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IMPACT is an economic and demographic research project conducted by Commonwealth Government agencies in association with the Faculty of Economics and Commerce at The University of Melbourne and the School of Economics at La Trobe University.

SOME PROJECTIONS OF AUSTRALIAN POPULATION AND LABOUR FORCE, 1980 TO 2001

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1. INTRODUCTION

Through the development of a suite of integrated economy-wide policy-analytic models, the IMPACT Project[1] has attempted to provide a systematic framwork for the analysis of the impact of economic, demographic and social change on the structure of the Australian economy. One such model is BACHUROO, a large economic-demographic model of population and labour supply, which is intended to model the size and skill composition of the Australian labour force. Within BACHUROO, the population projection facility has the task of tracking the evolution through time of the age, sex and marital status composition of the Australian population and labour force.

The population projection facility is designed to provide, within a tightly integrated framework, annual projections of the Australian population disaggregated by sex, age and marital status. A high level of disaggregation is maintained for all population stocks and demographic flows, such as deaths, migration and marital status change, and the facility ensures that strict accounting identities are maintained between all population stocks and flows. But this facility has not been developed simply to provide alternative demographic projections using conventional demographic techniques. It extends these techniques by integrating them with an econometric model of fertility, marriage and divorce, which allows these demographic events to be influenced by changing economic and social

conditions. As part of this econometric model, the facility also incorporates a set of equations for the projection of female labour force participation which determines the labour force participation rates of women in a simultaneous and consistent framework with the level of fertility, marriage and divorce. Components of the population projection facility at various stages of its development have been documented elsewhere[2]. However, in Section 2, we provide a short summary of the features of the projection facility, borrowing heavily from previous documentation, in order to provide the reader with an outline of its current stage of development.

This paper presents a set of three projections of the Australian population and labour force from 1980 to 2001, produced with the fully-linked population projection facility. These fully-linked projections enable analysis of the relationship between the future size and composition of the population and labour force on the one hand, and future levels of fertility, marriage, divorce and labour force participation on the other. Further, they enable analysis of the sensitivity of these demographic variables to changing economic conditions by adopting exogenous scenarios (detailed in Section 3) which represent three different levels of economic growth -- low, medium, and high. The results reported in Section 4 highlight these linkages between demographic variables and economic conditions. They indicate that increasing economic growth will lower the level of fertility, thus reducing the proportion of children in the population. Given the assumption of declining death rates and these projected declines in fertility, the ageing of the population appears inevitable, even with assumed migration targets set at 0.6 per cent of the population. The projections also suggest that increasing economic growth

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will be accompanied by higher rates of marriage and divorce, leading to a movement in the marital status structure of the population away from never married persons and towards married and divorced persons. The size of the labour force will also be sensitive to the level of future economic growth, both directly via the effects on labour force participation rates and indirectly via the effects on the age and marital status structure of the population. In particular, in periods of increasing economic growth, married women will respond to declining levels of fertility and rising real wage rates by entering the labour force. At its current stage of development, however, the facility does not fully exploit all the linkages between demographic and economic phenomena. Its strengths and weaknesses are discussed in the concluding remarks in Section 5.

2. THE POPULATION AND LABOUR FORCE PROJECTION FACILITY

A schematic representation of the IMPACT facility for the projection of the population and of the labour force is given in Figure 1. As illustrated at the bottom of the figure, the facility produces annual projections of the population disaggregated by 101 single years of age, four marital states[3] and two sexes. Also produced are projections of the labour force disaggregated by eight age groups for males and by three age groups and two marital states[4] for females. These projected populations are the outputs of the population projection algorithm, which calculates consistent and disaggregated population projections from a set of demographic rates and flows. The inputs to the population projection algorithm are supplied either exogenously or via several mechanisms driven by a simultaneous econometric model of fertility, marriage, divorce and female labour force participation, as illustrated in the upper parts of Figure 1. The labour force projections are produced by combining the projected populations with a set of disaggregated labour force participation rates, supplied exogenously for males and by the econometric model for females. In this section, we outline the functioning of each of the elements of Figure 1 and in the next section we detail the economic and demographic scenarios which have been adopted to produce the projections reported in this paper.

The population projection algorithm is implemented as a set of demographic accounting identities and is a central component of the

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TABLE 1.7 : ESTIMATED EQUATIONS FOR LABOUR FORCE PARTICIPATION RATES - MARRIED FEMALES 55 YEARS AND OVER, UNMARRIED FEMALES 15 YEARS AND OVER

Equation For	EXPLANATORY VARIABLES								Coefficient of determination
	W	G_a	G_w	L_D	u	z_2	z_5	Constant	
Married females aged 55 years and over	0.5120* (0.2325)	-0.0883 (0.2505)		5.6770* (0.6008)	0.2975* (0.0426)	-0.1131 (0.0730)		-3.9343* (0.8201)	0.9301
Unmarried females aged 15-24 years	0.5601 (0.2949)		0.2523 (0.1311)	1.2324 (1.0550)	-0.0315 (0.1021)	0.1608 (0.1194)	-0.3099 (0.2977)	1.2883* (0.6047)	0.9310
Unmarried females aged 25-54 years	0.4948* (0.0982)		0.0292 (0.0448)	-0.6333 (0.3454)	-0.0298 (0.0341)	0.1089* (0.0387)	-0.1524 (0.1024)	1.0704* (0.2019)	0.9215
Unmarried females aged 55 years and over	0.1078 (0.0768)	-0.4351* (0.0904)	-0.0417 (0.0295)	0.0487 (0.2165)	0.0167 (0.0229)	-0.1052* (0.0238)	-0.2293* (0.0631)	-0.3756 (0.2621)	0.7903

NOTES:
1. All explanatory variables, with the exception of the dummy variables and the constant, enter the equations as their natural logarithms. The labour force participation rates enter as their inverse logistic transform. The explanatory variables are: the real female hourly wage rate, W , the real old age and invalid pension, G_a , the real widows' pension, G_w , the indicator of demand for female labour , L_D , the unemployment rate, u , the dummy variable for World War II , z_2 , and the dummy variable for the widows' pension, z_5 .
2. The values in brackets are asymptotic standard errors.
3. An asterisk indicates the parameter is significant at the 5 per cent level.
4. All equations are estimated using FIML.

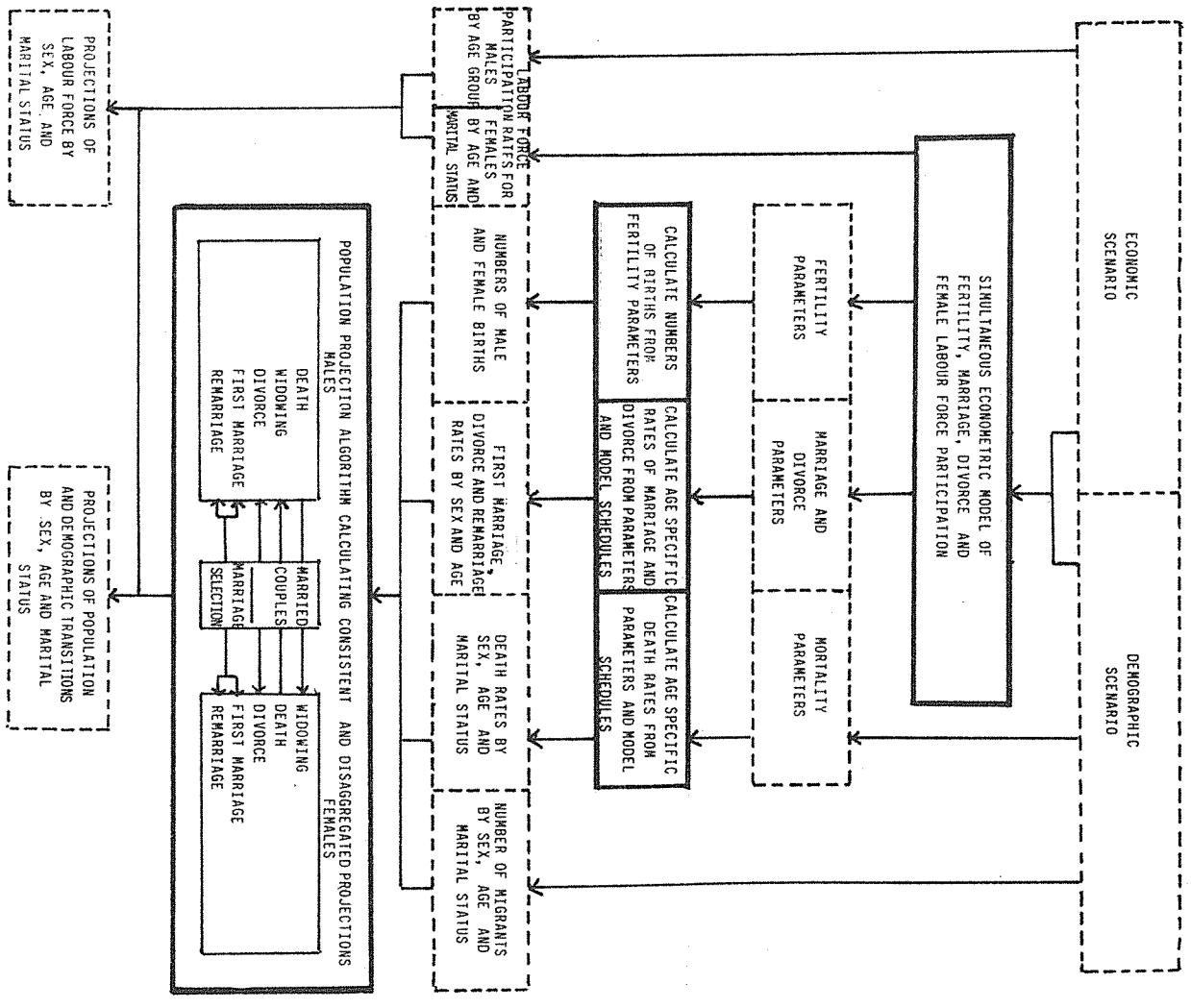


FIGURE 1: SCHEMATIC REPRESENTATION OF THE IMPACT POPULATION AND LABOUR FORCE PROJECTION FACILITY

population projection facility (see Sams (1979) for details). It determines the composition of the population at the end of each period from:

(i) the initial composition of the population;

(ii) the age specific rates of first marriage, remarriage and divorce for both sexes;

(iii) the annual number of births by sex;

(iv) the net immigration of men and women by age, sex and marital status; and

(v) death rates by age, sex and marital status. Widowings of both men and women at each age are determined by applying the appropriate death rates to the age distribution of spouses.

It is this algorithm which enables the facility to produce consistent population projections at the high level of disaggregation adopted. The algorithm incorporates the conventional demographic technique of applying age specific rates to appropriate populations at risk to allow the resultant population to be influenced by both changes in these rates and in the sex, age and marital status structure of the population. The algorithm also includes a two-sex marriage model which ensures consistency between the numbers of men and women marrying at each age and a two-sex divorce model which achieves the analogous result for divorces (see Sams (1981) for details). As well, the method adopted to calculate widowings of women (men) ensures that their number is consistent with the number of deaths of married men (women) in each year.

TABLE 1.6 : ESTIMATED EQUATIONS FOR LABOUR FORCE PARTICIPATION RATES - MARRIED FEMALES 15 TO 54 YEARS

Equation for	EXPLANATORY VARIABLES								Coefficient of determination
	W	L_D	u	KQ	Ω	$\hat{c}$	Z_2	Constant	
Married females aged 15-24 years	0.9634* (0.2310)	0.9288 (0.8187)	-0.3659* (0.0556)	0.5454* (0.1424)	-0.0038 (0.0377)	-1.9938* (0.2732)	0.3305* (0.0930)	6.1596* (1.2942)	0.9850
Married females aged 25-54 years	0.2933 (0.1830)	0.7631 (0.6485)	-0.1091* (0.0441)	0.8077* (0.1128)	0.1233* (0.0298)	-1.2369* (0.2164)	0.3621* (0.0737)	0.1348 (1.0250)	0.9845

NOTES: 1. All explanatory variables, with the exception of the dummy variables and the constant, enter the equations as their natural logarithms. The labour force participation rates enter as their inverse logistic transform. The explanatory variables are: the real female hourly wage rate, W , an indicator of demand for female labour, L_D , the unemployment rate, u , children under 15 years per married female 15 years and over, K , child quality proxy Q , the oral contraceptive usage rate, Ω , weighted nuptial confinements per thousand married females aged 15 to 44 years, $\hat{c}$, and the dummy variable for World War II, Z_2 .

2. The values in brackets are asymptotic standard errors.

3. An asterisk indicates the parameter estimate is significant at the 5 per cent level.

4. All equations are estimated using 2SLS.

TABLE 1.5 : ESTIMATED DIVORCE EQUATIONS FOR MALES

Equation For	EXPLANATORY VARIABLES						Coefficient of determination
	Y	$W/\tilde{W}$	G_w	K	z_4	Constant	
Index of propensity to divorce	0.1686 (0.3709)	0.4491 (0.6346)	0.5532* (0.2230)	-2.0891* (0.4308)	0.5870* (0.1090)	4.0949 (2.3044)	0.9520
Mean of the age distribution of age specific rates of divorce	-0.1134 (0.1415)	0.1233 (0.2422)	0.0848 (0.0851)	0.6005* (0.1644)	0.0076 (0.0416)	4.1509* (0.8794)	0.6007
Variance of the age distribution of age specific rates of divorce	-0.7551 (0.6800)	0.8562 (1.1636)	0.6139 (0.4088)	2.4767* (0.7898)	-0.0121 (0.1999)	8.9831* (4.2249)	0.6484

NOTES: 1. All variables, with the exception of the dummy variables and the constant, enter the equations as their natural logarithms. The explanatory variables are: real gross domestic product per head, Y, lagged two periods; the female/male relative hourly wage rate, $W/\tilde{W}$, lagged two periods; the real widows pension, G_w, lagged two periods; children under 15 years per married female 15 years and over, K, lagged two periods; and the dummy variable for the Family Law Act, z_4, lagged two periods.

2. The values in brackets are asymptotic standard errors.

3. An asterisk indicates the parameter estimate is significant at the 5 per cent level.

4. All equations are estimated using FIML.

The high level of disaggregation maintained within the projection facility enables the projections to be used very flexibly, but it does impose an enormous information load upon the facility (see the list of inputs itemized above). Whilst annual projections of the net numbers of international migrants are assumed to be supplied exogenously to the projection facility, model schedules of the age distributions of mortality and of marriages and divorces have been used to condense the required disaggregated annual projections of these demographic transitions into a few parameters for each transition in each year.

For marriages and divorces, the age specific rates of first marriage, divorce and remarriage of divorced and of widowed persons for each sex in each year are assumed to be adequately approximated by a gamma distribution (see Williams (1981) for more details). Each of these eight age distributions in each year can then be fully characterized by three variables -- the index of propensity (the area under the age distribution) and the mean age and variance in age of the distribution. The model schedules for the age distributions of age specific death rates of persons of each sex and marital status in each year are based upon the distributions suggested by Heligman and Pollard (1979) (see Brooks, Sams and Williams (1980) for details of the exact specification of the distributions used). Using these model schedules, the eight age distributions of age specific death rates in each year can each be characterised by nine or fewer parameters.

The use of these model schedules has the advantage of providing, for each demographic transition in each year, a manageable number of

interpretable descriptive statistics. The time series of these statistics can capture changes in the underlying determinants of demographic transitions and thereby provide the basis for econometric estimation and projection (in the case of marriage and divorce) or allow straightforward projection of future trends (in the case of mortality).

In the population projection facility, marital fertility is treated as a set of sequential decisions consisting of the decision to have a first nuptial confinement and then to have higher order confinements. The number of higher order confinements can be obtained from the number of first nuptial confinements and the parity progression ratios for all higher order births, where the parity progression ratio is defined as the probability that a married female with a given number of children will have at least one additional confinement in the current period. Parity progression ratios can be calculated from the distribution of implied completed family size, which can be fully characterized by its mean and variance. Thus, the number of nuptial confinements can be determined from the number of first nuptial confinements and the mean and variance of implied completed family size. The number of live nuptial births of each sex is then determined as a constant multiple of the number of confinements. Ex-nuptial births are assumed to be proportional to the number of nuptial births and currently that proportion is set exogenously. Sams (1979) and (1979a) provides a full description of the calculation of the number of confinements and of births, and readers should refer to these references for further details.

TABLE 1.4 : ESTIMATED DIVORCE EQUATIONS FOR FEMALES

Equation For	EXPLANATORY VARIABLES						Coefficient of determination
	Y	$W/\tilde{W}$	G_w	K	Z_4	Constant	
Index of propensity to divorce	0.2331 (0.3666)	0.4483 (0.6272)	0.5060* (0.2204)	-2.0816* (0.4258)	0.5812* (0.1078)	-4.4722 (2.2773)	0.9527
Mean of the age distribution of age specific rates of divorce	-0.0557 (0.1420)	-0.1624 (0.2429)	0.0749 (0.0854)	0.4675* (0.1649)	-0.0014 (0.0417)	3.6785* (0.8820)	0.5154
Variance of the age distribution of age specific rates of divorce	-0.4867 (0.6631)	0.9359 (1.1346)	0.4846 (0.3986)	1.8496* (0.7707)	-0.0541 (0.1949)	7.3695 (4.1196)	0.5920

NOTES: 1. All variables, with the exception of the dummy variables and the constant, enter the equations as their natural logarithms. The explanatory variables are: real gross domestic product per head, Y, lagged two periods; the female/male relative hourly wage rate, $W/\tilde{W}$, lagged two periods; the real widows pension, G_w, lagged two periods; children under 15 years per married female 15 years and over, K, lagged two periods; and the dummy variable for the Family Law Act, Z_4, lagged two periods.

2. The values in brackets are asymptotic standard errors.

3. An asterisk indicates the parameter estimate is significant at the 5 per cent level.

4. All equations are estimated using FIML.

TABLE 1.3 : ESTIMATED MARRIAGE EQUATIONS FOR MALES

Equation for	EXPLANATORY VARIABLES								Coefficient of determination
	S	Y	W/W	E	Ω	Z_2	Z_3	Constant	
Index of propensity to first marry	0.0523 (0.0753)	0.6406* (0.1101)	-0.8500* (0.2226)	-0.3231* (0.1035)	-0.0308 (0.0198)	0.2021* (0.0465)	0.7478 (0.4979)	-3.4619* (0.7510)	0.8268
Mean of the age distribution of age specific rates of first marriage	-0.0259* (0.0053)	-0.0352* (0.0078)	0.0771* (0.0157)	0.0135 (0.0073)	0.0009 (0.0014)	-0.0053 (0.0033)	-0.1771* (0.0352)	3.8529* (0.0531)	0.9410
Variance of the age distribution of age specific rates of first marriage	0.0673 (0.0539)	-0.1070 (0.0789)	0.7551* (0.1595)	0.2491* (0.0742)	-0.0602* (0.0142)	-0.0089 (0.0333)	0.3779 (0.3567)	4.6198* (.5380)	0.8234
Index of propensity to remarry for divorcees	-0.0551 (0.1924)	0.8220* (0.2816)	0.7453 (0.5439)	-0.9369* (0.2636)	-0.0731 (0.0453)	0.5130* (0.1194)		-0.3788 (1.9081)	0.7464
Mean of the age distribution of age specific rates of remarriage of divorcees	-0.1637* (0.0363)	0.0914 (0.0531)	0.0172 (0.1026)	0.1426* (0.0497)	0.0069 (0.0085)	-0.1401* (0.0225)		3.4782* (0.3599)	0.7392
Variance of the age distribution of age specific rates of remarriage of divorcees	-0.2242 (0.1569)	0.1451 (0.2296)	2.5913 (0.4435)	-0.5755* (0.2149)	0.0020 (0.0369)	0.1126 (0.0973)		10.5880 (1.5559)	0.5740
Index of propensity to remarry for widows	-0.4574* (0.1136)	0.8433* (0.1662)	0.0194 (0.3210)	-0.3370* (0.1556)	-0.0636* (0.0267)	-0.0348 (0.0705)		-0.9344 (1.1264)	0.4973
Mean of the age distribution of age specific rates of remarriage of widows	-0.1495* (0.0240)	-0.0350 (0.0351)	0.0828 (0.0678)	0.0462* (0.0329)	-0.0043 (0.0056)	0.0341* (0.0149)		2.8944* (0.2378)	0.8911
Variance of the age distribution of age specific rates of remarriage of widows	0.2556* (0.0614)	-0.3359* (0.0898)	0.1795 (0.1735)	0.0664 (0.0841)	0.0138 (0.0145)	0.0714 (0.0381)		5.9810 (0.6087)	0.7443

NOTES: 1. All variables, with the exception of the dummy variables and the constant, enter the equations as their natural logarithms. The explanatory variables are: child services, S , real gross domestic product per head, Y , the female/male relative hourly wage rate, W/W , an indicator of female educational attainment, E , the oral contraceptive usage rate, Ω , the dummy variable for World War II, Z_2 , and the dummy variable for conscription, Z_3 .
2. The values in brackets are asymptotic standard errors.
3. An asterisk indicates the parameter estimate is significant at the 5 per cent level.
4. All equations are estimated using 2SLS.

The econometric model

As discussed above, the IMPACT projection facility extends conventional demographic techniques by integrating them with an econometric model of fertility, marriage, divorce and female labour force participation, which allows these events to be influenced by each other and by changing economic, social and demographic conditions. This treatment differs significantly from standard methods of producing demographic projections which have avoided any explicit attempt to incorporate the influence of economic and social factors within a systematic framework.[5]

The econometric model is inspired by the so-called "new home economics", which explores the relationships between economic variables and marriage, divorce, childbearing and labour force participation (see Becker (1960) and (1965), Lancaster (1966), and Willis (1974)). This approach (which is an extension of consumer theory to incorporate non-pecuniary aspects of consumption) treats the individual or, where appropriate, the family as a decision-making unit which maximises its utility from the consumption of "household commodities" subject to a household production function, a budget constraint and a time constraint. Thus the household is seen not only as a consumer but also as a producer; goods and services purchased in the market are combined with the time of the individual or family members to produce household commodities, which include children (where children are viewed as home-produced durable assets), home-cooked meals and the like. The inclusion of non-pecuniary aspects of household consumption, such as the utility derived from children and the role of time constraints, enables the "new home economics" to deal with demographic topics such as fertility, marriage, divorce and labour force participation.

With respect to fertility, children appear as an argument in the family utility function in the sense that parents, or would-be parents are assumed to choose a certain volume of "child services", which is a function both of the number of children and the resource intensity or "quality" of these children. Thus, although children are not purchased in the market, inputs of market goods and services and of time are used by the household to "produce" child services. Children therefore have a shadow price, partly reflecting the time intensity of their production and the opportunity cost of that time. Thus, with regard to fertility, the members of a family are faced with a decision concerning the allocation of their resources of time between child-rearing, labour force participation and leisure. Since the value of the time of parents, especially of mothers, is a major cost of having and rearing children, the number of children will decline with the increasing cost of the mother's time, as measured by her wage rate in the labour force (Mincer (1963), Heckman (1974), and Butz and Ward (1979)). Now if, as we expect, child services are "normal goods", an increase in family income will tend to increase consumption of child services, which can imply growth in the number of children and/or in expenditure per child (that is, child quality). Thus, if an increase in family income derives from an increase in the female wage rate, this income effect will be combined with an increase in the shadow price of the woman's time, implying that a larger part of the increase in child services may be directed towards increased child quality, rather than increased numbers of children. The effect on fertility of non-economic variables, such as birth control and infant mortality rates, can be incorporated via their effect upon the relative prices of the number and quality of children.

TABLE 1.2 : ESTIMATED MARRIAGE EQUATIONS FOR FEMALES

Equation for	EXPLANATORY VARIABLES								Coefficient of determination
	S	Y	W/W	E	Ω	Z_2	Z_3	Constant	
Index of propensity to first marry	0.3918* (0.0699)	0.4272* (0.1022)	-0.8198* (0.2064)	-0.4713* (0.0956)	-0.0920* (0.0185)	0.3178* (0.0439)	0.0013* (0.0005)	-3.2949* (0.6983)	0.8898
Mean of the age distribution of age specific rates of first marriage	-0.0307* (0.0070)	-0.0493* (0.0103)	0.0090 (0.0208)	0.0212* (0.0096)	0.0125* (0.0018)	-0.0124* (0.0044)	-0.0003* (0.0001)	3.8242* (0.0703)	0.9517
Variance of the age distribution of age specific rates of first marriage	-0.2262* (0.0362)	-0.1724* (0.0528)	0.6101* (0.1067)	0.3216* (0.0494)	0.0376* (0.0095)	-0.1904 (0.0227)	-0.0007* (0.0002)	6.3219* (0.3610)	0.8269
Index of propensity to remarry for divorcees	0.3971* (0.1405)	0.5938* (0.2056)	-0.4553 (0.3963)	-0.6687* (0.1918)	-0.1518* (0.0330)	0.2826* (0.0884)		-2.5437 (1.3951)	0.8275
Mean of the age distribution of age specific rates of remarriage of divorcees	-0.1509* (0.0332)	0.1337* (0.0486)	-0.1677 (0.0936)	0.1588* (0.0452)	0.0172* (0.0078)	-0.0799* (0.0209)		2.7623* (0.3267)	0.7549
Variance of the age distribution of age specific rates of remarriage of divorcees	-0.3583* (0.1073)	0.7756* (0.1570)	-0.3031 (0.3027)	0.3879* (0.1461)	-0.0111 (0.0252)	-0.4529* (0.0676)		0.3314 (1.0658)	0.6432
Index of propensity to remarry for widows	-0.0111 (0.1228)	0.6100* (0.1797)	0.0233 (0.3465)	-0.7945* (0.1672)	-0.1165* (0.0288)	0.1111 (0.0773)		-0.7756 (1.2198)	0.7412
Mean of the age distribution of age specific rates of remarriage of widows	-0.0195 (0.0348)	0.1193* (0.0509)	-0.1398 (0.0981)	0.1089* (0.0473)	0.0043 (0.0082)	-0.0239 (0.0219)		2.2877* (0.3453)	0.6448
Variance of the age distribution of age specific rates of remarriage of widows	0.2267* (0.0463)	-0.2859* (0.0677)	0.1610 (0.1305)	0.2674* (0.0630)	0.0219* (0.0109)	0.0263* (0.0291)		4.6490 (0.4594)	0.8892

NOTES: 1. All variables, with the exception of the dummy variables and the constant, enter the equations as their natural logarithms. The explanatory variables are: child services, S, real gross domestic product per head, Y, the female/male relative hourly wage rate, W/W, an indicator of female educational attainment, E, the oral contraceptive usage rate, Ω, the dummy variable for World War II, Z_2, and the dummy variable for conscription, Z_3.
2. The values in brackets are asymptotic standard errors.
3. An asterisk indicates the parameter estimate is significant at the 5 per cent level.
4. All equations are estimated using 2SLS.

TABLE 1.1 : ESTIMATED FERTILITY EQUATIONS

Equation for	explanatory variables									Coefficient of determination
	Y	W	G_a	ϕ	Ω	$\hat{f}$	Z_2	Z_1	Constant	
Mean implied completed family size(a)	0.2544* (0.0844)	-0.1710 (0.1321)	-0.2928* (0.1461)	-0.0965 (0.1010)	-0.0094 (0.0135)		-0.0790* (0.0297)	-0.0408 (0.0390)	0.3417 (1.0724)	0.3300
Variance of implied completed family size(b)	0.4909* (0.1605)	-1.0932* (0.2575)	-0.6718* (0.2848)	-0.3126 (0.1968)	0.0442 (0.0263)		-0.1539* (0.0579)	-0.2507* (0.0760)	-0.1108 (2.0912)	0.8246
First nuptial confinements per thousand married females aged 15 to 44 years(b)	0.3294* (0.0503)	-0.1312 (0.0840)	-0.3933* (0.0837)	-0.1237* (0.0576)	-0.0172 (0.0090)	0.3390* (0.0708)	0.0071 (0.0201)	0.1613* (0.0237)	1.6410 (0.6393)	0.8689
Child quality proxy (a)	0.3648* (0.1148)	0.7073* (0.1601)		-0.5787* (0.1125)	0.0503* (0.0168)				4.5581* (1.0105)	0.9835

(a) - equation estimated using 2SLS.
(b) - single equation estimated using FIML.

NOTES: 1. All variables, with the exception of the dummy variables and the constant, enter the equations as their natural logarithms. The explanatory variables are: real gross domestic product per head, Y, lagged one period; the real female hourly wage rate, W , lagged one period; the real old age and invalid pension, G_a , lagged one period; the infant mortality rate, ϕ , lagged one period; the oral contraceptive usage rate, Ω , lagged one period; weighted first marriages of females per 1000 married females aged 15 to 44 years, $\hat{f}$; the dummy variable for World War II, Z_2 , lagged one period; and the dummy variable for the immediate post War period, Z_1 , lagged one period.
2. The values in brackets are asymptotic standard errors.
3. An asterisk indicates the parameter estimate is significant at the 5 per cent level.

The "new home economics" approach has also been applied to marriage (Becker (1974)) and divorce (Becker, Landes and Michael (1977) and Hutchens (1979)) behaviour. People are assumed to marry when both parties expect to enjoy a level of utility which is greater than that attainable if they remained single. Gains from marriage are related to the complementarity of the inputs to the household of the husband and wife. This complementarity is higher for large relative wage differentials between men and women. Children provide an important source of utility to their parents, so the demand for child services, and the complementarity of inputs of males and females in producing these child services, will act as an incentive to marry and to remain married. However, the decision to marry is not costless, since a single person must spend resources searching for a spouse. According to this approach, the decision to marry, the timing of that decision and the duration of search will depend upon the gains to marriage and the costs of search (Keeley (1977) and (1978)). Since divorce and separation are the result of conscious choice on the part of at least one spouse to terminate the marriage, the reverse of the factors discussed above are assumed to apply.

The "new home economics" provides a consistent framework for dealing with female labour force participation; married females are assumed to choose to allocate their time between labour force participation, leisure and participation in household activity, whereas unmarried females are assumed to have only the former two choices open to them. Where the choice is between labour force participation and leisure, it is expected that the level of the female wage rate and the demand for female labour will act as positive inducements for women to join the labour force. The availability of alternative income, either from government transfer

payments for unmarried women or from increases in the spouse's income for married women, will tend to reduce participation in the labour force. For married women of the childbearing and rearing ages, the fertility decisions of earlier periods and the desired levels of child quality can also influence the level of participation in the labour force, and, in particular, rising levels of child quality can act as an inducement for married women to enter the labour force in order to supplement the family income.

The econometric model of fertility, marriage, divorce and female labour force participation which is used in the IMPACT projection facility incorporates the essential features of this "new home economics" approach and also attempts to capture some of the dynamic elements of family formation, family size and female labour force participation and their interactions. The model is discussed fully in Filmer and Silberberg (1977) and in Brooks, Sams and Williams (1982) and will only be briefly outlined here.

In the econometric model, fertility is modelled in terms of the decision to have a first nuptial confinement and then to have higher order confinements. Higher order confinements are calculated from the mean and variance of implied completed family size, which are related to:

(i) the real female hourly wage rate;

(ii) real GDP per head;

(iii) the infant mortality rate;

(iv) the oral contraceptive usage rate;

APPENDIX 1 : THE ESTIMATED EQUATIONS OF THE ECONOMETRIC MODEL

In Tables 1.1 to 1.7, the equations of the econometric model of fertility, marriage, divorce and female labour force participation are presented with their estimated coefficients.

FOOTNOTES

1. The IMPACT Project is an inter-agency initiative of the Commonwealth Government in co-operation with the University of Melbourne. For a full discussion of the IMPACT Project and the BACHUR00 module see Powell (1977) and (1981).

2. The population projection facility has been outlined in several previous papers: Sams (1979) provides an overview of the demographic accounting equations in the facility; Sams and Williams (1980) provide a summary of the useful features of the facility; Sams, Williams, Williams and Stevenson (1981) provide a comparison of the projections of the facility and those of the Australian Bureau of Statistics as a test of the demographic accounting equations; and Brooks, Sams and Williams (1982) describe the econometric model.

3. The four marital states are never married, married, divorced and widowed.

4. The two marital states are married and unmarried.

5. For Australian examples see National Population Inquiry (1975), Australian Bureau of Statistics (1979) and Sams, Williams, Williams and Stevenson (1981).

6. For example, see Williams and Sams (1982), where the facility has been combined with a model of household headship ratios to produce projections of Australia's future household formation.

(v) the real old age and invalid pension rate; and

(vi) two dummy variables to account for the effects of World War II.

First nuptial confinements are determined by an equation which relates the first nuptial confinement rate to the above variables plus an additional variable, the number of weighted first marriages per married woman. This variable is included to take account of the effect upon the first nuptial confinement rate of the timing decisions about children taken by recently married couples. In parallel with these equations which determine the number of children, the model also determines the desired level of child quality, which is related to:

(i) the real female hourly wage rate;
(ii) real GDP per head;
(iii) the infant mortality rate; and
(iv) the oral contraceptive usage rate.

The econometric model explains the probability of marital status change (that is, the propensity to marry, to divorce and to remarry) and the age profile of this marital status change (via the mean age and variance in age at marriage, at divorce and at remarriage) by relating the parameters of the model schedules of marriage and remarriage to:

(i) the demand for child services;
(ii) the female/male relative wage rate;

(iii) real GDP per head;

(iv) an index of female educational attainment;

(v) the oral contraceptive usage rate; and

(vi) two dummy variables to account for the effects of World War II.

The parameters of the model schedules of divorce are related to:

(i) the female/male relative wage rate;

(ii) real GDP per head;

(iii) the number of dependents per married female;

(iv) the real widows' pension; and

(v) a dummy variable for the effects of the Family Law Act.

Labour force participation rate equations are estimated for females disaggregated by two marital states (married) and (unmarried) and by three age groups (15 to 24 years, 25 to 54 years and 55 years and over). The labour market decisions of women will vary according to whether or not they are married and whether or not they are past child bearing and rearing ages. Consequently, the variables chosen to explain the labour force participation rates for married females aged 15 to 24 years and aged 25 to 54 years are:

(i) the total demand for child quality per married female;

(ii) weighted nuptial confinements per married female;

(iii) the oral contraceptive usage rate;

(vi) the real female hourly wage rate;

to increase at the same rate as real GDP per head. Since for other users the adopted scenarios may not be suitable, the facility has been designed to enable maximum flexibility in the choice of exogenous scenarios.

Whilst the facility is able to specify tightly the relationships between demographic variables in its population projection algorithm, its econometric model does not fully exploit the linkages between economic and demographic behaviour. As discussed in Brooks, Sams and Williams (1982), the econometric model has several weaknesses. In particular, the model does not deal adequately with the links between fertility and nuptiality, nor does it capture the life-cycle timing of child-bearing satisfactorily. Labour force participation rates for males are not modelled in terms of their economic determinants and the modelling of participation rates for females may not fully incorporate the life-cycle variation in their participation behaviour. Work to remove these weaknesses is currently proceeding. Even at the current stage of development, however, we believe that the econometric model and the facility as a whole provide a useful tool for the analysis of the interactions between demographic and economic phenomena.

5. CONCLUDING REMARKS

In this paper we have presented three projections of the Australian population and labour force produced with the IMPACT Project's population projection facility. The significance of these projections is three-fold:

(i) they illustrate the validity and usefulness of the "new home economics" approach in the development of a model to capture the interaction of economic conditions with demographic phenomena;

(ii) they show that projections of the population and labour force can be made using a consistent set of fully integrated demographic and economic equations; and

(iii) they provide projections of population and labour force which are suitable for linking to other models of the Australian economy.[6]

These projections and the exogenous scenarios used to produce them should not be interpreted as forecasts of the future of the Australian economy. The facility has been designed to provide a tool for policy analysis and the outputs from the facility must be treated as conditional projections based on the assumed demographic and economic scenarios. The scenarios adopted for the projections reported here posit relatively simple relationships between the exogenous economic variables; for instance, real social security payments and real hourly wage rates for males are assumed

(v) an indicator of demand for female labour;

(vi) the unemployment rate of all persons; and

(vii) a dummy variable to account for the effects of World War II.

The variables chosen to explain the labour force participation rates for married females aged 55 years and over and for unmarried females aged 15 to 24 years, 25 to 54 years and 55 years and over are:

(i) the real female hourly wage rate;

(ii) an indicator of demand for female labour;

(iii) the unemployment rate of all persons;

(iv) the real old age and invalid pension;

(v) the real widows' pension;

(vi) a dummy variable to account for the effects of World War II;

(vii) a dummy variable to proxy for the financial assistance which was available to widows prior to the introduction of the widows' pension; and

(viii) the education participation rate of females aged 15 to 24 years, which appears only in the equation for unmarried females aged 15 to 24 years.

Unfortunately, at this stage the projection facility has no econometric model to determine male labour force participation rates, so they must be supplied exogenously (currently for eight age groups).

These twenty-two equations were estimated using annual time series data for the period 1921-22 to 1975-76, with the exception that the

divorce equations were estimated using data from 1950-51 onwards. The estimated equations are given in Appendix 1. A full discussion of the performance of these equations is given in Brooks, Sams and Williams (1982); suffice it to say that the coefficients on the variables generally accorded with our a priori expectations and that the model has been moderately successful in explaining Australian marriage, divorce, fertility and labour force participation over the period 1921-22 to 1975-76.

For a projection of population and labour force, the IMPACT projection facility requires, for each year of projection, a demographic and an economic scenario. For the demographic scenario, we require:

(i) net numbers of international migrants by sex, age and marital status; and

(ii) parameters of mortality for each sex and marital status.

For the economic scenario, we require:

(i) the labour force participation rates for males by age group;

(ii) real gross domestic product per head;

(iii) the real female hourly wage rate;

(iv) the female/male relative hourly wage rate;

(v) the unemployment rate;

(vi) the real old age and invalid pension;

(vii) the real widows' pension;

(viii) an index of female educational attainment;

is opposed partly, over the first part of the projection period, by the movement of encouraged workers out of the labour force as the unemployment rate declines, and partly, in the higher growth projections, by the growth in the real old age pension.

Young unmarried women experience a decline in their participation rates in all three scenarios, principally as a result of the assumed increase in their education participation. However, there are some slight offsetting effects from the higher real wages and demand for female labour in the higher growth projections. The rise in the participation rates for unmarried females aged 25 to 54 years is principally due to the growth in the female wage rate, whilst, for the older unmarried females, this positive effect is swamped by the negative effect of a rise in the real old age pension, especially in the higher growth scenarios.

In summary, the net effect of the shifts in the participation rates of males and females and in the population structure is to increase the size of the labour force faster than the population in all three projections. Specifically, the ratio of the labour force to the population increases from 46.2 per cent in 1980/81 to [47.30, 49.34, 51.42] per cent in the [low, medium, high] scenario. This positive relationship between participation rates and economic growth is such that, despite the negative relationship between population growth and economic growth, labour force numbers are greater for the higher growth projections.

growth in child quality. The net effect, under all three scenarios, is for demand for child services to increase with higher economic growth and to grow more rapidly after 1990/91, when the decline in the number of dependent children per married female is projected to level off. The latter variable, measured by weighted nuptial confinements per married woman, grows in the low scenario, grows only slightly in the medium scenario, and remains steady in the high scenario. The combined effect of these fertility variables is, in the low projection, to take married women out of the workforce, via the immediate effect of increased levels of childbearing, and, in the higher projections, to draw women into the workforce to provide them with sufficient income to support high levels of child quality. In general, the effect of labour market variables is to draw young married women into the labour force in all three projections, although this effect is minimal in the low projection. Rising real female wage rates encourage married women to join the labour force, this effect becoming more pronounced under the assumption of higher economic growth. In the higher growth projections, the assumed decline in unemployment rates to 1990/91 and the slight increase in demand for female labour lead to the return of discouraged women to the workforce. Thus, the separate effects of the fertility and labour market variables on the participation rates of married women of child bearing age are complementary for the high and medium projections but countervailing for the low projection, leading to the result discussed earlier: participation rates rise in the high and medium projections but remain approximately constant in the low projection.

Participation rates for older (55 years and over) married women grow over time, especially in the higher growth projections. This growth arises principally from the rising demand for female labour, although it

(ix) the education participation rate of unmarried females aged 15 to 24 years; and

(x) the oral contraceptive usage rate.

There are also five other required variables, four of which are actually simultaneous outputs of the projection facility and the last of which is derived from a combination of the inputs and outputs of the facility. These variables are, respectively:

(i) the infant mortality rate;

(ii) weighted first marriages per married female;

(iii) weighted nuptial confinements per married female;

(iv) children per married female; and

(v) an indicator of demand for female labour.

These inputs are determined within the facility, providing a further link between demographic and economic behaviour.

3. THE EXOGENOUS SCENARIOS

The three projections of Australia's population and labour force presented in this paper employ three exogenous scenarios, corresponding to low, medium and high economic growth. In this section, we consider in turn the assumed demographic scenarios, the assumed economic scenarios and the resultant movements in those inputs to the econometric model which are determined within the projection facility. To aid the reader, a summary of the values for each projection of the exogenous demographic and economic variables and of the simultaneously determined inputs to the econometric model in 1980/81, 1990/91 and 2000/01 are given in Table 1.

The demographic scenarios

For each of the three projections, the same demographic scenarios are used; that is, the future numbers and sex, age and marital status distribution of net international migration, and the future parameters of the eight model schedules of mortality (one for each sex/marital status group) are assumed to be the same for each projection.

Specifically, net annual international migration is assumed to maintain a level approximating 0.6 per cent of the population, such that the net number of migrants for all three projections grows from around 87,500 in 1980/81 to around 115,500 in 2000/01. The differing rates of population growth in the three projections are such that the crude migration rates grow from 5.94 per thousand in 1980/81 for all projections to 5.95, 5.96 and 5.97 per thousand in 2000/01 for the low, medium and high projections respectively. The sex, age and marital status disaggregation of net migration is determined by using the average distribution of

TABLE 6 : PROJECTIONS OF THE LABOUR FORCE BY SEX AND MARITAL STATUS, 1980/81 AND 2000/01.[1]

	1980/81	2000/01		
		Low	Medium	High
Males	4238177 (62.72)	5659680 (62.08)	5660038 (59.60)	5660224 (57.30)
Married females	1513791 (22.40)	1869426 (20.51)	2291146 (24.12)	2702233 (27.36)
Unmarried females	1005799 (14.88)	1587368 (17.41)	1545857 (16.28)	1515631 (15.34)
Total	6757767 (100.00)	9116474 (100.00)	9497041 (100.00)	9878088 (100.00)

1. The proportion (in percentages) of the labour force in each sex and marital status group is given in brackets.

econometric model. In this sub-section, we consider the relationship between variations in economic conditions, as encapsulated by the economic scenarios, and variations in participation rates for married and unmarried women.

According to the econometric model, participation rates for young married women aged 15 to 24 years and 25 to 54 years are influenced by both labour market variables, such as the level of real female wages and the state of the labour market, as well as by fertility variables, such as their recent childbearing experience and their demand for child services. In all three projections, women's participation rates are increased by the growth in demand for child services but diminished by growth in fertility. Movements in the former variable are composed, partly, of a decline in the number of dependent children per married female and, predominantly, of a

female participation rates in the higher growth projections is accompanied by higher growth in the population of married women. In the [low, medium, high] projection, the total married female labour force participation rate grows over the projection period at an average annual rate of [-0.10, 0.77, 1.46] per cent, whilst the number of married women grows at [1.19, 1.30, 1.40] per cent. Consequently, the labour force of married women grows at [1.09, 2.07, 2.86] per cent per year.

The slight decline in the labour force participation rates for males and the large changes in the rates for married women lead to significant variation in the sex and marital status composition of the labour force, as given in Table 6. In all three projections, the share of males in the labour force falls and the share of unmarried females rises, whilst the share of married females falls in the low projection but rises in the medium and high projections. The changes in participation rates are not uniform across ages, as Table 1 shows for males, and Table 5 for females. Participation rates for prime-aged males are assumed to be constant, whilst those for younger and older males decline. The growth over time in participation rates for married women declines with increasing age, whilst the participation rates decline under all scenarios for unmarried women in the young age group (15 to 24 years), increase slightly in the prime aged group (25 to 54 years) under all scenarios, and either remain approximately constant or decline for the older age group (55 years and over).

Why do participation rates vary over time and between scenarios?

The participation rates for males are set exogenously, but those for married and unmarried females of three age groups are determined by the

permanent arrivals and departures over the period 1976 to 1978, with a small adjustment to ensure consistency between the numbers of married male and female migrants.

In all three projections, the parameters of the model schedules of mortality were held constant at their 1975/76 levels over the whole projection period, with the exception that the level parameters were assumed to decline by 1.5 per cent per annum to the year 2000/01, implying an equivalent decline in the age specific death rates for all ages. Given that the population and its sex/age/marital status distribution will vary over time and between the three projections, the number of deaths implied by these death rates will also vary. Thus, the number of deaths in 1980/81 is around 108,650 for all three projections, but by 2000/01 it varies from around 144,500 in the low projection to around 144,000 in the high projection. However, given the assumption of equivalent sex/age/marital status-specific death rates in each projection, it is not surprising to find that the crude death rate is approximately the same in all three projections, having grown from 7.38 in 1980/81 to 7.45 in 2000/01.

The economic scenarios

The economic scenarios generally vary between the three projections, a major exception being that the labour force participation rates for males are assumed to have equivalent future values in all three projections. In the past, male labour force behaviour has been relatively insensitive to small changes in economic conditions, so such an assumption should not be crucial. Specifically, male labour force participation rates in each projection are assumed to decline for 15 to 19 year old males in response to a return to rising education participation for young people,

TABLE 1 : SUMMARY OF THE DEMOGRAPHIC AND ECONOMIC SCENARIOS AND THE SIMULTANEOUS INPUTS TO THE ECONOMETRIC MODEL

Variables[a,b]	1980/81[c]	1990/91[d]			2000/01[d]		
		Low	Medium	High	Low	Medium	High
Demographic scenario							
- net numbers of international migrants	87515		101502			115488	
- crude migration rate (per thousand)	5.94	5.99	5.99	5.99	5.95	5.96	5.97
- number of deaths	108650	125363	125270	125184	144494	144263	144061
- crude death rate (per thousand)	7.38	7.40	7.39	7.39	7.45	7.45	7.45
Economic scenario							
- labour force participation rate for males aged:							
15-19 years	62.8		61.4			60.0	
20-24 years	90.6		90.6			90.6	
25-34 years	95.5		95.5			95.5	
35-44 years	95.9		95.9			95.9	
45-54 years	91.4		91.4			91.4	
55-59 years	83.3		79.0			75.0	
60-64 years	50.1		60.0			50.0	
65 years and over	11.1		10.5			10.0	
- real gross domestic product per head	2762	2735	3051	3401	2735	3371	4145
- real female hourly wage rate	1.41	1.50	1.67	1.87	1.50	1.85	2.27
- female/male relative hourly wage rate	0.93		1.00			1.00	
- unemployment rate	5.63	6.00	4.00	2.00	6.00	4.00	2.00
- real old age pension	51.10	50.59	56.44	62.90	50.59	62.35	76.68
- real widows' pension	45.96	45.50	50.76	56.58	45.50	56.08	68.96
- index of female educational attainment	31.91		35.53			37.65	
- education participation rate of 15-24 year old unmarried females	30.81		37.13			39.21	
- oral contraceptive usage rate	24.00		24.00			24.00	

TABLE 5 : PROJECTED LABOUR FORCE PARTICIPATION RATES (IN PERCENTAGES) FOR MALES AND MARRIED AND UNMARRIED FEMALES, 1980/81 TO 2000/01

	1980/81	1990/91			2000/01		
		Low	Medium	High	Low	Medium	High
Males	78.19		77.51			76.12	
Married females							
- total	44.79	44.24	49.30	54.55	43.56	52.18	60.43
- 15 to 24 years	58.90	58.42	67.32	77.04	56.79	70.68	83.09
- 25 to 54 years	52.46	52.33	57.51	63.27	52.30	61.17	70.03
- 55 years and over	17.22	18.05	20.91	22.60	18.49	23.79	28.04
Unmarried females							
- total	47.82	47.89	48.03	48.22	47.60	47.78	48.04
- 15 to 24 years	65.70	59.80	60.22	60.62	57.83	58.48	59.00
- 25 to 54 years	69.53	70.12	70.97	71.96	70.05	71.75	73.56
- 55 years and over	9.24	9.35	8.98	8.58	9.35	8.69	8.04

FIGURE 6 : PROJECTED LABOUR FORCE PARTICIPATION RATES AND LABOUR FORCE FOR MALES AND MARRIED AND UNMARRIED FEMALES, UNDER SCENARIOS OF LOW (----), MEDIUM (——) AND HIGH (x——x) ECONOMIC GROWTH, 1980/81 TO 2000/01

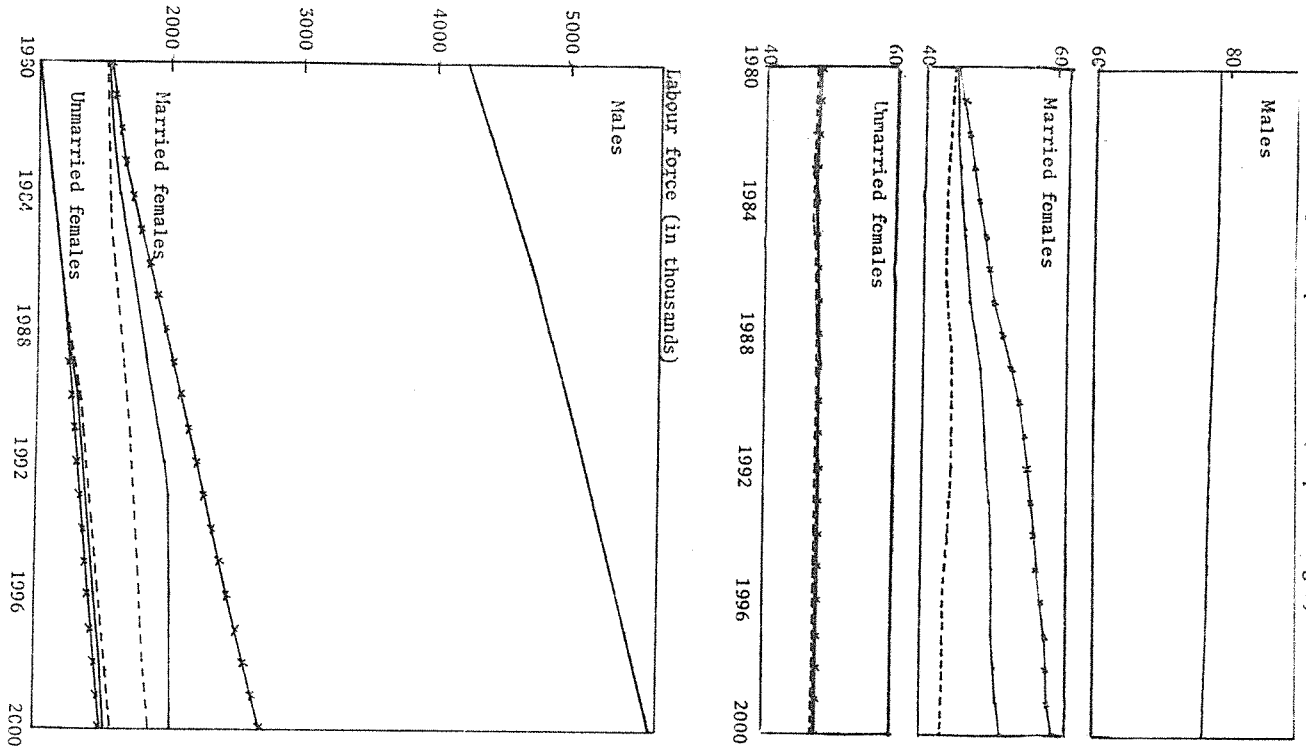


Table 1 (cont'd)

Simultaneous inputs to model

- infant mortality rate	10.91		9.38			8.07	
- weighted first marriages per thousand married females	42.8	47.8	50.2	52.3	49.7	52.4	52.0
- weighted nuptial confinements per thousand married females	101.73	105.86	104.02	102.18	112.25	106.80	101.39
- children per married female	1.09	0.99	0.98	0.97	0.98	0.95	0.93
- indicator of demand for female labour	1.50	1.51	1.58	1.65	1.51	1.61	1.71

a. For a listing of sources and a detailed description of these variables see Brooks (1981).

b. All monetary variables are converted to real terms and expressed in constant 1966/67 Australian dollars.

c. As all variables were projected forwards from known data in 1979/80, there are some minor variations between the values for each scenario in 1980/81 which have not been reported.

d. Where values are quoted only for the medium scenario, the same values apply for all three scenarios.

to remain constant for prime-aged (20 to 54 year old) males, and to decline for older males in response to improved possibilities for, and social acceptance of, early retirement. (However, there is an assumed rise in participation rates for 60 to 64 year olds up to 1990/91 as a consequence of a return to more normal retirement patterns after the substantial early retirement of war veterans in the 1970's).

The three economic scenarios can be best characterised by the assumptions regarding the growth in real Gross Domestic Product per head and the choice of the long term unemployment rate. In the [low, medium, high] growth scenario, real GDP per head grows at [0.0, 1.0, 2.0] per cent per year, while the unemployment rate is [6.0, 4.0, 2.0] per cent after 1990/91. These scenarios are quite pessimistic and do not indicate a return to the high growth economy of the 1960's. Naturally, more optimistic scenarios could have been applied if desired.

The real male hourly wage rate has been assumed to grow at the same rate as real GDP per head and the female/male relative hourly wage rate is assumed to move towards unity by 1990/91 and remain at that level thereafter. Consequently, the real female hourly wage rate is assumed to grow slightly faster than the growth in real GDP per head up until 1990/91 in each scenario. Social welfare payments (that is, the real old age and invalid pension and the real widows' pension) are assumed to grow at the same rate as real GDP per head.

The last three variables are assumed not to differ between scenarios. In all three scenarios, the index of female educational attainment and the education participation rate of 15 to 24 year old

birth rate per married woman aged 15 to 44 years increases from 118.7 in 1980/81 to [127.0, 120.2] in the [low, medium] projection and falls to 113.2 in the high projection.

4.2 The Projections of the Labour Force

The total projected labour force and its components

Projections of the labour force vary over time and between scenarios with changes in labour force participation rates and in the sex/age/marital status structure of the population. In Figure 6, the projected labour force participation rates for males and for married and unmarried females are illustrated along with their contributions to the size of the labour force.

Since the age specific participation rates for males are set exogenously and are assumed to be the same in each scenario, the size of the male labour force and the total male labour force participation rate varies little between the projections. As shown in Table 5, the total participation rate for males declines by only 2.07 percentage points between 1980 and 2000. The total labour force participation rate for unmarried females varies little over time or between the projections, but the size of the unmarried female labour force increases over time and is larger in the lower growth projections. For married women, the total labour force participation rate varies substantially between the projections; under the low growth scenario, the participation rate changes only slightly over the projection period, but, under the higher growth scenarios, the rate increases substantially. The higher growth in married

fall, particularly for higher birth orders. The other component of higher order confinements is the population of women at risk of a confinement at each birth order, which is calculated from past confinements of the previous order. This definition of the women at risk provides an automatic link between past and current confinements, but does not directly relate confinements to the current population of married women. Thus, in the lower growth scenario, where parity progression ratios are relatively unchanged and first nuptial confinements are assumed to grow over the projection period, the number of women at risk continues to grow and the number of confinements at higher birth orders continues to grow. For the higher scenarios, however, parity progression ratios at higher birth orders are declining over time. So, despite increasing numbers of first nuptial confinements, fewer women progress to higher birth orders. This leads to fewer women at risk and an even smaller number of confinements. The decline in confinements at higher birth orders leads to a slower growth in the total number of confinements in the higher growth projections, which is accentuated over time as the number of women at risk continues to decline.

In summary, nuptial confinements increase over the projection period under all three scenarios of economic growth, but the rate of increase is lower under higher economic growth. In calculating the number of births, the addition of constant proportions of multiple births and ex-nuptial births amplifies these differences between the projections. At the same time as births are increasing, the proportion of married women in the population is falling in all three projections. Consequently, in contrast to the decline in the crude birth rate for all three projections, the

married females are both assumed to rise logistically to long term maxima of 40.0 per cent, with the latter rising at a faster rate. Finally, the oral contraceptive usage rate, which has been approximately constant in recent years, is assumed in all three scenarios to remain constant throughout the projection period.

The simultaneous inputs to the model

The simultaneous inputs to the econometric model are determined by the assumptions made earlier for the demographic and economic scenarios and/or by the outputs from the projection facility. The infant mortality rate is determined directly from the assumptions made for mortality in the demographic scenario. Thus, in all three projections, the infant mortality rate is assumed to fall by 1.5 per cent per year.

Weighted first marriages, weighted nuptial confinements and children per married female are all simultaneously determined outputs of the projection facility, which are fed back into the econometric model. For all three projections, weighted first marriages per thousand married females increase over the projection period from 42.8 in 1980/81 to [49.7, 52.4, 52.0] in the [low, medium, high] projections in 2000/01. In 1980/81, weighted nuptial confinements were 101.73 per thousand married females, and in the low and medium projections they increase steadily to 112.25 and 106.80, respectively, in 2000/01. In the high projection, however, the higher economic growth has the effect of reducing weighted nuptial confinements slightly to 101.39 per thousand married females by 2000/01. The cumulative effect of changing marriage, divorce and fertility behaviour over the projection period results in a decline in children per married

female from 1.09 in 1980/81 to [0.98, 0.95, 0.93] in the [low, medium, high] projections by 2000/01.

The indicator of demand for female labour is measured as the ratio of total employment of males and females to the male labour force. Since the male labour force and the unemployment rate are already specified in the economic scenario, the demand for female labour must be simultaneously determined from these values and the equations explaining female labour force participation. The demand for female labour so determined grows over the projection period from 1.50 in 1980/81 to [1.51, 1.61, 1.71] in the [low, medium, high] projections by 2000/01.

The exogenous scenarios outlined above are not an attempt to forecast what will happen in the future; they simply represent three plausible scenarios of future economic growth characterised broadly as low, medium and high. Given the estimated sensitivities of fertility, marriage, divorce and female labour force participation to changes in economic and demographic conditions, we are able, in the next section, to analyse what these scenarios imply for the future population and labour force in Australia. Other economic and demographic scenarios could be developed and their effect upon population and labour force investigated.

that projection. As for the first nuptial confinement rate, however, the rate of growth of the number of women at risk falls over the projection period. As a result of these movements, the number of first nuptial confinements grows over the period for all three projections, with the rate of growth slowing over the projection period. Between the growth scenarios, there are two counteracting influences: the first nuptial confinement rate grows less rapidly with higher economic growth, but the growth rate of the population of married women at risk falls less rapidly with higher economic growth. The outcome of these two influences is that, initially, the growth rate is highest for the high projection but, in the latter part of the projection period, the high projection has the slowest growth in first nuptial confinements.

The number of higher order confinements also varies over time and between scenarios. The mean and variance of implied completed family size are projected to decline over the projection period, for the medium and high projection, and to increase slightly for the low projection. These movements can be attributed to the positive influence of declining infant mortality (in all three scenarios) and of rising real GDP per head (in the medium and high scenarios) and the negative influence of rising female wage rates and social security payments (in the medium and high scenarios). Thus, for the medium and high projections, the negative influences predominate, especially in the earlier part of the projection period, when female wage rates are growing more quickly. As a result of these movements in the mean and variance of implied completed family size, the parity progression ratios for the low projection change very little over the projection period, whilst in the medium and high projection they

family size and the number of women at risk of having a confinement of each order. The parameters of the family size distribution are projected by the econometric model, and are used to determine parity progression ratios at each birth order, whilst the number of women at risk of having a confinement of each order is calculated as a weighted average of past confinements of the previous orders, where the weights approximate the interval between births of each order.

We will consider each of these components of fertility in turn.

Changes in the first nuptial confinement rate projected by the econometric model can be attributed, in all three projections, to the positive effects of increasing numbers of weighted first marriages and to declining infant mortality rates. In the medium and high growth projections, there is an additional positive effect due to increasing real GDP per head, which is generally outweighed by the negative effects of rising female wage rates and the rising old age pension. As a result of these influences, the first nuptial confinement rate projected by the econometric model grows at a declining rate over time for all three projections, with the least growth being obtained in the high economic growth projection. The declining rate of growth over time in all projections is due partly to the declining rate of increase in weighted first marriages, and partly to the declining rate of growth of female wage rates after 1990/91, when female/male equality is assumed to be reached and maintained. The number of married women aged 15 to 44 years grows in all three projections, with the highest rate of growth occurring in the high projection in response to the more substantial marital status change in

4. THE PROJECTIONS OF POPULATION AND LABOUR FORCE

The three exogeneous scenarios outlined in Section 3 were fed into the IMPACT projection facility to produce three projections of population and labour force, corresponding to the low, medium and high economic growth scenarios. These three projections provide an indication of the sensitivity of Australian population and labour force to changing economic conditions, an aspect which will be highlighted in the results reported below.

4.1 The Projections of the Population

The projections of the total population for each scenario, given in Table 2, indicate an annual average growth rate of between 1.46 and 1.44 per cent, with the rate of growth increasing over the projection period. Whilst the differences between the total populations are not substantial, the results show higher population growth under scenarios of lower economic growth. The change in total population numbers over a given period is equal to the total number of births less the total number of deaths plus the total net migration over that period. These components of the total projected population change between 1980 to 2001 and between two sub-periods, 1980 to 1990 and 1990 to 2001, are given in Table 3. Table 3 indicates that the differences in population growth between the three projections are principally due to the higher fertility under the lower economic growth scenarios. For this set of projections, we assume that total net migration numbers are the same for all three scenarios; consequently, the positive contribution to population change from migration

TABLE 2 : THREE PROJECTIONS OF THE TOTAL AUSTRALIAN POPULATION, 1980 TO 2001

As at June	Economic growth scenario		
	Low	Medium	High
1980	14615172	14615172	14615172
1981	14828729	14828810	14828890
1982	15041218	15041196	15041174
1983	15256748	15256475	15256200
1984	15475355	15474629	15473897
1985	15695554	15694178	15692799
1986	15917895	15915679	15913462
1987	16142607	16139399	16136198
1988	16369773	16365457	16361105
1989	16599671	16594150	16588366
1990	16832107	16825296	16817697
1991	17067062	17058890	17049276
1992	17304506	17294894	17283032
1993	17544087	17532954	17518664
1994	17785902	17773156	17756280
1995	18029706	18015240	17995587
1996	18275325	18259016	18236400
1997	18522723	18504346	18478664
1998	18771790	18751103	18722241
1999	19022490	18999237	18966046
2000	19274904	19248822	19210039
2001	19529070	19499899	19454044
Average annual growth rate (in percentages)	1.46	1.45	1.44

are only influenced by the adopted economic scenarios to the extent that these scenarios influence the age and marital status structure of the population. The higher rates of marriage and divorce in the higher growth projections produce a small shift in the age distribution of married couples towards younger ages, thus lowering the widowing rate in those projections.

What do the projections suggest about future fertility patterns?

As discussed above, and depicted in Figure 2, the projections indicate an increasing number of births, but a declining crude birth rate, for all three scenarios of demographic and economic growth, with a much faster decline in the crude birth rate in the case of the higher growth projections. As outlined in Section 2, the fertility projections assume that ex-nuptial births are a constant proportion (set at ten per cent in all three scenarios) of total births and that nuptial births are a constant multiple (set at 1.01 in all three scenarios) of nuptial confinements. Thus, variations in fertility over time and between projections derive from variations in nuptial confinements, which depend upon:

(i) variations in the number of first nuptial confinements which, in turn, depend upon the first nuptial confinement rate projected by the econometric model and the number of women at risk (which is broadly defined as the number of married women aged 15 to 44 years); and

(ii) variations in the number of higher order confinements which, in turn, depend upon the mean and variance of implied completed

rates of the rising relative wage rate and level of educational attainment to dominate the positive effect of the growth in demand for child services. In the medium and high growth projections, however, there are greater positive contributions from the growing demand for child services and increasing real GDP per head which lead to increased marriage rates. The population at risk of marriage partly determines marriage behaviour and is, in turn, altered by it. This relationship is most readily observed in the case of remarriage of divorcees, where the annual number of remarriages of divorcees increases substantially over the projection period, predominantly in response to the rapidly increasing population of divorced persons.

The popularity of divorce, in the econometric model, is positively related to the growth in real GDP per head, in the relative wage rate and in the real widows' pension and to the decline in the number of children per married woman. The latter variable is the dominant influence producing the rising divorce rates in the first decade of the projection period, but its effect is lessened after 1990/91, when its rate of decline slows. The assumed constancy after 1990/91 in the relative wage rate in all scenarios also contributes to a slower growth in divorce rates in the latter half of the projection period. Higher levels of real GDP per head and of the real widows' pension contribute to higher divorce rates in the medium and high growth projections. Whilst the relative size of the population at risk of divorce, the married population, falls in all three projections, this is less pronounced in the high and medium projections, providing a further impetus for their relatively higher levels of divorce.

Since widowings are calculated by applying the appropriate death rates of married men and women to the age distributions of spouses, they

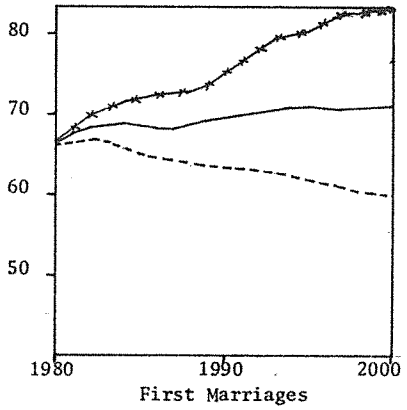
TABLE 3 : COMPONENTS OF PROJECTED POPULATION CHANGE, 1980 TO 2001

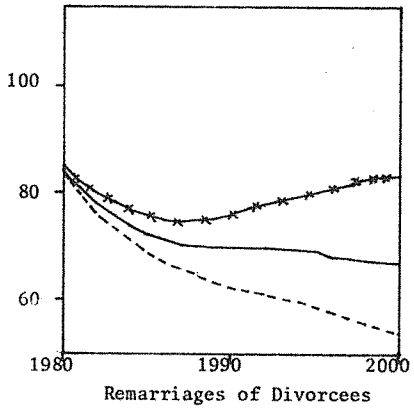
	Projection period		
	1980-1990	1990-2001	1980-2001
Low economic growth scenario			
Population change	2216935	2696963	4913898
Births	2436223	2987521	5423744
Deaths	1157382	1484003	2641385
Migration	938093	1193445	2131538
Medium economic growth scenario			
Population change	2210124	2674603	4884727
Births	2429035	2963400	5392435
Deaths	1157003	1482242	2639245
Migration	938093	1193445	2131538
High economic growth scenario			
Population change	2202525	2636347	4838872
Births	2421059	2923543	5344602
Deaths	1156625	1480642	2637267
Migration	938093	1193445	2131538

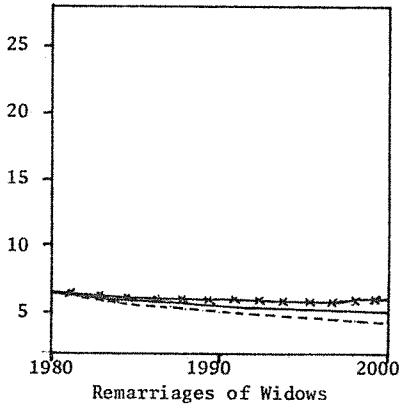
is the same in all three projections. We also assume that mortality parameters are the same for all three scenarios, implying that the numbers of deaths will only vary between projections with differences in population size and its sex/age/marital status structure. As Table 3 shows, the negative contribution from deaths, when compared with the medium projection, is slightly lower for the high projection (0.07 per cent) and slightly higher for the low projection (0.08 per cent). These differences between the projected deaths are predominantly the result of the slower population growth under the higher economic growth scenarios. Thus, as the projected populations diverge more over time, so too do the differences between the projected deaths. By far the most important source of the differences between the three projected populations, however, is the number of births. The positive contribution of births to population change over the projection period varies from 5,423,700 in the low projection to 5,344,600 in the high projection. Unlike deaths, this variation cannot be predominantly attributed to differences in population growth. In Figure 2, the number of births and the crude birth rate are depicted for each of the three projections. It is the substantial differences in the crude birth rates that are the source of the variation in the numbers of births and, given the similarity of migration and deaths between the projections, in the projected populations. The reasons for these differences in fertility between the projections will be discussed later.

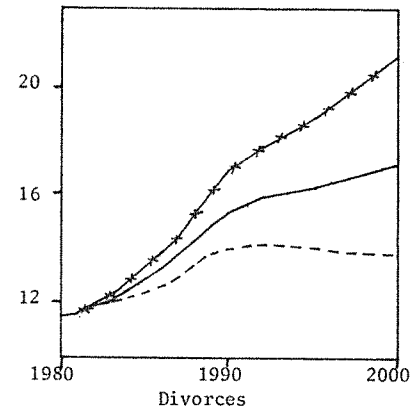
Population pyramids, as depicted in Figure 3, provide a convenient means of observing changes in the age and marital status distribution of projected populations. The pyramids provide clear evidence of the ageing of the Australian population -- whatever the scenario of

FIGURE 5 : PROJECTED CRUDE MARITAL FLOW RATES (PER THOUSAND) FOR FEMALES, UNDER SCENARIOS OF LOW (----), MEDIUM (——) AND HIGH (x——x) ECONOMIC GROWTH, 1980/81 TO 2000/01









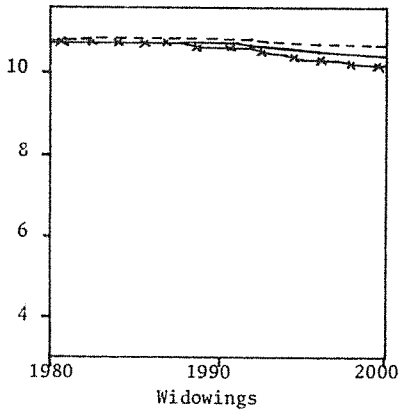
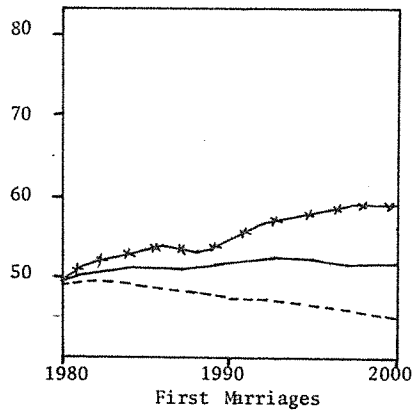
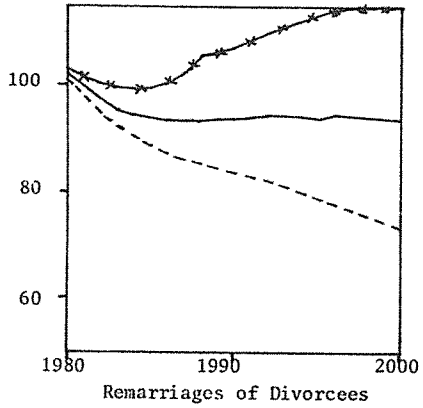
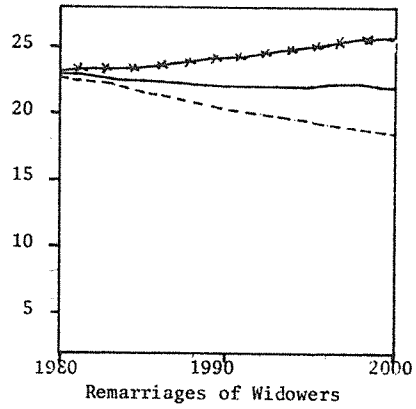
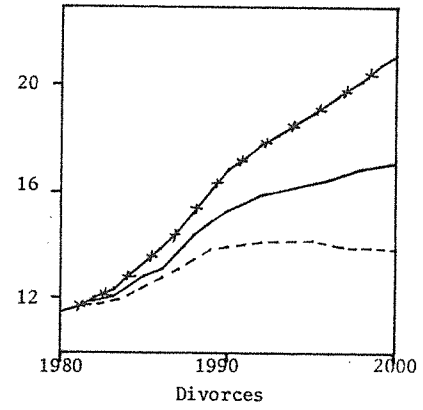


FIGURE 4 : PROJECTED CRUDE MARITAL FLOW RATES (PER THOUSAND) FOR MALES, UNDER SCENARIOS OF LOW (----), MEDIUM (——) AND HIGH (x——x) ECONOMIC GROWTH, 1980/81 TO 2000/01









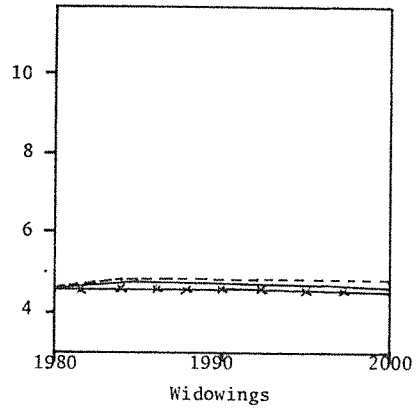
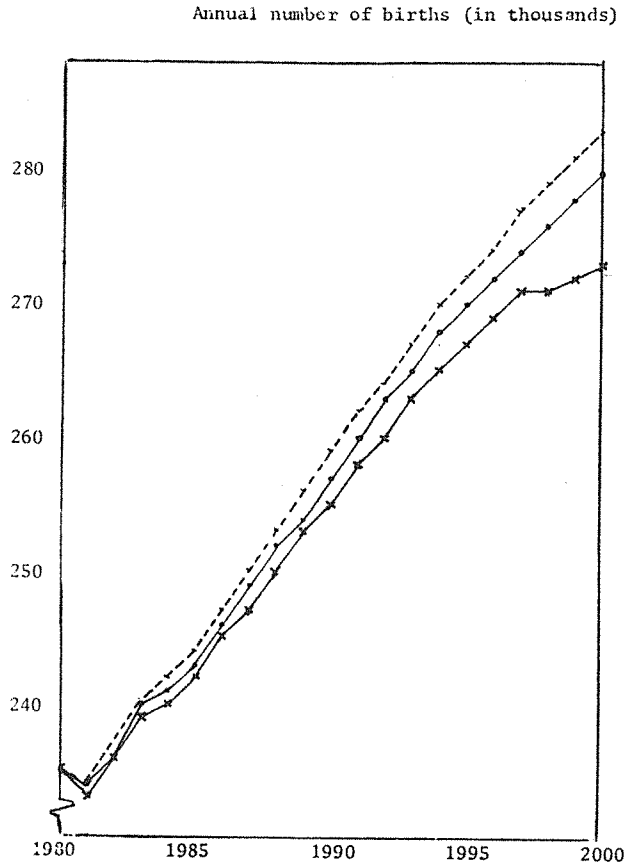


FIGURE 2 : PROJECTED ANNUAL NUMBER OF BIRTHS AND CRUDE BIRTH RATE, UNDER SCENARIOS OF LOW (----), MEDIUM (——) AND HIGH (x——x) ECONOMIC GROWTH, 1980/81 TO 2000/01



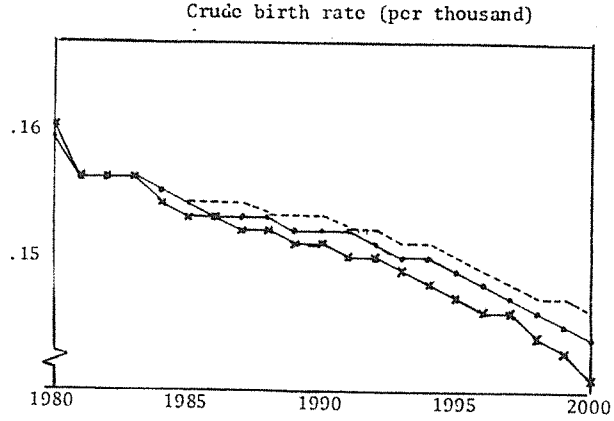
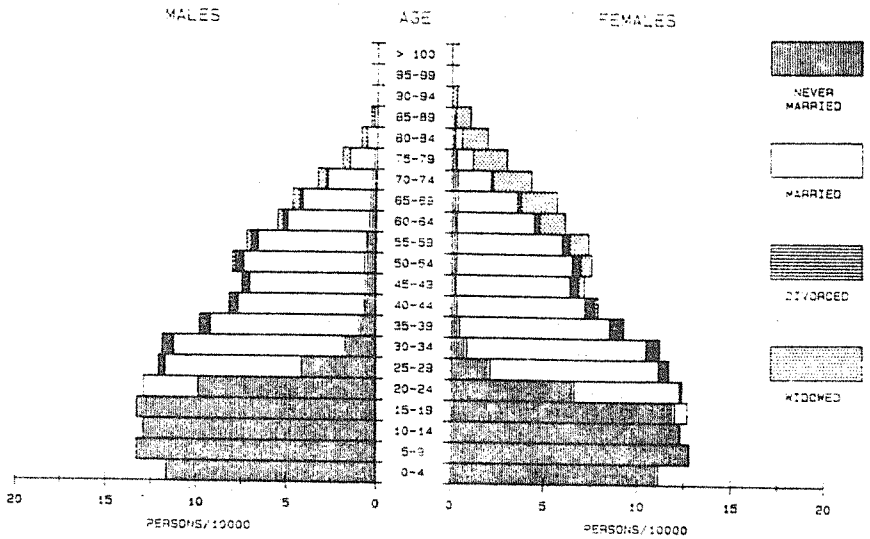
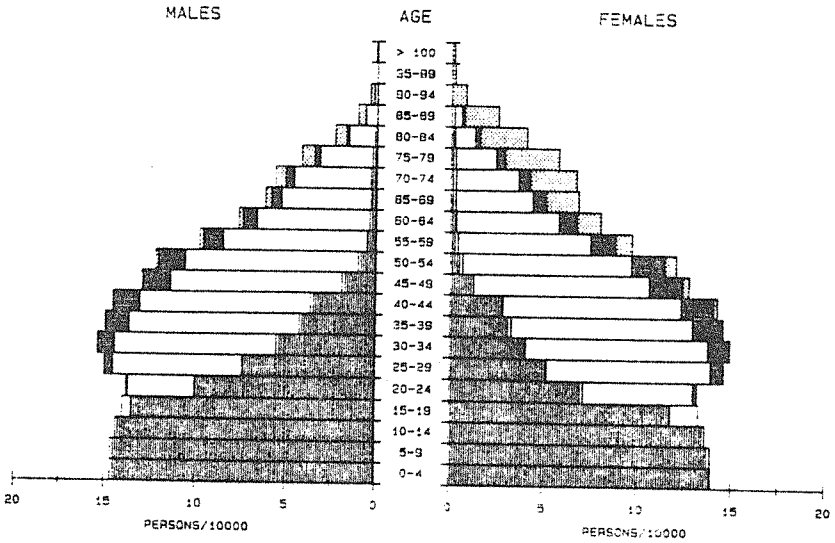


FIGURE 3 : AGE AND MARITAL STATUS PYRAMIDS FOR THE AUSTRALIAN POPULATION AS AT JUNE 1980 (ACTUAL) AND 2001 (PROJECTED UNDER SCENARIOS OF LOW, MEDIUM AND HIGH ECONOMIC GROWTH)



JUNE POPULATION 1980.



JUNE POPULATION 2001. LOW GROWTH SCENARIO

(ii) variations in the projected population at risk of such marital status changes.

The marital status changes projected in the above manner are also reconciled to balance the mutual demands for marriage by each sex on the opposite sex, to ensure that divorces of each sex are consistent with divorces of the other sex and to ensure that deaths of married persons of each sex are consistent with the widowings of their spouses. Whilst this reconciliation process forces some adjustment, the projected rates of marriage and divorce are predominantly determined by the econometric model, and projected widowings are predominantly determined by the death rates of married persons. We will consider the determinants of marriage, of divorce and of widowing in turn.

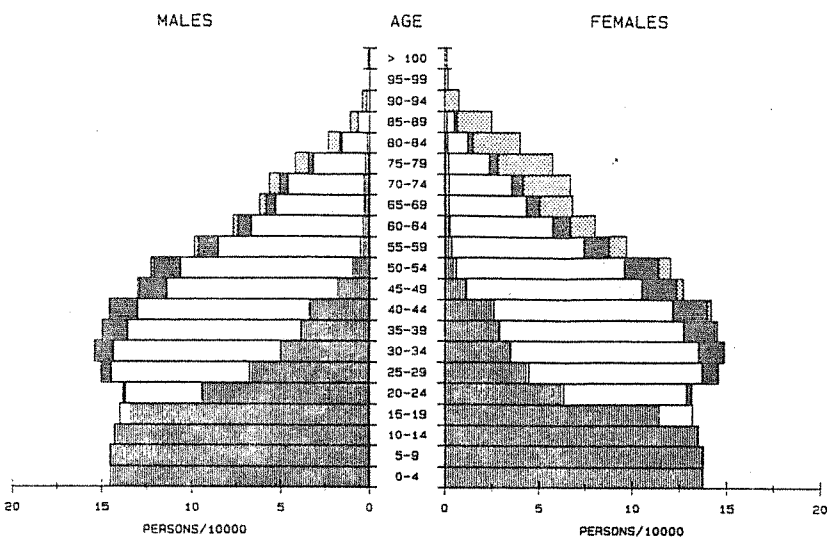
According to the econometric model, changes in the popularity of first marriage, remarriage of divorcees and remarriage of widowed persons can be attributed to the positive effects of rising demand for "child services" and rising real GDP per head, and to the negative effects of the increasing female/male relative wage rate and the increasing level of female educational attainment. The demand for child services, which is simultaneously projected by the econometric model, increases more rapidly in the higher growth projections, although this growth rate declines after 1990/91, principally as a result of the assumed slower growth in real female wage rates after that date. In all three scenarios, the female/male relative wage rate grows to unity by 1990/91 and remains constant thereafter, whilst the level of female educational attainment increases throughout the projection period. The combined effect of these influences, in the low growth projection, is for the negative effects upon marriage

being higher for those projections which assume higher economic growth. At the same time, the proportions married are projected to decline, with this decline being less severe for the projections assuming higher economic growth. This seemingly anomalous result follows from the projected crude rates of marital status change for males and females, depicted in Figures 4 and 5. For first marriages, remarriages and divorces, for both males and females, higher crude rates are projected for the higher growth scenarios. For first marriages of males and females, the crude rate increases over the projection period for the high and medium projections, but falls for the low projection. For remarriages, the crude rate generally increases for only the high projection and, for divorces, the crude rate increases in all projections, but more so for the high projection. Thus, the presence of higher economic growth tends to promote increased movement between marital states, with the result that, in the higher growth projections, the proportions never married fall whilst the proportions married and divorced increase over the sample period.

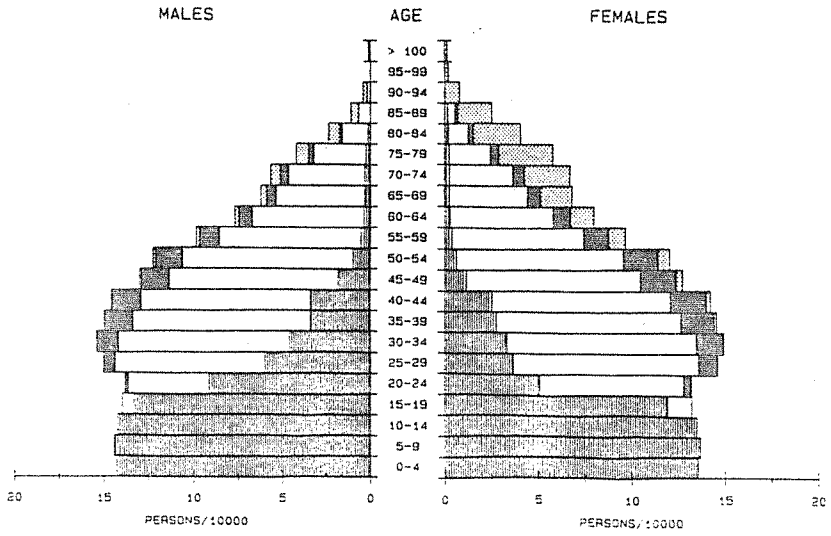
In the facility, movements in marital status change, over time and between projections, depend upon:

(i) variations in the age specific rates of marriage, divorce and widowing which, for marriage and divorce, are derived using model schedules and the econometric model projections of the propensity, mean and variance of the age distribution of marriage and divorce, and, for widowing, are derived from the death rates of married persons; and

FIGURE 3 *continued ...*



JUNE POPULATION 2001. MEDIUM GROWTH SCENARIO



JUNE POPULATION 2001. HIGH GROWTH SCENARIO

economic growth chosen. In all three projections, the population of children (defined as persons under 15 years) falls over the projection period from over 25 per cent in 1980 to [21.8, 21.7, 21.5] per cent in the [low, medium, high] projections in 2001. The fall is more severe for the high projection as a result of its lower fertility. The proportion of older persons (defined as persons 65 years and over) increases in all three projections from 9.6 per cent in 1980 to [12.15, 12.17, 12.20] per cent in the [low, medium, high] projections by 2001. This ageing of the population does not, however, imply an increase in the dependency ratio (defined as the number of dependents -- persons under 15 years plus persons over 64 years -- divided by the population of working age -- persons aged between 15 and 64 years). In fact, the dependency ratio falls from 53.8 per cent in 1980 to [51.4, 51.2, 50.8] per cent in the [low, medium, high] projections in 2001. This is a result of several factors. *First*, the ageing process has not been as severe as declining death rates would suggest because the people moving into the aged group during the projection period are the relatively small cohort who were born in the low fertility years of the Depression. *Second*, the population of working age is still enlarged by the cohort who were born in the "baby-boom" of the 1950's. *Third*, the assumption of a continued migration level of around 0.6 per cent of the population also serves to swell the population of working age.

The pyramids in Figure 3 also indicate substantial changes in the marital status distributions of the projected populations. The most significant change over the sample period is the growth in proportion of divorced males and females. As Table 4 shows, the proportion divorced for both sexes is projected to double by the year 2001, with that proportion

TABLE 4 : PROJECTED MARITAL STATUS PROPORTIONS FOR ADULT MALES AND FEMALES, 1980 AND 2001

		2001		
Males	1980	Low	Medium	High
Never married	31.4	32.7	31.0	29.6
Married	62.2	57.6	59.0	60.1
Divorced	3.8	7.0	7.4	7.8
Widowed	2.6	2.7	2.6	2.5

		2001		
Females	1980	Low	Medium	High
Never married	23.0	24.7	22.8	21.3
Married	61.6	56.2	57.5	58.6
Divorced	4.4	8.8	9.3	9.8
Widowed	11.0	10.4	10.4	10.3