THE SPECIFICATION AND ESTIMATION OF A DISEQUILIBRIUM LABOUR MARKET MODEL

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The specification and estimation of a disequilibrium labour market model

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In this study an aggregate labour market model is formulated and its parameters estimated, using Maltese annual time-series data, covering the years 1955–79. The constraint that the wage rate clears the market in all periods is not imposed and the model is specified in such a way as to enable the researcher to judge whether or not the assumption of equilibrium is valid. One conclusion that emerges from this study is that the Maltese labour market was not characterized by equilibrium during the period under consideration.

I. INTRODUCTION

In this study an aggregate labour market model is formulated and its parameters estimated using Maltese annual time-series data, covering the years 1955–79. Many empirical studies on labour markets do not make adequate allowance for the possibility of disequilibrium, and some contain the assumption, implicit or otherwise, that the wage rate continually clears the market.[1] The purpose of the present paper is to propose a model which does not impose the 'equilibrium' constraint. For this reason, the model is specified in such a way as to enable the researcher to judge whether or not the equilibrium assumption is valid.

The most important conclusions that emerge from this paper are that during the period of the study

1. real wage rate changes were determined by the balance between labour demand and labour supply, and by non-market forces, the most important of which was union pushfulness
2. the balance between labour demand and labour supply was itself determined by real wage rates and other variables, the most important of which were the size of the working age population and real output
3. the labour market in Malta was not characterized by equilibrium and

[1]See for example Lucas and Rapping (1970). The development of econometric models for markets in disequilibrium is of fairly recent origin, and mostly followed the seminar paper by Fair and Jaffee (1972). Other works which dealt with such methods include Fair and Kelejien (1974), Maddala and Nelson (1974), Amemiya (1974), Goldfield and Quandt (1975), Laffont and Garcia (1977), Rosen and Quandt (1978) and Bowden (1978). The method used in this present work draws principally on Bowden (1978).

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4. the model can be used to yield useful predictions about the variations in the rate of 'involuntary' unemployment

Since this study utilizes Maltese data, we thought it desirable to describe briefly the setting within which the labour market interrelationships to be examined occurred. For this purpose we begin by investigating how certain variables associated with the Maltese labour market changed during the period of our study. We then discuss the labour market model, and describe the method of estimation. The estimates produced by the model will then be presented and interpreted.

II. CHANGES IN SOME LABOUR MARKET VARIABLES

Table 1 presents the average annual rate of change[2] of a number of variables associated with the Maltese aggregate labour market.[3] The rates of change apply to 1955–79 and to five 5 yearly sub-periods.[4] GDP at factor cost and employment are associated with the demand side of the market. It can be seen from Table 1 that employment, measured in manhours, tended to increase during the first, third and fifth sub-periods, and tended to decrease during the second and fourth sub-periods. We shall show below that a reverse pattern of change emerged with respect to the rate of registered unemployment. GDP at factor cost, measured at 1954 prices, also tended to decrease during the second sub-period but registered positive growth rates during the other sub-periods.

From Table 1 it can be seen that GDP at factor cost grew at a much faster rate than employment during 1955–79, suggesting that labour productivity increased during this period. The reason for this could be that wage rates increased quite rapidly, thereby exerting pressures on employers to economize on labour costs and/or substitute labour by capital. Wage rates will be considered separately below.

The size of the working age population is associated with the supply side of the labour market. It appears from Table 1 that it is not possible to detect any upward or downward trend in the size of the working age population when the period 1955–79 is considered. During the different periods, however, a pattern of fluctuations emerges, with the size of the working age population growing at a relatively fast rate during the third and fifth sub-periods, and at a relatively slow rate during the other sub-periods. The reason for this is principally emigration which reached relatively high levels during the second and fourth sub-periods.

Another variable which is thought to belong to the supply side of the labour market is short

[2]The rate of change was estimated by applying OLS to the equation $Y_t = Y_0 e^{rt}$ where Y stands for the variable whose rate of change is to be estimated, t is time taking values of 1, 2 . . . T, (T is the number of years) and r is the rate of change. The test of statistical significance of r was conducted using the t-ratio.
[3]The data used here, with the exception of the Registered Unemployment Rate, also feature in the labour market model, and are presented in more detail in the Appendix. This Rate of Unemployment is computed as $UNR/(UNR + EMP)$ where UNR is a twelve month average number of registered unemployed persons, and EMP is the number of gainfully occupied persons.
[4]The 25 year period was divided into five sub-periods because on plotting the data for most variables, there appeared to be a cyclical pattern whose peaks and troughs by and large fell on the last year of each sub-period.

Table 1. *Percentage annual rate of change of some labour market variables. Averages for 1955–79 and sub-periods*

	1955–59	1960–64	1965–69	1970–74	1975–79	1955–79
Employment (manhours)	2.2	−0.8	2.5	−1.0	0.7	0.9
GDP at factor cost[b]	6.3	−1.5	7.6	7.6	11.0	6.3
Population of 15 years and over	0.1	0.9	2.0	0.0	2.0	1.0
Unemployment rate	−7.4	19.7	−22.0	9.5	−10.9	−0.4[a]
Emigration rate	−19.7	19.4	−25.9	11.7	−9.0	−7.0
Average hourly wage[b]	−0.4[a]	0.0	3.8	6.8	9.6	4.8

[a]Indicates that the estimate was not different from zero at the 95% level of statistical significance.
[b]Indicates that the variable was measured at 1954 prices. See Appendix.

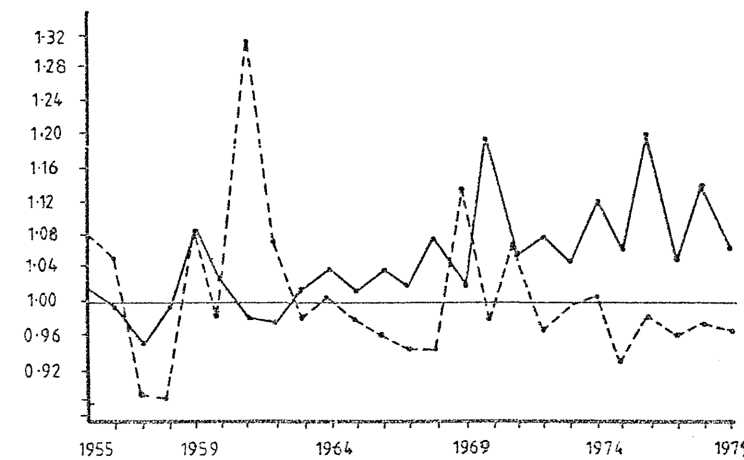

Fig. 1. Annual changes in average hourly employee compensation, measured in real terms, and in union density. ------- union density, ———— wage rates.

run employment opportunities.[5] In Table 1 we present two indices of short run employment opportunities, namely the rate of registered unemployment and the rate of emigration of labour-force members. The pattern that emerges from these changes is that both indices tended to decrease during the first, third and fifth sub-periods, and to increase during the second and fourth sub-periods. These five-yearly fluctuations are of interest because of their implications regarding the degree of labour market tightness, and the response this evokes from labour-force members. This pattern of change also suggests that the Maltese labour market was not probably characterized by equilibrium during the period of our study.

[5]The variable representing short term employment opportunities is usually introduced into labour supply equations to allow for the 'discouraged worker' and 'added worker' effect.

The last variable included in Table 1 is average hourly employee compensation, measured in real terms. For simplicity we shall henceforth refer to this variable as the wage rate. This variable is thought to affect the demand as well as the supply side of the labour market. It appears from Table 1 that the wage rate did not change in a significant way up to 1964, and that during the last three sub-periods, this variable increased at an increasing rate from one sub-period to another.

An alternative way of observing how the wage rate changed during the period of our study is by taking ratios of a current wage rate to its previous year's value, as shown in Fig. 1. Such changes are of interest in this study since our model will contain a wage setting equation based on these annual ratios. Fig. 1 also shows annual changes in union density, on which we shall comment below.

The changes illustrated in Fig. 1 suggest that the highest relative increases in the wage rate occurred between 1969 and 1970, and between 1975 and 1976. Wage rate decreases were registered between 1960 and 1962, a period which was characterized by high rates of unemployment. It may appear surprising that the wage rate increased so rapidly during the fourth sub-period when the rate of unemployment was rising, and that the wage rate did not experience a more noticeable decline, during the second sub-period, when the rate of unemployment reached its highest levels. However it is possible that non-market forces, such as union activity, has had an independent effect on the wage rate changes, and this may explain why changes in the average employee compensation did not seem to follow the ups and downs of labour market slackness.

In our model we shall make specific allowance for the effect of union pushfulness on wage rate changes. The question of which index is most suitable to measure union pushfulness is subject to much debate. (See, for example, Purdy and Zis, 1974, 1976; Dogas and Hines, 1975.) We have chosen the index based on changes in union density on the grounds that it has desirable properties for the purpose for which we intend to use it. (For a discussion on the desirable properties of an index of union pushfulness see Armstrong *et al.*, 1977.) This variable is a direct measure of the changes in the percentage of the wage and salary earners over which unions have some form of jurisdiction, and on whom, therefore, unions may rely in the event of strike action. In this sense, changes in union density may be related to the ability of unions to reduce the degree to which employers can substitute striking workers with others, and to foster solidarity among the workers. In reality the strength of a union derives from its ability to impose costs on the employer, an ability that may be threatened and taken seriously, but not actually exercised.

In Malta, trade union activity was widespread during the period of our study, and on average, about 45% of all wage and salary earners were unionized during this period. The year to year changes in union density are given in Fig. 1. It can be noticed that the highest increases in union density occurred in the first half of the sixties, a period during which, as already noted, unemployment reached very high levels, and during which therefore, one would have expected wage rates to fall very rapidly, had wage adjustment been fully flexible. Of interest also is the fact that most of the decreases on union density occurred during the second half of the fifties, of the sixties, and of the seventies when the labour market was relatively tight.

The relationship between changes in union density and changes in real wage rates, keeping excess labour demand or supply constant, will be investigated in a more rigorous manner below.

III. SPECIFICATION OF THE MODEL

The log–linear formulation of our labour market model is of the following form

$$\ln L_t^d = a_0 + a_1 \ln W_t + a_2 \ln Y_t + a_3 \ln L_{t-1} + u_t^d \quad (1)$$

$$\ln L_t^s = b_0 + b_1 \ln W_t + b_2 \ln P_t + b_4 \ln E_t + u_t^s \quad (2)$$

$$\ln L_t = \min(\ln L_t^d, \ln L_t^s) \quad (3)$$

$$\ln W_t - \ln W_{t-1} = c_0 + c_1 (\ln L_t^d - \ln L_t^s) + c_2 \ln V_t \quad (4)$$

All variables in this system of equations are annual observations, and are described in the Appendix.

Equation 1 expresses the labour demand relation, in which L_t^d stands for aggregate employment measured in manhours, W_t is aggregate average employee compensation measured in real terms, Y_t is GDP at factor cost also measured in real terms, t is time, taking values of 1, 2 . . . T where T is the number of years in the sample, and u_t^d is a random term. This equation can be derived from the marginal productivity condition of the CES production function, assuming that labour demand is only partially adjusted to its desired level.[6]

We expect a_1 to be negative, a_2 to be positive, a_3[7] to be either positive or negative, and a_4 to be positive but not to exceed unity.

Equation 2 expresses the labour supply relation, in which L_t^s stands for the aggregate labour supply, measured in manhours, W_t stands for average hourly employee compensation measured in real terms, P_t is the size of the working age population multiplied by the number of average weekly hours of work, E_t stands for the number of emigrants who used to be in the labour-force as a percentage of the labour-force and t takes the same values as before.

[6] It can be shown that the marginal product of labour from the CES production function, set equal to the real wage rate and rearranged, will yield an equation for the desired labour demand, expressed in log–linear form as

$$\ln L_t^* = \text{constant} - s \ln W_t + [1 + (v-1)]/v \ln Y_t + (s-1)rt$$

The coefficients in this equation are s which is the elasticity of substitution, v which is the degree of returns to scale, and r for neutral or labour augmenting technical change. (See David and Van de Klundert, 1965, for the interpretation of r).

If we incorporate the following partial adjustment scheme

$$\ln L_t - \ln L_{t-1} = i(\ln L_t^* - \ln L_{t-1}) \qquad 0 \leqslant i < 1$$

where L_t^* stands for the desired amount of labour services, L_t denotes the actual amount and i is the speed of adjustment coefficient, we will obtain Equation 1 of the labour market model in which $a_1 = i(s)$, $a_2 = i[1 + s(v-1)]/v$, $a_3 = i(s-1)r$ and $a_4 = (1-i)$. It should be noted however, that Equation 1 has intuitive appeal in its own right, and need not rest exclusively on the CES production function.

[7] If the time variable is taken to stand for technological change, the sign on its coefficient would indicate technological progress or regress. However the time variable may stand for other influences on labour demand, which varied smoothly over time, and for which no specific allowance has been made in Equation 1. In this case, the coefficient on t would not yield useful information regarding technological change.

In similar work on the subject, the value of b_1 for the aggregate labour supply was found to be approximately zero.[8] The sign of b_2 is expected to be positive and approximately unity, that of b_3 to be either positive or negative,[9] and that of b_4 to be negative, indicating a net 'discouraged worker' effect.[10]

Since labour demand and labour supply are not assumed to be equal, we make the assumption that the transacted (and observed) quantity of labour is the minimum of the quantity demanded and supplied at the current wage rate. This condition is expressed by Equation 3.

The interest of this study lies principally in the joint determination of labour supply, labour demand and wage rates. For this purpose we assume that the forces of supply and demand tend to move the real wage rate towards its equilibrium level, but the speed of adjustment may be such that the market is not completely cleared during any given period. We assume also that changes in the real wage rate not only depend on excess labour demand, but also on pushfulness by employee unions. This 'augmented' wage adjustment relation is expressed by Equation 4 in which L_t^d and L_t^s have the same meaning as before, and V_t stands for union pushfulness. As noted earlier, we measure union pushfulness by changes in union density. The inclusion of the constant term c_0 in Equation 4 can be justified on the grounds that factors, other than excess labour demand and variation in union pushfulness may have had an effect on wage rate changes. For example, smooth increases over time of the prevalence of business concentration may have had such an autonomous impact on wage rate changes.[11] We expect c_0, c_1 and c_2 to be positive.

To anticipate later results, we have experimented with using $V_t = D_t/D_{t-1}$ and $V_t = D_{t-1}/D_{t-2}$, where D_t stands for union density, and found that the latter produced better results in terms of statistical significance in the wage setting equation.[12] This is not counter-intuitive, since it is possible that successful union bargains may not be implemented during the same period in which they are secured. Also, the spillover effects, resulting from the impact of successful union bargains on the wage rates of the non-unionized sector, may be realized after some time has elapsed.

It should be noted at this stage that in Equation 4 we are considering real wage adjustment, and that therefore the effect of union pushfulness would already be included in the price variable used for deflating the money wage rate, if during negotiations, unions bargained for, and

[8] See for example Lucas and Rapping (1970) and Rosen and Quandt (1978). The introduction of W_t in the labour supply equation is intended to capture the opportunity cost of activities other than market work, and its coefficient is therefore related to decisions about the allocation of time between market and non-market activities. See Mincer (1962).

[9] The time variable may be thought to stand for the effect of attitudinal changes. As is the case with the time variable in the labour demand equation, however, t may capture other influences which varied smoothly over time.

[10] In many studies on labour supply, the 'discouraged worker' effect was found to predominate. See for example Tella (1964) and Wachter (1974).

[11] On this point see Tobin (1972). Briguglio (1980) has shown that there is some evidence that the degree of business concentration in the Maltese industrial production has increased during the period of our study.

[12] We note here that the union variable is indexed so that 1959, when $\ln V_t$ had its lowest level, its value was set to zero, and the values for the other years were scaled accordingly. The inclusion of the constant term in Equation 4 may therefore also be justified on the grounds that union pushfulness was not zero in 1959, as assumed when computing $\ln V_t$. The reason for scaling $\ln V_t$ in the manner just described will be given at a later stage.

succeeded in obtaining full compensation for price increases, and nothing more.[13]

IV. ESTIMATION PROCEDURE

To derive a system suitable for estimation, we start by defining the unobservable variable W_t^* as the market clearing real wage rate, so that in equilibrium we have

$$\begin{aligned}\ln L_t^d = \ln L_t^s &= a_0 + a_1 \ln W_t^* + a_2 \ln Y_t + a_3 t + a_4 \ln L_{t-1} + u_t^d \\ &= b_0 + b_1 \ln W_t^* + b_2 \ln P_t + b_3 t + b_4 E_t + u_t^s\end{aligned} \tag{5}$$

from which we obtain

$$\begin{aligned}(b_1 - a_1)\ln W_t^* &= (a_0 + a_2 \ln Y_t + a_3 t + a_4 \ln L_{t-1} + u_t^d) \\ &\quad - (b_0 + b_2 \ln P_t + b_3 t + b_4 E_t + u_t^s)\end{aligned} \tag{6}$$

We now substitute Equations 1 and 2 into Equation 4, and rearrange the terms to obtain

$$\begin{aligned}[1 + c_1(b_1 - a_1)]\ln W_t &= \ln W_{t-1} + c_1[(a_0 + a_2 \ln Y_t + a_3 t + a_4 \ln L_{t-1} + u_t^d) \\ &\quad - (b_0 + b_2 \ln P_t + b_3 t + b_4 \ln E_t + u_t^s)] + c_0 + c_2 \ln V_t\end{aligned} \tag{7}$$

The left hand side of Equation 6 is now substituted into the right hand side of Equation 7. Rearranging the resultant equation, we obtain

$$\ln W_t^* - \ln W_t = [d/(1-d)][\ln W_t - \ln W_{t-1} - (c_0 + c_2 \ln V_t)] \tag{8}$$

where d is $1/[1 + c_1(b_1 - a_1)]$.

The parameter d is of some importance for the purpose of this study. It can be regarded as a measure of the degree of sluggishness of wage adjustment. Thus we note from Equation 8 that if the parameter d is zero, it is implied that the wage rate adjusts fully to its equilibrium level, since in this case $\ln W_t^* = \ln W_t$. If $d = 1$, it is implied that wage adjustment is infinitely slow. Given that the value of $(b_1 - a_1)$ is positive, as expected, the parameter d will take a value of between zero and unity.

We note from Equation 8 that given that d is positive, if the real wage rate is higher than its equilibrium level, i.e. if $W_t^* - W_t < 0$, the expression

$$M_t = \ln W_t - \ln W_{t-1} - (c_0 + c_2 \ln V_t) \tag{9}$$

will have a negative sign. On the other hand, if the wage rate is lower than its equilibrium level, i.e. if $W_t^* - W_t > 0$, the expression for M_t will have a positive sign. This conclusion is of interest as far as this study is concerned because it can be used as a rule for partitioning our sample of observations into periods of excess labour demand and periods of excess labour supply. The reason for this is that when the wage rate is higher than its equilibrium level, it is implied that excess labour supply exists, in which case we have negative values of M_t. Similarly, when the

[13]The restriction of unitary elasticity of money wage rates with respect to price changes, implied by Equation 4 would take care of this effect, and the union variable in such a case would be redundant.

wage rate is lower than its equilibrium level, and M_t has positive values, excess labour demand is implied.

According to Equation 3 we assume that the observed quantity of labour lies on the short side of the market, which means that in periods of excess labour supply, labour demand is observed and labour supply is not, and vice versa for periods of excess labour demand. If we have excess labour supply (or demand) we cannot therefore use the observed quantity of labour L_t to estimate the labour supply (or demand) relation. However, we can combine Equations 1, 4 and 9 to obtain an expression for the observed quantity of labour as follows

$$L_t = a_0 + a_1 \ln W_t + a_2 \ln Y_t + a_3 \ln L_{t-1} - (1/c_1)G_t + u_t^d \qquad (10)$$

where $G_t = M_t$ if $M_t > 0$ and zero otherwise; and $L^t = L_t^d$ if $M_t < 0$ and L_t^s otherwise. Similarly, we can combine Equations 2, 4 and 9 to obtain

$$L_t = b_0 + b_1 \ln W_t + b_2 \ln P_t + b_3 \ln E_t + (1/c_1)H_t + u_t^s \qquad (11)$$

where $H_t = M_t$ if $M_t < 0$ and zero otherwise; and $L_t = L_t^s$ if $M_t > 0$ and L_t^d otherwise. For reference, we shall call Equation 10 the 'disequilibrium' demand equation and Equation 11 the 'disequilibrium' supply equation. It should be noted however that both equations explain the observed quantity of labour, which is not assumed to equal to demand and supply in all years.

By rearranging Equation 7 we can obtain the reduced form equation for $\ln W_t$ which is implied by Equations 1, 2 and 4 to be

$$\ln W_t = \text{constant} + d \ln W_{t-1} + qa_2 \ln Y_t + qa_4 \ln L_{t-1} - qb_2 \ln P_t - qb_4 \ln E_t$$
$$+ q(a_3 - b_3)t + dc_2 \ln V_t + q(u_t^d - u_t^s) \qquad (12)$$

where the constant $= dc_0 + (1-d)(a_0 - b_0)/(b_1 - a_1)$ and $q = (1-d)/(b_1 - a_1)$.

We expect the coefficients on $\ln Y_t$, $\ln E_t$, $\ln L_{t-1}$ and $\ln V_t$ to be positive, and that on $\ln P_t$ to be negative. As already noted, the parameter d is expected to have a numerical value of between zero and unity.

If d is found to have a value of zero, Equation 12 would be identical to a reduced form equation for $\ln W_t^*$, as can be verified by rearranging Equation 6. This value of d is therefore compatible with the assumption that the wage rate clears the market in all years. Also, when $d = 0$, the labour Equations 10 and 11 will not include the implicit adjustment for disequilibrium, since $1/c_1$ would also be equal to zero, in which case Equations 10 and 11 would be identical to Equations 1 and 2. This is of course expected, since when $\ln W_t$ is at its equilibrium level $L_t = L_t^d = L_t^s$.

Equations 10, 11 and 12 form our basic disequilibrium system to be estimated. The estimation procedure that we shall use is the 2SLS suggested by Bowden (1978) and basically consists of using OLS to obtain the fitted values of $\ln W_t$ from Equation 12, which also yields an estimate of d (which if found to be different from zero would confirm the disequilibrium hypothesis) and, by substituting, of c_2. The fitted values of $\ln W_t$ are also used to compute $\hat{M}_t$ from Equation 9 and therefore of $\hat{G}_t$ and $\hat{H}_t$. In the second stage, OLS is applied to the labour Equations 10 and 11 with the modified variables that contain the endogenous wage term. (A more detailed description of this estimation method is given by Briguglio, 1982.)

V. ESTIMATES OF THE REDUCED FORM EQUATION

We present here the estimates of the coefficients of the reduced form equation for $\ln W_t$. We decided to drop the time variable from the equation, since the coefficient on this variable was not found to be statistically significant, and moreover, the introduction of this variable produced a wrong sign on and adversely affected the statistical significance of the population variable.[14]

Reduced form estimates

$$\begin{aligned} \ln W_t = & -3.106 + 0.272 \ln W_{t-1} + 0.655 \ln Y_t - 0.653 \ln P_t \\ & \quad (3.092) \quad (2.371) \qquad\qquad (6.442) \qquad (-3.496) \\ & + 0.389 \ln L_{t-1} + 0.070 \ln E_t + 0.129 \ln V_t \\ & \quad (2.287) \qquad\qquad (4.560) \qquad (2.001) \end{aligned} \tag{13}$$

$R^2 = 0.997 \qquad \text{D.W.} = 1.80$

As noted earlier, the coefficient on $\ln W_{t-1}$ is an estimate of the parameter measuring the degree of drag in market clearing. The t-ratio of this estimate (shown in brackets beneath it) suggests that the estimate of d is different from zero at the 95 % level of statistical significance, and it is therefore implied that the labour market was not cleared in every period, and that the model would have been misspecified had we assumed equilibrium.

All the estimated coefficients on the other variables have the expected sign, and would seem to be different from zero as indicated by the t-ratios. The Durbin–Watson statistic suggests that autocorrelation is probably absent.[15]

The fitted values of $\ln W_t$ from the estimated equation will be used to replace the observed values of this variable in the labour equations and to obtain the predicted values of $\hat{M}_t$, whose sign will be used to determine which periods are to be assigned to the excess supply, and which to the excess demand regimes. As explained earlier, negative values of $\hat{M}_t$ imply excess labour supply, since this is associated with a wage rate higher than its equilibrium level, as shown by Equation 8, while positive values of $\hat{M}_t$ imply excess labour demand.

VI. ESTIMATES OF THE LABOUR EQUATIONS

To estimate the labour equations we have to assign values of $\hat{M}_t$ to $\hat{G}_t$ and $\hat{H}_t$. A practical problem that arises when computing $\hat{M}_t$ is that the scale used to measure $\ln V_t$ affects the sign of the expression. To find a way out of this problem, we assume that in 1959, when $\ln V_t$ was at its

[14] To anticipate later results, the time variable also produced statistically insignificant coefficients in the labour equations. By dropping the time variable we do not imply that technological change did not effect labour demand, or that attitudinal changes did not influence labour supply. As already noted, the time variable may stand for a variety of factors, and it is possible that the effects of such factors offset each other during the period of our study.

[15] A more appropriate test for autocorrelation in an equation with a lagged dependent variable is Durbin's h-statistic which, when computed for the reduced form equation for $\ln W_t$, confirmed that autocorrelation was probably absent.

lowest level, its value was zero, and the values for the other years were scaled accordingly. This ensures that union pushfulness was never negative. Negative values of $\ln V_t$ would be implausible, since they suggest that unions pushed wage rates in the downward direction, something that it is not in the interest of unions to do. This scaling of $\ln V_t$ affects the constant term of the reduced form equation, but not the estimates of the other coefficients of this equation.[16]

A related problem that arises when computing $\hat{M}_t$ is that the value of c_0 cannot be identified from the reduced form equation for $\ln W_t$ without prior knowledge of a_0, b_0, a_1 and b_1 from the labour equations, which in turn requires prior knowledge of the value of c_0. To get around this problem we introduced arbitrary values of c_0, starting from $c_0 = 0$, and incrementing its value in stages, by 0.001, until all the values of $\hat{M}_t$ became negative, that is until all values of $\hat{M}_t$ were assigned to $\hat{H}_t$, implying that all years were characterized by excess labour supply.

The results of computing $\hat{M}_t$ with $\ln V_t$ scaled in the manner just described, and with c_0 set equal to zero are presented in Fig. 2, where $\hat{M}_t$ takes negative values for 15 out of 25 years, implying that in most years there was excess labour supply. It can be noted that the highest positive value of $\hat{M}_t$ is just under 0.127, which means that the procedure just described produced 127 possible values of c_0 and therefore 127 possible values of $\hat{G}_t$ and $\hat{H}_t$. Since c_0 takes a range of values between one year and another, the change of the value of $\hat{M}_t$ from 0 to 0.127 produced 10 possible partitionings of the sample into excess demand and excess supply.[17] It should be noted

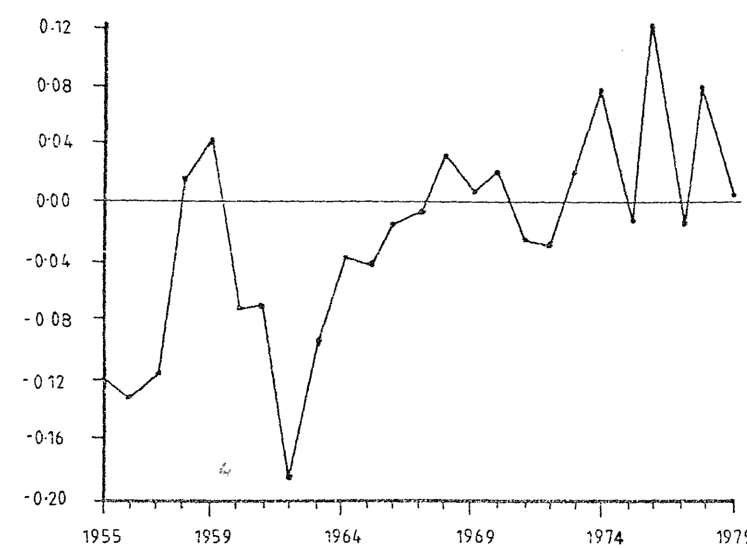

Fig. 2. Computed values of $\hat{M}_t$ with $c_0 = 0$.

[16]In a multiplicative equation the scale used for measuring the variables does not effect the elasticity estimates.

[17]The reason for this is that $\hat{M}_t$ had positive values for 10 years, and the range of these values is 0 to just under 0.127.

here that as c_0 is incremented, the points for $\hat{M}_t$ shown in Fig. 2 shift in the downward direction.

The estimation results from the 127 pairs of labour equations that utilized different values of $\hat{G}_t$ and $\hat{H}_t$ from the procedure just described, indicated that the estimated coefficients $\ln \hat{W}_t$, $\ln Y_t$, $\ln L_{t-1}$, $\ln P_t$ and $\ln E_t$ did not change in an important way. In all pairs of labour equations, these coefficients appeared to be different from zero at the 95 % level of statistical significance, and had the expected sign and magnitudes. The coefficients on $\hat{G}_t$ and $\hat{H}_t$ were also statistically significant at the 95 % level, and had the expected sign, but did not have the expected magnitude. In all pairs of labour equations there did not appear to be serious problems of autocorrelation.

The only unsatisfactory result was that the coefficients on $\hat{G}_t$ and $\hat{H}_t$ from each pair of labour equations did not have an equal absolute value as expected. In the pair of labour equations which utilized the value of c_0 = zero, for example, the coefficient on G_t was -0.396 and that on H_t was 0.252, implying that real wage adjustment was faster in the downward direction. This implausible result led us to reestimate all the labour equations, with the imposed restriction that both coefficients had an absoluted value of $(1/c_1)$.[18] The value of $(1/c_1)$ that we shall impose on the labour equations comes from the model itself, since by arranging the expression for the parameter d, we can obtain an expression for c_1 as follows

$$c_1 = (1-d)/[d(b_1 - a_1)]. \tag{14}$$

Our reduced form equation for $\ln W_t$ produced an estimate of $d = 0.272$, but we do not have any knowledge of the values of b_1 and a_1 unless we estimate the labour equations first which in turn requires knowledge of c_1. We propose to get around this problem by taking the values of b_1 and a_1 of the unrestricted labour equations, and performing a series of iterations until the value of $\hat{c}_1$ implied by the estimated coefficients on $\hat{G}_t$ and $\hat{H}_t$ converges with $(1-\hat{d})[d(\hat{b}_1 - \hat{a}_1)]$.[19]

This iterative procedure was applied to all the pairs of labour equations which utilized the different values of $\hat{M}_t$. With these restrictions on the values of c_1 the estimated coefficients did not change considerably, with the exception of course of the coefficients on $\hat{G}_t$ and $\hat{H}_t$. The procedure just described produced almost identical values of $(1/c_1)$ for all pairs of labour equations that utilized different values of the constant c_0.[20]

Of interest is that as more years were assigned to the excess supply regime, the value of the correlation coefficients (R^2) of the labour equations changed, and appeared to reach a maximum when c_0 was given a value of around 0.02. On the criteria of goodness of fit we are inclined therefore to choose as our preferred pair of labour equations those which utilized values of $\hat{G}_t$ and $\hat{H}_t$ based on $c_0 = 0.02$. The improvement of R^2 is, however, very small and does not by itself shed any light on the statistical significance of c_0. The value of c_0 of around 0.02 suggests that there was an autonomous increase of real wage rates of about 2 % per annum, and that 18 out of

[18]The serious computational problems that arise if unequal wage adjustment is assumed in the upward and downward direction are discussed in Bowden (1978), pp. 208–11.

[19]Thus, for example, for the pair of equations which utilized $c_0 = 0$, we start by setting the value of $c_1 = (1-0.272)/[0.272(0.026+0.552)] = 4.63$ so that the coefficients of $\hat{G}_t$ and $\hat{H}_t$ are restricted to equal $1/4.63 = 0.216$. We reestimated the labour equations with the dependent variables modified as $L_t + 0.216\,\hat{G}_t$ for the demand equation and $L_t - 0.216\,\hat{H}_t$ for the supply equation. This produced new estimates of b_1 and a_1 and therefore of c_1. The new value of c_1 was imposed and the labour equations estimated again. The procedure was continued until the restricted value of c_1 was not found to differ from $(1-0.272)/[0.272(\hat{b}_1 - \hat{a}_1)]$ by more than 0.001.

[20]The value is 0.221 which implies that c_1 is around 4.5.

25 years were characterized by excess labour supply.[21]

The following are the re-estimated labour equations with $c_0 = 0.02$ and with the imposed restrictions on the coefficients on $\hat{G}_t$ and $\hat{H}_t$.

Disequilibrium labour demand equation

$$\ln L_t + 0.221\,\hat{G}_t = -0.576 - 0.561 \ln \hat{W}_t + 0.524 \ln Y_t + 0.344 \ln L_{t-1} \qquad (15)$$

$$\phantom{\ln L_t + 0.221\,\hat{G}_t = } (1.112)\;(-8.001)\qquad (9.576)\qquad (3.957)$$

$R^2 = 0.974$ D.W. $= 1.98$

Disequilibrium labour supply equation

$$L_t - 0.221\,\hat{H}_t = 0.768 + 0.026 \ln \hat{W}_t + 0.733 \ln P_t - 0.047 \ln E_t \qquad (16)$$

$$\phantom{L_t - 0.221\,\hat{H}_t = } (1.667)\;(2.129)\qquad (9.654)\qquad (-7.984)$$

$R^2 = 0.975$ D.W. $= 2.10$

VII. FURTHER EXAMINATION OF THE ESTIMATION RESULTS

The estimates obtained from the procedure we have outlined produce the following labour demand, labour supply and wage setting[22] equations

$$\hat{L}_t^d = 0.562\,\hat{W}_t^{-0.561}\,Y_t^{0.524}\,L_{t-1}^{0.344} \qquad (17)$$

$$\hat{L}_t^s = 2.156\,\hat{W}_t^{0.026}\,P_t^{0.733}\,E_t^{-0.047} \qquad (18)$$

$$\hat{W}_t / W_{t-1} = 1.020\,(\hat{L}_t^d/\hat{L}_t^s)^{4.545}\,V_t^{0.473} \qquad (19)$$

All estimates have plausible signs and magnitudes. The estimated labour demand equation suggests that the increases of average employee compensation have had a negative impact on labour demand.[23] This equation also indicates that GDP increases have had a positive effect on labour demand.[24] The results also suggest that the response of labour demand to changes in the

[21]Since in Malta unemployment was registered for all years during the period of our study, the implication that excess labour supply was absent in some years may appear implausible. However the registered unemployed may have included those who could find employment at the going wage rate, and were not therefore involuntarily unemployed.

[22]The coefficients of the wage setting equation are e^{c_0} for the constant, and c_1 for the exponent on L^d/L^s, the estimates of which were produced by the procedure just described. The exponent on V_t is c_2, the estimate of which was obtained from the reduced form equation for $\ln W_t$.

[23]As suggested in footnote 6 the coefficient on W_t may stand for the elasticity of factor substitution if Equation 1 was assumed to be derived from the CES production function. For a discussion on the elasticity of substitution in developing countries see Williamson (1971), Gaudé (1975) and Bruton (1972).

[24]If Equation 1 is assumed to be derived from the CES production function, the coefficient on Y_t would have implications regarding returns to scale (see footnote 6). This coefficient has also implications regarding the extent of labour absorption. See Baer and Herve (1966) and Harris and Todaro (1969) on the question of labour absorption in developing countries. The results of our model indicate that labour absorption in Malta was rather low, particularly in the short-run.

real wage rate and output was smaller in the short run than in the long run, as expected. The elasticity estimates for the long run are 0.80 with respect to output, and 0.86 with respect to the wage rate. It is probable that the sluggish labour demand adjustment in the short run was due to the costs of hiring, training and firing labour.[25]

The estimated labour supply relation suggests that the labour force responded to a very small extent to changes in the real wage rate, and to changes in short run employment opportunities. Since the labour force is composed of various age and sex groupings, these estimates of labour supply elasticities should be interpreted as some form of weighted average response by the different groupings.[26] The most important variable in the labour supply relation is the working age population, a change in which had an almost proportional effect on labour supply.

The estimates of the wage setting equation indicate that real wage rate changes in Malta were influenced to a very large extent by the balance between labour demand and labour supply. However, non-market forces, in particular union pushfulness, have also had a bearing on wage rate changes. This would seem to suggest that even when excess labour supply was present, positive wage rate changes could have been registered by the combined effect of market and non-market forces. This is possibly the reason for the finding, presented in Section II, that when the labour market in Malta appeared to be relatively loose, real wage rates continued to rise.

These results have well known implications relating to wages and employment policies. They certainly confirm that policies aimed at eliminating involuntary unemployment may conflict with those aimed at promoting real wage stability.[27]

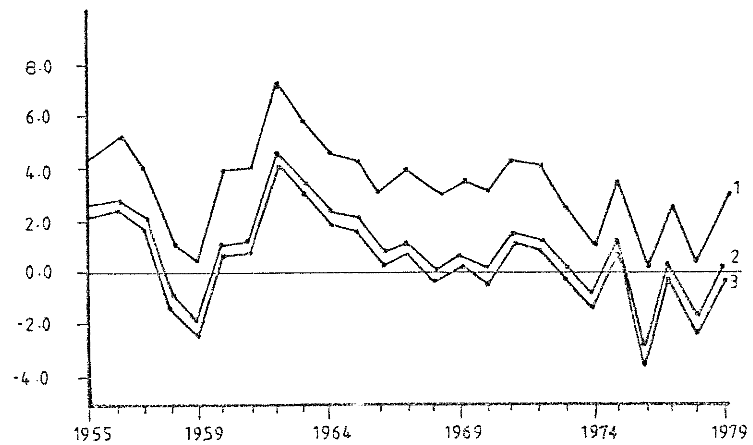

Fig. 3. Estimates of R_t with different values of c_0. 1. $C_0 = 0.0$, 2. $C_0 = 0.02$, 3. $C_0 = 0.0127$.

[25]For a discussion on the costs of adjustment of the labour input see Soligo (1966) pp. 173–5, and Oi (1962).

[26]For example, it is to be expected that the female members of the labour force are more responsive to changes in wage rates, and to long run employment opportunities. Econometric tests performed by the present author in the preliminary stages of this study suggest that this was the case in Malta.

[27]The results of our model suggest that attempts to promote full employment would themselves result in increases in wage rates. Course of action that may be pursued to improve the possibility of a trade off at acceptable levels of excess labour supply and wage inflation include incomes policies and policies to improve the competitiveness of the labour market.

An interesting result that can be obtained from our model is related to the rate of involuntary unemployment (R_t), the estimate of which can be expressed as follows

$$\hat{R}_t = 1 - (\hat{L}_t^d / \hat{L}_t^s) \tag{20}$$

By predicting L_t^d and L_t^s from the labour demand and labour supply equations, values of $\hat{R}_t$ can be computed. The results of such computation are given in Fig. 3, which gives estimates of R_t from three versions of the model, namely those utilizing values of $c_0 = 0$, values of $c_0 = 0.02$ and values of $c_0 = 0.127$. As explained earlier, the different values of c_0 have implications regarding the number of years assigned to the excess supply regime, and the value of $c_0 = 0.127$ indicates that all observations where assigned to labour demand. As expected, the computed values of $\hat{R}_t$ increase as the assumed values of c_0 increase.

Although our model cannot be used to obtain reliable estimates of the magnitude of $\hat{R}_t$, since we used arbitrary values of c_0, the information presented in Fig. 3 suggests that the variation of $\hat{R}_t$ is hardly affected by the magnitude of this constant.

The variation of $\hat{R}_t$ is of interest because it appears to reflect the ups and downs of labour market tightness described in Section II. It can be seen that the lowest values of $\hat{R}_t$ occur in the late fifties, late sixties and late seventies, periods during which the rate of registered unemployment in Malta was relatively low.[28] During these years emigration also reached very low levels, and output and employment grew at relatively fast rates. The highest values of $\hat{R}_t$ occur during the early sixties, a period during which the Maltese economy performed very badly. Relatively high rates occur also during the early seventies, and between 1955 and 1957, periods during which registered unemployment and emigration reached very high levels. Thus although our model did not yield useful predictions about the magnitude of the rate of involuntary unemployment, it produced plausible predictions regarding its year to year variation.[29]

APPENDIX

Variables used for the model estimation

Total manhours worked:	$L_t = (EMG_t^g \cdot HRS_t \cdot 52)/1\,000\,000$
Real average hourly employee compensation:	$W_t = [INC_t^e/(EMP_t^h \cdot HRS_t \cdot 52)]/PRC_t$
Real gross domestic product at factor cost:	$Y_t = GDP_t/PRC_t$

[28] The relatively low value of $\hat{R}_t$ in 1974 however does not conform to what was expected, since during this year the labour market appeared to be relatively slack.

[29] The year to year variation of $\hat{R}_t$ is of interest since it can be used in equations where the variables measuring excess labour demand are required. For example, we used R_t from the preferred version of the model to estimate c_0, c_1 and c_2 directly. The results are

$$W_t/W_{t-1} = 1.026(L_t^d/L_t^s)^{3.46}\, V_t^{0.376}$$

where all estimates were found to be statistically significant at the 95% level. These results, though not identical with those obtained indirectly from the preferred version of the model, confirm the findings that real wage rate changes have been influenced by excess labour demand and by union pushfulness.

Potential number of hours of work:	$P_t = (POP_t \cdot HRS_t \cdot 52)/1\,000\,000$
Rate of emigration:	$E_t = (EMG_t/EMP_t^g) \cdot 100$
Rate of change of union density:	$V_t = (UNN_{t-1}/EMP_{t-1}^h)/(UNN_{t-2}/EMP_{t-2}^h)$

Basic data

EMG_t	number of emigrants who were labour force members
EMP_t^g	number of gainfully occupied persons
EMP_t^h	number of wage and salary earners
GDP_t	gross domestic product at factor cost
HRS_t	average number of hours worked
INC_t^e	income from employment
PRC_t	implicit GDP deflator in year t with 1954 = 1.00
POP_t	total Maltese population, aged 15 years and over
UNN_t	number of members of employee unions

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