

# Statistical and Social Inquiry Society of Ireland

## ***The Determinants of Female Labour Force Participation: An Econometric Analysis of Survey Data***

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### INTRODUCTION

This study has a double focus, substantive and methodological. Substantively, it attempts to apply and test a fairly well known model of labour supply. From a methodological point of view, it shows how the Linear Probability Function (LPF) may be applied to the analysis of survey data. This technique is one of a family of multivariate methods which are being increasingly applied to the analysis of behaviour on the micro-level in a wide variety of social science disciplines: economics, sociology, psychology, demography, etc. The LPF is of the same general type as Sonquist and Morgan's Automatic Interaction Detection (AID) and Multiple Classification Analysis (MCA). It is also closely related to the classical Discriminant Function, and to conventional regression analysis<sup>1</sup>.

<sup>1</sup> The following is a brief list designed to illustrate the range of problems to which these techniques have been applied. AID and MCA are described in Sonquist *Multivariate Model Building*, Institute for Social Research, University of Michigan, Ann Arbor, Michigan 1970. The Bibliography given on p. 231 of this book shows that the

We believe the LPF to be a powerful technique which finds an application in the analysis of surveys on many topics. Its main advantages are (i) it forces the researcher to specify an explicit model of human behaviour, (ii) it provides a convenient method of compressing and summarizing the net effects of large numbers of variables, (iii) it provides tests of significance for both the model as a whole and for the net effects of individual variables. A programme is available which performs the statistical algorithms.<sup>2</sup> We hope that the technique will commend itself to potential users in many social science disciplines. In our account of the present research we devote more space to a discussion of the method of analysis than would be normal if the techniques in question had been widely used in previous Irish studies.

## BACKGROUND TO THE STUDY

The economic determinants of labour force participation have attracted considerable attention in recent years. The analysis of labour supply focuses chiefly on the effects of rising real wages on the amount of labour supplied by households to the labour market. This supply has two dimensions, namely the number of hours worked (per week, for example) by each person who is in the labour force, and the number of persons who are in the labour force. One of the most striking aspects of the supply of labour in several advanced industrial countries during the twentieth century has been the more or less steady increase in the proportion of married women who are economically active. Economists have therefore devoted special attention to the factors affecting the labour supply behaviour of married women, and a relatively new body of theoretical and empirical work has emerged in this area. Several studies have elaborated and tested hypotheses about labour force participation based on neo-classical micro-economic theory.<sup>3</sup> The contributions of

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techniques have been applied to the following problems (among others) Saving and Consumer Finances, Delinquency, Road Safety, Effects of Radio and T V, Demographic Research and Voting Behaviour. Ladd (Linear Probability Functions and Discriminant Functions, *Econometrica* Vol 34, No 4, pp 873-885 (1966)) cites a series of studies in economics to which discriminant analysis has been applied. Among recent studies that used one or more of these techniques are Bowen and Finegan's study of labour force participation, which has had a considerable influence on the present study, Monica Boyd's study 'Occupational Mobility and Fertility in Latin America', *Demography* Feb 1973, and several of the studies reported in the *Journal of Political Economy* Vol 81, No 2, Part II (March/April 1973), 'New Economic Approaches to Fertility'. For a recent treatment of Labour Force Participation which uses Discriminant Analysis see W L Gramm 'The Labour Force Decision of Married Female Teachers', *Review of Economics and Statistics* Vol LV, No 3, August 1973.

<sup>2</sup> Cf B J Whelan, Economic and Social Research Institute, Memorandum, 94, Dublin.

<sup>3</sup> Notably, Mincer, Jacob, 'Labour Force Participation of Married Women' in *Aspects of Labour Economics: A Conference of the Universities* (NBER Princeton 1962), Cain, Glen G, *Married Women in the Labour Force: An Economic Analysis* The University of Chicago Press, 1966, Brown, William G and Finegan, T Aldrich, *The Economics of Labour Force Participation* Princeton, 1969. The present discussion draws freely on Cain, Chapter II.

Becker to the analysis of time as a variable in economics have more recently led to attempts to measure the value of time to housewives<sup>4</sup>

The purpose of the present study is to analyse certain survey data on Irish women's labour force participation, applying the techniques developed by Mincer, Cain, Bowen and Finegan. Some extensions of the methodology developed by these economists are explored in parts of the present study, but the main focus of our work has been the attempt to examine the relevance of their models to the Irish situation. These models can only be tested satisfactorily when data relating to individuals (as distinct from county or national averages) are available. The results of a survey inquiry into the "labour force status of women in Ireland" provided the statistical material on which the present work is based<sup>5</sup>

The present study's emphasis on the disaggregated data is warranted in view of the fairly intensive analysis that has already been performed on the limited material on county participation rates available from Census of Population sources<sup>6</sup>. This analysis of aggregate participation rates was seriously deficient in that only "marital status standardized" rates could be used, rather than the marital status specific rates that are needed to isolate the separate determinants of labour force participation by single, married, and widowed women. The absence of wage data by county also rendered it impossible to discuss the influence of this key variable on female labour supply. Nonetheless, the study of county participation rates established that inter-county variation is systematically related to the degree of excess labour supply in the county (as measured by the unemployment rate, or the net emigration rate, or both) and the specific job opportunities available to women (as measured by the "femininity" of the county's industrial structure). Thus high participation rates are most likely in low unemployment/emigration counties with a "feminine" industrial structure. Since a county participation rate may be taken as a measure of the probability that an individual in the county would be in the labour force, the implication of these findings is that a woman is most likely to take up employment in a situation of low unemployment and where the type of jobs available are in the traditionally "female occupations". These findings agree with the results of published research in other countries. One purpose of the present study is to extend and complete the analysis of Irish female participation rates that has been commenced on the basis of Census of Population data, paying

<sup>4</sup> G. S. Becker's seminal article is 'A Theory of the Allocation of Time', *Economic Journal* Vol. 75, No. 299, pp. 493-517 (1965). These ideas are used to estimate the value of a housewife's time by Reuben Gronau, 'The Intra Family Allocation of Time: The Value of the Housewife's Time', the Hebrew University of Jerusalem, Department of Economics, *Research Report* No. 28, June 1971. See also, Reuben Gronau, 'The Effect of Children on the Housewife's Value of Time', *Journal of Political Economy* Vol. 81 (March/April 1973, Pt. 2), p. 199.

<sup>5</sup> These data have already been presented in a more descriptive way in B. M. Walsh, and A. O'Toole, 'Women and Employment in Ireland', *The Economic and Social Research Institute Paper* No. 69, Dublin 1973.

<sup>6</sup> Cf. B. M. Walsh, 'Aspects of Labour Supply and Demand, with Special Reference to the Employment of Women in Ireland', *Journal of the Statistical and Social Inquiry Society of Ireland*, Vol. XXII, Part III, 1970-71.

particular attention to the effect of wage and household income variables whose role could not be studied on the basis of the aggregate data

When these two approaches to the study of participation rates are available, the main gap that will remain in our knowledge of this topic will be the absence of a study of the year-to-year variations in participation rates. In some ways such a study would be the most useful type of research in this area, since it would explore how the "secondary labour force" responds over time to changes in the macro-economic situation. Recently in Ireland low migration and high unemployment rates may have combined to depress participation rates among certain demographic groups, but an econometric analysis of this important phenomenon is precluded by the absence of annual data on participation rates among the various population groups

### *The Theoretical Model*

The starting point of the analysis is a relatively simple version of an already widely used model of labour supply. It is postulated that wives (much of the analysis is concerned with married women) may divide their time between three kinds of activity, namely, work in the market place, work at home or "household duties", and leisure. Although the borderline between these activities may not always be very well defined, for the most part it is easy to assign an activity to one of these categories. The main contrast between male and female allocation of time is that tradition generally assigns to women the chief responsibility for "household duties", and hence male labour supply can be regarded to all intents and purposes as an allocation of time between work in the market place and leisure. For women the supply of labour to the market depends not only on the market wage rate,  $W$ , but also on an imputed value or wage for work in the household,  $W^h$

$$S_L = f(W, W^h),$$

$$\text{We expect that } \frac{\delta S_L}{\delta W} > 0, \quad \frac{\delta S_L}{\delta W^h} < 0$$

In order to justify the expectation that  $\frac{\delta S_L}{\delta W} > 0$  (i.e. that the change in

labour supply with respect to an uncompensated change in the market wage is positive) Cain has argued that the welfare compensated price effect of a change in the market wage is likely to be large in the case of wives, and hence their supply curve of labour should exhibit relatively high (positive) elasticity with respect to  $W$ .<sup>7</sup> This price effect is expected due

<sup>7</sup> The distinction between compensated and uncompensated price effects arises because of the two-fold effect of an increase in market wages: (a) potential real income increases and (b) leisure and household work become more expensive due to the increased income-loss they now entail. The effect of (a) is called the welfare effect, of (b), the price effect. When we become wealthier we generally desire more leisure (other factors equal), and thus the effect of (a) should be to increase the amount of leisure time demanded by wives as real wages rise. However, the effect of (b) should be to

to the existence of two important substitute activities (housework and leisure) in relation to a wife's market work. Thus, as real market wages rise, it is possible, and even likely, that housewives increase their supply of market labour *and* their demand for leisure time (which probably exhibits a high positive income elasticity) by a substantial reduction in the time spent on housework. This last effect is, of course, facilitated by (and no doubt partly responsible for) a decline in average family size, an increasing capital intensity of housework, and the commercialization of some activities formerly performed in the household, all trends which have been observed in most Western countries in recent years.

It is obvious that in studies of labour force participation, the market wage rate,  $W$ , must be modified by some measure of the uncertainty that any individual job-seeker will be able to obtain work at the going wage. The normal way to take this consideration into account is to introduce a measure of unemployment in the local labour market. Ideally this measure should take into account the specific job opportunities available, and their compatibility with the aspirations of the job seekers. Usually, however, the most that can be done is to calculate separate male and female unemployment rates. The use of unemployment rates in studies of labour supply must, however, be circumspect, since the unemployed are part of the labour force and hence part of the phenomenon to be explained. In addition, married women who do not believe that suitable jobs are available, and who have consequently abandoned job-search, are not likely to be included in any of the conventional measures of unemployment.

There are some additional factors which are *a priori* likely to be among the determinants of female labour supply. Family income from sources other than the wife's work in the market may be expected to reduce the wife's supply of labour to the market if we assume that leisure is a normal good for the family as a whole.<sup>8</sup> The housewife's "tastes" for housework and leisure relative to market work cannot be ignored in a study based on micro data (as might be possible with aggregate data in which an averaging process could result in there being little systematic relationship between group differences in tastes and the dependent variable).

The issue may be raised whether "tastes" really constitute an extra independent variable or are so highly correlated with the other variables included among the determinants of labour supply as to be regarded as having no separate validity. All of the other variables included as explanatory in the present study may, with a high degree of plausibility, be assumed genuinely exogenous (that is not influenced by the model's

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cause wives to substitute market work for household work or leisure. The compensated price effect is a measure of (b) after (notionally) adjusting the housewife's potential income so as to leave her at the same welfare level as before the change in the wage rate. Whether the gross or uncompensated effect of a change in wages increases or decreases the time worked in the market place depends on whether the price effect of the wage increase is greater or less than its welfare effect (that is, whether (b) exceeds or is less than (a), assuming (b) to be positive).

<sup>8</sup> This discussion is very truncated. A full presentation would require a system of equations which jointly determined husband's and wife's labour supply. Cf. Cain, *Loc Cit*

dependent variable) The assumption of exogeneity is far less plausible with regard to "tastes", it may be argued that any measure of a respondent's preferences for work over leisure or household duties will be strongly affected by her own labour force status, and hence the introduction of such variables creates a strong possibility of simultaneity or joint dependence between the variables of the analysis. In this situation, single equation analysis becomes inappropriate, and the more complicated procedure of estimating two equations which will simultaneously "explain" both tastes and labour force participation must then be considered. However, a simultaneous equation approach would encounter the problem of under-identification.<sup>9</sup> From the viewpoint of the present study, however, some justification for the use of "tastes" as an exogenous variable may be sought in the time lag with which verbally expressed opinions may reasonably be assumed to adjust to current realities. "Tastes" variables might, in econometric terminology, be treated as lagged endogenous, and hence predetermined, variables whose inclusion as explanatory variables in a single equation model would not violate the basic assumptions of the model. In any event, it may be recalled that even if there is an element of simultaneity in a single equation model, the validity of all the findings is not thereby undermined.

There seems to be no unanimity among sociologists and social psychologists about the role of attitudinal data as causal factors in models of human behaviour. One study of "the readiness of an individual to translate his (previously expressed verbal) attitude into overt action in relation to the attitude object" points out the need for further research in connection with this "perplexing relationship".<sup>10</sup> It is not generally claimed by social psychologists that attitudinal variables alone are capable of accounting for a majority of the variance in observed behaviour. However, it has been pointed out that in many situations, attitudes are frequently very significant in predictive studies, and that even if a "pessimistic assessment to the effect that attitudes rarely account for

<sup>9</sup> This problem exists when it is statistically impossible to estimate all the parameters of the structural equations that make up the model. In non-technical language, it is impossible to isolate the effects of the variables that are believed to influence each of the endogenous variables. A simple discussion of this question is provided in L. R. Klein, *An Introduction to Econometrics* Englewood Cliffs, N.J. Prentice-Hall Inc. 1962, p. 10 ff. Some of these ideas are treated from a sociological viewpoint in David R. Heise, *Problems in path analysis and causal inferences* in *Sociological Methodology* 1969, ed. by Edgar F. Borgatta, San Francisco, Jossey-Bass Inc. 1969. Most of the econometric techniques that have been developed to deal with simultaneous equation situations are concerned with over-identified models. When under-identification is the problem, the usual way of obtaining estimates of the parameters is to incorporate additional restrictions on the relations, such as specifying that certain exogenous variables do not influence certain endogenous variables.

<sup>10</sup> De Fleur, M. L. and Westie, F. R., "Verbal attitudes and overt acts", *American Sociological Review* (1958), pp. 667-73, reprinted in *Attitudes* ed. by Jahoda, M. and Warren, N., Penguin Modern Psychology, 1966.

more than 10 per cent of the variance were true, this would still not make them an unworthy area of research”<sup>11</sup>

### *Measurement of the Variables to be Used*

In brief, then, the supply of market labour by the housewife may be considered a function of the following variables: the market wage rate, the value of a housewife's time in home duties, family income from various sources, the likelihood of a job-seeker finding suitable work, and the housewife's "tastes" or preferences for market activity. The task of making these variables operational is a formidable one, and no survey research design could gather all of the information required in exactly the correct format. The measures that provide the basis for the present analysis may be briefly described.

*Labour Supply* The labour force consists of people who are either working or unemployed. Our data asked a direct question on whether the respondent was working (defined as any activity, other than normal housework, which brought in extra income to the household)<sup>12</sup>. A problem arises, especially in connection with married women, in defining the unemployed. Two questions were asked that were relevant to this: first, women who were not working were asked to state "the main reason" for not working. One possible approach to the definition of the unemployed is to include all those who gave "no (suitable) jobs available" as their answer to this question. A second question was asked (later in the interview) about whether the respondent planned on returning to work, and if so, when. Those who answered "now if (suitable) jobs were available" could also be considered unemployed. For the most part, women who said that their main reason for not working was unavailability of suitable jobs also said they would return to work now if work were available, but some answered the second question negatively – perhaps discouraged from even planning to work in future due to difficulty in obtaining suitable jobs. In order to avoid an excessively comprehensive definition of labour supply, we decided to treat as unemployed only those who *both* said they were not working due to the unavailability of jobs *and* who said they would work if suitable jobs were available<sup>13</sup>. Applying this concept of the labour force to the two categories of women analysed in this study (i.e. married and single women not resident on farms) gave the following distribution of the labour force.

<sup>11</sup> Davis, E. E., 'On the Construct of Social Attitude: Some Recent Developments in Conceptualization and Measurement' *Economic and Social Research Institute Seminar Paper* (13 June 1973), p. 17, Dublin.

<sup>12</sup> For more details on this and other questions, the reader is referred to Walsh and O Toole, *Op Cit*.

<sup>13</sup> The questionnaire did not include a question on whether those not working were actively seeking work, and hence this approach to a definition of unemployment was ruled out. The realism of defining unemployment by a question "looking for work" has recently been questioned by Gordon, who points out that "waiting" rather than "searching" is the relevant description of how even the male unemployed spend most of their time, cf. Gordon, Robert J., 'The Welfare Cost of Higher Unemployment', *Brookings Papers on Economic Activity* 1 1973, p. 154.

		(percentages)	
		<i>Married</i>	<i>Single</i>
Working		83.4	98.1
“Unemployed”		16.6	1.9
Labour force		100.0	100.0
Participation rate =	Labour force as		
	percentage of	20.8	83.0
	total population		

The high “unemployment” rate for married women, and the low rate for single women, is expected. Similarly, the high participation rate for single women, and the low rate for married women, is in accordance with other evidence on the Irish labour force, such as, for example, the Census of Population data. Our participation rate among married women is however well in excess of the rate that may be derived from Census data, because of the inclusiveness of both our definition of “working” and of “unemployment”.

We confined our analysis in the present study to married and single non-farm women. Although some initial work has been completed on non-farm widows, and on single women living on farms, we are doubtful whether the definition of the dependent variable can be made sufficiently precise for these groups to justify econometric analysis. (The fact that our sample contained only 269 non-farm widows, and only 217 farm single women further constrained our analysis of these groups.) For married and widowed women living on farms the measurement of labour supply raises even greater conceptual problems than those already discussed, and hence we have not included these groups in any of the analysis of the present study.

The dependent variable, as defined, has been measured dichotomously, assuming a value of zero for those not in the labour force, and of unity for those in the labour force.<sup>14</sup>

*Wage Rate* The key independent variable is the wage rate available to a woman who decides to seek work. Obviously, when dealing with women some of whom are in the labour force and others of whom are not, the relevant measure is a “potential wage”. Education attainment is commonly used by economists as a measure of this potential wage. It is recognized, of course, that the wage actually received in a given labour market by individuals with identical educational backgrounds may exhibit considerable variance, attributable to differences in years of work experience and individual abilities, and to the existence of labour market

<sup>14</sup> It would probably be preferable to measure labour force participation as the proportion of the previous year spent in the labour force, but the information was not obtained on the questionnaire. This point has been discussed by Fleisher, B., ‘The Economics of Labor Force Participation: A Review Article’, *Journal of Human Resources* Vol VI, No 2 Spring 1971.



rigidities<sup>15</sup> The age of the individuals is generally introduced explicitly into the analysis that follows, and in as much as this is a net source of variation in earning capacity, it has been allowed for The measure of education used in the present study includes information on the type of education last attended full-time, as well as on years spent in formal education<sup>16</sup> The only additional influence on potential wage rates that has been introduced is a simple measure of work experience, which in the case of married women is a dichotomy between those who have and who have not worked before their marriage

Given these measures of the potential wage, a modification must be introduced to allow for the uncertainty facing any individual job-seeker regarding whether she can obtain employment at this wage Two approaches have been used in measuring this factor first, geographical variables, assigning the respondents to the regions of the country or to areas ranked by proximity to urban centres, have been used in the belief that there are major differences between areas of Ireland in regard to the state of the local labour markets for female employment<sup>17</sup> Secondly, the respondents' own evaluation of the "availability of work for married women within easy reach" have been introduced as an alternative (or supplementary) measure of employment, although it is recognized that these responses may well reflect other factors, including the respondents' "tastes" for market work

*Value of a Housewife's Time in Home Duties* The shadow wage ( $W^h$ ) of housewives in home duties is not a directly measurable variable Recent work by Gronau has approached the question of evaluating a housewife's time from a rigorous choice-theoretic framework On the basis of two alternative assumptions he is able to derive an upper and a lower bound to the price of time These assumptions were (a) zero variance in the market wage offers received by women with the same potential income and (b) zero variance in the value of time to women in the same income group "According to the first assumption, women who work are those who have the lowest price of time (i.e. are those who are least productive at home) while by the second assumption women who work are those who have received the highest wages offers (i.e. are the most productive

<sup>15</sup> It may be argued that entrepreneurial income is not very highly correlated with educational attainment, but this source of income is probably relatively unimportant in the case of married women The literature on the economics of wage determination is voluminous, but for a survey of the human capital arguments relevant to our present context, cf Mincer, J, The Distribution of Labour Incomes A Summary with Special Reference to the Human Capital Approach, *Journal of Economic Literature* Vol VIII, No 1 (March 1970), pp 1-26

<sup>16</sup> It should, of course, be appreciated that the additional potential income associated with a given educational attainment is not by implication necessarily a return to that education factors such as innate ability and motivation may be highly correlated with the educational variable, and hence it may not be possible to separate their contribution to income from that of education

<sup>17</sup> The question why these differentials persist is not explored here In the case of married women, however, job search mobility is probably very low, and hence differences in regional unemployment rates may be mainly attributed to regional variations in the demand for labour

in the market place) ”<sup>18</sup> Gronau favours the second assumption and he shows for his data that under both assumptions the value of time at home is greater to women with young children than to those without. The relevance of this to studies of labour force participation is the satisfactory theoretical underpinning it provides for the frequently encountered use of “presence of children” as a measure of the value of a housewife’s time in home duties. The presence or absence of children of various ages in the household may be assumed to measure major differences in the shadow wage of the housewife in home duties more accurately than any other single variable.<sup>19</sup>

*Family Income* Family income from sources other than the wife’s own work would ideally be included as a cardinal measure, in money terms. Some data on household income were gathered in the interview, but there was a high rate of refusal and “don’t knows” to this question. Unfortunately the obvious problems of eliciting this type of information from wives through questionnaire interviews render the quality of the data obtained suspect. As an alternative to the use of these responses, the best proxy for household income is probably the husband’s occupation (coded into socio-economic class). This latter measure at least has the advantage over a current cash income figure that it may provide a more accurate ranking of respondents’ “permanent” or expected life-time family income. As is discussed below, no assumptions concerning income being a monotonic function of a socio-economic “gradient” have been made in the present analysis.

*Tastes* When we turn to the problem of quantifying the “tastes” (or preference for market work relative to housework and leisure) variable, the problem of measurement becomes even more complex. Two possible proxies are introduced at an early stage in our analysis, namely age and farm/non-farm residence. It is to be expected that preference for leisure increases with increasing age, hence increasing the propensity of older people to retire from the labour force. The division of the sample into farm/non-farm sub-samples should control for one major influence on preferences for market work.<sup>20</sup> Unfortunately, both these variables may also include the effects of other considerations – employer prejudice against the old, for example, or the high productivity of “household duties” in the farm context. Apart from these objective characteristics that may be proxies for “tastes”, economists have traditionally eschewed employing more subjective measures of attitudes in their analysis. As mentioned earlier, this reticence may be appropriate in connection with aggregate data (such as used in many cross-section or time series macro-

<sup>18</sup> *Op Cit* p 21

<sup>19</sup> Average family size is, however, probably influenced by the potential wage available to the wife outside the home, as one part of the opportunity cost of children. The limitations of a single equation approach are evident in this context. For a simultaneous-equation approach to these two variables (viz fertility and labour force participation), see O Donnell, Dennis J and Robinson, Warren C, *Income Price and Taste Effects in the Microeconomics of the Family-Size Decision*, paper read to the International Union for the Scientific Study of Population, Liege, August 1973.

<sup>20</sup> In fact as explained above, we present results only for the non-farm sample.

economic studies) where the averaging process is assumed to remove most of the variance in the attitudinal variables. However, with the use of disaggregated data no such assumption can be invoked, and the complete omission of attitudinal variables would have to be acknowledged as a defect in research design. As Cain admits "we do not know much about the properties of these factors, and it is unsatisfactory simply to ignore the issue"<sup>21</sup> The questionnaire on which the present study is based included a number of relatively simple attitudinal questions. Two of these have been introduced into the analysis that follows, namely the respondent's reply to the question whether she approved or disapproved of married women working, and her reply to the question whether she believed her husband approved or disapproved. The variables are introduced at the later stages of the analysis, to see whether they add anything to the explanation achieved by the variables used earlier.

### *The Method of Analysis*

The statistical model that forms the basis of our analysis is the Linear Probability Function. This technique is closely related (at least as far as its statistical properties are concerned) to Discriminant Analysis but has the advantage of being a relatively obvious extension of the linear regression model familiar to economists<sup>22</sup>

Using a dichotomous (0, 1) dependent variable,  $Y$ , the regressors consist of  $n$  sets of dummy variables,  $R_i$  ( $i=1, \dots, n$ ). Each of these sets is composed of  $K_i$  individual dummy variables, corresponding to the  $k_i+1$  categories in the set – one of which is arbitrarily designated the reference category for the set and taken into account in the intercept term for the equation. The function may be written

$$Y = C + \sum_{i=1}^n B_i R_i + U \quad (1)$$

(Where  $C$  is the intercept and  $U$  the residual, and the subscript relating to individuals on  $Y$ ,  $R$ , and  $U$  has been omitted.  $B_i$  is a vector of coefficients, corresponding to each of the dummy variables in the  $i^{\text{th}}$  set,  $R_i$ .) If the individual dummy variables are denoted by  $r_{ij}$ , – referring to the  $j^{\text{th}}$  category in the  $i^{\text{th}}$  set – the linear probability function may be written as

$$Y = C + \sum_{i=1}^n \sum_{j=1}^{k_i} b_{ij} r_{ij} + U \quad (2)$$

where the  $b_{ij}$  are the coefficients of the individual dummy variables

<sup>21</sup> *Op Cit* p 21

<sup>22</sup> Cf Ladd, *Op Cit*. The linear probability function is less exacting in the assumptions made about the independent variables, which need not be normally distributed. For a discussion of the programme we have used, and its relationship with discriminant analysis, cf Whelan, B J, *Op Cit*

To illustrate the use of this notation, consider the way age is treated. We distinguish nine age groups in the survey including a category for "no answer". Using the 14-19 age group as the reference category, eight dummy variables are defined. Each respondent is coded 1 for one of these variables only, zero on all the others (if she is in the reference category, she is coded zero on all 8 variables, and as far as her age is concerned the intercept is the relevant coefficient). The  $b_{1j}$  for age are the eight coefficients which show the change in the value of the dependent variable caused by membership of each category of the independent variable as compared with the reference category. This procedure is followed for all  $n$  independent variables.

The model outlined above postulates that membership of a particular category of an independent variable changes the probability of being in the labour force by a constant amount, regardless of which categories of all other independent variables the respondent belongs to. In other words, the model assumes that the effects of the variables are additive. This is a strong, and perhaps unrealistic, assumption, since interaction between some of the independent variables cannot be ruled out. A model that allows for some interaction may be specified by including new variables formed as the product of any two of the original independent variables.

$$Y = C + \sum_{i=1}^n B_i R_i + \sum_{i=1}^n \sum_{j=1}^{k_i} D_{ij} R_i R_j + U \quad (3)$$

$i \neq j$

The total number of possible interaction terms,  $R_i R_j$ , is  $\frac{1}{2} n(n-1)$ , even though this specification allows only pairwise interaction between the variables. However, attention can be confined to some subset of all possible interactions on the grounds that many of the possibilities are unlikely to yield significant improvements in the relationships. It must be recalled that since both  $R_i$  and  $R_j$  are each sets of dummy variables, the number of coefficients to be estimated for just one such interaction variable is the product,  $k_i k_j$ , of the number of categories in each of the independent variables in question. For example, an interaction between age (8 dummy variables) and education (12 dummy variables) requires the estimation of 96 coefficients. Hence, before exploring the question of interaction, there is an obvious need to attempt to reduce the number of categories in the independent variables to a minimum.

This issue was dealt with by initially estimating the equations using the most detailed classifications available from the coded questionnaires. The matrix of  $t$  values for the differences between the coefficients within each set of dummy variables was then examined, and groups of categories were combined if the  $t$ -test did not lead to the rejection of the hypothesis that their coefficients were equal. In terms of equation (2) above, we tested whether  $b_{11} = b_{12} = \dots = b_{1k}$ , for all  $i$ .

Let us take for instance the variable "Age" for the Single Non-Farm

Group The coefficients of the most detailed classifications available are shown in the column headed "Age" in Table 2 (below) A matrix of all possible differences between these coefficients was formed, and this was translated into a matrix of *t*-values by dividing each difference by its standard error This gave the following result

	Age Group							
	20-24	25-29	30-34	35-39	40-44	45-54	55-64	No Ans
25-29	1 90							
30-34	<u>3 52</u>	1 68						
35-39	<u>3 73</u>	<u>2 09</u>	0 99					
40-44	<u>4 80</u>	<u>3 00</u>	1 35	0 73				
45-54	<u>7 65</u>	<u>4 90</u>	<u>2 70</u>	1 81	1 01			
55-64	<u>10 04</u>	<u>7 26</u>	<u>4 91</u>	<u>3 93</u>	<u>3 28</u>	<u>2 93</u>		
No Ans	<u>3 43</u>	<u>2 19</u>	0 96	0 48	0 11	0 89	<u>2 62</u>	
14-19 Ref								
Category	0 43	1 73	<u>3 48</u>	<u>3 67</u>	<u>4 80</u>	<u>8 07</u>	<u>10 66</u>	<u>3 34</u>

(*t*-values underlined once are significant at the 95 per cent level and those underlined twice at the 99 per cent level )

On the rule of thumb that no two categories should be combined if their coefficients were significantly different this table led to the following combinations of categories

- Under 30 (viz 14-19, 20-24, 25-29)
- 30-44+No Ans
- 45-54
- 55-64

Thus eight categories have been reduced to four These amalgamated or "transformed" categories are those which were utilised in estimating the "transformed" equation (see Table 3)

It is possible to apply this test with the added constraint that no "unacceptable" combinations will be formed in other words, if a significant difference exists between two categories, these will not be amalgamated, but the absence of a significant difference need not dictate amalgamation For example, in the case of the age categories, it may be felt that only adjacent categories should be amalgamated The advantages of examining the matrix of *t*-values are obvious, providing as it does a statistical test for the amalgamation of codes and hence avoiding rather

arbitrary combinations such as "manual" and "non-manual" social groups

This procedure was adopted for all the variables with the exception of the "presence of children" variable. In the case of this variable, three age groups were distinguished (under 4, 4 to 14, 14 to 18 years) and 8 dummy variables were used according to whether or not children were present in any combination of the age groups thus, all possibilities of interaction were explicitly explored within this group of variables

Analysis based on dummy variables has been defended by Suits on the grounds that dummy variables are "more properly scaled than conventionally measured variables. By partitioning the scale of a conventionally measured variable into intervals and defining a set of dummy variables on them, we obtain unbiased estimates" since the regression coefficients of the dummy variables are free to conform to any change of slope that may occur over different ranges of the independent variables<sup>23</sup> Thus the use of dummy variables (in any event inevitable with variables that are measured only by category) is not necessarily a second best option

A problem is however associated with the estimation of the  $b_{1j}$  by ordinary least squares regression techniques. It is well-known that the application of classical least squares (OLS) estimation techniques when the dependent is a dummy variable will not result in minimum variance estimates of the  $b_{1j}$  due to the presence of heteroscedastic disturbances<sup>24</sup> A generalized least squares (GLS) approach will yield minimum variance estimators. While this problem is acknowledged, the analysis that follows utilizes only OLS estimators. Evidence available from other studies suggests that tests of significance on the individual regressors based on the OLS results err on the conservative side<sup>25</sup>

*Evaluation of Results* The evaluation of the overall goodness of fit of the equations has been based in the first place on the  $\bar{R}^2$  as conventionally defined for multiple regression analysis. Although highly significant, these  $\bar{R}^2$ s were generally very low in comparison with those obtained in the typical (aggregate) cross section or time series econometric study. Since the dependent variable in the present study can only assume values of zero and one, and since  $\bar{R}^2$  is based on the unexplained sums of squares, practically all predicted values, even those close to the true value of one or zero, are making some contribution to the unexplained sum of squares, thus reducing the value of  $R^2$ . It therefore seemed more reasonable to develop an alternative measure of the goodness of fit of the estimated equation. Such a measure was suggested to us by the practice in discriminant analysis of using an estimated discriminant to allocate the members of the sample into two groups and utilizing the proportion of

<sup>23</sup> This discussion and our notation draw heavily on Suits, D. B., "Use of dummy variables in regression equations", *Journal of the American Statistical Association* (December 1957), pp. 548-551

<sup>24</sup> Cf. Johnston, J., *Econometric Methods* New York: McGraw-Hill, First Edition, 1963, p. 227

<sup>25</sup> Cf. Bowen and Finegan, *Op. Cit.*, p. 648

correct allocations as a measure of the discriminatory power of the estimated function<sup>26</sup>

To apply this technique in the present instance, it was necessary to calculate a score for each observation on the basis of the estimated function (in regression terminology this score is simply the estimated  $y$ -value) and to allocate the observation to one group or another depending on whether or not the score was below or above a certain critical value. The formula for this critical value was developed from that used in classical discriminant analysis to discriminate optimally between two groups when the "*a priori* probabilities" of these groups are unequal. The formula is derived and more fully discussed elsewhere<sup>27</sup>

For the purpose of evaluating the equations, three alternative measures are therefore presented: (i) an overall  $F$ -value, (ii)  $R^2$  and  $R^2$ , and (iii) the number of correct assignments into each of the two groups. A separate examination of the proportion of correct assignments in each group is more useful than merely calculating the overall proportion of correct assignments since it gives a clear idea of the improvement in prediction that results from using the equation as opposed to assuming everyone belongs to the majority classification<sup>28</sup>

A further, and more rigorous, test of the quality of an equation is to estimate the equation on one randomly selected half of the sample and to test the discriminatory power of the equation on the other half. This provides a test of the stability of the coefficients over different samples. Such stability can be an important consideration in multivariate analysis. For instance, recent research by Fielding<sup>29</sup> has shown that the AID techniques can be highly unstable even when large samples are used. In the present case, the random split half technique was applied to the sample of married women, and it showed that the coefficients were very stable.

Since the dummy variables are included in sets, the significance of the individual coefficients is not at stake, but rather whether the inclusion of the entire set raises the explained variance significantly. Thus,  $F$ -tests for each set of variables are shown. It should be borne in mind that these tests are affected by the order in which the sets are introduced if there is a non-zero correlation between the sets. Examination of the correlations

<sup>26</sup> Cf. Morrison, D. F., *Multivariate Statistical Methods*. New York, McGraw-Hill, 1967, pp. 130.

<sup>27</sup> Whelan, B. J., *Op. Cit.*

<sup>28</sup> This point may be illustrated. 81 per cent of non farm single women were in the labour force. If the proportion of correct assignments on the basis of the LPF were only 80 per cent, it might seem that a better result would be obtained by simply predicting that *all* respondents will be in the labour force. This latter rule would, however, lead to 100 per cent error in predicting the labour force status of those not in the labour force, whereas the linear probability function would correctly predict the labour force status of some of those not in the labour force. As mentioned above, the decision rule used in our analysis is one that incorporates information about the proportion of the demographic group in the labour force (the *a priori* probabilities). Cf. Morrison, Donald F., *Op. Cit.*

<sup>29</sup> Reported at the British Sociological Association, Statistics, Mathematics and Computing Applications Group Conference, Southampton, April 1973.

between the regressors suggested that, with the present data, this problem is quite unimportant. We therefore adopted the following rather pragmatic procedure, making an exception for the attitudinal ("tastes") variables, which we introduced last in all equations. We estimated an equation including all the sets of variables which we thought appropriate, calculated an *F*-value for each set in this equation and then re-estimated the equation introducing the sets of variables in descending order of these *F*-values. This gave a new *F*-value for each set which reflected its contribution over and above that of the variables already included. When there is non-zero intercorrelation, this procedure is equivalent to attributing most significance to the variables which made the largest independent contribution to explaining the dependent variable.

In Table 1 we set out the "independent" variables used in our analysis, grouped in sets on the basis of the most detailed codes available from the original questionnaires. In each case, the reference category is indicated: this is the category to which the intercept applies and from which the coefficients of the other categories represent shifts.

### *The Empirical Results*

The main results obtained are shown in Tables 2-7. The term "original equation" refers to equations specified in the most detailed classifications of the variables, and "transformed equation" refers to the equation re-estimated with some of the codes for each variable combined according to the procedure described above. In addition to "original" and "transformed" equations for single and married women, we present a (transformed) equation estimated on a randomly selected half-sample of the sample of married women. Finally, an equation incorporating interactions between variables is presented for the married women.

The results are discussed in the order in which they appear in Tables 2-7 against the background of the general theoretical framework outlined above.

*Non-farm Single Women* Five variables have been used in specifying the equation presented in Table 2, and all of these make a significant contribution to explaining the variation in the dependent variable (as may be seen from the values of the *F*-tests). Two of the variables - "location" and "availability of jobs" - measure labour demand conditions in local labour markets. The large negative coefficient associated with the "open country" code for location is interpreted as reflecting the scarcity of (female) job opportunities outside urban areas.<sup>30</sup> It must be recalled that our definition of labour supply includes those who are not working due to a belief that suitable jobs are not available, so that this coefficient indicates that in areas of very low employment opportunities, entry to the labour force is less likely. This is a characteristic "discouraged worker" syndrome. A similar interpretation is consistent with the coefficients obtained for the "availability of jobs" variable, although this variable

<sup>30</sup> Our analysis is concerned with the non farm population, and consequently we are interested only in non farm employment opportunities.



makes a less significant contribution to the explanation of the dependent variable. The question asked related to the availability of jobs locally to *married* women, and hence was only an indirect measure of the single respondents' beliefs about their own local employment opportunities. Nonetheless, the pattern of the estimated coefficients indicates that single women are less likely to enter the labour force when they believe that local job opportunities are scarce. The magnitude of the coefficient of the "definitely no" category for this variable is, however, only one-fifth that obtained for the "open country" code of the location variable.

It may be maintained, as an alternative interpretation of these two variables, that both of them contain substantial attitudinal or "taste" elements – single women living in country areas having a stronger preference for leisure or work in the household than their more urbanized counterparts, and single women who say there are "definitely not" jobs available locally for married women being also less approving of women working outside the home. Whilst it is not inconsistent with our interpretation above to acknowledge the possible attitudinal content of these two variables, we believe their main role is to measure variations in local labour market conditions. Attitudinal variables are unlikely to play an important role in the decision of a single woman to enter the labour market in view of the absence of a clearcut alternative use of time (such as child-care). The availability of suitable jobs is, however, likely to be a binding constraint, especially in rural areas.

The age variable is highly significant as a whole, and the estimated coefficients of the individual categories show a very reasonable pattern, with a steadily decreasing probability of being in the labour force with increasing age. As mentioned in the theoretical discussion, this result is consistent with the interpretation that preference for leisure over market activity increases with advancing age, but other factors may also be subsumed by these coefficients. In particular, employers may exercise considerable selectivity with respect to age in their hiring practices, and hence the negative coefficients for the older age groups may reflect a discouraged worker effect. It is also likely that older women experience a depreciation of their initial stock of human capital, and hence have a lower potential income in market activities than do younger women with equal educational attainment. To the extent that this is the case, the age variable may be a proxy for a variable such as "length since last job".

Our emphasis on the educational variable is primarily based on an interpretation of this as a measure of "potential income in the market activities". The very significant, negative coefficient for those who left school without completing primary education indicates that these women face very restricted earnings prospects in the market place<sup>31</sup>.

At the other extreme, significant, positive coefficients were obtained for those with commercial or business training and those who had completed university. The very substantial increase in the probability of a single

<sup>31</sup> The student code relates to those still in third level education, and its negative coefficients merely a reflection of the definition of the dependent variable.

woman being in the labour force when she has, for example, completed university education compared with incomplete primary education (+ 312) is an indication of a very high, positive elasticity of supply for this category of labour

Finally, a variable measuring whether or not the single respondent was "head of household" was included among the regressors. This variable, which has no counterpart among married women, is interpreted as measuring two factors: on the one hand, those who were heads of household presumably enjoyed a lower income from family sources other than their own market work than did those who were not heads of household, moreover, single women who are not heads of household may be presumed to have a higher value of time in non-market activities (looking after other members of the household) than those who are heads of households. (There may be exceptions to this second assumption – such as unmarried mothers looking after children but these are unlikely to exercise much influence on the overall result. "Head of household" was defined for single women as someone other than the daughter, sister, etc. of the head of household, so that daughters looking after parents etc. were not classified as heads of household.) For both these interpretations the coefficient of the "head of household" variable is expected to be positive, and Tables 2 and 3 show that in fact a highly significant, positive coefficient was obtained.

The possibility of two-way causation cannot be ignored in connection with the head of household variable. To some extent, becoming head of household may be occasioned or facilitated by obtaining a job, and thus this variable may not be truly exogenous. For present purposes, however, we must be content to treat it as a genuinely exogenous variable.

The "transformed" equation presented in Table 3 summarizes the same results with a greatly reduced number of categories for each variable, and makes interpretation far simpler. The age variable, for example, reduces to four categories, with no significant differences between the coefficients of the age groups "under 30". The education variable reduces to five categories in addition to the reference group.<sup>32</sup> In general, comparison of the "original" and "transformed" equations shows that the latter contains a greatly expanded reference category, and separate coefficients are retained only for the more extreme categories of the independent variables. Thus, one important function of the method we have adopted is to isolate those situations which have a significant impact on the dependent variable, thereby greatly simplifying the interpretation of the results.

The "goodness of fit" of the equations in Tables 2 and 3 may be evaluated either by considering the  $\bar{R}^2$ , the  $F$ -value, or, more relevantly, by the proportion of correct assignments (see discussion, above). The value of  $\bar{R}^2$  of .27 in both Tables 2 and 3 is satisfactory for this type of work (the corresponding multiple correlation coefficient is 0.54), and it

<sup>32</sup> It will be noted that not all of the coefficients of these five categories are significant in the re-estimated "transformed" equation, even though the fact that they have been retained as separate categories here indicates that there was a significant difference between their coefficients and those of adjacent categories in the "original" equation.

may be seen that virtually nothing is lost in moving from the “original” to the “transformed” equation. The *F*-value for the whole equation is, of course, highly significant, and, in the transformed equation each variable included makes a significant contribution at the 0.1 level. The proportion of correct assignments is 86 per cent. At first sight this may not appear to be a significant improvement over the outcome from assuming that all single women are in the labour force since the participation rate is 83 per cent, the proportion of correct assignments if all women were assumed to be in the labour force would be 83 per cent. However, this rule of thumb would lead to 100 per cent error in the assignment of women who were not in the labour force (and 100 per cent success in the assignment of those in the labour force). Compared with this, our equation gives 95 per cent correct assignment of those in the labour force, and 41 per cent correct assignment of those not in the labour force. Thus, a large improvement in the accuracy of prediction of those in the minority group (not in the labour force) has been gained at the cost of a small loss in terms of the majority group. The decision rule used to assign women on the basis of our equation incorporated, however, “*a priori* probabilities” – that is, the knowledge that in fact 83 per cent of single women were in the labour force. An alternative evaluation of the equation’s performance is to compare it with the outcome from using a rule of thumb that randomly assigns 83 per cent of single women to the labour force, and 17 per cent to not in labour force. This would result in 72 per cent correct assignments – consisting of 17 per cent of those who were not in the labour force and 83 per cent of those who were in the labour force.

To summarize this discussion of the predictive performance of the equation, the following table of “correct assignments” under various prediction rules may be considered.

<i>Prediction rule</i>	<i>Assign all to labour force</i>	<i>Randomly assign 83 per cent to labour force</i>	<i>Use equation of Table 3 and decision function</i>
Actual labour force status	(percentage of correct assignments)		
Women in labour force	100	83	95
Women not in labour force	0	17	41
Total	83	72	86

This shows the superiority of the decision rule based on the equation, especially in connection with its prediction of the minority classification (not in labour force).

To summarize our substantive findings on labour supply by single women in the non-farm situation, we have seen that a limited number of variables contributes very significantly to our understanding of this phenomenon. Labour force entry is much more likely when the job opportunities for women are abundant. Younger women are far more likely to be in the labour force than their older counterparts. When a

woman's potential income (as measured by her educational level) is high, she is more likely to enter the labour force. Finally, single women who are not the head of the household in which they live are less likely to be in the labour force than those who are heads of household, presumably due to the lower "other family income" enjoyed by the latter and the lower value of time in household activities for them.

These variables help to account for the relatively low labour force participation among single women in Ireland in the past, as well as for the increased participation in recent years.<sup>33</sup> Assuming that the variables shown to be significant in our cross-section analysis will prove to operate in the same direction over time, it is possible to predict a continuing rise in the proportion of single women in the labour force, due especially to the contraction in the proportion of women with only primary education and to the continuing concentration of the population in cities, towns and villages. Furthermore, if economic growth increases the number of job opportunities for women, it seems that this too will further reduce the proportion of single women remaining outside the labour force.

*Non-farm married women* In outlining our theoretical approach to the analysis of labour force participation by married women, a number of variables were hypothesized as influencing labour supply in this population group. The results obtained from our attempts to test this model are presented in Tables 4 ("original" equation), 5 ("transformed" equation), 6 ("transformed" equation on random half-sample) and 7 ("transformed" equation with interactions). We shall discuss these results by looking at the performance of each of the principal independent variables in turn.

Local labour market conditions have been measured in the equation by the "location" and "availability of jobs" variables. The "availability of jobs" variable was not significant in the original equation, and has been dropped from subsequent analysis. The "location" variable is significant (by the *F*-test) in Table 4, and is retained in subsequent analysis. The coefficients obtained are, however, not in conformity with theoretical expectations (or, indeed, with those obtained for single women). A significant, *positive* coefficient for the "open country" code is the main disparity between the empirical results and the theoretical model. A possible *ex post* rationalization of this outcome is the likelihood that a high proportion of the *non-farm* married women living in the "open country" are wives of shopkeepers, publicans, etc., among whom labour force participation is high. In the transformed equation (Table 6), it may be seen that all the location codes are amalgamated with a significant positive shift coefficient relative to the reference category ("residential areas", i.e. suburbs), and the level of significance of the variable has fallen to .05. Thus, this attempt to measure the influence of local labour market

<sup>33</sup> Cf. Walsh, B. M., 'Aspects of Labour Supply and Demand, with Special Reference to the Employment of Women in Ireland', *Journal of the Statistical and Social Inquiry Society of Ireland* Vol. XXII, Part III, May 1971. It is estimated in this paper that between 1961-66 the rise in labour force participation (according to the Census of Population concepts) among single women over 8,000, compared with an increase of only 236 due to rising married female participation rates (cf. Table 8).

conditions on married women's labour supply must be judged inconclusive. When "area" rather than "location" was used as the measure of local labour market conditions, no improvement resulted. It is possible that the explanation of these findings lies in the inclusiveness of our measure of labour supply, especially the concept of unemployment used. (It will be recalled that we defined as members of the labour force both women who were employed and those who, though currently unemployed, expressed a desire to return to work if suitable jobs were available.) When an equation was estimated with the *employed* labour force as the dependent variable, a significant positive coefficient was obtained for the "business district" code of the local variable.

The education and "work history before marriage" variables are our measures of potential market wages.<sup>34</sup> The age variable also measures this factor, among others. It may be seen that in the original equation "never worked before marriage" had the expected negative coefficient, but was not statistically significant. The educational variable was highly significant in the original equation, although very many of the individual codes were not. The transformed equation, therefore, resulted in a great simplification for the codes of this variable, with only "university (complete or incomplete)" and "other professional/technical training" causing a very substantial net increase in the probability of being in the labour force, and only "no answer, etc." causing a net decrease. The reference category is thus greatly enlarged. It is striking that such wide variations in educational attainment (potential wage) seem to exert little influence on whether or not a married woman becomes a member of the labour force.

The age variable displays very little variation in coefficients in the original equation, and in the transformed equation the only code that remains significant is the negative value for "55-64", indicating either a lower potential wage for women in this group or a greater preference for leisure, or some combination of both factors. The net effect of both the age and education variables is thus seen to be much less than that which might be inferred from simple cross tabulations.<sup>35</sup> It seems that only relatively extreme values of these variables make a significant difference to the probability that a married woman will be in the labour force.

Our model postulated that the higher "other household income", the less likely the wife was to enter the labour market. Our only measure of this variable is "husband's occupation", which has been coded into twelve socio-economic groups. The net influence of this variable was highly significant, but once again very few of the individual coefficients were significantly different from the others, so that the transformed equation retained only two separate coefficients in addition to the reference group. Only the highest socio-economic group ("professional, higher administration") had a significant negative coefficient, indicating

<sup>34</sup> The education variable included a code for those who had received special on-the-job training in previous employment. This was a separate variable with a zero/one code depending on whether the informant had any on-the-job training.

<sup>35</sup> Cf. Walsh and O Toole, *Op Cit*.

that only in this group is "other household income" on average high enough to cause a significant reduction in the labour force contribution of wives when variables such as education, age, etc are controlled. On the other hand, there is a very significant, positive coefficient for the "inspectoral-supervisory-other-non-manual" category. This may be partly explained by relatively low "other household income" in this group (low, especially, in relation to aspirations), but a further possibility is the tendency for shopkeepers, etc (who are generally coded to this group) to utilize their wives' services in the family business. Thus, low work-related expenses and high productivity at work are possible influences behind this positive coefficient, supplementing the influence of relatively low "other family income". Some further evidence on this variable is provided in the discussion of the results obtained from the interaction variables, below.

Our emphasis on the presence of children as a factor influencing the wife's decision to enter the labour force derives from the belief that the value of time in household duties rises sharply when children, especially young children, are present. Thus, other things being equal, it is expected that women with children to look after are less likely to be in the labour force than those without children. The results in Tables 4-7 strongly confirm this expectation: the "presence of children" variable is a highly significant influence on labour force participation, and with "no children" as reference category, all the combinations of children present in the different age groups have negative coefficients, four of which are highly significant in the original equation. In the transformed equation, this variable simplifies down to a reference category and two other codes. The two codes that are retained are "children under age four present" and "children aged 4-14 present, but none aged under four". The first situation has just over twice as large a negative effect on labour force participation as the second. The presence of children aged 14-19 only has no significant influence on labour force participation. Thus, our regression results support the hypothesis that both the presence of children, and the ages of the children present, exert an important influence on the supply of labour by married women.

The "tastes" or "preferences" of married women for labour force participation (compared with housework or leisure) were measured by the answers given to a question as to whether the respondent approved or disapproved of married women working, and her belief about whether her husband approved or disapproved. (Of course other variables, especially the age variable, may also have measured components of the tastes variable.) The estimated equations clearly show that both of these variables have a significant influence on labour force participation. In the case of "wife's own attitude", only the "unconditional approval" code resulted in a significant increase in labour force participation compared with the reference category ("conditional approval"), whilst only "no strong feelings" resulted in a significant decrease. It is easy to accept that "no strong feelings" was a more "negative" attitude than "strongly disapprove", since respondents giving the latter answer at least indicated

that they had considered the matter, whereas those giving the former may have been totally indifferent and unconcerned. From this viewpoint, as well as on the showing of the statistical results, the indirect evidence obtained on the respondents' attitudes by asking them about their husband's attitudes may have been a better measure of the tastes variable. The increase in labour force participation associated with the "husband approves" response is the largest coefficient obtained for any variable (in the transformed equation), and its contribution to  $\bar{R}^2$  is also the greatest. We interpret this finding as meaning, first, that a husband's attitude towards whether his wife should work is an important variable in the wife's decision about labour force entry,<sup>36</sup> and secondly, that an indirect question of this type may also provide a useful measure of the wife's own attitudes.

We have, however, already mentioned the special problems that are posed by the use of attitudinal variables of this type as independent variables in our analysis. If, for example, all working women felt constrained to state that they believed that their husbands approved of married women working, and many non-working women used the idea that their husbands disapproved as an explanation for their own non-entry to the labour force, then clearly our "independent" variable is not genuinely exogenous. However, despite these problems, we believe that the tastes variables are at least partly exogenous, and we favour their retention in our analysis. In order to test the validity of retaining these variables we calculated the equations of Tables 4 and 5 without the attitudinal variables. The results showed a significant reduction in the  $\bar{R}^2$  (from 0.186 to 0.079 for the original equation, Table 4), but no reduction in the significance of the other variables and very little change in any of their coefficients.<sup>37</sup>

Husband's labour force status was included as a measure of "other household income" – an unemployed husband is one possible reason for a wife's entry to the labour force.<sup>38</sup> It may be seen that this variable was significant, but the positive coefficient obtained for "employed" is not in conformity with expectations. It is hard to conceive of even an *ex post* rationalization for this finding, so that it must be ascribed to the effect of the peculiarities of the particular sample on which our regression is based.

The estimated equations in Tables 4 and 5 are of course highly significant by the *F*-test. The  $\bar{R}^2$  obtained is lower than that for the sample

<sup>36</sup> This interpretation is consistent with evidence from Wail's study, in which it was claimed "a woman will perform or plan to perform in the career role when her husband's attitude towards her outside employment is positive." Cf. Wail, A. M., 'An Analysis of the Factors Influencing Married Women's Actual and Planned Work Participation', *American Sociological Review* (1961), Vol. 26, p. 91.

<sup>37</sup> This stability of the coefficients of the other independent variables is reassuring evidence of the orthogonality of the attitudinal variables and the remainder of the set of regressors, which in turn suggests that the attitudinal variables are genuinely exogenous to the system.

<sup>38</sup> This 'additional worker effect of unemployment has not generally been found to prevail over the 'discouraged worker' effect.

of single women ( 186 compared with 272), as is the proportion of correct assignments (81 per cent compared with 86 per cent) On the whole, even when attitudinal variables are included in our regressions, the economic model that forms the basis of our study performs less well for the married than for the single sample

It is of interest to show the results of comparing the performance of our model with naive methods of assigning subjects to categories

<i>Prediction Rule</i>	<i>Assign all to 'not in labour force'</i>	<i>Randomly assign 21 per cent to labour force</i>	<i>Use equation of Table 5 and decision function</i>
Actual labour force status	(percentage of correct assignments)		
Women in labour force	0	21	35
Women not in labour force	100	79	93
Total	79	67	81

Once again, the econometric approach is superior to either of the naive alternatives as far as prediction of the minority category ("in labour force") is concerned

We referred above to the desirability of testing the stability of the equation's coefficients by estimating the equation on a randomly chosen half of the sample and then assessing the predictions made by this equation on the individual observations in the other half of the sample The results of this exercise are shown in Table 6 When the coefficients in this equation are compared with those shown in Table 4, it may be seen that very little change has occurred either in sign, magnitude or level of significance The two sets of coefficients were so similar that it was considered unnecessary to perform any statistical tests of significance for the differences that do emerge This evidence on the stability of the coefficients over different sub-samples is very reassuring as far as the reliability of the overall results is concerned

When the coefficients of Table 6 were applied to the prediction of the labour force status of the women in the *other* half-sample, the following results were obtained

<i>Assigned</i>	<i>Actual</i>		<i>Total assigned</i>
	<i>In labour force</i>	<i>Not in labour force</i>	
In labour force	86	71	157
Not in labour force	184	884	1,068
Total actual	270	955	1,225

Percentage of correct assignments = 79.2

This table shows that the predictive power of the model is very nearly as high as would have been concluded on the basis of the equations



estimated for the entire sample. The overall proportion of correct assignments for this experiment (79 per cent) is virtually as high as in the equation on the full sample (81 per cent). Moreover, the proportion of correct assignments to the minority category ("in labour force") is also very similar for the two situations (32 per cent in the experiment compared with 35 per cent in the equation).

The final modification which was made was to introduce *interaction* terms into the equation. As explained previously (p. 12), these allow for effects other than purely additive ones. We experimented with a fair number of intuitively plausible interactions, but most of these were not significant. The two most interesting interaction terms which emerged are shown in Table 6. The first is an interaction of presence of children and husband's occupation. It shows a significant negative coefficient of  $-0.01$  when children under four are present in a household where the husband is in the Inspectoral/Supervisory/Other Non-Manual class. This coefficient is of roughly the same order of (absolute) magnitude as the positive coefficient for this category of husband's occupation ( $0.138$ ). Thus, the presence of children under four substantially reduces the effect of the husband's being in this occupational category. It may be seen that wives who are highly educated and whose husbands are in the "Inspectoral/Supervisory/Other Non-Manual" social group have a very high probability of being in the labour force, over and above the already high probabilities associated with each of these categories on its own (the coefficient of the interaction variable is  $+0.312$ ). However, in evaluating these interaction terms, it must be borne in mind that their overall contribution to the equations' goodness of fit is quite slight. Perhaps the most important showing of Tables 6 and 7 is that the additive model (Table 6) serves as a very reasonable approximation.

One way of summarizing the results of our findings on married women's participation in the labour force is to draw up two profiles, one of a combination of characteristic (or values of our variables) that together would lead to a very high probability, the other of a combination that would lead to a very low probability, of labour force participation. These combinations could be thought of as profiles of stereotypical wives, even though no individual (in our sample or in the population) may actually have *all* of these characteristics.

#### Combination of characteristics leading to

HIGH

LOW

Probability of labour force participation

No children under 14 present

University or technical/professional education

Husband in "inspectoral/supervisory/other non-manual" social group

Husband approves of married women working

Children under four present

No third level education

Professional husband

Husband disapproves of married women working

We would predict that any woman with all of the characteristics in the right-hand column is most unlikely to be in the labour force (in fact, the value of the linear probability function would be negative), whereas there is a very good chance that a woman with all of the characteristics in the left hand column would be in the labour force (the value of the function is 0.77)

It is worth emphasizing the omissions from this table, as well as the inclusions. Measures of local job market conditions do not appear. Age is not included as an influence on labour force participation. Over the age interval up to 55 years, no significant influence was apparent, and for the 55-64, it would clearly be improbable that the respondent had young children to care for. Hence, there is a somewhat arbitrary choice between the age and the presence of children variable for inclusion in this table, and the latter has been given greater prominence due to its larger coefficient. Moreover, even more striking than the restricted number of variables included in this table, is the restricted number of codes from each variable that was shown to exert an important influence on labour force participation. In all cases, our method of deriving the transformed equation has led to a very substantial reduction in the number of codes that qualify for separation from the reference category. Thus, our original equation distinguished eleven educational categories (in addition to the reference category) but, in the transformed equation only two remain outside the reference category. A similar simplification was achieved with the husband's occupations variable. One of the most useful aspects of this type of analysis is, then, its ability to simplify codes and to focus attention on the extreme situations which make an important contribution to the explanation of the variance in the dependent variable.

#### *Summary and Conclusions*

This paper has attempted an analysis of survey data based on a statistical technique designed to test certain hypotheses regarding the net influence of "independent" variables on a "dependent" variable. Our "dependent" variable was the labour force status of women, based on a dichotomy between those in the labour force (at work or looking for work) and those not in the labour force. The independent variables included in the study were based on an economic theory of labour supply, which posits potential income, value of time in home duties, availability of suitable jobs and husband's income as the main factors influencing the wife's decision to enter the labour force. An extension of the basic model attempted to include an attitudinal or "taste" variable as a further influence on the wife's behaviour.

The model was tested on survey data relating to single and married women in non-agricultural households in Ireland in 1971. From a statistical point of view, it may be claimed that the analysis was successful in explaining the behaviour of the women in the sample. (A number of statistical criteria designed to evaluate the results are discussed in the paper.) The main findings of the study can be summarized separately for single and married women.

Single women are more likely to be in the labour force if they live in areas of the county where female-type job opportunities are abundant. With increasing age, other factors equal, labour force participation becomes less probable. When a single woman's potential income (as far as this is measured by her educational attainment) is high, she is more likely to be in the labour force. Finally, single women who are heads of households are more likely to be in the labour force than those who are not, which was taken to reflect the effect of the lower level of "other household income" enjoyed by the former.

Married women's labour force status is influenced by the number and ages of the children present in their families. In economic terms this was taken as a measure of the value of time in non-market work to wives – the higher this value, the less likely is entry to the labour force. Potential income (as measured by educational attainment) also seems to play an important part in the labour force decision of wives. There is some tendency for wives whose "other household income" (as measured by their husband's socio-economic status) is high to be less likely to enter the labour force. Finally, an attitudinal variable helps to account for some of the differences between wives in labour force status – if they or their husbands approve of wives working, they are more likely to be in the labour force.

In several of these areas, especially in connection with attitudinal variables, it is recognized that cause and effect cannot readily be identified in the framework of a study that analyses only one dependent variable. The most basic extension of this type of research is to attempt to analyse the extent of labour force participation over a woman's lifetime as a jointly dependent variable along with family size.

## DISCUSSION

*Dr Geary* Methodologically this paper is of great interest, particularly so to me, for some colleagues and I in ESRI had independently planned to use it for a research on the growth of middle-sized Irish towns. As far as I am aware this is the first time the method has been used in Ireland. As we have heard, the depvar (whether the subject is in the labour force or not) and the very considerable number of indvars can assume only the values 0 or 1, thus, the 9 age classes entail 8 variables, and our authors meticulously study interaction as well. They adopt an ingenious technique to reduce the number of indvars.

Obviously they are disappointed at the low values of  $R^2$  and  $\bar{R}^2$  they obtained. A partial explanation may be found in their manner of calculation of these statistics. If the original depvar is  $Y$  (i.e. all 0's or 1's) and  $Y_c$  is taken as the value calculated from the regression, the formula for  $(N-1) s^2$ , (namely  $\Sigma(Y-Y_c)^2$ ) must be large. Hence  $\bar{R}^2$  must be small. It might have been more logical to convert the  $Y_c$  to their appropriate 0 and 1 values giving a new variable,  $Y'_c$  say. Then take  $\Sigma(Y-Y'_c)^2$  for the

calculation of  $R^2$ . This procedure would be very like what they did for their discriminant analysis. I suspect it would result in much larger and, indeed, more realistic values of the  $R^2$ .

The method we have been trying in our towns inquiry is as follows. We took measured pairs  $(X'_1, Y'_1)$ , i.e. measured in the ordinary way. If  $M_x$  and  $M_y$  were their respective medians I converted them to new pairs  $(X_1, Y_1)$ , where the  $X_1$  and  $Y_1$  could assume only the values 0 or 1, by giving  $X_1$  the value 1 if  $X'_1 \geq M_x$ , otherwise 0. Similarly  $Y_1$  if  $Y'_1$  and  $Y'_1$  were correlated, it would require a random sample to establish this fact  $2\frac{1}{2}$  as large for  $(X, Y)$  as for the original  $(X', Y')$ . In general, I suspect this (0, 1) technique is insensitive for establishing relationship.

No nice-minded regressionist really likes a large number of indvars. What would our lecturers think of treating their data in cardinal fashion as much as they could, e.g. actual age, which would mean one variable instead of 8? God forgiving me, I have even used socio-economic group numbers 1, 2 etc as indvars values in regression. Of course, I recognize the difficulty that the labour force indvar is necessarily (0, 1) – or is it? Larger values of  $R^2$  might transpire.

I found the conclusions, after the use of such sophisticated methodology rather obvious. Surely it is no news that mothers of very young children are less available for paid jobs than are others, that younger women and better educated women are the more job-worthy, and job-inclined, that with higher family income women are the less likely to go out to work. On the other hand, it is reassuring to find analysis confirming these facts.

I thoroughly approve of the authors' method of showing the superiority of their technique over naive assignment. In the test I would, however, be less naive. Would the authors, having concealed the actual labour-force status, go through all forms making assignment solely on the other information as to conjugal condition, age, education etc etc? I would be surprised if they didn't do as well as with their regressions.

Even if their  $R^2$  are too small, there is no likelihood that, on recalculation on the lines indicated, they can be made large. Have the authors any ideas as to other indvars they might take into account which would improve the explanation of the depvar?

*Dr W O'Riordan* The paper is really excellent – the data have been collected carefully and are up-to-date, the method is new to this country and the results have both practical and theoretical significance. Anything that one could say by way of criticism is necessarily of a minor nature.

The treatment of interaction between the indvars (independent variables) calls for some comment. Since the number of these is very great, each group is collapsed into a smaller number of sections on the basis of the  $t$ -values of the coefficients. Then the interaction variables are added. Unfortunately we have no way of knowing that the  $t$ -values would not be greater in the presence of the interaction variables, if this were so, one would not be justified in using the collapsing process. It is quite possible that in the present case no great harm is done but as a general

procedure it cannot be recommended I think that this difficulty in handling interaction must be recognized as one of the weaknesses of the method used

There is no reason why all the indvars should be dummies It is quite possible to mix dummies and cardinally measured variables and in general, provided we can find the correct functional form, there will be a gain in information if we use a cardinal variable rather than a set of dummies It would seem that age could be more satisfactorily treated in this way, particularly since it is recognized as having the effect of causing the probability to "decrease steadily" The same might be true of the number of years' work-experience and possibly even of the dependent variable (depvar)

The treatment of the  $F$ -values of the sets of coefficients seems unnecessarily complicated It would surely have been better if the  $F$ -value given referred to the contribution made by the set when it is added last The  $F$ -values would then be unambiguous If, as seems likely, there is little multicollinearity between the indvars this would make little difference to the size of these statistics At the very least it would be an improvement if an indication was given of the other indvar-sets included in calculating the  $F$ -values

Finally, it is clear that the question of the overall goodness of fit has given the authors a good deal of trouble I think it is necessary to recognize the fact that a substantial proportion of the variance of the depvar is "unexplained" even when we make allowance for the technical difficulties of measuring correlation when the depvar is a dummy For example, two tables are presented showing the superiority of the predicting power of the present method compared with a random assignment of 83 per cent to the labour force However in the second of these tables the improvement is significant only at the 70 per cent level or thereabouts This by no means implies that the results of the enquiry are trivial, but it does mean that there is room for improvement in our understanding of the forces which encourage women to work

I wish to compliment the authors on a really fine piece of work It gives me great pleasure to propose the vote of thanks

*Terence Ryan* I would like to begin by thanking Brendan Walsh and Brendan Whelan for a very stimulating paper It was very interesting to see an economic application of the LPF technique, and I am sure that subsequent researchers in this and related fields will be grateful for the amount of groundwork covered by the authors of tonight's paper

I would like to confine my comments on the paper to two points which are of a purely technical nature

1 The first concerns the use of the  $F$ -statistic as the basis for inferential statements on the LPF model The estimated coefficients appear to be highly significant in the majority of cases, in terms of the  $F$ -values Given the nature of the Linear Probability Function however, one must have certain reservations about the legitimacy of such inferential statements The estimate of the dependent variable,  $\hat{y}$ , is interpreted in LPFs as the

conditional probability of the occurrence of an event given the values of the independent variables. Unlike a discriminant function score, therefore, the estimated  $\hat{\gamma}$  value must always lie in the interval zero to unity. This is equivalent to placing inequality constraints on sums of the RHS coefficients, such that they never produce values for  $\hat{\gamma}$  lying outside the unit interval. In consequence, the sampling distribution of the estimates is affected and therefore standard inferential statements based on normality are not, strictly speaking, legitimate.

On this point, it would have been very interesting to see a printout of the estimated  $\hat{\gamma}$  values, in order to decide whether the *a priori* constraints on  $\hat{\gamma}$  constitute a serious problem or not.

2 The next point is similar to one made by Dr O'Riordan. While the case for categorizing a variable such as education is fairly obvious (since only nominal measures are possible), one must have certain reservations in carrying out the same procedure on cardinally measurable variables, such as age or income. There would appear to be an information loss though the issue is not at all clear cut, because in categorizing a variable one is effectively relaxing the assumption that the influence of that variable is a linear function of the observed values. The "age" variable in Table 2 does not appear to contradict the linearity hypothesis, while "age" in Table 4 displays a well-defined non-linearity. It seems to me that the effect of such a variable may be more efficiently estimated by using cardinal measures and (possibly) specifying a non-linear relationship. If, on the other hand, the purpose of categorizing cardinally-measurable variables is to allow for a pattern of estimates similar to that on education in Table 4, namely apparently arbitrary changes in sign and magnitude between neighbouring categories, one would generally have difficulty in putting a plausible behavioural interpretation on such coefficients.

*Reply by B M Walsh and B J Whelan* We are very grateful to the proposer and seconder of the vote of thanks, and to the other speakers, for the obvious care with which they have studied our paper. They raise some important points on which we would like to comment briefly.

A number of speakers have mentioned the desirability of using cardinal, as opposed to categorical or ordinal, measures wherever possible. In a general sense we share this view, but it is clear that frequently no cardinal measure can be obtained from a questionnaire. Moreover, even with a variable such as age or socio-economic group, we would prefer to avoid assuming that the categories can be ranked in an order that is known *a priori* and that the increment from one category to the next is always equal – two assumptions that are introduced when you attempt to treat these variables in any way other than the method we used in the present study. The issue is, as Mr Ryan put it, a trade-off between the flexibility of the specification and the loss of information possibly contained in the data. However, the use of a categorical variable as a dependent is undesirable, because it introduces heterovariance, and on economic grounds also a more refined measure of participation would be desirable (e.g. proportion of last year spent in labour force).

Dr O'Riordan raised the question whether our experiment with interactions is valid given that we have first of all amalgamated so many codes. We acknowledge the force of this point, while pleading that it is very difficult to deal with it. He also wonders about our stress on the *F*-test as a criterion for the *order* in which the variables were introduced. The apparent absence of multicollinearity in the present problem certainly reduces the need to worry about this problem, but in other contexts it might be more important.

Mr Ryan raised the issue of constraining the estimating equation so that  $0 \leq Y_c \leq 1$ , where  $Y_c$  is the value of the dependent variable calculated from the regression. We did not so constrain the regression, although we have seen this done in other studies. It is not evident to us which is the better procedure.

Dr Geary's suggestion that we calculate  $R^2$  on the basis of a 0, 1 value of  $Y_c$  is feasible. When we performed the calculations we found, rather surprisingly, that the re-calculated  $R^2$  was actually lower than the conventional  $R^2$ . It is also true that the use of this re-calculated  $R^2$  implies unequal costs (losses) for different types of misallocation. In view of these problems, perhaps the moral is that we should concentrate on the other measures of "goodness of fit" which we have provided in each Table, and omit  $R^2$  entirely.

This brings us to the question whether our results do not reveal a very low explanatory power for the model as a whole. Certainly, even if we concentrate on the proportion of correct assignments as our criterion, a lot remains to be explained. Perhaps this is inevitable with data on individuals, which may contain a lot of "noise". Some may draw the moral that we should concentrate (as economists usually do) on information about aggregates (e.g. national time series, county averages, etc). There are, however, likely to be some situations in which it is very hard to test hypotheses without resort to a study of the individual. It is also fair to say that although the "unexplained variance" (however measured) is very large in our equations, many of the variables reach significance at extremely high confidence levels. Whether you call the results "good" or "bad" thus depends on which aspect you stress! Moreover, even with the extraordinarily high  $R^2$  common in time-series studies, the predictive performance of the equations is frequently poor. Our "random split half" experiment was reassuring on this score.

Finally, the question of the "obviousness" or otherwise of our findings. We would be the first to agree that nothing very startling emerged from this investigation. There is, however, a distinction between results that seem obvious after the research is completed and the variety of hypotheses that might appear plausible *ex ante*. There is moreover a value in systematizing and confirming "what oft was thought, but ne'er so well expressed"! Furthermore, the substantive conclusions of most empirical economic research are probably even less startling (being of the type, "the consumption of a commodity depends on its price and consumers' income"). Most of the attention in other research focuses not on the direction of the association between variables, but on the numerical

estimates of the parameters So in a way the point about “obviousness” comes back to the point about cardinality – the study would be both more interesting and more useful if it could, for example, provide numerical estimates of parameters such as the elasticity of labour supply with respect to wage rates

But that is another and very formidable day’s work

TABLE 1

*List of independent variables used in study*

*Area*

- |  |                              |
|--|------------------------------|
| 1 Non Dublin County Boro’              | 5 Town 1,500–3,000           |
| 2 City (other than Dublin) over 10,000 | 6 DEEDS with town 500–1,500  |
| 3 Town 5,000–10,000                    | 7 DEEDS with towns under 500 |
| 4 Town 3,000–5,000                     | 8 DEEDS with no towns        |

*Reference Category* Dublin

*Location*

- |                                   |                      |
|-----------------------------------|----------------------|
| 9 Open country                    | 11 Business district |
| 10 Near town, outside speed limit |                      |

*Reference Category* Residential area, inside speed limit

*Are you head of household?*

- 12 Yes

*Reference Category* No

*Age*

- |          |                       |
|----------|-----------------------|
| 13 20–24 | 17 40–44              |
| 14 25–29 | 18 45–54              |
| 15 30–34 | 19 55–64              |
| 16 35–39 | 20 Refused, No Answer |

*Reference Category* 14–19

*Husband’s occupation*

- |  |                        |
|--|------------------------|
| 24 Professional & Higher Administrative          | 29 Manual semi-skilled |
| 25 Managerial and Executive                      | 30 Routine manual      |
| 26 Inspectoral, and Supervisory                  | 31 Farm/Agric workers  |
| 27 Inspectoral, Supervisory and other non manual | 32 Social Benefits     |
| 28 Routine Grades non-manual                     | 33 No Answer           |

*Reference Category* Skilled Manual

*Husband’s labour force status*

- 34 Employed

*Reference Category* Not employed

*Presence of children*

- |                                 |                                     |
|---------------------------------|-------------------------------------|
| 35 Children under 4 only        | 39 Children under 4 and 14–19 only  |
| 36 Children 4–14 only           | 40 Children 4–14 and 14–19 only     |
| 37 Children under 4 & 4–14 only | 41 Children under 4, 4–14 and 14–19 |
| 38 Children 14–19 only          |                                     |

*Reference Category* No Children