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The Employment of Married Women in the United Kingdom 1970-83

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The proportion of married women in employment in the United Kingdom grew rapidly during the 1970s rising from around 50 to 60 per cent. The paper investigates this change using a time-series of cross-sections from the Family Expenditure Survey. An attempt is made to assess how much of the change was due to trends in the observable characteristics of the population and what part was played by changes in behavioural and other factors reflected in the coefficients of the model. A technique of growth accounting is proposed and used to this purpose.

INTRODUCTION

The proportion of married women in employment in the United Kingdom grew rapidly during the 1970s rising, for those under 60, from around 50 to 60 per cent. This continued a period of fast and fairly steady growth from the Second World War, prior to which only around a third of married women under 60 were in paid work. Our purpose in embarking on the investigation described in this paper was to contribute to the understanding of the determinants of the proportion of married women in paid work and especially of its change over time. We have access to a rich data source, namely the Family Expenditure Survey (FES), which has around 7200 responding households per year, with different households being involved each year. It is not a panel but a time-series of cross-sections. The FES has a deservedly high reputation for the quality of its data collection and documentation and has the great advantage of consistency across the years. It gives a complete description of the composition of each household and has good data on current income and its sources. It lacks some of the variables that would have been very useful for our study, such as level of education and past work experience, but nevertheless is one of the best existing data sets encompassing our period of interest.

There have been a number of valuable studies of women's employment in the United Kingdom using cross-section data (see for example Greenhalgh, 1977, 1980; Layard, Barton and Zabalza, 1980; Blundell and Walker, 1982; Joshi, 1984; Martin and Roberts, 1984; and Arrufat and Zabalza, 1986), and there have been several time-series investigations of aggregate data which have also been instructive (see for example Joshi and Owen, 1981, 1984, 1985; Joshi, Layard and Owen, 1985; Sprague, 1988). While these enquiries have provided important insights into the determinants of women's employment, they have left a major part of the increase unexplained, and one would like to know whether a time-series of cross-sections, such as the FES, can help to identify how the changes have been determined. To make use of this particular data structure, we estimated a model of employment on each annual cross-section and then looked at the changes over time in both the model, i.e. its coefficients, and the explanatory variables.

The models we used are now fairly standard in the literature for women's employment and have been estimated for many countries. (See, for example, the collection in Layard and Mincer, 1985.) They follow the literature on microeconomic studies of households in being primarily supply-oriented, although we have tried to include some variables intended, in part, to capture demand effects. The measure of employment we use is simply a (0-1) variable which describes whether or not the woman is in paid employment. We do not attempt to explain women's unemployment since the notion of seeking work is hard to make precise in any satisfactory way and may be subject to changing definition or interpretation over time. Explanatory variables for employment include age, wage and husband's income, and we focus, in particular, on a fairly detailed description of household structure. We use probit models and estimate a fitted wage for the wife (including the Mills' ratio).

We have looked carefully at the specification of the model, experimenting with the choice and the definitions of explanatory variables, and we have constructed a number of tables of the estimated coefficients, similar to Table 1 below. In none of them could we detect by inspection any clear trend in the coefficients of the annual models corresponding to the trend in the total proportion of married women in paid employment. If the model changed over the years in some systematic way reflecting behavioural changes, it was not evident from the time trajectories of single coefficients. Testing the hypothesis of constancy of the coefficients over the whole period or certain sub-periods goes some way towards answering the question whether a change in the model has occurred, but it does not allow the quantification of the possible impact of such changes on the proportion employed. An attempt to do this led us to a method called here 'growth accounting'.

As a part of this technique, we used each estimated annual model in turn to 'forecast' the proportion of women in employment for every year in the sample. The results (Table 2) were not very flattering for the predictive power of the models: none of them predicted more than 2-3 percentage points of growth in the proportion employed over the period studied, against 10 percentage points for the actual growth mentioned above and borne out by our samples. This pattern of prediction was quite robust. It remained essentially the same for the probit, logit or linear probability models and for the reduced-form as well as the structural models that we tried. Moreover, the probit equation that was used to generate Table 2 may be viewed as the reduced form for a number of possible structures. Therefore it is plausible that the reasons for poor prediction lie in the data themselves rather than in deficiencies of modelling. We take the results presented in Table 2 to indicate that only a small part of the actual rise over time in the proportion employed was associated with the changes in the measured characteristics of the population, and that most of it was due to other factors which are not included in our specification and are reflected in our models through changes in their coefficients. These changes may be associated with any aspects of behaviour or the environment, economic or otherwise, that we have not been able to capture adequately in our model. We have conducted considerable trials of other variables and formulations, some of these being discussed briefly in Section III below, and have found nothing which dents in any way the conclusion that, given the variables at our disposal, there have been substantial changes in the way the probability of employment of married women is determined.

The plan of the paper is as follows. In the next section we present the method used for accounting for growth in terms of changes in measured variables and changes in estimated coefficients. In Section II we describe our data and choice of variables, and in Section III we present the model, estimation techniques and some testing. Results are set out in Section IV, and the final section contains some concluding comments.

I. Growth Accounting

We wish to decompose the change over time in a dependent variable into elements associated with changes in the variables which determine it in any given period, and changes in the function describing the underlying relation. Our concern is mainly with the aggregate across individuals, namely the proportion of married women doing paid work.

A theoretical framework for decomposing a change of an aggegate variable into a change of a behavioural micro model and a change in the distribution of micro variables has been proposed by Stoker (1985). His aim is to estimate marginal effects of both factors on the basis of one set of cross-sectional data, taken at a particular moment in time. We have obtained the maximum likelihood estimates of our model for a series of cross-sections for the tax-years from 1970/1 to 1982/3, and we would like to use these results directly to throw some light on the relative importance of the model changes versus the distributional changes.

The task of decomposition would be easier if the dependent variable, y, could be adequately modelled by a simple linear regression. If α is the vector of coefficients, X the vector of exogenous variables, and ε the random term in the equation

$$(1) \qquad y=\alpha X+\varepsilon$$

for a given year, then we know that

$$(2) \qquad \bar{y}=\hat{\alpha}\bar{X}$$

where, for the given year, $\hat{\alpha}$ is the ordinary least-squares estimate of α and $\bar{y}$ and $\bar{X}$ are the means across households of the observed values, which consistently estimate the expected values of these variables in the population. The linear form allows straightforward decomposition of changes in $\bar{y}$ into changes in $\hat{\alpha}$ and $\bar{X}$. For the periods indexed by the superscripts 0 and 1, we have

$$(3) \qquad \bar{y}^1-\bar{y}^0=(\hat{\alpha}^1-\hat{\alpha}^0)\bar{X}^1+(\bar{X}^1-\bar{X}^0)\hat{\alpha}^0.$$

We can think of the first term as showing the element of the change arising from changes in coefficients at constant values of the variables, i.e. measuring the shift in the relationship, and the second as showing the effects of changes in the variables at constant values of the coefficients. This second term represents the forecast, using the model for the year 0, of the increase in the mean of y. In the framework of (1)–(3), the household data would be needed only for the estimation of the coefficients, and for the decomposition one could work with the average or aggregated value of each variable.

In this paper our dependent variable is binary and will be modelled using the probit. In this case the change in the aggregate proportion working depends not only on the change in the means of variables as in (3) but on their distribution. Consider the expectation in the population of the variable y which takes the value 1 if the wife works and 0 otherwise. For any year, the model specifies the probability of working conditional on a given set of characteristics, $\Pr(y=1|X)$, as a function of X and of the model parameters α:

$$\text{(4)} \qquad \Pr(y=1|X)=P(\alpha, X).$$

If $\phi(X)$ is the probability density function for X, then

$$\text{(5)} \qquad E(y)=\int P(\alpha, X)\phi(X)\,\mathrm{d}X.$$

If $\hat{\alpha}$ is a consistent estimate of α, and X a random sample (not necessarily the same as that which was used to compute $\hat{\alpha}$), then one can show that the right-hand side is consistently estimated by the sample average

$$\text{(6)} \qquad \hat{y}\equiv\bar{P}(\hat{\alpha}, X)\equiv\frac{1}{N}\sum_h P(\hat{\alpha}, X_h)$$

where X_h is the vector of exogenous variables for household h. This result has obvious intuitive plausibility and has been given a firm foundation by Peter Robinson. His two theorems, given in Appendix 2 below, imply consistency and asymptotic normality of $\hat{y}$ and give an expression for its limiting variance, thus enabling us to calculate standard errors of our 'forecasts'. The left-hand side of (5) is also consistently estimated by the sample mean $\bar{y}$. Therefore an exact relationship (2) is now replaced by an asymptotic equality of $\bar{y}$ and $\hat{y}=\bar{P}(\hat{\alpha}, X)$, which are both estimates of the population proportion $E(y)$. If the superscript 0 or 1 indicates the year, we have

$$\text{(7)} \qquad E(y^1)-E(y^0)=\int \{P(\alpha^1, X)-P(\alpha^0, X)\}\phi^1(X)\,\mathrm{d}X + \int \{\phi^1(X)-\phi^0(X)\}P(\alpha^0, X)\,\mathrm{d}X.$$

The first integral on the RHS of (7) evaluates the effects of changes in the values of the coefficients given the distribution of the explanatory variables, and the second the effects of the change in the distribution of the explanatory variables for given values of the coefficients, α^0.

Accordingly, we carry out our decomposition of the change in the average value in the sample $\hat{y}^1-\hat{y}^0$ in an analogous manner as follows:

$$\text{(8)} \qquad \hat{y}^1-\hat{y}^0=\{\bar{P}(\hat{\alpha}^1, X^1)-\bar{P}(\hat{\alpha}^0, X^1)\}+\{\bar{P}(\hat{\alpha}^0, X^1)-\bar{P}(\hat{\alpha}^0, X^0)\}$$

where $\bar{P}(\hat{\alpha}^i, X^j)$ is the average across the sample X^j of the predicted probabilities using the coefficients $\hat{\alpha}^i$, and where the first term in braces describes the change arising from the changing coefficients and the second the changes arising from the changing population, i.e. the forecast of $\hat{y}$ conditional on X^1, X^0 and y^0. We shall be examining in some detail, when we present our results in Section IV, the matrix $\bar{P}(\hat{\alpha}^i, X^j)$, which in our case is 13×13.

Having found the change in employment associated with the change in coefficients, one might then ask which coefficients were particularly 'responsible'. To answer this, one can decompose the first term in braces on the RHS of (8) as follows.

$$\bar{P}(\hat{\alpha}^1, X^1) - \bar{P}(\hat{\alpha}^0, X^1) = \{\bar{P}(\hat{\alpha}^1, X^1) - \bar{P}(\hat{\alpha}^{k_1}, X^1)\} + \{\bar{P}(\hat{\alpha}^{k_1}, X^1) - \bar{P}(\hat{\alpha}^0, X^1)\} \tag{9}$$

where $\hat{\alpha}^{k_1}$ represents the vector of estimated coefficients made up of the first k from year 1 and the remainder from year 0. The first term on the RHS of (8) then tells us how much of the change arising from the coefficients, using the sample for year 1, is associated with those coefficients (those outside the first k) that are 'allowed' to change over the years. The statistical properties of 'composite' models made up from two sets of estimates are not clear-cut, and we should not claim for this exercise the status of legitimacy enjoyed by the previous one. Nevertheless, we think that it has considerable heuristic value.

We can also investigate the role of the changes over time in some particular population characteristics. Since the presence of young children is among the most important determinants of the employment decision, the changes in family structure constitute an obvious candidate. The question then would be, to what extent these changes could be responsible for any increase in employment. This question can be formalized in the following way.

We partition the vector of characteristics

$$X = (X_{kids}, X_{rest}) \tag{10}$$

into those describing family structure (X_{kids}) and the remaining (X_{rest}). Then the density $\phi(X)$ in expression (5) can be decomposed accordingly, and we obtain

$$E(y) = \int P(\alpha, X)\phi_k(X_{kids} \mid X_{rest})\phi_r(X_{rest})\,\mathrm{d}X \tag{11}$$

where ϕ_k is the density of the vector variable X_{kids} conditional on other variables in the model, and ϕ_r is the density of the remaining variables. Introducing explicitly superscript i for the year and omitting arguments of the density functions, we can write

$$E(y^i) = \int P(\alpha^i, X)\phi_k^i\phi_r^i\,\mathrm{d}X. \tag{11'}$$

If the only change between the years 0 and 1 were the change in the family structures, then for the year 1 we would have

$$E(y^1) = \bar{y}_k^{01} = \int P(\alpha^0, X)\phi_k^1\phi_r^0\,\mathrm{d}X. \tag{12}$$

Thus, we 'forecast' participation in the year 1 using the coefficients for year 0 and the distribution of other characteristics for year 0 but allow the number of children conditional on these other characteristics to follow the pattern for year 1. That provides an answer to our question: the difference between (12) and the participation rate in the year 0 measures the effect of a partial change in the population characteristics. To calculate the sample analogue of the expression (12), we first rearrange the integrand in (12) to obtain

$$(13) \qquad \bar{y}_k^{01} = \int (\phi_k^1/\phi_k^0) P(\alpha^0, X) \phi^0 \, dX.$$

It is now obvious that $\bar{y}_k^{01}$ is the weighted mean participation rate (for the year 0) with the weights equal to the ratio of the conditional densities. The problem is thus reduced to estimating these densities and taking the weighted mean of the predicted participation rates over the sample. We shall give details of the approximate estimation of the conditional densities at the end of Section IV.

II. Data and Choice of Variables

In the Introduction we gave a short description of the Family Expenditure Survey (FES) from which we extracted our data. We limited our sample to married women, whose husbands satisfy the following conditions: they are heads of households, in employment, and aged 18–64. We also eliminated households where either husband or wife had income from self-employment. From an original sample of around 7200, the conditions eliminate around 4400, leaving the annual sample studied at around 2800.

The proportion of wives in paid work in the sample for the 13 years were as follows:

1970/1	1971/2	1972/3	1973/4	1974/5	1975/6	1976/7
0·501	0·491	0·515	0·554	0·569	0·560	0·595
1977/8	1978/9	1979/80	1980/1	1981/2	1982/3	
0·596	0·590	0·618	0·623	0·591	0·579	

Average gross wages for those employed in the sample rose from 39p per hour in 1970/1 to around 53p at the end of the period (in 1970/1 prices). The average earnings of the husband over the period rose by 10 per cent, and household income from neither husband nor wife by more than 20 per cent. Thus we have a picture of rising real wages for both husband and wife and rising real incomes from other sources. Rising real wages of the husband and rising real incomes elsewhere might be expected to reduce the propensity for the wife to work, but rising women's wages might work in the other direction. (Many earlier studies, see references above, seem to show upward-sloping labour supply curves for women.) Family structure also showed striking changes, with the number of children falling. For example, the proportion of households with one child aged 4 or under and more than one between 5 and 11 dropped from $4\frac{1}{2}$ to 2 per cent, the proportion of households with more than one child between 5 and 11 (and none aged 4 or under) dropped from nearly 3 to $1\frac{1}{2}$ per cent, and the proportion of households with no children rose from 52 to 58 per cent. Variables are defined and means and standard deviations provided in Appendix 1.

We model the wife's decision as conditioned on two variables representing net family income other than the wife's earnings (husband's earning, *AVEAN*, and other, *AMHWE*) and treat them as exogenous. We do not attempt to model any joint family decision over hours of work of husband and wife. Such a procedure would necessitate an explicit treatment of the tax system for each year and the complex family budget constraint implied by it. We take a simple view of the wife looking at her husband's wage packet and other family income and basing her decision on that. From this point of view, it is net (rather than gross) income from other sources that is relevant. This should perhaps be seen as a polar case, alternative to the joint-decision model, where we have elected for simplicity, and chosen a standard model, in order to focus on movements over time.

The modelling of the tax system facing the household would have been a substantial and complex exercise for any one year. As Atkinson and Sutherland (1988) have argued, capturing the precise detail of the system is crucial, and a satisfactory extension of tax-benefit modelling, for the United Kingdom, to behavioural models has yet to be achieved. Changes in the tax-benefit system may be a factor in changing coefficients for our models from year to year (and see Section III below for some further comments).

We examined in detail the modelling of family structure, especially the appropriate description of the presence of young children, and the group of seven dummies used in the estimations presented here proved most successful in terms of significance and explanatory power. They can be described as follows:

<table>
<tr><th></th><th></th><th>Age 0–4</th><th></th></tr>
<tr><th>Age 5–11</th><th>0</th><th>1</th><th>>1</th></tr>
<tr><td>0</td><td>base</td><td>CH4ONE</td><td>CH4FEW</td></tr>
<tr><td>1</td><td>CH11ONE</td><td>ONE4–111</td><td rowspan="2">FEW4–11</td></tr>
<tr><td>>1</td><td>CH11FEW</td><td>ONE4–F11</td></tr>
</table>

The family income and its structure are, in our model, determinants of both the employment and the expected wage of the wife. The regional and occupational dummies, on the other hand, are used only to predict the wage. For this purpose the wife's occupation would be much more suitable than the husband's. Unfortunately, in our data only very few of non-employed wives have an occupational coding. A brief discussion of some experiments with alternative variables is provided in the next section.

The picture of employment and its correlates that emerges from the FES is broadly in line with the alternative data sources that have been used to examine the paid work of women. We shall not provide a detailed comparison here, since the different sources (particularly the various Censuses, the Labour Force Survey and the General Household Survey) have been subject to careful scrutiny in the valuable work of Joshi and Owen (1984) (and see also Gomulka and Stern, 1986).

III. The Model, Estimation and Testing

We have estimated an econometric model of the form that has been used many times before in similar studies:

(14) $y_h = \delta w_h + \beta z_h^1 + \varepsilon_h^1$

(15) $w_h = \gamma z_h^2 + \varepsilon_h^2$

where the subscript h denotes the household and $y_h > 0$ if the woman is employed, otherwise $y_h < 0$; w_h is a market wage for the woman; z_h^1, z_h^2 are vectors of personal and household characteristics; and δ, β, γ are parameters. The error terms $(\varepsilon_h^1, \varepsilon_h^2)$ are jointly normally distributed. Only the sign of the variable y_h is observed.

The model was estimated using a two-stage procedure: the second (wage) equation was substituted into the first one, and the resulting equation estimated by the maximum likelihood (ML) method. Estimates of this reduced-form probit are presented in Table 1. Our growth accounting (see Section IV) has been based on the reduced form, and in this paper we do not focus on the wage equation or the structural probit—see Gomulka and Stern (1986) for details. Sample selection bias in the wage equation was treated in the usual way (Heckman, 1979), by including the inverse of Mills' ratio calculated from the reduced-form probit.

In the final specification, the vector z^1 consisted of the following variables: *AVEAN, AMHWE, AGEW, AGEWSQ, NEARN, CH4ONE–FEW*4–11 (see Appendix 1 for definitions). The vector z^2 had the same variables, except *NEARN*, and had moreover *OWN*, *DR*1–*DR*12 and *OCC*1–*OCC*8. (The list of variables in the different equations indicates that the system is substantially over-identified.) According to this model, the employment decision is influenced, apart from the expected wage, by the family net income, age of the woman and the presence of young children. All these factors also play roles as determinants of the wage, which however depends further on the region, whether the household is owner-occupied, and the occupation. The family structure is assumed to be exogenous. (While we are not entirely happy with this assumption, an alternative would have taken us far afield.)

We comment briefly on some experiments carried out prior to selecting the final set of variables for inclusion. We have already described our selection of family structure variables. A second set of issues concerned regional variables, unemployment and job opportunities. The local unemployment rate (available monthly by region) performed poorly relative to regions, as measured by the large increase in likelihood when it is replaced by regions. We also tried three variables in an attempt to capture local job opportunities for women (one measuring part-time employment, another measuring jobs often associated with women, and a third based on semi-skilled manual workers), but none had enough explanatory power to replace regional dummies.

We investigated the possible presence of cohort effects, e.g. changing attitudes to work across generations, by including seven cohort dummies using age in 1976: 16–25, 25–30, 31–35, 36–40, 41–45, 46–50, 51–55, the base group being the over-55s. The replacement of the two variables, age and its square, by these seven variables resulted in a lower likelihood value for every year. Further, the inclusion of these seven variables in addition to age and age squared generally resulted in insignificant coefficients on the cohort dummies and an acceptance of the null hypothesis (using standard log-likelihood comparisons) that the dummies should be excluded.

As we noted in the Introduction, education and work experience variables are not available in the FES. However, we are reassured that their exclusion does not overturn the basic result of important changes in coefficients, both by its resilience to all the other experiments we tried and by the finding of Joshi, Layard and Owen (1985). These authors used data from 1950–74 from an annual $\frac{1}{2}$ per cent survey of all employees covered by national insurance. (The survey was discontinued in 1975.) They found that more educated women were more likely to work than less educated women, holding age constant. 'However, the difference between the different groups is so small that, even if all women had moved from the lowest to the highest educational group, this would only account for a fraction of the actual increase in women's participation since World War II' (pp. S167–8).

The hypothesis that the coefficients are unchanged across the whole period was tested using the standard comparisons of twice the log-likelihood for the sample of pooled data for all years with twice the sum of the log-likelihood for each year separately. It was decisively rejected. To check for periods of stability, we pooled data for each of the 11 triples of three consecutive years and carried out a similar test. The hypothesis of constancy of coefficients within the three-year period was rejected at the 5 per cent level for all triples except that beginning in 1973/4 and those beginning in 1978/9 and after. Hence a suggestion that the rise happened in discrete steps would not receive much support in the data.

The particular changes affecting the position of women in the labour market during the 1970s, on which attention is sometimes focused, include the following (see Hart and Trinder, 1986). There was a series of employment laws enacted in the 1970s including the Equal Pay Act 1970, the Sex Discrimination Act 1975, and the Employment Protection Acts of 1975, 1978, 1980, 1982. It is possible that the first of these might have operated against the employment of women and the second in favour. It is sometimes argued that the protection acts encouraged more casual and part-time work, and thus greater employment of women, since they made dismissal rather difficult. It is possible that this changing environment played a part in the upward trend, but the tests we have just described do not appear to indicate that there are sharp breaks associated with the particular events. One should not generally expect legislation to permeate the labour market immediately (and the Equal Pay Act was phased over five years). The national insurance (NI) system also changed radically in the period, with the introduction of a threshold (below which NI was not paid) in 1975 which again may have militated in favour of the employment of part-timers and women. And the new tax system of 1973 came with a higher exemption level, which might again have encouraged part-time work. Thus, we have a picture of many changes that may have contributed to the upward trend, but in our data they do not seem to provide a sharp break in structure associated with one particular point in time.

Another view expressed sometimes is that most of the increase in women's employment in the 1970s occurred through increases in part-time working. This is not so in our sample. Between the years 1970/1 and 1980/1, the percentage of the employed women who worked over 30 hours per week fluctuated between 44·4 and 48·8 per cent without any clear trend. Only in the last two years of the period do we observe a decline to 42·7 per cent in

1981/2 and 41·4 per cent a year after. On another definition of part-time working, if we consider the employed women who worked over 23 hours per week, then there is a decline from about 63·5 per cent in the period 1970/1–1973/4 to about 61·5 per cent in the years 1974/5–1979/80 followed by another 4 per cent decline in the last three years of the period.

IV. Results

The central equation for our purposes here is the reduced-form probit, where the probability of working is written as a function of all the independent variables in the model. It is presented in Table 1. The wage equation and the structural probit are available in Gomulka and Stern (1986).

We begin our discussion of the results with Table 1. Of the 32 variables (including the constant term) in the reduced-form model, 7 represent the ages and number of children, 11 regions, and 7 occupations, with the remaining 7 comprising the age of the wife (with its square), the earnings of the husband, other family income (including earnings of others), the number of earners, the dummy for owner-occupation, and the constant term. We consider the role of these groups of variables in turn. The reduced form has considerable interest in its own right, being consistent with a number of possible structures, in addition to its association with the particular structure we have chosen. In the sense that it involves fewer assumptions, the reduced form is more robust and accordingly will provide the basis for our analysis of growth accounting.

Not surprisingly, the largest and most significant of the coefficients are those associated with the effects of family structure. The coefficients of the variables describing the number and ages of children are all highly significant and are stable over time, with no obvious trend. Consider, for example, the coefficients on *CH4ONE* with standard error around 0·11. The difference between the largest and the smallest is around 0·44, i.e. four standard errors. If the two extreme values are disregarded, the range becomes 0·24, slightly more than two standard errors. The 'base' family is the husband and wife without young children, so that the negative coefficients show that the presence of children reduces the probability of working, as one would expect.

The rate of change of the probability with respect to an explanatory variable is, for a probability of 0·5, given by 0·40 (more precisely, $1/\sqrt{(2\pi)}$) times a coefficient. Thus, for example, a linear approximation to the effect of one child under 5 in 1970/1 on the probability, if it were around 0·5, would be a reduction of $0{\cdot}40 \times 1{\cdot}51$, i.e. 0·6, illustrating not only that the coefficient is very large, but also that the linear approximation is inadequate for the (very substantial) change from 0 to 1. For a woman with the average characteristics in the sample (see Appendix 1), the effect of moving from zero to one child aged under 5 for 1970/1 is a reduction in the probability of working from 0·65 to 0·13.

The extra effect of further children under 5 may be seen by comparing the first two coefficients for the number of children (for *CH4ONE* and *CH4FEW*, and recalling that the states are mutually exclusive), and we see that the coefficient on *CH4FEW* is roughly 0·2 to 0·3 larger in absolute magnitude. Thus, the crucial feature is the presence of one child aged 0–4, and the effect of the extra child aged 0–4, while significant, is much smaller than the first. For women with the average characteristics in the sample, the effect of moving

TABLE 1

ESTIMATED COEFFICIENTS OF REDUCED-FORM PROBIT

(Standard errors in parentheses)

Variable	1970/1	1971/2	1972/3	1973/4	1974/5	1975/6	1976/7	1977/8	1978/9	1979/80	1980/1	1981/2	1982/3
WRONG	0·285	0·291	0·286	0·288	0·278	0·282	0·269	0·277	0·284	0·263	0·270	0·279	0·281
EFRSQ	0·229	0·225	0·236	0·217	0·230	0·225	0·234	0·232	0·202	0·235	0·210	0·213	0·226
MFRSQ	0·177	0·174	0·183	0·166	0·178	0·176	0·186	0·183	0·157	0·187	0·165	0·167	0·179
CONST	−0·281	−0·084	−0·373	−0·115	0·269	−0·303	0·264	−0·423	−0·062	0·522	−0·819	0·442	−0·367
	(0·337)	(0·316)	(0·332)	(0·333)	(0·329)	(0·332)	(0·338)	(0·340)	(0·354)	(0·375)	(0·368)	(0·367)	(0·366)
AVEAN	−0·0163	−0·0178	−0·0128	−0·0085	−0·0109	−0·0169	−0·0198	−0·0213	−0·0096	−0·0177	−0·0094	−0·0141	−0·0140
	(0·0031)	(0·0037)	(0·0031)	(0·0046)	(0·0033)	(0·0034)	(0·0039)	(0·0034)	(0·0033)	(0·0033)	(0·0028)	(0·0030)	(0·0033)
AMHWE	−0·0267	−0·0151	−0·0158	−0·0163	−0·0291	−0·0240	−0·0167	−0·0213	−0·0281	−0·0177	−0·0190	−0·0240	−0·0205
	(0·0059)	(0·0052)	(0·0056)	(0·0052)	(0·0057)	(0·0057)	(0·0062)	(0·0059)	(0·0056)	(0·0057)	(0·0056)	(0·0053)	(0·0053)
AGEW	1·113	1·037	1·091	0·997	0·882	1·202	0·984	1·297	0·924	0·825	1·341	0·760	1·103
	(0·170)	(0·162)	(0·165)	(0·168)	(0·164)	(0·167)	(0·175)	(0·172)	(0·175)	(0·193)	(0·185)	(0·181)	(0·185)
AGEWSQ	−0·167	−0·160	−0·167	−0·157	−0·139	−0·183	−0·163	−0·196	−0·141	−0·140	−0·198	−0·130	−0·171
	(0·021)	(0·020)	(0·020)	(0·020)	(0·020)	(0·020)	(0·021)	(0·021)	(0·021)	(0·023)	(0·022)	(0·021)	(0·022)
OWN	−0·151	0·026	0·048	−0·140	−0·107	−0·105	0·016	0·160	0·051	0·147	0·014	0·108	0·130
	(0·056)	(0·056)	(0·056)	(0·059)	(0·058)	(0·057)	(0·058)	(0·058)	(0·061)	(0·066)	(0·063)	(0·063)	(0·065)
NEARN	0·258	0·186	0·143	0·268	0·319	0·390	0·226	0·283	0·319	0·320	0·277	0·462	0·292
	(0·079)	(0·070)	(0·077)	(0·084)	(0·085)	(0·080)	(0·089)	(0·084)	(0·088)	(0·091)	(0·088)	(0·091)	(0·083)
CH4ONE	−1·514	−1·625	−1·640	−1·512	−1·680	−1·557	−1·897	−1·741	−1·462	−1·753	−1·538	−1·520	−1·557
	(0·108)	(0·108)	(0·108)	(0·109)	(0·109)	(0·103)	(0·113)	(0·110)	(0·106)	(0·122)	(0·109)	(0·114)	(0·103)
CH4FEW	−1·716	−1·921	−2·199	−1·856	−2·034	−1·874	−2·044	−1·903	−1·827	−1·804	−1·870	−1·888	−1·940
	(0·128)	(0·145)	(0·156)	(0·133)	(0·141)	(0·134)	(0·142)	(0·135)	(0·144)	(0·158)	(0·155)	(0·140)	(0·131)
CH11ONE	−0·291	−0·536	−0·429	−0·398	−0·514	−0·434	−0·467	−0·480	−0·390	−0·336	−0·437	−0·281	−0·603
	(0·087)	(0·080)	(0·081)	(0·090)	(0·084)	(0·086)	(0·087)	(0·086)	(0·088)	(0·096)	(0·089)	(0·090)	(0·089)
CH11FEW	−0·575	−0·640	−0·599	−0·613	−0·615	−0·751	−0·651	−0·727	−0·645	−0·617	−0·663	−0·614	−0·731
	(0·095)	(0·093)	(0·090)	(0·096)	(0·095)	(0·093)	(0·092)	(0·096)	(0·097)	(0·109)	(0·106)	(0·102)	(0·096)
ONE4–111	−1·376	−1·272	−1·485	−1·333	−1·377	−1·368	−1·408	−1·397	−1·225	−1·382	−1·171	−1·321	−1·353
	(0·126)	(0·114)	(0·126)	(0·118)	(0·119)	(0·110)	(0·121)	(0·119)	(0·116)	(0·119)	(0·127)	(0·126)	(0·110)

TABLE 1—continued

Variable	1970/1	1971/2	1972/3	1973/4	1974/5	1975/6	1976/7	1977/8	1978/9	1979/80	1980/1	1981/2	1982/3
*ONE*4–*F*11	−1·447	−1·358	−1·356	−1·382	−1·321	−1·275	−1·237	−1·324	−1·374	−1·574	−1·655	−1·550	−1·425
	(0·134)	(0·136)	(0·141)	(0·134)	(0·144)	(0·147)	(0·164)	(0·156)	(0·186)	(0·195)	(0·187)	(0·195)	(0·199)
*FEW*4–11	−1·993	−1·849	−2·104	−1·832	−1·924	−2·003	−1·718	−1·509	−2·113	−2·012	−2·029	−1·615	−2·196
	(0·208)	(0·189)	(0·210)	(0·187)	(0·195)	(0·238)	(0·226)	(0·222)	(0·284)	(0·260)	(0·254)	(0·268)	(0·267)
*DR*1	−0·563	−0·368	−0·286	−0·304	−0·273	−0·435	−0·416	−0·552	−0·249	−0·331	−0·147	−0·454	−0·191
	(0·122)	(0·121)	(0·127)	(0·122)	(0·124)	(0·119)	(0·129)	(0·126)	(0·134)	(0·133)	(0·138)	(0·138)	(0·137)
*DR*2	−0·286	−0·386	−0·349	−0·112	−0·186	−0·142	−0·268	−0·462	−0·367	−0·298	−0·098	−0·464	−0·315
	(0·114)	(0·111)	(0·107)	(0·110)	(0·112)	(0·113)	(0·117)	(0·116)	(0·118)	(0·125)	(0·123)	(0·121)	(0·121)
*DR*3	−0·520	−0·282	−0·025	0·029	−0·007	−0·196	−0·124	−0·273	0·044	−0·144	−0·237	−0·329	−0·353
	(0·122)	(0·120)	(0·121)	(0·131)	(0·127)	(0·119)	(0·124)	(0·123)	(0·129)	(0·137)	(0·133)	(0·128)	(0·126)
*DR*4	−0·252	−0·665	−0·227	−0·134	−0·035	−0·426	−0·421	−0·423	−0·250	−0·113	−0·200	−0·333	−0·250
	(0·157)	(0·143)	(0·156)	(0·147)	(0·159)	(0·154)	(0·168)	(0·163)	(0·152)	(0·168)	(0·153)	(0·158)	(0·161)
*DR*6	−0·282	−0·193	−0·078	0·042	−0·306	−0·106	−0·163	−0·153	−0·127	−0·207	−0·002	−0·201	−0·105
	(0·098)	(0·088)	(0·093)	(0·094)	(0·095)	(0·097)	(0·101)	(0·101)	(0·101)	(0·108)	(0·104)	(0·103)	(0·103)
*DR*7	−0·427	−0·260	−0·248	−0·130	−0·277	−0·284	0·223	−0·074	−0·269	−0·367	−0·052	−0·389	−0·279
	(0·128)	(0·122)	(0·123)	(0·121)	(0·124)	(0·128)	(0·126)	(0·128)	(0·124)	(0·141)	(0·132)	(0·133)	(0·124)
*DR*8	−0·558	−0·338	−0·229	−0·470	−0·361	−0·490	−0·511	−0·319	−0·520	−0·645	−0·074	−0·309	−0·437
	(0·136)	(0·132)	(0·138)	(0·133)	(0·131)	(0·128)	(0·141)	(0·140)	(0·145)	(0·155)	(0·136)	(0·141)	(0·139)
*DR*9	−0·245	−0·095	−0·091	−0·150	−0·188	−0·077	−0·292	−0·149	−0·006	−0·110	−0·001	−0·231	−0·229
	(0·117)	(0·100)	(0·108)	(0·109)	(0·110)	(0·114)	(0·117)	(0·116)	(0·117)	(0·123)	(0·126)	(0·120)	(0·118)
*DR*10	−0·141	−0·034	−0·014	−0·035	−0·162	−0·253	−0·032	−0·040	−0·152	−0·190	0·057	−0·305	−0·047
	(0·103)	(0·098)	(0·103)	(0·102)	(0·106)	(0·110)	(0·111)	(0·113)	(0·115)	(0·121)	(0·117)	(0·113)	(0·115)
*DR*11	−0·405	−0·384	−0·434	−0·171	−0·283	−0·367	−0·138	−0·227	−0·261	−0·316	0·003	−0·459	−0·248
	(0·111)	(0·108)	(0·108)	(0·112)	(0·111)	(0·113)	(0·114)	(0·115)	(0·115)	(0·121)	(0·118)	(0·124)	(0·124)
*DR*12	−0·560	−0·257	−0·664	−0·405	−0·255	−0·539	0·060	−0·699	−0·375	−0·758	−0·182	0·198	0·195
	(0·194)	(0·191)	(0·212)	(0·200)	(0·197)	(0·217)	(0·233)	(0·228)	(0·233)	(0·239)	(0·216)	(0·239)	(0·258)
*OCC*1	0·059	−0·239	−0·020	−0·242	0·019	0·126	−0·094	−0·039	−0·178	0·031	0·056	0·102	0·144
	(0·105)	(0·097)	(0·099)	(0·104)	(0·102)	(0·098)	(0·104)	(0·104)	(0·100)	(0·106)	(0·104)	(0·104)	(0·102)
*OCC*2	−0·008	−0·153	−0·099	−0·127	−0·117	0·062	0·296	−0·011	−0·129	0·031	0·050	0·146	0·227
	(0·104)	(0·100)	(0·100)	(0·105)	(0·098)	(0·096)	(0·100)	(0·094)	(0·101)	(0·102)	(0·101)	(0·105)	(0·098)

*OCC*3	0·177	−0·141	0·198	0·133	0·316	0·360	0·164	0·190	0·186	0·585	0·222	0·182	0·479
	(0·161)	(0·158)	(0·172)	(0·158)	(0·158)	(0·160)	(0·160)	(0·150)	(0·139)	(0·182)	(0·165)	(0·149)	(0·145)
*OCC*4	0·087	−0·102	0·173	−0·108	0·141	0·145	0·151	0·036	0·080	0·071	0·053	0·063	0·198
	(0·103)	(0·100)	(0·110)	(0·108)	(0·114)	(0·104)	(0·107)	(0·111)	(0·119)	(0·121)	(0·122)	(0·118)	(0·119)
*OCC*5	−0·147	−0·310	0·070	0·444	0·218	0·689	−0·368	0·071	0·065	0·316	−0·001	−0·077	0·349
	(0·263)	(0·293)	(0·280)	(0·386)	(0·387)	(0·347)	(0·303)	(0·459)	(0·360)	(0·357)	(0·333)	(0·536)	(0·363)
*OCC*6	0·100	−0·127	0·020	−0·029	−0·080	0·075	0·074	0·130	0·069	−0·026	−0·050	0·038	0·105
	(0·068)	(0·066)	(0·070)	(0·070)	(0·069)	(0·069)	(0·069)	(0·069)	(0·072)	(0·080)	(0.079)	(0·78)	(0·076)
*OCC*8	0·161	−0·154	−0·014	0·060	−0·269	0·053	−0·085	0·279	−0·143	−0·051	0·082	0·060	0·054
	(0·104)	(0·098)	(0·105)	(0·107)	(0·115)	(0·114)	(0·138)	(0·155)	(0·137)	(0·153)	(0·150)	(0·161)	(0·156)

Notes:
1. The variables are defined in Appendix 1.
2. *WRONG* is the proportion of wrong predictions, where we predict 1 if the probability is over 0·5 and 0 otherwise; *MFRSQ* is McFadden's R^2, and *EFRSQ* Efron's R^2—see Amemiya (1981) and Maddala (1983).

from one child aged under 5 (1970/1) to more than one is a reduction in probability from 0·13 to 0·09.

There is little extra effect from having children aged 5–11 *in addition to* children under 5, as may be seen by comparing the coefficient on *CH4ONE* with those on *ONE*4–111 and *ONE*4–*F*11 and comparing the coefficient on *CH4FEW* with that on *FEW*4–11. Indeed, from the first comparison we see that the women with a child or children between 5 and 11 in addition to one under 5 seem more likely to work than one with a single child under 5. It is possible that a woman who has an older child or children in addition may be under greater financial pressure, or be more ready for a change from home; or she may have already organized help with looking after the older child which could be repeated or adapted to include the younger child.

The signs of all the significant coefficients on the regional variables are negative, showing that participation in paid work is lower in the regions than in the base case, Greater London. There is a larger number of significant coefficients in the earlier years than the later ones, and there appears to be an overall decline in the absolute magnitude. The movements are not especially clear or systematic, but one possible interpretation from the reduced form might be that women's employment in the regions is becoming more like Greater London. One looks for cyclical effects in the constant term, but these coefficients are largely insignificant and possibly are obscured by the large number of zero–one dummies.

The occupational variables for the husband are measured relative to a base group of semi-skilled manual workers. Overall, the husband's occupation does not seem to exert a major role with the possible exception of teachers, where, when significant, the coefficient indicates that being the wife of a teacher raises the probability of employment by around 10 per cent. The age of the wife and its square are significant throughout, and fairly stable, with that on the former having a value around 1 and the latter, −0·15. The maximum given these values would occur at 30 years. (Age here is measured in decades.) There does not appear to be any marked trend in the coefficients or the maximum.

There are three variables describing income other than earnings of the wife, and they are all significant throughout. The coefficient on the net earnings of the husband has a value around −0·015. (A 10 per cent fall in earnings increases the probability by around $\frac{1}{2}$ percentage point.) An additional earner other than the husband and wife (with an average coefficient for *NEARN* of 0·296) increases the probability of the wife working, holding incomes constant, by around 12 per cent for given values of net incomes and other variables. The positive effect could be associated with a number of factors. It may, for example, indicate that jobs are easier to come by, that there is less company at home, that the age of the children is higher, that there is another person who can share in the organizational problems of child care, or that there is a household preference for working. The coefficients on this group of variables are fairly stable, with no marked trends.

The wage equation and structural probit are not presented here—the interested reader may consult Gomulka and Stern (1986)—since our main concern is growth accounting, which we have based on the reduced form. In the wage equation the Mills' ratio, playing a role in correction for sample selection basis, is significant in eight of the years and positive throughout.

This provides some justification for the correction and indicates that those who are working form a biased sub-sample in the sense that they face a higher wage than would be predicted given the measured characteristics.

We present in Figure 1 some graphs showing the distribution of the predicted probabilities from the reduced-form probit for the years 1970/1, 1976/7 and 1980/1. There are marked changes in the pattern over time. At the beginning of the period we have a two-humped distribution, suggesting a sharp difference between 'workers' and 'non-workers'. In the later years the first hump moves slightly in the direction of higher probabilities, becomes flatter and, in 1980/1, virtually disappears. Movement in the direction of higher probabilities is even more pronounced for the second maximum, which is also becoming higher. As a result, in 1980/1 we have 'bunching' near the 85-90 per cent mark.

We want to put the estimates in Table 1 to use in accounting for the growth in women's employment in the 1970s. The proportion of women in employment in each of the 13 years in our sample is set out at the bottom of Table 2 and shows a rise of around 10 per cent over the 1970s.

Our analysis of growth accounting begins with Table 2. Reading along a row—the first, for example—we have the mean of the predicted probabilities calculated using the data for 1970/1 but the estimated coefficients for the year given by the column. The diagonal entry corresponds to the mean of the predicted probability for the year using the estimated coefficients for that year. This is roughly equal to the actual proportion in the sample, as can be seen by comparing the diagonal elements with the exact sample proportions which are given at the bottom of Table 2. As we noted in Section I, there is asymptotic equality (it is exact for the logit), and the figures are fairly close for our sample size. The average predicted probabilities in Table 2 were calculated using the reduced-form estimates; the broad picture using those for the structure is very similar (see Gomulka and Stern, 1986).

Looking along a row of Table 2, we see the differences in predictions, for a *given* sample, that result from using the estimated probit coefficients for different years. It provides in this sense a measure of the extent to which the estimated coefficients are changing over the years, and one can interpret the change along the row, as we described in Section I, as measuring how much of the increase in the proportion of women working is explained by the change in the model. We see from Table 2 that the effect of this change is substantial, with a marked increase as we move from left to right—in the range of 6-9 percentage points. Standard errors are around 1 per cent, rising slightly as we move away from the diagonal.

Looking down a column in Table 2, we have a fixed set of coefficients corresponding to the year associated with the column and a changing sample. This experiment indicates what change in the mean of the predicted probability arises from the changing distribution of characteristics in the sample at constant coefficients. We see from Table 2 that the increases as we move down the columns are small, in the range 0-3 percentage points.

The overall conclusion from Table 2 is that 6-8 of the 9-10-percentage-point increase in the proportion of women working is associated with changes in coefficients describing the combination of behaviour and environment, with a much smaller contribution from the change in the structure of the population. This result is striking—the major part of the growth is associated with changing

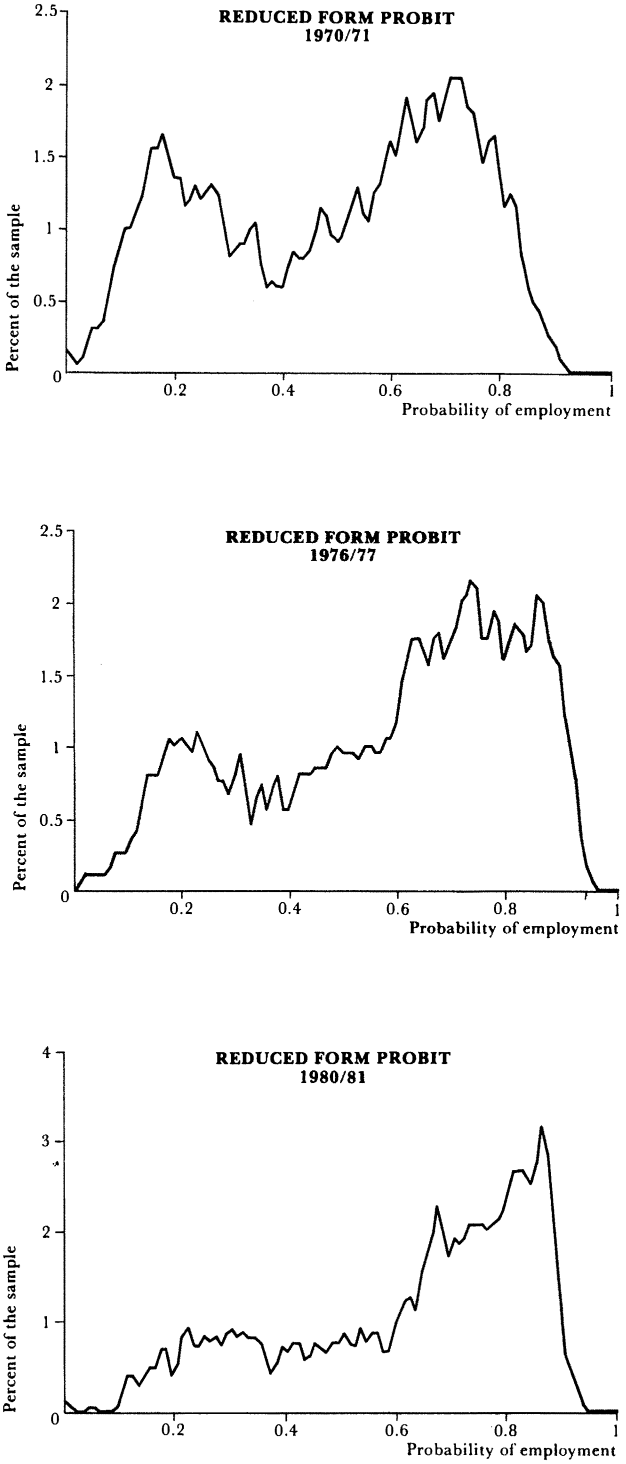

FIGURE 1. Distribution of predicted probability of employment.

TABLE 2

PREDICTED SAMPLE PROPORTION EMPLOYED USING COEFFICIENTS FOR YEAR j AND SAMPLE FOR YEAR i

	Coefficients (Standard errors in parentheses)												
Sample	1970/1	1971/2	1972/3	1973/4	1974/5	1975/6	1976/7	1977/8	1978/9	1979/80	1980/1	1981/2	1982/3
1970/1	50·1	48·5	51·3	55·9	56·6	55·2	56·7	56·2	57·4	58·8	58·8	56·9	54·6
	(0·9)	(0·9)	(0·9)	(0·9)	(0·9)	(0·9)	(1·0)	(1·0)	(1·0)	(1·1)	(1·1)	(1·1)	(1·2)
1971/2	51·0	49·2	52·3	56·7	57·4	56·1	57·1	57·0	58·4	59·7	59·9	57·8	55·4
	(0·9)	(0·9)	(0·9)	(0·9)	(0·9)	(0·9)	(1·0)	(1·0)	(1·0)	(1·1)	(1·0)	(1·1)	(1·1)
1972/3	50·2	48·2	51·6	56·3	56·8	55·4	56·6	56·1	57·8	59·0	59·4	57·3	54·9
	(0·9)	(0·9)	(0·9)	(0·9)	(0·9)	(0·9)	(1·0)	(1·0)	(1·0)	(1·1)	(1·0)	(1·1)	(1·1)
1973/4	49·3	47·8	51·2	55·4	56·4	54·3	55·8	55·3	57·3	58·4	58·9	56·5	54·4
	(1·0)	(0·9)	(0·9)	(0·9)	(0·9)	(0·9)	(1·0)	(1·0)	(1·0)	(1·1)	(1·0)	(1·1)	(1·1)
1974/5	50·1	48·5	51·8	56·2	56·9	55·2	56·6	56·1	58·0	59·2	59·7	57·2	55·1
	(1·0)	(0·9)	(0·9)	(0·9)	(0·9)	(0·9)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·1)	(1·1)
1975/6	50·4	49·3	52·7	56·6	57·7	56·0	57·5	56·9	58·7	60·3	60·4	58·1	55·9
	(1·0)	(0·9)	(0·9)	(0·9)	(0·9)	(0·9)	(0·9)	(0·9)	(1·0)	(1·0)	(1·0)	(1·0)	(1·1)
1976/7	52·3	51·1	54·3	58·1	59·4	57·6	59·6	58·7	60·4	62·2	61·7	59·6	57·5
	(1·0)	(0·9)	(0·9)	(1·0)	(0·9)	(0·9)	(0·9)	(0·9)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)
1977/8	52·6	51·7	54·9	58·4	59·7	58·2	60·3	59·5	60·9	62·8	62·3	60·3	58·3
	(1·0)	(1·0)	(1·0)	(1·0)	(0·9)	(0·9)	(0·9)	(0·9)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)
1978/9	50·6	49·7	53·3	57·1	57·8	56·3	58·1	57·6	59·1	61·3	61·2	58·6	56·8
	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(0·9)	(0·9)	(1·0)	(0·9)	(1·0)	(1·0)	(1·0)	(1·0)
1979/80	50·9	50·2	54·0	57·7	58·3	56·9	59·1	58·0	59·5	61·9	61·8	59·3	57·5
	(1·1)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)
1980/1	51·1	50·3	54·3	57·9	58·5	57·0	59·2	58·2	59·6	61·9	62·3	59·7	58·1
	(1·1)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(0·9)	(1·0)	(1·0)
1981/2	50·8	50·2	54·4	57·2	58·2	56·6	58·7	58·0	59·5	62·1	61·7	59·2	57·7
	(1·1)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(0·9)	(1·0)
1982/3	50·2	50·2	54·2	57·0	57·5	56·3	58·9	58·5	59·3	62·0	61·9	59·3	57·9
	(1·1)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(1·0)	(0·9)
Sample proportion employed	50·1	49·1	51·5	55·4	56·9	56·0	59·5	59·6	59·0	61·8	62·3	59·1	57·9

coefficients, and attempts to forecast the later period on the basis of an early set of coefficients and predicted demographic and other changes in variables would have performed very poorly.

We can now go on to ask which coefficients seem to be central among those that are changing and which aspects of the sample or population are responsible for the change arising from the sample. Following our discussion of the estimated coefficients presented in Table 1, we concentrate on regions for the first category and the role of children in the second. We pursue these decompositions in the manner described in Section I. As we mentioned there, we cannot calculate standard errors for the predicted participation rates calculated from 'composite' models. Therefore conclusions from Table 3 and 4 have to be tentative, although they are strongly suggestive.

The effects of changes in children's coefficients are set out in Table 3. This table should be read along the rows and not down the columns. Across a row we have a constant sample, and all coefficients (except those for children) are constant at the values associated with the sample. Thus, we isolate the effects of changing children's coefficients. As was to be expected from the constancy of the coefficients for children which we saw in Table 1, there is rather little change across the rows of Table 3, indicating that changes in children's coefficients play no role in explaining the increase in participation in paid work. Thus, attitudes to work and children, or the ability to work while having children, do not seem to have changed in so far as this would be revealed through these coefficients. The number of children has, however, changed, and the effect of this is examined in Table 5. Notice that the increase down the columns of Table 3 is closely related to the diagonal; and this is to be expected, since down the column we now have both sample and coefficients changing except for those that are related to children, which in turn, as we have seen, have rather little movement.

In Table 4 we examine the effect of changing regional coefficients, and, analogous to Table 3, along a row all coefficients except those for regions are held constant at their levels for the year of the row. Now we find that there is substantial change across the row, as we might expect from our discussion of Table 1. Hence a considerable part of the increase in participation, perhaps 5 percentage points or so, seems to be associated with the effects of changes in the role of regional variables. An important part of the regional effect may operate through wages (see Gomulka and Stern, 1986).

The effects of changing numbers of children of different ages are modelled in Table 5. As we described at the end of Section I, in particular expression (13), to isolate the effect of this change between the years, say, 1970/1 and 1982/3, we should weight each household in the sample of 1970/1 by the ratio ϕ^1/ϕ^0 of the probability densities, for the years 1982/3 and 1970/1 respectively, of the relevant family type conditional on other characteristics. Since with our rather modest sample sizes we felt unable to estimate these probabilities in full, we decided to take into account only one conditioning variable, namely the age of the wife. For each range of the wife's age, and for each year, the percentage of families is calculated for each of the eight family structures we have considered in the estimation. We used these percentages to construct the weights for Table 5. In each column of this table, we use the coefficients and the sample of the year at the top of the column. For each row, we find for

TABLE 3

PREDICTED SAMPLE PROPORTION EMPLOYED USING COEFFICIENTS ON FAMILY STRUCTURE FOR YEAR j AND OTHER COEFFICIENTS AND SAMPLE FOR YEAR i

	Coefficients												
Sample	1970/1	1971/2	1972/3	1973/4	1974/5	1975/6	1976/7	1977/8	1978/9	1979/80	1980/1	1981/2	1982/3
1970/1	50·1	48·7	48·4	49·6	48·4	48·8	48·2	48·4	49·7	48·9	49·0	49·9	47·8
1971/2	50·6	49·2	49·1	50·2	49·0	49·4	48·7	49·0	50·3	49·4	49·6	50·5	48·4
1972/3	53·3	51·8	51·6	52·8	51·5	51·9	51·3	51·5	52·9	52·0	52·2	53·1	50·9
1973/4	55·9	54·6	54·2	55·4	54·3	54·7	54·0	54·3	55·6	54·7	54·9	55·7	53·7
1974/5	58·8	57·3	56·9	58·3	56·9	57·4	56·5	56·9	58·5	57·4	57·7	58·6	56·4
1975/6	57·3	55·9	55·6	56·8	55·6	56·0	55·2	55·5	57·1	56·1	56·4	57·2	55·1
1976/7	61·8	60·3	60·0	61·3	60·0	60·4	59·6	59·9	61·5	60·6	60·8	61·6	59·5
1977/8	61·3	59·9	59·6	60·8	59·6	60·1	59·3	59·5	61·1	60·2	60·4	61·2	59·2
1978/9	59·3	57·9	57·6	58·8	57·6	58·0	57·1	57·4	59·1	58·1	58·5	59·2	57·1
1979/80	63·1	61·8	61·4	62·7	61·4	61·9	61·0	61·3	63·0	61·9	62·4	63·0	61·0
1980/1	63·2	61·7	61·5	62·7	61·5	61·9	61·1	61·4	62·9	62·0	62·3	63·1	61·0
1981/2	59·4	57·9	57·7	58·8	57·6	58·0	57·2	57·5	59·1	58·3	58·5	59·2	57·1
1982/3	60·2	58·7	58·3	59·6	58·3	58·8	57·9	58·2	59·9	58·9	59·4	60·0	57·9
Sample proportion employed	50·1	49·1	51·5	55·4	56·9	56·0	59·5	59·6	59·0	61·8	62·3	59·1	57·9

TABLE 4

PREDICTED SAMPLE PROPORTION EMPLOYED USING COEFFICIENTS ON REGIONS FOR YEAR j AND OTHER COEFFICIENTS AND SAMPLE FOR YEAR i

	Coefficients												
Sample	1970/1	1971/2	1972/3	1973/4	1974/5	1975/6	1976/7	1977/8	1978/9	1979/80	1980/1	1981/2	1982/3
1970/1	50·1	52·7	54·5	56·6	53·6	52·8	53·9	52·9	54·2	52·2	58·4	50·8	54·2
1971/2	46·7	49·2	51·1	53·2	50·0	49·5	50·3	49·6	50·9	49·0	54·9	47·3	50·6
1972/3	47·3	49·7	51·6	53·9	50·7	50·2	51·1	50·1	51·4	49·5	55·6	47·9	51·2
1973/4	48·9	51·4	53·3	55·4	52·3	51·7	52·5	51·8	53·1	51·1	57·3	49·5	52·8
1974/5	53·5	56·1	57·8	60·0	56·9	56·4	57·2	56·4	57·7	55·8	61·8	54·1	57·4
1975/6	52·9	55·5	57·6	59·6	56·6	56·0	56·7	55·9	57·3	55·4	61·4	53·8	57·0
1976/7	55·9	58·4	60·2	62·4	59·3	58·8	59·6	58·8	60·1	58·2	64·0	56·5	59·7
1977/8	56·5	59·1	61·0	63·1	60·1	59·6	60·3	59·5	60·8	58·9	64·7	57·2	60·4
1978/9	54·8	57·2	59·2	61·5	58·3	57·8	58·6	57·8	59·1	57·2	63·3	55·4	58·7
1979/80	59·5	61·9	63·8	65·8	62·9	62·4	63·0	62·3	63·7	61·9	67·3	60·1	63·2
1980/1	53·8	56·3	58·3	60·5	57·3	56·7	57·6	56·8	58·0	56·1	62·3	54·6	57·9
1981/2	58·5	61·0	63·1	65·1	62·0	61·4	62·1	61·5	62·8	60·9	66·6	59·2	62·3
1982/3	54·1	56·7	58·8	60·9	57·6	57·2	57·8	57·2	58·4	56·5	62·3	54·8	57·9
Sample proportion employed	50·1	49·1	51·5	55·4	56·9	56·0	59·5	59·6	59·0	61·8	62·3	59·1	57·9

TABLE 5

PREDICTED SAMPLE PROPORTION EMPLOYED USING COEFFICIENTS FOR YEAR j AND SAMPLE FOR YEAR j REWEIGHTED TO ALLOW FOR CHANGING FAMILY STRUCTURE ASSOCIATED WITH YEAR i

	Coefficients												
Weights	1970/1	1971/2	1972/3	1973/4	1974/5	1975/6	1976/7	1977/8	1978/9	1979/80	1980/1	1981/2	1982/3
1970/1	50·1	48·6	50·4	54·2	55·4	53·8	56·0	55·7	55·3	57·0	57·5	54·4	53·2
1971/2	50·6	49·2	51·1	54·8	56·1	54·5	56·6	56·3	56·1	57·7	58·3	55·2	54·1
1972/3	51·1	49·6	51·6	55·4	56·5	55·0	57·1	56·7	56·6	58·2	58·7	55·6	54·5
1973/4	51·2	49·8	51·7	55·4	56·7	55·0	57·3	56·9	56·7	58·3	58·7	55·6	54·6
1974/5	51·5	50·0	52·0	55·7	56·9	55·3	57·3	57·1	57·1	58·8	59·2	56·0	55·0
1975/6	52·2	50·7	52·7	56·4	57·6	56·0	58·1	57·8	57·8	59·5	59·9	56·7	55·8
1976/7	53·6	52·0	54·2	57·7	59·1	57·3	59·6	59·2	59·2	61·2	61·4	58·2	57·3
1977/8	53·9	52·4	54·5	58·0	59·4	57·7	59·9	59·5	59·5	61·4	61·6	58·5	57·7
1978/9	53·3	51·9	53·9	57·5	58·8	57·2	59·2	58·9	59·1	60·8	61·2	58·1	57·3
1979/80	54·2	52·9	55·0	58·4	59·9	58·2	60·3	60·0	60·0	61·9	62·2	58·9	58·4
1980/1	54·5	53·1	55·2	58·7	60·0	58·5	60·4	60·2	60·3	62·1	62·3	59·2	58·5
1981/2	54·4	53·1	55·1	58·5	60·0	58·4	60·3	60·1	60·2	62·1	62·3	59·2	58·6
1982/3	53·8	52·5	54·4	57·9	59·2	57·7	59·5	59·4	59·5	61·3	61·7	58·4	57·9
Sample proportion employed	50·1	49·1	51·5	55·4	56·9	56·0	59·5	59·6	59·0	61·8	62·3	59·1	57·9

each household the percentages corresponding to the age of wife and the family structure for this household and divide the 'row' year percentage by the 'column' year percentage. Reading Table 5 by columns, we can see that the changes in family structure on their own would be associated with a 4–5 percentage point increase in the participation rate. Note that most of this change in Table 5 appeared to occur in the years 1970–77, corresponding to the period of an increase in the sample proportion of working wives. Here again, the margin of error is uncertain, mainly because we could not, on samples below 3000, obtain very precise estimates of the probability of a given family structure conditional on other variables. However, the pattern of numbers in Table 5 is very clear and gives us some confidence in the conclusions we have drawn from it.

V. CONCLUSIONS

Our main purpose was to propose and examine a method of accounting for the growth, over the period 1970–83, in the proportion of wives working, using estimated models for a cross-section for each year. The first task was to estimate these models, and we summarize these results briefly before turning to the growth accounting.

There are several stable effects across the years, among which the most important was family structure. We took some care with the selection of variables to capture family structure and found that the coefficients of the selected variables were highly significant and steady over time. Thus, there appears to be no change in the way in which family structure affects the propensity to work. And the important determinants appear to be the presence or absence of young children rather than their precise number. While the coefficients on the monetary variables do not show the same very high significance levels or stability, they appear to go in the direction one would expect from simple theory, with the variables on incomes to those other than the wife exerting a negative influence. Overall, we find that the standard model that we employed exhibited a performance that was fairly familiar from earlier studies of different countries and data-sets.

While there were some important stable coefficients, the hypothesis of no change in coefficients over the years is overwhelmingly rejected. One single year can be very misleading if taken by itself. The likelihood ratio tests seem to indicate a gradual change over the period from 1970 to 1978, most marked around the tax year 1973/4, and a greater stability from 1978/9 onwards. Our concern, however, is much more than simply testing the hypothesis of no change in the model. We are concerned with providing a quantification of how much the model has changed. The method adopted was growth accounting, which constitutes the main methodological contribution of the paper.

Growth accounting is essentially a decomposition of aggregate changes into those arising from changes in coefficients, or shifts in the relationship, and those associated with changes in the explanatory variables. To quantify the effects of changing coefficients, we calculate, for each set of coefficients, the mean across households of the predicted probability for each household for a fixed sample. The difference in the calculated means provides a measure of the change in coefficients. We showed also how these shifts could be further decomposed into effects associated with particular coefficients. This procedure indicated that, overall, the changing coefficients constituted a major element in the explanation of the rise in the proportion working, accounting for around 65–75 per cent of the change, i.e. 6–8 percentage points (out of 9–10), while around 2–3 percentage points of the rise were attributable to changes in the population. However, practically no change was associated with the coefficients on family structure, and among the changing coefficients, the effects of regions appear to be the most important with an apparent tendency for non-metropolitan regions to become more like London and the South-East in the propensity for wives to work. In part, the changing effects of regions appears to operate through their association with wages, although the precise role of the particular effects is not easy to assign.

Finally, we showed how the effects of a changing population for fixed coefficients could be decomposed into its constituent elements. Focusing on family structure, we reweighted observations for a given sample, say 1970/1, to allow for the changes in family structure that occurred in the population to, say, 1982/3. This calculation indicated that the decline in the number of children appeared to generate a rise in the proportion of married women working, which tracked the observed increase in the sample farily well. The decline in the number of children seems to account for around 4 of the overall 9–10-percentage-point increase in the proportion of women working. This is rather more than the 2–3 percentage points mentioned above, and points to some offsetting population changes.

For all the uncertainty about margins of error of some of the above numbers, it seems to us that using a time-series of cross-sections adds a new dimension to the analysis of women's employment and gives insights not easily gleaned from other data sources. It certainly puts into perspective results obtained from one cross-section. A large part of the rise in participation over the 1970s would not have been forecast on the basis of precise knowledge of how the characteristics of the population were changing together with standard participation models using data for the early years. The technique of growth accounting can usefully complement more established statistical techniques of investigating changes in cross-sectional models.

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APPENDIX 1: DATA

The data source is the Family Expenditure Survey, organized by tax year for each year from 1970/1 to 1982/3.

WAGE	wage of wife in £ per hour (means for the employed only), deflated by the retail price index (=1 for the beginning of the tax year 1970/1)—this deflation applies also to *AMHWE* and *AVEAN*
AVEAN	average weekly earnings of the head of household in £ per week, net of tax
AMHWE	net household income, except for the earnings of the head of household (HOH) and wife
AGEW	age of wife of HOH, divided by 10
AGEWSQ	square of *AGEW*
OWN	=1 if the household accommodation is owner-occupied, otherwise 0
NEARN	number of earners in the household, apart from HOH and wife
CH4ONE to FEW4-11	This is a group of seven 0-1 dummy variables indicating presence and number of children of age 0-4 and 5-11:

CH4ONE	=1 if there is only one child, aged 0-4, and no other young children
CH4FEW	=1 if there is more than one child aged 0-4 and no children aged 5-11
CH11ONE	=1 if there is only one child aged 5-11
CH11FEW	=1 if there is more than one child aged 5-11 and no younger children
*ONE*4-111	=1 if there is one child aged 0-4 and one aged 5-11
*ONE*4-*F*11	=1 if there is one child aged 0-4 and more than one aged 5-11
*FEW*4-11	=1 if there is more than one child aged 0-4 and one or more children aged 5-11;
NOCHILD	=1 if there are no young children in the family

(The base group consists of households without young children—the variable is not used in estimation but is available in Appendix 1.)

*DR*1-*DR*12 0-1 dummies for the standard regions (the base group is the Greater London, *DR*5):

*DR*1	North
*DR*2	Yorkshire and Humberside
*DR*3	East Midlands
*DR*4	East Anglia
*DR*6	South-East
*DR*7	South-West
*DR*8	Wales
*DR*9	West Midlands
*DR*10	North-East
*DR*11	Scotland
*DR*12	Northen Ireland

*OCC*1-*OCC*8 0-1 dummies for the occupational group of the head of household (the base group is semi-skilled manual workers, *OCC*7):

*OCC*1	professional and technical
*OCC*2	administrative and managerial
*OCC*3	teachers
*OCC*4	clerical
*OCC*5	shop assistants
*OCC*6	skilled manual
*OCC*8	unskilled

The top three rows of Table A1 contain the number of households in the sample (*NOBS*), as well as the number (*NPARTCP*) and the proportion (*PARTRATE*) of wives in paid work.

Table A1

Means and Standard Deviations of Variables in Probit

Variable	1970/1	1971/2	1972/3	1973/4	1974/5	1975/6	1976/7	1977/8	1978/9	1979/80	1980/1	1981/2	1982/3	All Years
NOBS	2905	3159	3066	2946	2962	3040	2929	2965	2783	2517	2637	2714	2851	37474
NPARTCP	1454	1552	1580	1631	1684	1702	1743	1766	1643	1556	1644	1606	1651	21212
PARTRATE	0·501	0·491	0·515	0·554	0·569	0·560	0·595	0·596	0·590	0·618	0·623	0·591	0·579	0·566
WAGE	0·39	0·40	0·43	0·45	0·47	0·48	0·50	0·48	0·51	0·50	0·52	0·52	0·53	0·48
	(0·22)	(0·20)	(0·22)	(0·46)	(0·24)	(0·23)	(0·35)	(0·23)	(0·32)	(0·24)	(0·31)	(0·53)	(0·31)	(0·32)
AVEAN	22·475	23·265	24·458	25·352	24·734	23·452	22·390	22·212	23·943	24·496	25·234	24·516	24·927	23·934
	(10·127)	(11·420)	(12·143)	(15·232)	(12·004)	(9·410)	(9·153)	(8·559)	(9·703)	(10·031)	(11·040)	(10·482)	(11·165)	(10·950)
AMHWE	5·298	5·283	5·377	5·454	5·126	5·517	5·200	5·328	6·210	6·875	6·746	6·827	6·396	5·784
	(8·337)	(8·626)	(8·737)	(9·411)	(9·817)	(9·112)	(8·740)	(8·160)	(8·897)	(9·458)	(9.170)	(9·748)	(8·251)	(8·961)
AGEW	4·000	4·016	4·027	4·042	3·989	3·994	4·009	3·993	3·967	3·950	3·999	4·004	3·866	3·990
	(1·230)	(1·207)	(1·217)	(1·233)	(1·199)	(1·215)	(1·242)	(1·219)	(1·196)	(1·195)	(1·172)	(1·189)	(1·117)	(1·203)
AGEWSQ	17·513	17·583	17·700	17·856	17·347	17·423	17·613	17·433	17·162	17·030	17·362	17·445	16·193	17·368
	(10·163)	(9·942)	(10·124)	(10·232)	(9·928)	(10·085)	(10·340)	(10·164)	(9·931)	(9·990)	(9·804)	(9·989)	(9·232)	(10·000)
OWN	0·501	0·517	0·523	0·547	0·545	0·559	0·563	0·593	0·609	0·620	0·628	0·660	0·726	0·582
	(0·500)	(0·500)	(0·500)	(0·498)	(0·498)	(0·497)	(0·496)	(0·491)	(0·488)	(0·485)	(0·483)	(0·474)	(0·446)	(0·489)
NEARN	0·299	0·306	0·291	0·265	0·252	0·284	0·256	0·270	0·269	0·292	0·278	0·255	0·247	0·274
	(0·617)	(0·635)	(0·617)	(0·576)	(0·545)	(0·603)	(0·580)	(0·591)	(0·599)	(0·626)	(0·598)	(0·561)	(0·555)	(0·593)
CH4ONE	0·094	0·100	0·094	0·084	0·097	0·088	0·082	0·080	0·095	0·087	0·085	0·080	0·082	0·089
	(0·292)	(0·300)	(0·292)	(0·277)	(0·296)	(0·283)	(0·274)	(0·271)	(0·293)	(0·282)	(0·279)	(0·271)	(0·288)	(0·285)
CH4FEW	0·064	0·054	0·052	0·057	0·055	0·054	0·046	0·048	0·047	0·037	0·039	0·051	0·060	0·051
	(0·245)	0·226)	(0·222)	(0·231)	(0·228)	(0·227)	(0·209)	(0·214)	(0·213)	(0·190)	(0·195)	(0·220)	(0·237)	(0·221)
CH11ONE	0·112	0·117	0·121	0·107	0·123	0·117	0·122	0·121	0·114	0·114	0·129	0·120	0·112	0·118
	(0·315)	(0·322)	(0·326)	(0·309)	(0·328)	(0·322)	(0·327)	(0·327)	(0·318)	(0·317)	(0·335)	(0·326)	(0·315)	(0·322)
CH11FEW	0·092	0·085	0·095	0·091	0·097	0·096	0·108	0·092	0·095	0·091	0·082	0·084	0·093	0·092
	(0·289)	(0·278)	(0·294)	(0·288)	(0·295)	(0·294)	(0·311)	(0·289)	(0·293)	(0·288)	(0·274)	(0·278)	(0·290)	(0·290)
ONE4–111	0·051	0·053	0·048	0·053	0·055	0·064	0·052	0·055	0·061	0·066	0·050	0·051	0·067	0·056
	(0·221)	(0·225)	(0·214)	(0·223)	(0·227)	(0·244)	(0·221)	(0·228)	(0·240)	(0·248)	(0·218)	(0·220)	(0·250)	(0·229)

TABLE A1—continued

Variable	1970/1	1971—2	1972/3	1973/4	1974/5	1975/6	1976/7	1977/8	1978/9	1979/80	1980/1	1981/2	1982/3	All Years
*ONE*4–*F*11	0·044	0·038	0·039	0·039	0·032	0·031	0·023	0·027	0·020	0·023	0·022	0·020	0·019	0·029
	(0·205)	(0·191)	(0·193)	(0·195)	(0·176)	(0·174)	(0·150)	(0·161)	(0·139)	(0·150)	(0·147)	(0·138)	(0·136)	(0·168)
*FEW*4–11	0·027	0·025	0·023	0·023	0·020	0·015	0·015	0·013	0·015	0·015	0·014	0·011	0·014	0·018
	(0·163)	(0·155)	(0·150)	(0·151)	(0·141)	(0·122)	(0·120)	(0·115)	(0·123)	(0·120)	(0·119)	(0·105)	(0·118)	(0·133)
NOCHILD	0·516	0·529	0·528	0·547	0·522	0·535	0·553	0·564	0·553	0·567	0·578	0·582	0·544	0·547
	(0·500)	(0·499)	(0·499)	(0·498)	(0·500)	(0·499)	(0·497)	(0·496)	(0·497)	(0·495)	(0·494)	(0·493)	(0·498)	(0·498)
*DR*1	0·067	0·061	0·059	0·064	0·066	0·074	0·062	0·066	0·061	0·063	0·060	0·058	0·058	0·063
	(0·251)	(0·240)	(0·236)	(0·246)	(0·248)	(0·262)	(0·242)	(0·249)	(0·239)	(0·243)	(0·238)	(0·234)	(0·233)	(0·243)
*DR*2	0·091	0·084	0·102	0·092	0·096	0·095	0·096	0·094	0·096	0·097	0·089	0·091	0·088	0·093
	(0·288)	(0·278)	(0·302)	(0·289)	(0·295)	(0·294)	(0·295)	(0·292)	(0·295)	(0·296)	(0·284)	(0·287)	(0·284)	(0·291)
*DR*3	0·069	0·066	0·068	0·062	0·064	0·075	0·074	0·077	0·067	0·074	0·066	0·081	0·082	0·071
	(0·253)	(0·249)	(0·252)	(0·242)	(0·244)	(0·263)	(0·262)	(0·267)	(0·250)	(0·262)	(0·248)	(0·274)	(0·275)	(0·257)
*DR*4	0·034	0·038	0·035	0·035	0·031	0·037	0·032	0·032	0·038	0·036	0·041	0·038	0·034	0·035
	(0·181)	(0·191)	(0·184)	(0·183)	(0·174)	(0·188)	(0·176)	(0·175)	(0·192)	(0·187)	(0·198)	(0·190)	(0·182)	(0·185)
*DR*5	0·112	0·124	0·118	0·119	0·119	0·105	0·112	0·104	0·107	0·113	0·107	0·103	0·100	0·111
	(0·316)	(0·330)	(0·322)	(0·324)	(0·323)	(0·307)	(0·316)	(0·305)	(0·310)	(0·316)	(0·310)	(0·304)	(0·300)	(0·314)
*DR*6	0·175	0·184	0·186	0·178	0·177	0·184	0·182	0·186	0·183	0·183	0·195	0·190	0·201	0·185
	(0·380)	(0·387)	(0·389)	(0·382)	(0·382)	(0·388)	(0·386)	(0·389)	(0·387)	(0·387)	(0·396)	(0·392)	(0·401)	(0·388)
*DR*7	0·058	0·059	0·064	0·064	0·070	0·063	0·070	0·072	0·077	0·062	0·064	0·062	0·076	0·066
	(0·234)	(0·236)	(0·245)	(0·245)	(0·254)	(0·243)	(0·255)	(0·258)	(0·266)	(0·240)	(0·246)	(0·241)	(0·265)	(0·248)
*DR*8	0·053	0·045	0·047	0·049	0·048	0·058	0·048	0·051	0·048	0·045	0·058	0·054	0·054	0·051
	(0·224)	(0·208)	(0·211)	(0·216)	(0·213)	(0·233)	(0·215)	(0·219)	(0·214)	(0·208)	(0·233)	(0·226)	(0·226)	(0·219)
*DR*9	0·091	0·104	0·092	0·100	0·097	0·097	0·094	0·096	0·096	0·105	0·087	0·099	0·095	0·096
	(0·287)	(0·305)	(0·289)	(0·301)	(0·296)	(0·296)	(0·292)	(0·295)	(0·294)	(0·307)	(0·282)	(0·298)	(0·294)	(0·295)
*DR*10	0·128	0·125	0·114	0·125	0·116	0·103	0·112	0·112	0·109	0·110	0·113	0·125	0·118	0·116
	(0·335)	(0·331)	(0·318)	(0·331)	(0·320)	(0·304)	(0·315)	(0·316)	(0·311)	(0·313)	(0·316)	(0·331)	(0·322)	(0·320)
*DR*11	0·097	0·091	0·096	0·092	0·099	0·094	0·100	0·096	0·104	0·098	0·101	0·086	0·081	0·095
	(0·296)	(0·288)	(0·294)	(0·289)	(0·299)	(0·292)	(0·301)	(0·294)	(0·305)	(0·298)	(0·302)	(0·280)	(0·272)	(0·293)

*DR*12	0·024	0·018	0·020	0·019	0·018	0·015	0·017	0·015	0·015	0·014	0·019	0·013	0·012	0·017
	(0·153)	(0·132)	(0·140)	(0·138)	(0·133)	(0·123)	(0·130)	(0·120)	(0·121)	(0·117)	(0·136)	(0·114)	(0·110)	(0·129)
*OCC*1	0·092	0·110	0·107	0·116	0·106	0·108	0·101	0·105	0·120	0·125	0·128	0·148	0·134	0·115
	(0·289)	(0·313)	(0·310)	(0·321)	(0·307)	(0·311)	(0·301)	(0·306)	(0·325)	(0·331)	(0·334)	(0·355)	(0·341)	(0·318)
*OCC*2	0·100	0·105	0·119	0·117	0·126	0·124	0·126	0·142	0·128	0·160	0·161	0·140	0·163	0·131
	(0·300)	(0·307)	(0·324)	(0·322)	(0·331)	(0·329)	(0·331)	(0·349)	(0·334)	(0·366)	(0·368)	(0·347)	(0·370)	(0·337)
*OCC*3	0·028	0·028	0·028	0·031	0·034	0·032	0·035	0·034	0·042	0·034	0·036	0·043	0·043	0·034
	(0·165)	(0·164)	(0·165)	(0·173)	(0·181)	(0·175)	(0·183)	(0·182)	(0·202)	(0·181)	(0·187)	(0·204)	(0·203)	(0·182)
*OCC*4	0·082	0·078	0·073	0·074	0·070	0·083	0·077	0·070	0·063	0·072	0·071	0·078	0·066	0·074
	(0·275)	(0·268)	(0·260)	(0·261)	(0·256)	(0·275)	(0·266)	(0·255)	(0·243)	(0·258)	(0·257)	(0·268)	(0·248)	(0·261)
*OCC*5	0·009	0·008	0·008	0·005	0·005	0·006	0·005	0·002	0·006	0·006	0·008	0·003	0·004	0·006
	(0·092)	(0·087)	(0·088)	(0·074)	(0·073)	(0·077)	(0·074)	(0·049)	(0·080)	(0·074)	(0·091)	(0·054)	(0·065)	(0·076)
*OCC*6	0·387	0·369	0·399	0·374	0·390	0·372	0·402	0·401	0·395	0·390	0·381	0·394	0·391	0·388
	(0·487)	(0·483)	(0·490)	(0·484)	(0·488)	(0·483)	(0·490)	(0·490)	(0·489)	(0·488)	(0·486)	(0·489)	(0·488)	(0·487)
*OCC*7	0·219	0·215	0·185	0·209	0·203	0·212	0·211	0·209	0·201	0·172	0·173	0·162	0·166	0·196
	(0·413)	(0·411)	(0·388)	(0·407)	(0·402)	(0·409)	(0·408)	(0·406)	(0·401)	(0·377)	(0·378)	(0·368)	(0·372)	(0·397)
*OCC*8	0·084	0·088	0·081	0·074	0·066	0·063	0·044	0·037	0·045	0·042	0·041	0·032	0·033	0·057
	(0·277)	(0·283)	(0·273)	(0·261)	(0·248)	(0·244)	(0·205)	(0·188)	(0·207)	(0·201)	(0·198)	(0·176)	(0·178)	(0·231)

APPENDIX 2: CONSISTENCY AND ASYMPTOTIC NORMALITY OF FORECASTS

The following two theorems are due to Peter Robinson. They (respectively) establish consistency and asymptotic normality of the forecasts from the probit.

Theorem 1. Let X_i, $i=1,2,\ldots$, be a sequence of independent identically distributed $k\times 1$ vectors. Let $F(x;\,\theta)$ map $\mathbb{R}^k\times\mathbb{R}^p$ on to $[0,1]$, where $F(x;\,\theta)$ is continuous in a neighbourhood of θ_0 for each x and measurable in x for each such θ. Let $\hat{\theta}_n\to\theta_0$ almost surely (a.s.) as $n\to\infty$. Then

$$\lim_{n\to\infty}\frac{1}{n}\sum_{i=1}^{n}F(X_i;\,\hat{\theta}_n)=E\{F(X_1;\,\theta_0)\}\quad\text{a.s.}$$

Theorem 2. Let the condition of Theorem 1 hold. Let

$$\sqrt{n}\begin{bmatrix}\dfrac{1}{n}\sum_{i=1}^{n}F(X_i;\,\theta_0)-E\{F(X_1;\,\theta_0)\}\\ \hat{\theta}_n-\theta_0\end{bmatrix}\xrightarrow{d}N(0,\Omega).$$

Let $(\partial/\partial\theta)F(x;\,\theta)$ exist and be continuous in θ in a neighbourhood of θ_0 for each x, and measurable in x for each θ, and let $E|G(X_1)|<\infty$, where $G(x)=(\partial/\partial\theta)F(x;\,\theta_0)$. Then, as $n\to\infty$,

$$\sqrt{n}\left[\frac{1}{n}\sum_{i=1}^{n}F(X_i;\,\hat{\theta}_n)-E\{F(X_1;\,\theta_0)\}\right]\xrightarrow{d}N\left(0,[1,\,E\{G(X_1)\}']\Omega\begin{bmatrix}1\\ E\{G(X_1)\}\end{bmatrix}\right).$$

To calculate standard errors for Table 1, we used the following consistent estimate of the variance matrix from Theorem 2:

$$\frac{1}{N}\sum_h(\hat{\Phi}_h)^2-\left(\frac{1}{N}\sum_h\hat{\Phi}_h\right)^2+\left(\frac{1}{N}\sum_h\hat{\Phi}_{h\alpha}\right)'\hat{\Omega}_\alpha\left(\frac{1}{N}\sum_h\hat{\Phi}_{h\alpha}\right)$$

where $\hat{\Phi}_h=\Phi(\hat{\alpha}'X_h)$, Φ is the cumulative normal distribution function, X_h is the vector of exogenous variables for household h, $\hat{\alpha}$ is the vector of maximum likelihood estimates of the probit model, N is the sample size, $\hat{\Phi}_{h\alpha}$ is the gradient of $\hat{\Phi}_h$ with respect to α and $\hat{\Omega}_\alpha$ is the estimate of the covariance matrix of $\hat{\alpha}$ from the probit procedure.

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