment equations is examined. In all these tests with Finnish quarterly data the equilibrium hypothesis is rejected.

1. INTRODUCTION

We derive here a Lucas-Rapping-type model for the labor market starting from the notion of market clearing. That is, labor supply and demand are assumed to be equal and unemployment thus being only a consequence of unanticipated wage and price disturbances.

There are some, we think important, differences between our analysis and that of Lucas-Rapping (1970), particularly concerning the demand for labor. While Lucas and Rapping (1970) use a Jorgenson-type derivation, we consider a more general intertemporal maximization problem starting from a conventional adjustment cost framework. That, in turn, makes it possible to take into account the possibility of intertemporal substitution with the behavior of firms - not only with households (labor supply) as Lucas and Rapping (1970) do. Thus we, in fact, consider the "inventories" of labor input. The inventories of finished goods, another means of firms' intertemporal substitution, are not taken into account in this study.

After going through the theoretical considerations we start focusing the question of testing for the equilibrium in the labor market. That is, given our model specification, we test the hypothesis - essential to the new classical macroeconomics - that the labor market is (approximately) in equilibrium. Some alternative testing procedures are used here: estimation of a disequilibrium labor market model, testing for the stability of the parameters of an equilibrium labor market model and finally testing for the relationship between the residuals of labor supply and unemployment equations. The corresponding empirical analysis is carried out by quarterly Finnish data covering 1962.4 - 1979.3.

2. THEORETICAL CONSIDERATIONS

2.1. Supply of labor

Analogously to Lucas and Rapping (1970) we start from an intertemporal optimization problem (as for a general reference, see Deaton and Muellbauer (1980)):

$$\text{(1)} \qquad \max U = U(C_1, C_2, \ldots, C_T, Z_1, Z_2, \ldots, Z_T, A_T/P_T)$$

subject to:

$$\text{(2)} \qquad \sum_{t=1}^{T} R_t P_t C_t + \sum_{t=1}^{T} R_t W_t Z_t = \Omega_1$$

where C indicates consumption, Z leisure time, P price of C, W wage rate, A the stock of nominal quantity of (nonhuman) assets, R the discount factor with $R_1 = 1$, and Ω_1 the intertemporal wealth given by:

$$\text{(3)} \qquad \Omega_1 = (1 + r_1)A_0 + \sum_{1}^{T} R_t W_t (Z_t + N_t)$$

where N_t stands for the labor supply time, total time allowance being $Z + N$.

Now, given weak separability of U(.) the following consumption demand and labor supply function can be derived from (1)-(3):[1)]

$$(4) \qquad C_t = g(A_t, \bar{P}_t, \bar{P}_{t+1},\ldots,\bar{P}_T, \bar{W}_t, \bar{W}_{t+1},\ldots,\bar{W}_T)$$

where the upper bar indicates that the variable is multiplied by the discount factor, and

$$(5) \qquad N_t = f(A_t, \bar{P}_t, \bar{P}_{t+1},\ldots,\bar{P}_T, \bar{W}_t, \bar{W}_{t+1},\ldots,\bar{W}_T)$$

each schedule is homogeneous of degree zero in A_t, $\bar{P}_i$ and $\bar{W}_i$, $i = t, t+1,\ldots,T$. Following Lucas and Rapping (1970), consider the logarithmic version of (5):

$$(6) \qquad \ln N_t = a_0 + a_1 \ln(A_t/P_t) + \sum_{j=0}^{T'} k_j \ln(R_{t+j}W_{t+j}/P_t) + \sum_{j=0}^{T'} h_j \ln(R_{t+j}P_{t+j}/P_t) \qquad t+T' = T.$$

This can be transformed into an equation in terms of current and future real wages and real rates of interest (see e.g. Sargent (1980) p. 367 for an analogous derivation):

$$(7) \qquad \ln N_t = a_0 + a_1 \ln(A_t/P_t) + \sum_{j=0}^{T'} k_j (\ln W_{t+j} - \ln P_{t+j}) + \sum_{j=0}^{T'} h_j' (r_{t+j} - \ln P_{t+j+1} + \ln P_{t+j}).$$

2.2. Demand for labor

The firm, being a perfect competitor, maximizes its present value by choosing the optimal time path of employment, N_t, over time periods, t, t+1,...,T, given the following maximization problem, which is rather standard in the cost of adjustment literature:

$$(8) \qquad \max \sum_{t=1}^{T} R_t(P_t(f_1N_t - \tfrac{1}{2}f_2N_t^2 - \tfrac{1}{2}c(N_t - N_{t-1})^2) - W_tN_t),$$

where c indicates the adjustment cost term, assumed to reflect internal cost of adjustment (cf. Sargent (1978) and Meese (1980) for analogous models)[2)]. Now we write down the Euler equation of (8), solve the corresponding difference equation and derive the firm's demand for labor schedule. Thus, using

$$(9) \qquad P_t(f_1 - f_2N_t) - W_t - P_tc(N_t - N_{t-1}) + P_tcR(N_{t+1} - N_t) = 0$$

we can write

$$(10) \qquad N_{t+1} - ((f_2 + cR + c)/cR)N_t + (1/R)N_{t-1} = (1/P_tcR) \cdot (W_t - P_tf_1) = 0 .$$

Notice that this specification implies that the firm, in fact, maximizes <u>the real present value:</u> the RHS collapses namely into the real wage, w_t, and real productivity, f_1. Now, using lag operators, L, we can rewrite (10) into the form:

$$(11) \qquad (1 - z_1L)(1 - z_2L) = (1/cR)(w_t - f_1)$$

where z_1 and z_2 are defined as:[2)]

$$(12) \qquad z_1 + z_2 = (f_2 + cR + c)/cR$$

$$z_1z_2 = 1/R$$

Finally, using the fact that $1/(1 - zL) = -(zL)^{-1}/(1 - (zL)^{-1}$ we end up with:[3)]

$$(13) \qquad (1 - z_1L)N_{t+1} = \frac{-(z_2L)^{-1}}{1-z_2^{-1}L^{-1}}(1/cR)(w_t - f_1), \text{ i.e.}$$

$$(14) \qquad N_t = z_1N_{t-1} - (cR)^{-1}\sum_{j=0}^{T'}(1/z_2)^j(w_{t+j} - f_1) .$$

That is, the firm sets its employment according to the demand schedule in terms of current and future real wages and (exogeneous) productivity. So, if we indeed take seriously the idea of firm's (intertemporal) profit maximization with parametric prices, we end up with a very simple demand for labor function which is almost entirely built upon the real wage variable(s).

In this connection it is worthwhile to have a short look at the way Lucas and Rapping (1970) specify their demand for labor function (due to the fact that output appears as an explanatory variable in their equation they prefer not using the term "demand function" for it but instead they call it "the marginal productivity condition"). The corresponding derivation is based on a firm's cost minimization problem with parametric prices and a Harrod neutral CES production function. Finally by using a partial adjustment process in terms of the labor-output ratio Lucas and Rapping (1970) end up with:

$$(15) \qquad \ln(QN/y)_t = c_0 + c_1 \ln(w/Q)_t + c_2 \ln(QN/y)_{t-1} + c_3 \ln(y_t/y_{t-1}) ,$$

where Q denotes the index for labor quality. Clearly there are some important differences between (15) and (14). (15) does not include any future expectations, instead it is the output variables (level and difference of y_t which Lucas and Rapping assume exogeneous in their empirical work) which play the decisive role in the respective equation. Even if (14) is considered the basic equation in the subsequent empirical analysis, (15) will be applied as well to check for the robustness of our results.

2.3. Market equilibrium

In the previous sections we have derived the following labor supply-demand framework:[4)]

$$\text{(7')}\qquad \ln N_t^s = a_0 + a_1\ln(A_t/P_t) + \sum_{j=0}^{j=T'} k_j(\ln W_{t+j} - \ln P_{t+j}) + \sum_{j=0}^{T'} h_j(r_{t+j} - \ln P_{t+j+1} + \ln P_{t+j})$$

$$\text{(16)}\qquad \ln N_t^d = b_0 + b_1 N_{t-1} + \sum_{j=0}^{T'} d_j(\ln W_{t+j} - \ln P_{t+j}) + b_3 t$$

The main common element in these models is the (expected) real wage rate (W/P). The differences concern the future real interest rates, stock of assets, the time trend, and the lagged employment term. That is not to say that these variables cannot be introduced to either of these equations; it is perhaps only the stock of households' assets which by no means belongs to the demand for labor-equation[5)].

What we indend to do next is to collapse all the future price, wage and interest terms for periods t, t+1,...,T into one composite term for, say, t* (the corresponding index-number problem is discussed in Liviatian (1966)). In the same vain we impose (following again Lucas and Rapping (1970) the adaptive expectations hypothesis on these terms w_t^* and p_t^* by using the standard Koyck transformation[6)]. That gives the following labor supply and demand-equations, respectively:

$$\text{(17)}\qquad \ln N_t^s = (1-v)a_0 + a_1\ln(A_t/P_t) - a_1 v\ln(A_{t-1}/P_{t-1}) + h_0 r_t - h_0 v r_{t-1} + (k_0 + (1-v)k_1)\ln w_t - vk_0\ln w_{t-1} + (1-v)h_0\ln(P_t/P_{t-1}) + v\ln N_{t-1} + e_{1t}$$

$$= X_{1t}\alpha_1 + \alpha_2 \cdot w_t + e_{1t}$$

$$(18) \qquad \ln N_t^d = (1-s)b_0 + (b_1-s)\ln N_{t-1} - b_1 s \ln N_{t-2} + (d_0 + (1-v)d_1)\ln w_t - vd_0 \ln w_{t-1} + b_3 t - vb_3 t-1 + e_{2t}$$

$$= X_{2t}\alpha_3 + \alpha_4 \cdot w_t + e_{2t}$$

The error vectors (e_{1t}, e_{2t}) are assumed to be independent and identically distributed with a finite covariance matrix Σ and a mean vector (0,0)[7].

Now we are able to solve the reduced form of (17) and (18). That is done simply by equalling labor supply and demand, and solving the system with respect to the endogeneous variables, w_t and N_t, in terms of the predetermined variables A_t/P_t, A_{t-1}/P_{t-1}, r_t, r_{t-1}, (P_t/P_{t-1}), N_{t-1}, N_{t-2}, and t. Clearly both equations are overidentified.

That exercise produces the following equation for N_t

$$(19) \qquad \ln \bar{N}_t = b_0' + b_1' \ln N_{t-1} + b_3' \ln N_{t-2} + b_4' \ln(P_t/P_{t-1}) + b_5' \ln w_{t-1} + b_6' r_t + b_7' r_{t-1} + b_8' \ln(A_t/P_t) + b_9' \ln(A_{t-1}/P_{t-1}) + b_{10}' t + \bar{e}_t$$

The wage equation has the same arguments, but, of course, a different parametrization.

(17) differs to some extent from the reduced form specified by Lucas and Rapping (1970). As stated above, their system includes the level and change of output as explanatory variables - on the other hand they drop the asset and nominal interest rate terms from their supply function in the early phase of their study.

2.4. Testing for the equilibrium hypothesis

When the supply and demand equations (17) and (18) (or (15)) are concerned, two alternatives exist. First: market clearing - then supply equals demand and the real wage, w_t, is the solution of (17) and (18). Second: market disequilibrium - in this case the real wage rate, w_t, is, to use the Keynesian notion as a reference, exogeneous and employment is not always determined on the supply curve.

A very convenient test for this problem is offered by Hwang (1980). The proposed testing procedure goes as follows: Introduce a simple classification variable k_t so that:

$$(20) \qquad \begin{cases} k_t = 1, \text{ if } N_t^s \geq N_t^d \\ k_t = 0, \text{ if } N_t^s < N_t^d \\ N_t = k_t N_t^d + (1-k_t) N_t^s \end{cases}$$

Now, using (17) and (18) we can solve N_t in terms of X_{1t}, X_{2t}, w_t, e_{1t} and e_{2t}. That is:

$$(21) \qquad N_t = X_{2t}(\alpha_3 k_t) + X_{1t}(1-k_t)\alpha_1 + (k_t\alpha_4 + (1-k_t)\alpha_2)w_t + k_t e_{2t} + (1-k_t)e_{1t}$$

It can be shown, see Hwang (1980), p. 322 for details, that with equilibrium hypothesis a similar equation can be derived (i.e. with the same arguments appearing on the RHS of the equation) with respect to N_t, the major difference being in the stability of parameters (coefficients and variance of error term) in this regression equation of N_t against X_{1t}, X_{2t} and w_t. Obviously, the disequilibrium hypothesis implies that the parameters are not invariant over time.

When evaluating the stability of e.g. (21) one could use the rather standard Brown-Durbin-Evans- type approach, cf. Brown and Durbin and Evans (1975). The problem with this approach is that the alternative hypothesis includes all possible sources of instability.

Hence the the rejection of the null hypothesis of stability does not necessarily imply the rejection of the equilibrium model. A more affirmative result may be obtained by using the threshold (autoregressive) model of Tong (cf. Tong and Lim (1980)) which allows testing whether the parameters of the model(s) in question stay invariant given a threshold value of an indicator variable which in this case could be e.g. ΔlnGDP or unemployment rate, U_t, describing different levels (regimes) of economic activity.

Another test, which explicitly concerns the labor market, is proposed by Altonji (1978). His test procedure is based on the observation that the market equilibrium model (by Lucas and Rapping (1970), for instance) implies that the residuals of the labor supply and employment equations should be independent, while the disequilibrium view suggests that these residuals should be negatively correlated: for example during a recession period unemployment is higher than the corresponding equilibrium level while, at the same time, employment is smaller than labor supply.

Now, one should only estimate, preferrably by using the equilibrium model as a point of reference, the parameters of the labor supply and unemployment equations and then compute the conditional means of U_t and N_t. The deviations of U_t and N_t from these conditional means may be checked for independence, and if they are, in fact, significantly negatively correlated, the equilibrium hypothesis is rejected.

Finally, we should consider the alternative of estimating a disequilibrium labor market model along the lines of Rosen and Quandt (1978). This work is based on the notion that the (employed) labor input, which is observed, is the minimum of quantity supplied and quantity demanded at current wage:

(22) $\ln N_t = \min(\ln N_t^d, \ln N_t^s)$

Clearly, (22) is not very realistic in the sense that the effects of uncertainty and aggregation over different sub-markets (cf. e.g. Muellbauer (1978)) are ignored. The nice thing, in turn, is that (22) makes estimation rather straightforward[8)]. As far as the estimation of the supply and demand equations is concerned, we could, of course, start with (17) and (18). However, if we take the existence of disequilibrium seriously, it is not self-evident that these equations are correctly specified. The simple model of Rosen and Quandt (1978) might be of more relevance here. Using that model as point of reference leads to:

(23)
$$\begin{cases} \ln N_t^s = a_0 + a_1 \ln M_t + a_2 \ln w_t + a_3 \ln(A/P)_t + e_t^s \\ \ln N_t^d = b_0 + b_1 \ln w_t + a_2 \ln y_t + a_3 t + e_t^d \end{cases}$$

The supply equation of (23) is not based on the story of intertemporal substitution, instead it is derived from a one-period utility maximization problem. The demand function, N_t^d, is, in turn, derived from a standard static cost minimization problem the result being thus (apart from the lagged dependent term) similar to (15).

Estimating an equation system (22) and (23) enables us to to compute a disequilibrium unemployment rate, that is:

(24) $$U_{dt} = (\hat{N}^s_t - \hat{N}^d_t)/\hat{N}^s_t$$

where g.g. $\hat{N}^s_t$ stands for the (conditional) labor supply computed by estimated parameters of (23) for the whole data set. By drawing the time path of U_{dt} and comparing it with the corresponding employment survey figure, U_t, useful information may be obtained of the nature of eventual disequilibrium in the labor market.

Besides these three test procedures proposed above, there are still some other alternatives (cf. Quandt (1978) for a summary). As far as the labor market is concerned, we should mention the possibilities of utilizing the wage adjustment equation for this purpose. That is, we could by specify:

(25) $$\Delta w_t = \gamma(N^d_t - N^s_t), \text{ or}$$

(26) $$\Delta w_t = \Theta(w^*_t - w_{t-1})$$

where w^*_t is the unobservable market clearing wage. There are, however, many problems with these test procedures, as pointed out by e.g. Hwang (1980). For example, (25) requires the estimation of N^d_t and N^s_t, while (26) requires that w^*_t does not depend on w_{t-1}. And, of course, the main problem is that these tests are joint tests of equilibrium hypothesis and the particular form of the wage adjustment process, (25) or

(26). For example, the treating of expectations might crucially affect the results. That is why we exclude these tests from this study[9].

3. EMPIRICAL ANALYSIS

3.1. Data

Finnish quarterly data covering the period 1962.4 - 1979.3 is used in the empirical analysis. The data is seasonally adjusted; except for the time series for the households' (nonhuman) wealth, it is provided by the Bank of Finland (the data has been constructed in the context of the quarterly model of the Bank of Finland).

The variables used in the empirical study are listed below:

- A_t Households' nonhuman wealth: it includes currency, demand deposits, time deposits, government bonds, bank loans, stocks of consumer durables and houses. The time series is constructed in ETLA by the author.
- M_t Working-age population
- N_t Employed persons according to the employment survey
- P_t Implicit deflator of the consumer goods
- r_t Average lending rate of commercial banks
- U_t Unemployment rate according to employment survey
- W_t (Pre-tax) wage rate, $w_t = W_t/P_t$
- y_t GDP at factor cost (at 1975 prices).

3.2. Analysis of parameter stability

This piece of analysis consists of estimating (21) by using a threshold model so that the observations are divided into two regimes. This division was based on an indicator variable which in this case was the measured unemployment rate (or strictly speaking its deviation from trend, U_{ct}). Computation was carried out by the program TARSC[10]. That is, (21) was estimated in the form:

$$(27)\quad N_t = \begin{cases} X_t\beta_1 + e_{1t} & U_{ct} > \bar{U}_c \\ X_t\beta_2 + e_{2t} & U_{ct} \leq \bar{U}_c \end{cases}$$

The value of the threshold, $\bar{U}_c$ was determined on the base of Akaike´s Information Criterion, denoted by AIC (for other details see e.g. Tong and Lim (1980)). Parameter stability with respect to the (optimal value of) threshold was tested simply by Chow test.

Some preliminary results are presented in Table 1. These include the parameter estimates and their standard deviations by regime, the corresponding Chow- test statistic, Box-Pierce autocorrelation statistic with 12 lags (for the OLS regression residual over the whole period) and the estimated value of the threshold.

Table 1. Estimation results with the threshold model

	1-A	1-B	2-A	2-B	3-A	3-B	4-A	4-B	5-A	5-B
constant	1.963	1.286	1.758	.758	1.405	.668	1.681	4.967	3.487	3.451
	(1.046)	(0.438)	(1.275)	(0.498)	(0.594)	(0.699)	(1.156)	(4.967)	(1.383)	(1.701)
$\ln N_{t-1}$	.745	.832	.773	.905	.705	.780	.715	.702	.251	.783
	(0.136)	(0.057)	(0.167)	(0.066)	(0.083)	(0.078)	(0.147)	(0.069)	(0.219)	(0.065)
$\ln w_t$	.042	-.003	.048	.011	-.089	-.134	.031	.090	-.080	.009
	(0.032)	(0.005)	(0.039)	(0.009)	(0.033)	(0.040)	(0.037)	(0.033)	(0.064)	(0.035)
$\ln M_t$							.064	-.328	.110	-.390
							(0.102)	(0.115)	(0.091)	(0.147)
r_t			-.085	-.331						
			(0.284)	(0.172)						
$\ln(A/P)_t$									.007	-.041
									(0.042)	(0.032)
$\ln y_t$					.087	.100			.138	.143
					(0.028)	(0.030)			(0.056)	(0.038)
R^2	.857	.842	.858	.851	.891	.815	.861	.864	.916	.906
F:Chow	3.319		2.244		6.656		3.510		2.573	
Q(12)	26.87		20.46		22.17		31.30		22.24	
$\bar{U}_c$: Threshold	-.865		-.865		-.060		-.865		-.865	

A indicates the regime: $U_{ct} \leq \bar{U}_c$, B in turn the one with: $U_{ct} > \bar{U}_c$.

When estimating (21) by OLS it emerged that most of the variables had very low t-ratios (cf. Table 2 below). Hence we preferred estimating more parsimonious equations, i.e. such which include only $\ln w_t$, $\ln N_{t-1}$, and a few other variables. As for these other variables, it came out that the level of output ($\ln y_t$) - used by Lucas and Rapping (1970) - has large t-ratios which motivated its inclusion as an additional explanatory variable.

As far as these results are concerned, it is found that the hypothesis of parameter stability can be rejected with equations 1, 3, 4, and 5 at the 5 % level of significance (when evaluating the values of the test statistics notice that out test is a test of parameter stability given the threshold, not just an ordinary Chow test - on the other hand it is worthwhole to point out that the residuals are more or less serially correlated which makes the significance levels only approximative).

Table 1 contains only a fraction of the estimation results obtained. They do, however, give an idea of the general flavour of all results, that is, parameter stability (given the threshold) is rejected. Because the development of the computer program is still going on, we prefer not going further with this analysis in this context.

3.3. The test of Altonji

When carrying out the test procedure suggested by Altonji (1978) we used on the one hand the supply equation (17) and on the other hand the following unemployment equation:

$$(28) \qquad U_t = d_0 + d_1 U_{t-1} + d_2 \Delta \ln w_t + d_3 \Delta \ln P_t + d_4 t + u_t.$$

(28) is simply the same equation used by Lucas and Rapping (1970). It is only that the time trend variable is introduced to capture the effects of changes in the frictional unemployment. The parameter estimates of (17) and (28) are presented in Table 2; equations are estimated both by OLS and 2SLS. Standard errors (which are only assymptotic in the case of 2SLS) are presented inside parentheses, Q(12) denotes the Box-Pierce autocorrelation statistic with 12 lags, $r_{u1,u2}$ denotes the coefficient of correlation between the residuals of (17) and (28) and finally χ^2_1 stands for the corresponding χ^2-test statistics.

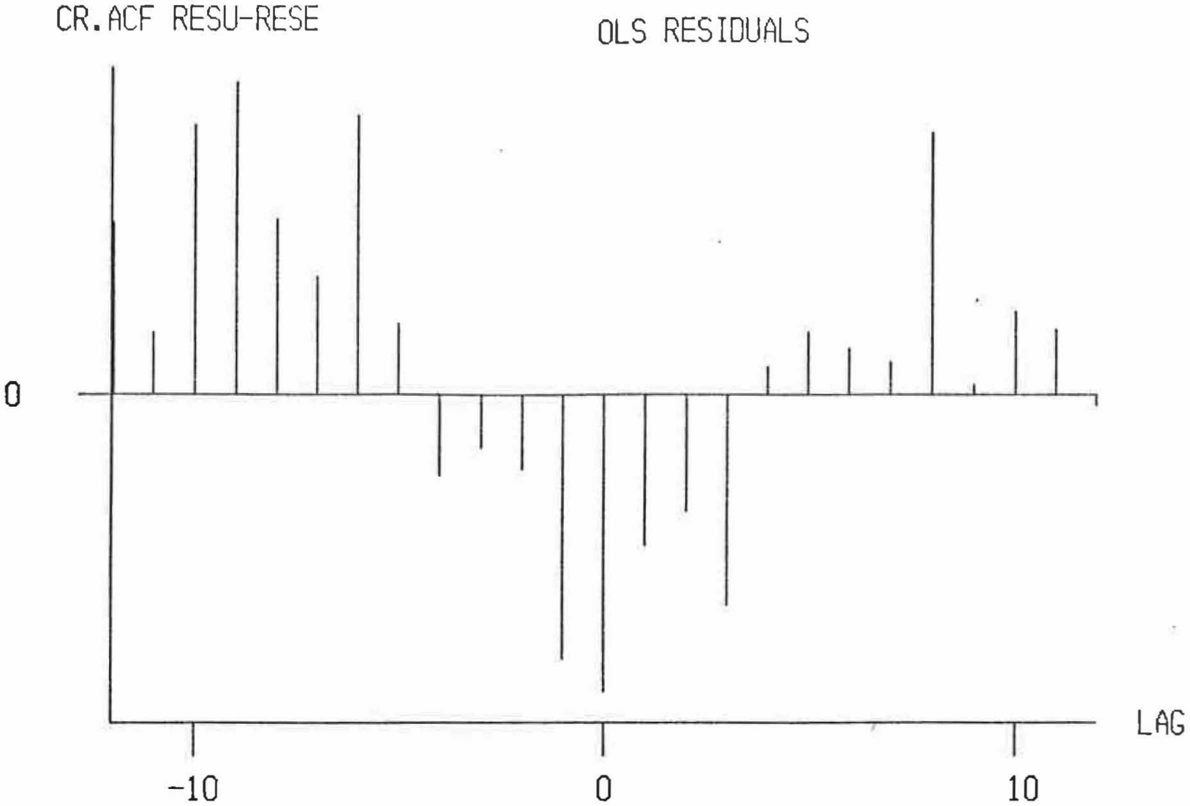
A short look at the estimation results reveals that the both equations perform rather poorly: the coefficient estimates of the labor supply equation are almost all of the wrong sign (especially in the case of (consistent) 2SLS estimation) and, on the other hand, the error term of the unemployment equation is far from being white noise.

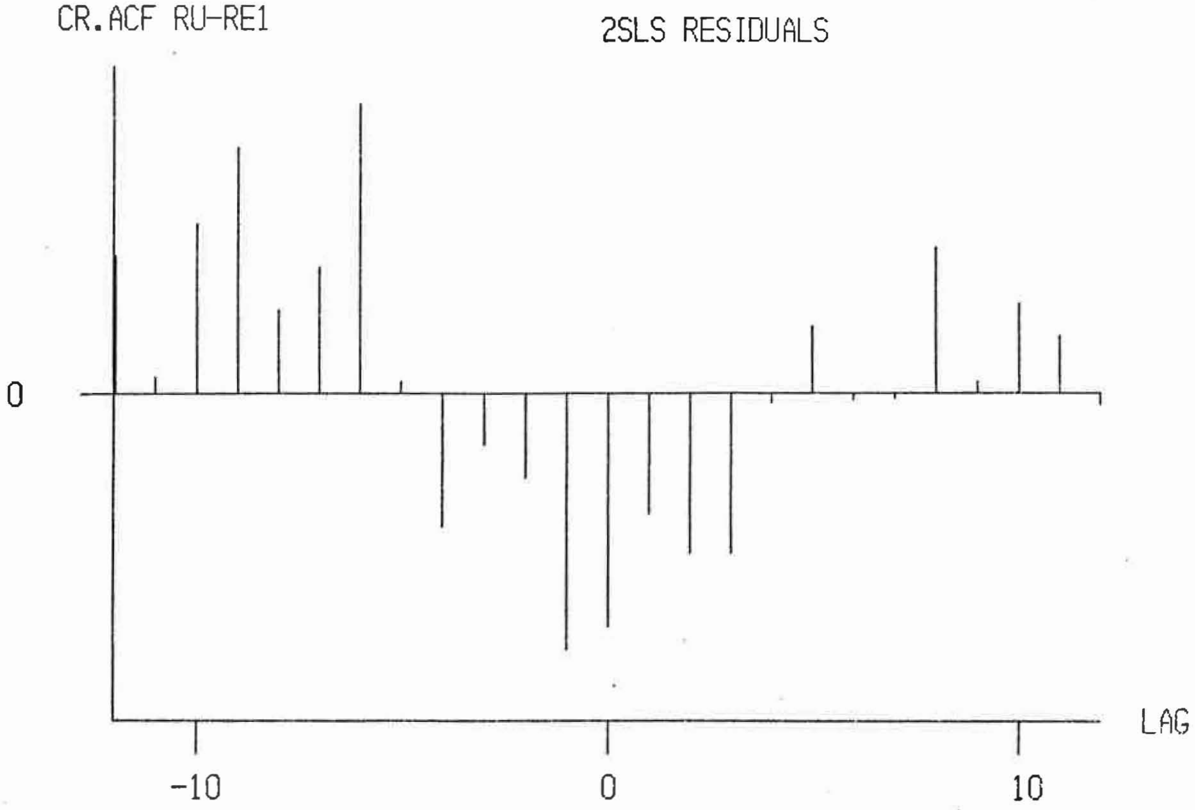
Now, if we look at the cross-correlograms between the two residuals (they are presented in Figure 1) we find a clear

Table 2. Estimation results of the labor supply and unemployment equations

	$\ln N_t$:OLS	U_t:OLS	$\ln N_t$:2SLS	U_t:2SLS
constant	2.589 (1.191)	.113 (0.136)	2.953 (2.020)	.145 (0.165)
r_t	-.161 (0.327)		.586 (0.672)	
$\ln M_t$	-.013 (0.098)		.089 (0.172)	
$\ln w_t$	-.069 (0.063)		-.712 (0.348)	
$\ln(A/P)_t$	.114 (0.047)		.204 (0.092)	
$\Delta \ln P_t$	.078 (0.083)	-.310 (4.104)	-.268 (0.226)	-.951 (4.714)
$\ln N_{t-1}$	.900 (.066)		1.018 (0.128)	
$\ln w_{t-1}$	.112 (0.059)		.622 (0.282)	
r_{t-1}	-.164 (0.304)		-1.072 (0.695)	
$\ln(A/P)_{t-1}$	-.099 (0.047)		-.103 (0.083)	
$\ln M_{t-1}$	-.209 (0.094)		-.473 (0.209)	
t		.003 (0.004)		.003 (0.004)
U_{t-1}		.951 (0.039)		.950 (0.042)
$\Delta \ln w_t$		-7.816 (3.703)		-9.693 (6.463)
R^2	.933	.962	.945	.961
Q(12)	29.76	42.57	15.61	46.86
$r_{u1,u2}$	-.407		-.324	
X_1^2	14.59		9.29	

Figure 1. Cross-correlograms between labor supply and unemployment residuals





negative dependence: as for period t only the coefficient of correlation with 2SLS is -.324 which is significant at all standard levels of significance. Thus, given equations (17) and (28), the labor market equilibrium hypothesis can be rejected[11)].

3.3. Estimating a disequilibrium labor market model

Empirical analysis in this context consisted of estimating (23), given the switching rule (22). Estimation was performed by using the program CLUSTREG of the University of Helsinki, Department of Statistics (cf. Mustonen and Mellin (1976) for details). Estimation was based on the method of selective least squares. Because the time series were both highly multicollinear and serially correlated we eliminated time trend from all variables.

Three sets of results are presented in Table 3, as for the other results, we can mention that they were not too diss-similar to those presented above. The first and second set differ with respect to the output variable in the demand equation, and the first and third with respect to the real rate of interest variable in the supply equation. Besides the disequilibrium supply and demand equations we present the corresponding reduced forms of the employment equations (which, by definition, are based on the assumption that supply equals demand with all observations). Comparing the residual sums of squares of the reduced form

Table 3. Estimation results of the disequilibrium model

	$\tilde{N}^s_t$	$\tilde{N}^d_t$	$\bar{\tilde{N}}_t$	$\tilde{N}^s_t$	$\tilde{N}^d_t$	$\bar{\tilde{N}}_t$	$\tilde{N}^s_t$	$\tilde{N}^d_t$	$\bar{\tilde{N}}_t$
constant	.0025 (2.37)	.0100 (3.41)	-.0000 (0.00)	-.0004 (0.38)	.0138 (6.53)	-.0000 (0.00)	.0025 (2.24)	.0098 (3.72)	.0019 (0.61)
$\ell n\ \tilde{M}_t$	.4692 (3.15)		.2056 (1.32)	.1098 (0.80)		.1892 (1.15)	.4602 (2.96)		.1834 (1.18)
$\ell n\ (\tilde{A/P})_t$	.3969 (7.42)		.2255 (5.22)	.2831 (7.73)		.3318 (12.95)	.3887 (6.53)		.2064 (4.62)
$\ell n\ \tilde{w}_t$	.0468 (0.82)	-.2129 (4.20)		.2167 (4.06)	.1317 (5.53)		.0519 (0.84)	-.2112 (4.39)	
$\ell n\ \tilde{y}_t$		.6562 (12.90)	.1682 (2.96)					.6550 (13.35)	.1815 (3.19)
t		-.0003 (5.19)	.0000 (0.00)		-.0003 (7.33)	.0000 (0.00)		-.0003 (5.61)	-.0000 (0.60)
$\hat{r}_t$							-.0624 (0.37)		-.2696 (1.50)
R^2	.8545	.9291	.7607	.8941	.8079	.7273	.8550	.9292	.7692
RSS	.00177	.00088	.00575	.00232	.000525	.00645	.00182	.00088	.00564
Q(12)			93.72			92.58			94.58
n	40	28	68	43	25	68	39	29	68

$\hat{r}_t$ denotes the real rate of interest. Variables indicated by ~ are deviations from linear trend. U_{dt} in Figure 2 corresponds to the first two columns of Table 3.

and the disequilibrium model gives some measure of the existence of disequilibrium in the labor market. Figure 2 serves the same purpose; the computed disequilibrium unemployment rate (cf. (23) and (24)) together with the actual (employment survey) unemployment rate gives some idea of the timing and magnitude of disequilibrium in the labor market.

If we consider first the estimation results presented in Table 3, we find that the specification which includes the output variable in the demand for labor equation performs very well, indeed. All coefficient estimates (except the one of the wealth variable, $(A/P)_t$) have expected signs and in most cases the t-ratios are very high. The fact that the coefficient of the wealth variable is positive is somewhat counterintuitive but it is by no means exceptional (see e.g. Rosen and Quandt (1978)). If we compute the residual sum of squares of the disequilibrium model for the whole period and compare it with the residual sum of squares of the reduced form, we find that the disequilibrium model fits substantially better thus suggesting that the hypothesis of disequilibrium in the labor market is not totally unjustified. On the other hand we can mention that if the system of equations (for N_t^d and N_t^s) are estimated over the whole period by 2SLS - thus assuming an equilibrium model - rather poor results are obtained. Particularly in terms of the signs of coefficient estimates (recall also the results presented in Table 2). Now, if the output variable, ℓny_t, id dropped from the demand equation, the performance of the disequilibrium model (and, in fact also the equilibrium model) becomes much worse; it seems indeed that the idea of profit maximization with parametric prices is not very useful in an empirical analysis (a similar conclusion has been reached by e.g. Brechling (1975)).

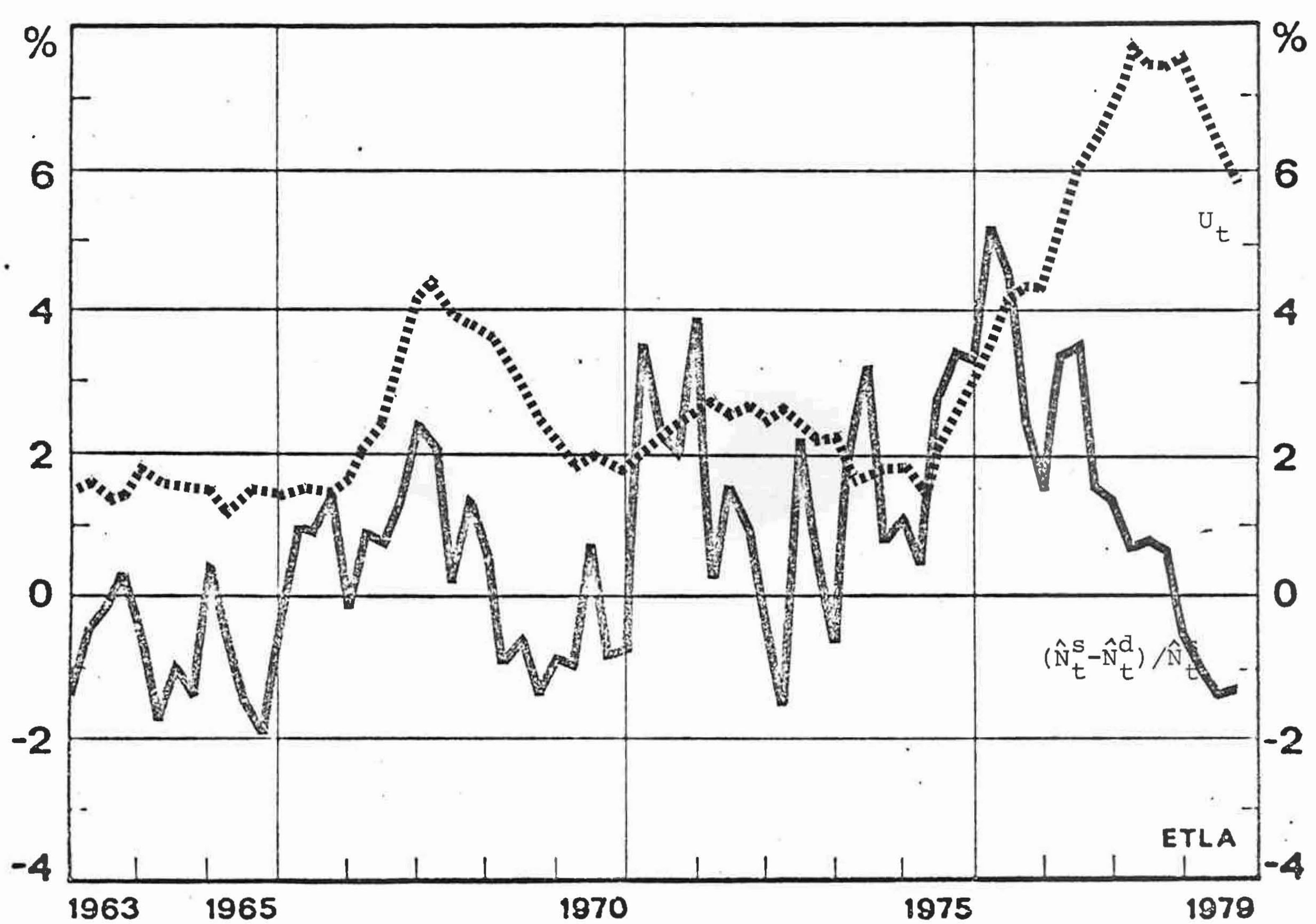
Finally, if Figure 2 is concerned, it appears that the unemployment rate produced by the disequilibrium model (with $\ln y_t$) scopes rather well with the intuitive idea of the employment situation in Finland during the 60´s and 70´s. It is also compatible with figures of the employment survey, especially if we consider the deviations from trend. In this sense the results are much better than those of Rosen and Quandt (1978) with U.S. data.

4. CONCLUSION

Our objective has been to survey some basic propositions of the labor market equilibrium hypothesis, to consider the alternative ways of testing for this hypothesis, and finally to carry out some suitable empirical tests. These tests with Finnish quarterly data covering 1962-79 demonstrate that the equilibrium hypothesis can be rejected. Further work is, however, needed, especially with the respecification of model(s), to ensure that this result is robust enough.

Finally, one remark is still merit note. Even if it appears that there are (periods of disequilibrium) in the labor market, it is not self-evident that the equilibrium models should not at all be used - they might still be good approximations to be utilized in e.g. policy purposes.

Figure 2. Measured and disequilibrium unemployment.



FOOTNOTES:

1) We use here the perfect foresight set-up for the sake of convenience - uncertainty on future relative prices is considered later on in section 2.3. If uncertainty were explicitly considered when deriving the supply and demand schedules, stochastic control theory should be applied. In this context the illustrative purpose of the paper is satisfied with a much simpler framework.

2) It is rather straightforward to show that the roots, z_1 and z_2, are distinct and real, the other being, however, unstable. Due to the transversality condition we must in fact solve this root forward, and only the stable root backward.

3) By using the transversality condition we can delete the additional cz_1^t-term being a part of the "general" solution of (11).

4) (16) is obtained from (14) by solving it w.r.t. period t-1 and adding a time trend to capture the eventual effects of changes in the marginal productivity of labor, f_1.

5) Introducing the capital input (with the user cost of capital) to the model would rationalize the inclusion of the real rate interest in the demand for labor-equation. In the same way, the hypothesis of 'habit persistance', as well as nonseparability of the utility function (1), would rationalize the lagged employment term in the supply of labor-equation.

6) Notice that - opposite to Lucas and Rapping (1970) - the adaptive expectations are, in fact, imposed to both labor supply and demand equations. It would be desireable to allow also the reaction parameters with respect to real wages and prices to differ. This more general model could be motivated by the observation that these variables have followed somewhat different pattern over time. Furthermore Turnovsky (1969) has shown that the reaction parameters are related to the variances of rates of inflation. It is only that the two-reaction parameter model with Koyck transformation would be too complicated for estimation given the number of explanatory variables in (17).
An obvious candidate for expectations formation hypothesis would in this context be the rational expectations hypothesis. The problem is that this procedure requiring the solving for the wage rate (and perhaps also the price level) as an endogeneous variable and estimating the complete system via FIML seems too complicated. Sargent (1978) who suggests this approach, in fact, avoids most of the problem by closing his model with a (real) wage equation where the wage rate is assumed to follow an AR process.

7) This assumption follows the one of Lucas and Rapping (1970), p. 277. Due to the fact that the Koyck transformation breaks the serial independence of the error terms, this assumption seems hard to swallow. In order to uphold the assumption we should, for instance, make the error terms of (7) and (16) (not presented) serially dependent furthermore v and s being then the corresponding correlation coefficients.

8) Instead of using (22) as a switching rule (cf. Maddala and Nelson (1974)) we should, given the fact that our data concerns the aggregate labor market, use the switching rule of Ginsburg and Tishler and Zang (1980) which is: $\ln N_t = \min(\ln \tilde{N}_t^s, \ln \tilde{N}_t^d) + u_t$ where u_t stands for a stochastic disturbance term and $\tilde{N}_t^s$ and $\tilde{N}_t^d$ the deterministic supply and demand equations. Unfortunately, the computer programs available do not allow this possibility.

9) As for other testing alternatives, see e.g. Altonji and Ashenfelter (1980). The test of Altonji and Ashenfelter (1980) focusing the intertemporal substitution aspect in the market clearing model of labor market concentrates to check whether the aggregate real wage process obeys a random walk and in part on whether the variance in the innovation in aggregate real wages is large relative to the transitory cross-sectional variation is real wages. Altonji and Ashenfelter find some evidence for the proposition that the noise is large enough to explain the magnitude of variation in unemployment. However, when estimating in the same context some unemployment equations, it comes out that most of the observed variation in postwar unemployment remains unexplained.

10) This program has been developed following partly the ideas of Tong (cf. SETAR of Tong and Lim (1980)). The prograamming has been carried out by Ritva Luukkonen and Timo Teräsvirta (University of Helsinki and the Research Institute of the Finnish Economy, respectively). Unfortunately no document of the program is yet available.

11) The same result was obtained also with more parsimonious versions of the supply of labor equation, (17). To save space, the corresponding estimation results are not presented here - they are, however, available upon request from the author.

REFERENCES

ALTONJI, J.: (1978) Does the Labor Market Clear? A Test of the Equilibrium Hypothesis, Princeton University, Industrial Relations Section, Working Paper No. 114.

ALTONJI, J. and ASHENFELTER, O.: (1980) Wage Movements and the Labor Market Equilibrium Hypothesis, *Economica*, 217-246.

BRECHLING, F.: (1975) *Investment and Employment Decisions*, Manchester University Press.

BROWN, R. and DURBIN, J. and EVANS, J.: (1975) Techniques for Testing the Constancy of Regression Relationships over time, *Journal of Royal Statistical Society*, (B), 149-192.

DEATON, A. and MUELLBAUER, J.: (1980) *Economics and Consumer Behavior*, Cambridge University Press.

GINSBURGH, V. and TISHLER, A. and ZANG, I.: (1980) Alternative Estimation Methods for Two-Regime Models: A Mathematical Programming Approach, *European Economic* Review, 207-228.

HWANG, H.: (1980) A Test of Disequilibrium Model, *Journal of Econometrics*, 319-333.

LIVIATAN, N.: (1966) Multiperiod Future Consumption as an Aggregate, *American Economic Review*, 828-840.

LUCAS, R. and RAPPING, L.: (1970) Real Wages, Employment and Inflation, in E. Phelps et al eds. *Microeconomic Foundations of Employment and Inflation Theory*, Norton, 257-305.

MADDALA, G. and NELSON, F.: (1974) Maximum Likelihood Methods for Models of Markets in Disequilibrium, *Econometrica*, 1013-1030.

MEESE, R.: (1980) Dynamic Factor Demand Schedules for Labor and Capital Under Rational Expectations, International Finance Discussion Papers, Federal Reserve System, 153.

MUELLBAUER, J.: (1978) Macrotheory vs. Macroeconometrics: The Treatment of Disequilibrium in Macromodels, Discussion Paper No. 59, Birbeck College, University London.

MUSTONEN, S. and MELLIN, L.: (1980) *SURVO 76 Program Descriptions*, Discussion Paper, University of Helsinki, Department of Statistics.

QUANDT, R.: (1978) Tests of the Equilibrium vs. Disequilibrium Hypotheses, *International Economic Review*, 435-452.

ROSEN, H. and QUANDT, R.: (1978) Estimation of a Disequilibrium Aggregate Labor Market, *Review of Economics and Statistics*, 371-379.

SARGENT, T.: (1978) Estimation of Dynamic Labor Demand Schedules Under Rational Expectations, *Journal of Political Economy*, 1009-1044.

SARGENT, T.: (1979) *Macroeconomic Theory*, Academic Press.

TONG, H. and LIM, K.S.: (1980) Threshold Autoregression, Limit Cycles and Cyclical Data, *Journal of Royal Statistical Society* (B), 245-292.

TURNOVSKY, S.J.: (1969) A Bayesian Approach to the Theory of Expectations, *Journal of Economic Theory*, 220-227.