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A PRELIMINARY ANALYSIS OF THE EFFECTS OF CHANGES IN THE OCCUPATIONAL STRUCTURE IN AUSTRALIA ON EMPLOYMENT BY SEX,

1971 - 1976

by

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I. INTRODUCTION

The relative wage changes which occurred in Australia in the mid-seventies have stimulated research concerning the importance of substitution effects on the demand for different types of labour. The major issue explored is the consequences for female employment of the phasing in of equal pay between 1972 and 1975. Among early investigations of the equal pay effect are the works of Snape (1979, 1981), Gregory and Duncan (1978), and Sheehan (1978). Stricker and Sheehan (1981) in their analysis of 'hidden' unemployment examined the special position of women. A theoretical analysis was undertaken by Gorden (1979).

The conclusions are diverse. Some economists (e.g., Gregory and Duncan (1978)) sought to discount the substitution response to wage changes and suggested that the Australian labour market is segmented into labour types which are apparently poor substitutes for one another. Others, (e.g. Snape (1979)) who believe that structural change masked the substitution of male for female labour, favour a micro-analytical approach in which employment by sex is further disaggregated by industry or occupation.

Only the occupational dimension of this approach is addressed in the present paper.¹ Thus it is hypothesised that in the nineteen-seventies there were changes in the occupational composition of the Australian workforce that favoured females and disguised the adverse effect on female employment of increased relative wage rates for women.

This paper represents an initial step in the testing of this hypothesis. The method adopted involves a decomposition of the growth observed in the employment of males and females between 1971 and 1976 into three effects :

- (i) changes in the shares held by each sex in the various occupations (the share effect),
- (ii) changes in the relative sizes of the different occupations (the structure effect),
and
- (iii) growth in the overall size of the workforce (the growth effect).

The share effect is identified with the substitution effect of microeconomics in which a rise in the relative price of one type

1. For a treatment which deals explicitly with the impact of changes in the industrial structure of the economy on the employment prospects of females and males, see Bonnell (1982).

of labour leads to a fall in its share of employment.¹ The result of changes in the relative sizes of employment of the different occupations, on the other hand, is identified with structural change.

1. Background assumptions are that the production functions are homothetic and separable, and that changes in the quality of factors occur at identical rates.

II. A DECOMPOSITION OF THE GROWTH IN EMPLOYMENT BETWEEN 1971 and 1976

The total change in employment for any group that occurs through time can be decomposed into three parts.¹ These are:

- changes in the share of the particular group in each occupation,
- changes in the occupational structure of total employment, and
- growth in the aggregate level of employment. The decomposition is based on the equation:

$$C_n = \sum_{j=1}^J S_{nj} Q_j N, \quad (1)$$

where C_n is the employment of group n , J is the number of occupations, S_{nj} is the share of occupation j accounted for by group n , Q_j is the share of the j^{th} occupation in total employment and N is total employment.

From equation (1) we can write the change in employment over any period as:

$$\Delta G_n = \text{share effect} + \text{structure effect} + \text{growth effect},^2$$

1. This methodological approach was used by Bonnell and Dixon (1982) to analyse the impact of structural change between 1971 and 1976 on employment disaggregated by birthplace.

2. In fact $\Delta G_n = F_n + C_n + L_n + W_n$,

where W_n is a residual term given by:

$$W_n = \sum_{j=1}^J (s_{nj}^{(2)} - s_{nj}^{(1)}) (q_j^{(2)} - q_j^{(1)}) (N^{(2)} - N^{(1)}) / 4.$$

W_n is generally small because it involves the multiplication of three changes.

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When the decomposition of employment change was made for separate groups of occupations it was found that the change in female employment attributable to the share effect, holding growth and the structure of employment constant, was positive in every category. Even in the blue-collar group of occupations, where it was argued by Snape that there was less opportunity to pass wage increases on into prices, the substitution response, as measured by the share effect, was perverse.

In Section III of the paper a more detailed examination of the contribution to the change in aggregate employment for each sex from structural change was assessed. Structural effects were found to have only a minor impact on female employment. The increased importance of the white-collar occupations in the structure of the work force resulted in a larger contribution to the percentage increase in employment for females than for males. In the blue-collar category, both sexes lost jobs because of the diminished importance of these occupations. The detailed examination of blue-collar employment revealed particular groups of occupations which had the greatest impact on the contribution to changes in employment.

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where

$$\text{share effect } r_n = \sum_{j=1}^J \bar{q}_j \bar{n} (s_{nj}^{(2)} - s_{nj}^{(1)}) \quad (2)$$

$$\text{structure effect } c_n = \sum_{j=1}^J \bar{s}_{nj} \bar{n} (q_j^{(2)} - q_j^{(1)}), \quad (3)$$

$$\text{growth effect } l_n = \sum_{j=1}^J \bar{s}_{nj} \bar{q}_j (n^{(2)} - n^{(1)}) \quad (4)$$

The superscripts 1 and 2 denote the values of the variables for the two dates. The bars indicate the average values for the two dates. For example, $\bar{n} = (n^{(2)} + n^{(1)}) / 2$.

Formulae (2) through (4) were implemented for the Census dates 1971 and 1976 with the workforce classified into 71 occupations (J = 71) and with the groups n defined according to sex. The occupational disaggregation is indicated in Tables 1 to 3. The occupations are a slightly modified version of the ABS Occupational Classification - Minor Groups.¹

In Table 1 the rows show the change in the numbers of females and males employed due to the effects described in equations (2) to (4) for the occupational groups indicated in columns 1 to X.

1. The computations were made with 71 groups derived from the Minor groups in the *Classification and Classified List of Occupations* (CHCS, June 1971) and *Occupation Classification Extract* (ABS, Catalogue No. 2114.0). To improve comparability between data for 1971 and 1976, it was necessary (1) to aggregate Dentists and Doctors in 1971 and (11) to distribute Apprentices to all other occupations in 1976. For both years the group, Occupation Inadequately Described or Not Stated was distributed to all other occupations.

TABIE 1. A Decomposition of the Change in Employment
1971-1976 (Thousands)

(a) Occupation Groups	m	Change in Employment Attributable to :									
		All Occupations		White-collar (b)		Farmers, Fishermen, Miners, etc.		Transport, Tradesmen		Service, Sport and Recreation, Armed Forces, etc.	
	m=1	j = 1, ..., 20 Female Male		j = 1, ..., 20 Female Male		j = 21, ..., 29 Female Male		j = 30, ..., 60 Female Male		j = 61, ..., 71 Female Male	
		I		III		VI		VIII		IX	
		1. Share Effects (c)		2. Structure Effects (d)		3. Growth Effects (e, L, nm)		Total Change in Employment (Ag, nm)			
		177.8	-177.8	91.1	-91.1	64.1	-64.1	17.2	-17.2	5.4	-5.4
		54.5	-54.5	7.3	-7.3	2.2	-2.2	-24.5	24.5	4.1	-4.1
		363.3	184.3	195.1	203.1	7.2	26.4	5.3	34.5	42.1	33.9
		416.6	131.0	293.5	104.7	73.5	-39.9	-2.0	41.8	51.6	24.4

Source : Census of Population and Housing, 1971 and 1976, Australian Bureau of Statistics.

- (a) For presentation the results are aggregated to the groups shown here. For example, the first 20 of the 71 occupations are the White-collar occupations.
- (b) This aggregation, j = 1, ..., 20, includes the 'Sales' occupations j = 18-20.
- (c) These reflect the changed importance of the two sexes within occupations.
- (d) These are compositional changes among the occupations j within the group of occupations identified at the head of the columns.
- NOTE: Odd (even) numbered columns in the fields III (IV) to IX (X) of rows 2 and 3 add jointly to the sub-total of these rows in column I (II).

IV. CONCLUSION

The major concern of this paper is the examination of the proposition that there was a substitution response to the relative increase in female pay in Australia in the seventies which was unfavourable for female employment. Two aspects of such a substitution response have been explored. A substitution response may be reflected as an increase in the share of male employment in individual occupations or in aggregated groups of occupations. Or, the substitution response may be thought of as the effect on the occupational structure brought about, in part, by the especially adverse effect on some of the more female-intensive sectors of the economy of relatively rapid increases in labour costs. The reasons for the actual changes in the occupational composition of employment are not addressed here. However it appears that structural changes in the Australian labour market in the 1970's favoured female employment. The paper tests the idea that the observed gains in female employment due to structural change, masked the adverse effects on female employment which would have occurred if a simple substitution of male and female labour had taken place in individual occupation.

At the aggregate level, the female share of employment increased. The partitioning of the change in total employment into the employment changes attributable to the effects of different sex shares of the various occupations, from structural change and from growth, which was undertaken in Section II of the paper showed that females gained jobs because of each of the three effects. Structural change did not offset or disguise the substitution response. Indeed, the gain in female jobs was much greater from the share effect than from structural change. This is the opposite of the expected result.

TABLE 3. Actual Changes in Employment by Occupation and the Contribution to White-collar and Blue-collar Employment by Sex of Changes in Occupational Shares, 1971-1976.

Occupation Group	Actual Percentage Change in Employment	Effect of Changes in Occupational Shares			
		Contribution Made to Percentage Changes (a) in Employment of			
		FEMALES		MALES (b)	
	I	II	III		
1-20 White-collar occupations	16.33	4.51	1.99		
5 Nurses	33.61	1.14	0.04		
17 Other clerical	8.96	2.61	1.00		
All other white-collar	8.12	0.76	0.95		
30-60 Blue-collar occupations	1.91	-2.50	-3.32		
30-39 Workers in transport, communication	3.35	-0.23	-0.44		
40 Spinners, weavers, etc.	-27.72	-0.37	-0.13		
41 Tailors, cutters, etc.	-9.06	-0.61	-0.09		
42 Leather cutters, etc.	-28.86	-0.18	-0.08		
43 Furriers, rollers, etc.	-21.67	0.00	-0.17		
44 Watchmakers, jewelers, etc.	12.73	0.00	0.01		
45 Tool makers, machinists, etc.	4.12	-0.02	-0.62		
46 Electricians, etc.	5.71	0.00	-0.16		
47 Metal workers, n.e.c.	-6.83	-0.32	-0.29		
48 Carpenters, etc.	1.48	-0.01	-0.30		
49 Painters, decorators	-1.00	-0.01	-0.15		
50 Bricklayers, plasterers	5.49	0.00	-0.14		
51 Compositors, engravers, etc.	-5.54	-0.07	-0.15		
52 Pottery, kilners, etc.	-17.97	-0.01	-0.07		
53 Millers, bakers, butchers	1.94	-0.08	-0.18		
54 Chemical, sugar workers, etc.	-19.15	0.00	-0.17		
55 Tobacco preparers, etc.	10.49	0.00	0.00		
56 Paper, rubber workers, etc.	4.70	-0.05	-0.04		
57 Packers, wrappers, etc.	-22.38	-0.45	-0.09		
58 Equipment operators, etc.	4.39	0.00	-0.12		
59 Storemen, freight handlers	6.24	-0.01	-0.11		
60 Labourers, n.e.c.	12.73	0.02	0.17		

Source and notes (a) and (b) as in Table 2, page 15.

For All Occupations, $j=1, \dots, 71$, the first column of the table shows that female workers gained jobs from each of the effects. The increase in female employment was over 400 thousand and for males it was 131 thousand. The largest part of the gain in both female and male jobs was due to overall employment growth computed as indicated in equation (4). The growth effect L_n simply reflects the actual increase of 9.93 per cent in total employment which would have been the increase for both groups if there had been no change in the occupational structure and if the sex shares of the occupations remained constant. Females gained almost as much from their increased shares of occupations as they did from overall employment growth. The change in the occupational structure, however, only contributed 13 per cent of the total female employment growth.

The share and structure effects diminished male workers' employment by amounts exactly matched by the corresponding gains made by females. However the growth effect, L_n , offset the negative effects from F_n and C_n producing the net gain in jobs for males. The simple disaggregation of employment by sex in columns I and II demonstrates that it is difficult to discern a substitution effect which accords with conventional economic theory. The increased shares of females in 58 out of 71 occupations which occurred despite an increase in the female/male relative wage do not support the view that plausible substitution effects were masked by the changing occupational structure. Rather than mask plausible substitution effects, the structure effect reinforced implausible changes in female shares of the different occupations.

Snape (1981) examined changes in employment by sex and occupation and found that:

"Male 'white-collar' employment increased by 10 per cent in persons and 8 per cent in hours between 1971 and 1977 as against 31 and 22 per cent, respectively, for females. At the same time 'blue-collar' employment for males decreased by one and six per cent respectively as against decreases of 11 and 17 per cent respectively for females." (Snape, page 181).

On either measure, female white-collar employment grew more rapidly than male, but in the blue-collar categories where employment fell, female employment deteriorated more than male.¹ Census data for 1971 and 1976 show that in the white-collar occupations, $j=1, \dots, 20$, female employment grew by 24.5 per cent and male employment grew by 8.4 per cent. For occupations, $j=30, \dots, 60$, the ones Snape designated as blue-collar, male employment actually grew by 2.3 per cent and female employment fell by 0.7 per cent. Thus the male share of blue-collar employment increased.

Snape analysed changes in the ratio of female to male employment in the blue-collar occupations and in 7 other occupational categories and commented on the increase in the male share of the blue-collar occupations. One way to interpret the increase at the aggregate level in the male share of the blue collar occupations is that it is the outcome of the substitution response to the rise in the relative wages of females. This appears to be Snape's interpretation.

1. Snape excluded Sales $j=17, \dots, 19$, from White-collar employment and used the Labour Force Survey data for the period 1971 to 1977.

one-third of the 1.99 per cent total contribution from this group. Columns II and III of Table 3 show that the percentage contribution to employment from changed shares of particular categories within the 31 blue-collar occupations is generally small. Changes in the shares of the textile-related occupations, 40 to 42, were more important sources of diminished employment prospects for females than for males, and a decreasing share in the workforce of a group of the skilled trades, occupations 45 through 51, accounted for most of the compositional changes working against male employment. A comparison between the columns shows the difference in the importance for females and males of changes in occupational shares of the workforce over 1971-1976.

occupation 40 in aggregate employment fell by 37.65 per cent (-27.72 - 9.93). Because the percentages of the female and male workforces represented by spinners, etc., were 0.99 and 0.35 respectively, the contributions to employment opportunities for the two sexes made by the reduction in the share of spinners in the overall workforce are shown in Table 2 as:

$$\begin{aligned} c_{f,40} &= -0.3765 \times 0.99 = -0.37, \\ c_{m,40} &= -0.3765 \times 0.35 = -0.13. \end{aligned}$$

For persons, where the percentage in spinning was 0.57 the contribution is shown as:

$$c_{p,40} = -0.3765 \times 0.57 = -0.21.$$

This example illustrates how the contributions (c_{nj}) to employment prospects are derived.

In Table 3 a more detailed analysis of individual occupations is given. The loss of employment for females from the declining aggregate workforce share of the blue-collar occupations (30-60) was -2.50 per cent.¹ This is a smaller percentage contribution to the reduction in employment prospects for women than the contribution of -3.32 per cent from these occupations for male workers. Occupation 5, where growth was more than 30 per cent over the five years, was responsible for a quarter of the total contribution from the white-collar group ($j=1, \dots, 20$). For males the contribution of the increased workforce share of occupation 17, other clerical, was

1. Notice that this aggregation includes workers in transport and communication in line with the aggregation used by Snape.

This suggestion is that the substitution response which is concealed when total employment is examined may be revealed when the examination of shares is conducted at a disaggregated level. He concluded that:

"Reasonable hypotheses appear to be: (1) in the blue-collar occupations, there was least opportunity for passing wage increases on into prices: in these occupations female employment in particular has been hit significantly by wage rises; and (2) in the white-collar areas the effects of changes in legislation (for example, relating to the employment status of married women in the public service), in custom and in the average education level of females were very significant in creating new employment opportunities for females and outweighed the relative wage effect." (Snape (1981), page 183.)

A crucial question about disaggregation is: when does one stop? Snape recognised that the blue-collar group should be treated separately from the seven other major groups identified by him. In this paper the richer detail available in the Census data is exploited. In particular, structural changes in the occupational composition within major occupational groups are assessed.

This has been done in Table 1 for the four major occupational categories in columns III to X by manipulating equations (1) through (4) as following. Letting $A_1, \dots, A_4$ stand for these four groups of occupations, (1) can be rewritten as:

$$G_n = G_{n1} + \dots + G_{nA}$$

$$= \sum_{j \in A_1} S_{nj} Q_j N + \dots + \sum_{j \in A_4} S_{nj} Q_j N$$

$$= \sum_{j \in A_1} S_{nj} \frac{Q_j}{\sum_{k \in A_1} Q_k} \left(\sum_{k \in A_1} Q_k N \right) + \dots$$

$$\dots + \sum_{j \in A_4} S_{nj} \frac{Q_j}{\sum_{k \in A_4} Q_k} \left(\sum_{k \in A_4} Q_k N \right)$$

$$= \sum_{j \in A_1} S_{nj} Q_{j1} N_1 + \dots + \sum_{j \in A_4} S_{nj} Q_{j4} N_4, \quad (5)$$

where

$$Q_{jm} = \frac{Q_j}{\sum_{k \in A_m} Q_k} \quad (j \in A_m; m=1, \dots, 4) \quad (6)$$

is the share of occupation j within major group A_m and

$$N_m = N \sum_{k \in A_m} Q_k \quad (7)$$

is the number of persons in major group A_m.

Then

$$\Delta G_{nm} = F_{nm} + C_{nm} + L_{nm} + W_{nm} \quad (n=1, 2; m=1, \dots, 4), \quad (8)$$

where

$$F_{nm} = \sum_{j \in A_m} \bar{Q}_{jm} \bar{N}_m (s_{nj}^{(2)} - s_{nj}^{(1)}), \quad (9)$$

$$C_{nm} = \sum_{j \in A_m} \bar{S}_{nj} \bar{N}_m (Q_{jm}^{(2)} - Q_{jm}^{(1)}), \quad (10)$$

$$L_{nm} = \sum_{j \in A_m} \bar{S}_{nj} \bar{Q}_{jm} (N_m^{(2)} - N_m^{(1)}), \quad (11)$$

TABLE 2. Actual Changes in Employment by Occupation and the Contribution to Employment by Sex of Changes in Occupational Shares, 1971 to 1976.

Occupation Group	Actual Percentage Change in Employment I	Effect of Changes in Occupational Shares Contribution Made to Percentage Change in Employment of (a)			
		Females II	Males III	Persons IV	
1-20 White-collar occupations	16.33	4.51	1.99	2.84	
21-26 Farmers, fishermen hunters, timber-getters	8.09	-0.04	-0.21	-0.15	
27-29 Miners, quarrymen	-6.42	0.00	-0.16	-0.11	
30-39 Workers in transport and communication	3.35	-0.23	-0.44	-0.37	
40-60 Tradesmen, production process workers and labourers	1.66	-2.27	-2.88	-2.67	
40 Spinners, weavers etc.	-27.75 ^(c)	-0.37	-0.13	-0.21	
61-71 Other occupations	14.81	0.97	0.19	0.46	
1-71 Total	9.93	2.94	-1.51	0.00	

Source :

Census of Population and Housing, 1971 and 1976. Australian Bureau of Statistics.

(a) The contribution (c_j) of the change in the share of occupation j in total employment n_j for group n was calculated as:

$$c_{nj} = 100 \bar{S}_{nj} (Q_j^{(2)} - Q_j^{(1)}) \bar{N}/\bar{N}_n$$

where the notation is described in Section II and $\bar{N}_n$ is the average for 1971 and 1976 of total employment for sex n. Except for occupation 40 (see (c) below) these occupations are aggregated according to equation (13) to obtain the results shown above for the six groups.

(b) For persons (Column IV) the sum of the contribution effects is zero. Recall that we are examining the effects of changes in occupational shares holding aggregate employment constant.

(c) Occupation 40, although displayed separately, is included in the figures for the blue-collar group 40-60.

In the first column of Table 2 the percentage change in employment for each group is given. Total employment grew by 9.93 per cent. The rapid growth in the white-collar group contrasts with sluggish growth of blue-collar employment. Columns II and III show the contributions to total employment growth by sex from the individual occupations within each major occupational group. The gain in the share of the workforce by the white-collar group contributed 4.51 per cent to female employment growth but was offset by losses (negative values of c_{nm}) in three of the other major groups. The diminishing share of the workforce held by the blue-collar group (occupations 40 through 60) reduced female employment prospects by 2.27 per cent. The overall contribution to female employment growth from compositional change was 2.94 per cent. For males, structural change decreased employment prospects by 1.51 per cent. The positive contribution from the white-collar occupations $j=1, \dots, 20$ was smaller for males than for females. At -2.88 per cent, the contribution to the change in male employment from the reduced importance of occupations $j=30, \dots, 60$ represented a slightly larger loss in employment than the corresponding loss for females, and outweighed the gain from the white-collar group.

The table includes the individual occupation 40, spinners, weavers, etc. From columns II and III, the decline of this occupation in the workforce is shown as reducing employment for females, by almost three times as much in percentage terms as for males (-0.37 versus -0.13). Employment of spinners declined by 27.72 per cent while aggregate employment increased by 9.93 per cent. Hence the share of

and W_{nm} is a residual term (usually small) which we ignore.¹ The total change in employment by sex in each occupational group is decomposed according to equations (8) to (11).

The interpretation of the share effects F_{nm} is as previously except that we confine our attention to one group m of occupations at a time. The share effects add across occupation groups, $m=1, \dots, 4$, to give the results shown for the overall workforce in columns I and II. C_{nm} is the effect on employment of sex n due to the change in the occupational structure within the group m . For example, the structure effects reported in columns III and IV of Table 1 are the consequence of changes in the importance of the various occupations within the white-collar group $j=1, \dots, 20$. The employment growth effects L_{nm} simply reflect the influence of changes in the absolute size of employment in the groups, $m=1, \dots, 4$. In white-collar employment and in the services group the growth effect L_{nm} was particularly important (row 3 of columns III and IV and IX and X).

Notably, the change in employment attributable to the share effect was positive for females in every major occupational group reported in Table 1 and in 58 out of 71 of the minor occupational groups. In the blue-collar group, $j=30, \dots, 60$, the share effect favoured female employment in spite of the small reduction (from 13.40 per cent in 1971 to 13.05 per cent in 1976) in the female share of

1. See footnote 2, page 4 above.

the group. This is because the changes in total employment for both sexes, which imply the shift in share, include the effects of both P_{nm} and C_{nm} . The results reported right across row 1 of the table are a clear refutation of the existence of the substitution response as measured by the share effect.

III. THE CONTRIBUTIONS TO EMPLOYMENT BY SEX OF CHANGES IN OCCUPATIONAL SHARES, 1971-1976

How important in the total growth of male and female employment were the consequences of structural change? In particular an investigation of the occupations at a more detailed level can be undertaken to identify where the structural changes occurred and to determine the contribution to the change in aggregate employment for each sex from changes in the importance of individual occupations.

The structure effect C_n may be expressed as a proportionate change. This is derived from equation (4) as:

$$c_n = 100 \left[\sum_{j=1}^J \bar{s}_{nj} (q_j^{(2)} - q_j^{(1)}) \bar{N} \right] / \bar{N}_n, \quad (12)$$

where $\bar{N}_n$ is the average of the numbers of people of sex n in employment. Table 2 explains the structure effects c_n in terms of what happened in 6 major occupational groups.¹ For this purpose, formula (12) is partitioned as follows. Letting $B_1, \dots, B_6$ represent the major groups, we have that:

$$\begin{aligned} c_n &= c_{n1} + \dots + c_{n6} \\ &= \frac{100 \bar{N}_n}{\bar{N}_n} \sum_{j \in B_1} \bar{s}_{nj} (q_j^{(2)} - q_j^{(1)}) + \\ &\quad \dots + \frac{100 \bar{N}_n}{\bar{N}_n} \sum_{j \in B_6} \bar{s}_{nj} (q_j^{(2)} - q_j^{(1)}). \end{aligned} \quad (13)$$

1. Number 40 is a single occupation.