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RESEARCH REPORT

The labour force participation of Australian mature-aged men: the role of spousal participation

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NATIONAL INSTITUTE OF LABOUR STUDIES
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This research was funded through an early career researcher funding round. These grants provided an opportunity for early career researchers, from disciplines such as economics and the social sciences, to undertake a modest research project in a topic relevant to NCVER's remit.

Professor Kostas Mavromaras, Director, National Institute of Labour Studies, was the mentor for Rong Zhu on this project.

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HILDA data

This paper uses unit record data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. The HILDA Project was initiated and is funded by the Australian Government Department of Social Services (DSS) and is managed by the Melbourne Institute of Applied Economic and Social Research (Melbourne Institute). The findings and views reported in this paper, however, are those of the author and should not be attributed to either DSS or the Melbourne Institute.

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About the research

The labour force participation of Australian mature-aged men: the role of spousal participation

Rong Zhu, National Institute of Labour Studies, Flinders University

An important policy concern for many Organisation for Economic Co-operation and Development (OECD) countries, including Australia, has been the potential impact on society of an aging population. Labour force participation and retirement decisions are of particular interest and in Australia one policy focus has been on keeping mature-aged people in employment longer, the rationale being that this may mitigate the impacts on areas such as pension and health systems.

While the participation rate for mature-aged men and women in the labour force has increased significantly over the last decade, there are several factors which influence the decision to work or not. Using data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey, the research addresses the interdependence of the labour force participation decisions of mature-aged couples from 2001 to 2011.

This research was funded with a grant that provides an opportunity for early-career researchers from disciplines such as economics and the social sciences to undertake a modest research project in a topic relevant to NCVER's remit.

Key messages

- The wife's choice to participate in the labour force influences directly the husband's decision to participate. Interestingly, the reverse does not hold true.
- The increased participation of married women in the labour force resulted in a four-percentage-point increase in the participation of mature-aged married men between 2001 and 2011.
- This relationship exists even when the persistence of labour force participation of mature-aged married men is taken into account.

The paper identifies that strategies and policies to increase workforce participation need to be based on joint modelling of the labour force decisions of couples. If there is a desire to increase the workforce participation of mature-aged men, policy should also consider increasing the participation of women.

Rod Camm
Managing Director, NCVER

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Executive summary

This paper investigates the labour force participation decisions made from 2001 to 2011 by older Australian couples. It focuses on couples with a mature-aged husband and estimates the interdependence of the labour force participation decision of the couple using data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey.

This study questions the understanding of labour force participation in today's research; namely, whether the labour force decisions made by couples are interdependent or not.

The paper contains several sophisticated empirical investigations that use the HILDA Survey for the years 2001 to 2011. The paper also applies a decomposition analysis, which allows us to judge the macroeconomic relationship between male and female employment in the context of how the increase in wives' labour force participation leads to corresponding increases in the participation of their husbands.

The paper finds evidence that the employment of wives encourages the employment of their mature-aged husbands. The paper estimates that the increased participation of married women in the labour force between 2002 and 2011 has been responsible for about a four-percentage-point increase in the participation of their mature-aged husbands.

This paper makes some contributions to the present literature. First, it uses a broad array of advanced econometric methods and shows how these can be crucial for the correct understanding of the evidence. Second, it provides supportive arguments to caution against the use of analysis that ignores the interdependence of the decisions of wives and husbands. Third, the paper offers novel evidence on the macroeconomic development of employment rates in Australia: the positive impact exerted by increasing female employment rates on male employment rates, which shed new light on the complementarity between male and female employment.

Introduction

Since the mid–1990s, most Organisation for Economic Cooperation and Development (OECD) countries, including the United States, the United Kingdon, Canada, Germany, Spain, France and the Netherlands, have witnessed a significant increase in the labour force participation rates of mature-aged men. Similarly, for Australia, the participation rate for mature-aged men has significantly increased during the last decade. OECD countries view the retirement decisions of mature-aged people with high interest, largely because of the demographic changes in economies and the pension-financing issues that have been caused by increased longevity (Department of Education, Employment and Workplace Relations 2003; Schirle 2008; Buddelmeyer, Lee & Wooden 2010).

This paper focuses on one core aspect of labour force participation; namely, the interdependence of the participation decisions and the outcomes for mature-aged couples. The specific question addressed is how the labour force participation of a wife may influence that of a husband aged between 55 and 64 years. The existing literature has shown that the retirement status of a wife significantly affects the retirement preference of a husband, while wives seem to be less sensitive to the participation status of their husbands (Gustman & Steinmeier 2000; Coile 2004). In this paper we examine whether changes in the participation rates of mature-aged men can be explained by the changes in the participation rates of their spouses. If the decision of a wife to work has a postitive effect on her husband's decision to work, then this would illustrate the need to base employment policy deliberations on the *joint* modelling of labour force participation decisions of couples. If there are private and public gains to be made by increasing the labour market participation of mature-aged men, then policy should also consider the impact of increasing female labour market participation as a means through which mature-aged men's participation may be increased.

Using data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey, we find that the participation rate of mature-aged men increased from 62% in 2001 to 73% in 2011, and in the same period, the participation of their wives increased from 50% to 63%. We also observe substantial male—female differences in aggregate participation rates, but their speed of increase and the patterns are similar.

The first step of the analysis uses multivariate regression to estimate the labour force participation propensity of mature-aged men and to examine how the participation of a husband may be influenced by the participation of his wife. In the general labour market context of ongoing increasing female participation, this relationship is important.

The second step of the analysis uses the multivariate regression results to decompose the extent to which the participation of a husband is dependent on (i) the personal characteristics and circumstances of the husband; (ii) the participation of his wife; and (iii) other unobservable factors. The use of participation estimation results to carry out the decomposition analysis is important in the context of continual demographic and economic change.

Both models show that the participation of men is influenced in a positive way by the participation of their wives.

We develop our analysis further by modelling an important factor that has been ignored in the previous literature; namely, that the labour force participation of mature-aged men may be persistent. Persistence refers to the cases where the individual participation status in one period may be

correlated with that of future periods. Without controlling for the persistence of the participation of a husband, the effect of the participation of his wife may be overstated if a positive correlation between the participation of the wife and that of her husband in the previous year had occurred. Our regression and decomposition results show that the role of labour force participation of the wife driving up her husband's participation rate can be overstated if the participation persistence of the husband is ignored. Estimation results confirm this by finding that the incorporation of persistence reduces the magnitude of the effect of the participation of a wife on the participation of her husband. The decomposition analysis shows that around 38% of mature-aged men's increasing participation during 2002—11 is attributable to the growing labour force participation of their wives. The participation rate of mature-aged men would have been about four percentage points lower had the participation rate of their wives not risen from 48% in 2002 to 63% in 2011.

This report is organised as follows. The next section discusses recent trends in labour force participation. The section that follows describes the link between data and theory, while the next describes the empirical framework. The main results are reported in the following section and the last section provides the conclusion. The appendices include details about the econometric modelling and a very brief consideration of some of the literature influencing this study.

Trends in labour force participation

This paper uses the first 11 waves (2001—11) of the Household, Income and Labour Dynamics in Australia Survey. As a nationally representative panel survey, HILDA collects rich information on people's demographics, education and labour market dynamics. A detailed description of the data is found in Wooden and Watson (2007).

For this analysis, we focus on males aged between 55 and 64 years. Australian men and their spouses are matched using household and relationship identifiers in the data. Couples where the husband or the wife have unknown or missing labour force status are excluded. Observations with missing information on any of the key variables displayed in table 1 are also dropped. We also exclude from the sample any husband who is more than 15 years younger or 15 years older than his wife, as the labour supply behaviour of couples with extreme age differences can be quite different (Schirle 2008). This gives us a final sample of 6684 observations from 2001 to 2011 (table 2).

Table 1 Participation rates of mature-aged men

	All married men	Men with wife in labour force	Men with wife not in labour force
2001	0.62	0.83	0.42
2002	0.63	0.84	0.44
2003	0.66	0.84	0.47
2004	0.68	0.83	0.49
2005	0.68	0.83	0.49
2006	0.71	0.85	0.49
2007	0.72	0.87	0.48
2008	0.70	0.85	0.46
2009	0.73	0.86	0.50
2010	0.73	0.85	0.52
2011	0.73	0.86	0.51
All years	0.69	0.85	0.48

Source: Household, Income and Labour Dynamics in Australia Survey, 2001–11.

Table 1 presents the labour force participation rates of (i) all mature-aged married men; (ii) all mature-aged men with a participating wife; and (iii) all mature-aged men with a non-participating wife. Table 1 reveals three broad patterns: (i) the participation rates are much higher for those men whose wives are in the labour force; (ii) the proportions of men in the labour force with participating wives remained relatively stable between 2001 and 2011; and (iii) in contrast, the participation rates of husbands with a non-participating wife increased significantly, from 0.42 in 2001 to 0.51 percentage points, in 2011.

Patterns (ii) and (iii) indicate that the increase in the participation of wives observed in table 2 (from 50% in 2001 to 63% in 2011) cannot be the sole reason for the participation rate of their husbands increasing (from 62% in 2001 to 73% in 2011), and that there will have been other factors that drive up the participation rates of married men. However, looking at the statistics presented in tables 1 and 2 jointly suggests that the increase in the participation of wives is indeed an important reason. Over the whole observation period, a mature-aged man with a participating wife (0.85) is 37 percentage points more likely to be a labour force participant than his counterpart with a non-participating wife (0.48). The relevant difference to observe here is that the participation rate of men with participating wives

increased by only three percentage points between 2001 and 2011 (from 83% to 86%), while for men with non-participating wives the corresponding increase was nine percentage points (from 42% to 51%).

Table 2 presents the summary statistics of Australian mature-aged men's labour force participation and other key variables used for this study. For all married men, the participation rate has risen from 0.62 in 2001 to 0.73 in 2011. The trend of increasing participation in Australia is similar to the corresponding trends in the US, UK and Canada. During the same time, the spousal participation rate of these men increased substantially from 0.50 in 2001 to 0.63 in 2011, an increment of 13 percentage points, as shown in table 2. One interesting observation is that most of the increase in the participation of men in Australia took place during 2001—07, where the rate climbed from 0.62 to 0.72. During the remaining years in the data (2008—11), the participation rate of men was largely unchanged, from 0.70 in 2008 to 0.73 in 2011. Interestingly, the same pattern also held for their spouses. Female participation increased from 0.50 in 2001 to 0.61 in 2007, but remained very stable at around 0.63 during 2008—11. It seems that the labour force participation rates for both mature-aged men and their wives increased and followed a shared pattern and speed. The question we ask in this paper is: What is the extent to which the participation of men is influenced by the participation of their wives.

Table 2 also presents the means for all control variables used in our analysis by year. These are largely factors that can be expected to either influence or at least be correlated with the labour force participation decision. Like most labour market decisions, the retirement decisions of mature-aged men will be associated or affected by their education levels. Education is known to be positively associated with labour force participation (Buddelmeyer, Lee & Wooden 2010). Age can be expected to play a role in many ways, including the preference for leisure, where it is known that, on average, an individual's marginal utility of leisure increases with age (Schirle 2008). We would therefore expect that age would exert a positive influence on the propensity to retire.

We account for the number of children within the household, whether the husband was born in a non-English speaking country and whether he has a long-term health condition. As several studies have demonstrated, whether the husband has a long-term health condition is a significant determinant of retirement decisions (Au, Crossley & Schellhorn 2005; Dwyer & Mitchell 1999). Similarly, whether the husband was born in an English-speaking country may influence labour force participation (Buddelmeyer, Lee & Wooden 2010). This variable is expected to capture some cultural differences in the participation behaviour of mature-aged men from different backgrounds. The inclusion of a region variable (whether the husband lives in a major city or in a regional or remote area in Australia) and the set of variables indicating the state/territory of residence are used to control for the labour market conditions that face each individual. We also report wife-related information; namely, the age of the wife and the age difference between the husband and wife. As discussed in Schirle (2008), the larger the age gap between husband and wife, the more likely it is that the retirement of the husband may be financially supported by the income of the working wife. In this sense, controlling for the couple's age difference would serve to capture some of the income effect stemming from the participation of the wife.

Table 2 Characteristics of married men aged 55–64 years, Australia

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Participation rate	0.62	0.63	0.66	0.68	0.68	0.71	0.72	0.70	0.73	0.73	0.73
Age	59.33	59.25	59.05	59.10	59.16	59.13	59.23	59.31	59.32	59.40	59.55
Education:											
Year 12 and below	0.45	0.43	0.43	0.43	0.42	0.40	0.37	0.36	0.35	0.33	0.31
Diploma or certificate	0.41	0.40	0.37	0.36	0.36	0.38	0.39	0.40	0.39	0.39	0.41
University degree	0.15	0.17	0.20	0.20	0.21	0.22	0.24	0.24	0.25	0.28	0.28
Number of children	0.48	0.45	0.46	0.43	0.42	0.48	0.45	0.48	0.50	0.54	0.56
Not born in English-speaking country	0.20	0.19	0.17	0.15	0.15	0.14	0.12	0.13	0.13	0.13	0.14
Long-term health condition	0.38	0.36	0.42	0.39	0.42	0.40	0.39	0.39	0.38	0.37	0.35
Area:											
Major city (reference category)											
Regional or remote Australia	0.42	0.41	0.42	0.44	0.43	0.42	0.44	0.44	0.45	0.44	0.42
State:											
NSW	0.32	0.30	0.29	0.28	0.29	0.29	0.30	0.30	0.30	0.30	0.31
Vic.	0.27	0.27	0.27	0.26	0.26	0.26	0.23	0.23	0.21	0.23	0.22
Qld	0.18	0.18	0.20	0.20	0.19	0.19	0.19	0.20	0.21	0.19	0.19
SA	0.09	0.09	0.09	0.10	0.10	0.10	0.11	0.10	0.11	0.11	0.12
WA	0.10	0.10	0.11	0.11	0.11	0.11	0.10	0.11	0.11	0.12	0.11
Tas.	0.03	0.02	0.03	0.03	0.03	0.04	0.04	0.03	0.03	0.02	0.02
NT	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
ACT	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Spouse:											
Participation rate	0.50	0.48	0.52	0.54	0.56	0.59	0.61	0.63	0.64	0.63	0.63
Age	56.11	55.99	55.77	55.98	56.03	56.20	56.32	56.37	56.30	56.53	56.79
Age difference	3.23	3.26	3.28	3.12	3.13	2.97	2.92	2.94	3.01	2.88	2.76
Mother employed when wife was aged 14 years	0.37	0.38	0.38	0.40	0.42	0.44	0.43	0.43	0.46	0.46	0.47
Observations	631	571	584	552	575	565	561	586	636	613	810

Source: Household, Income and Labour Dynamics in Australia Survey, 2001–11.

Linking theory with data

This section discusses briefly how the labour force participation decision of a mature-aged man can be influenced by the participation decision of his wife. We focus on the basic underpinning principles of economic theory and the resulting intuition. There are two pertinent economic forces at play in the context of making consumption decisions: the income effect and the substitution effect. The income effect stemming from the workforce participation of a wife predicts that a husband will work less when his wife works. The reason is that when the wife works, the added income brought to the family by her work will typically allow for higher consumption by both her and her husband, which may also include added leisure time consumption by her husband. The income effect is expected to increase the husband's consumption of leisure time and reduce his propensity to participate in the labour force, which means the income effect is always negative.

The substitution effect stemming from the workforce participation of a wife is a bit more complex. The workforce participation of a wife can exert an influence on the participation decision of her husband through three possible channels: (1) if the couple makes *independent* leisure decisions, then the substitution effect should not affect the decision of the husband to work or not (in this case we say that there is no substitution effect); (2) if the couple makes *interdependent* leisure decisions and they prefer to share leisure time together (positive preference for shared leisure), then the decision of the wife to participate should make it more likely that the husband will also decide to participate (in this case we say that there is a positive substitution effect); and finally, (3) if the couple makes *interdependent* leisure decisions, but they prefer not to share leisure time together (negative preference for shared leisure), then the decision of the wife to participate should make it less likely that the husband will also decide to participate (in this case we say that there is a negative substitution effect).

The sum of the income and substitution effects will form the overall participation effect observed. Considering the net influence of the substitution effect and income effect, a participating wife will reduce the participation of her husband (overall negative effect) when the couple make independent decisions regarding leisure time (that is, zero substitution effect), or when the couple have a negative preference for shared leisure time (that is, when they would prefer not to spend their free time together, in which case we say there is a negative substitution effect), as in these two cases the income and substitution effects will be negative. When a couple has a positive preference for shared leisure (that is, when they would like to not work and would like to spend their free time together, in which case we say there is a positive substitution effect), the net effect is indeterminate and could be positive if the (positive) substitution effect is larger than the (negative) income effect, or negative, if smaller.

The way we link the theory with the data in this paper is by using the HILDA Survey data from 2001 to 2011 to estimate the influence of the participation of a wife on the participation of her mature-aged husband. If we find that the overall impact is negative, we will not be able to draw any conclusions. If we find a positive overall impact, then we can say that we have evidence suggesting that, on average, the couples in our data have a positive preference for shared leisure and that the substitution effect is stronger than the corresponding income effect.

Empirical methodology

Before presenting the multivariate analysis results, we outline the main econometric methods used in this paper. More details about the empirical methods can be found in the appendix.

Probit regression

The variable of interest (often called outcome, explained, or dependent variable) is defined to be the labour force participation status of Australian mature-aged men, which is a binary variable, which takes the value of 1 if a man participates in the labour force and 0 otherwise. The appropriate estimation model for variables that take only the values 1 (for yes) and 0 (for no) is the probit model. We use the set of explanatory variables presented in table 2. We present both the coefficient estimates, which are the direct estimates of the parameters specified in the probit model and their marginal effects (ME), which are probability statements and are more informative when examining the effect of the explanatory variables on the outcome/dependent variable. For example, if the explanatory variable 'wife' has a ME of 0.214 in the probit estimation, as shown in table 3, we can interpret this result as a suggestion that, on average, a husband with a wife in the labour force is 21.4 percentage points more likely to be in the labour force than a husband with a non-participating wife.

Bivariate probit regression

By design, probit estimation treats the labour force participation decision of the wife as exogenous, as it cannot make a provision for any interdependence, which is tantamount to assuming that the participation decision of a wife is not affected by the participation decision of her husband.[1] We believe that this assumption is not realistic and our expectation is that the labour supply decisions of couples are jointly determined. In this sense, the status of a wife is endogenous. Whether our expectation is supported by the data or not is a testable hypothesis, and we test it below. In order to take the joint decisions of couples explicitly into consideration, we use the bivariate probit model for estimation. A bivariate probit model estimates simultaneously two equations: one for the labour force participation of the husband and one for the participation of the wife. We present both coefficient estimates and marginal effects. The interpretation of marginal effects in a bivariate probit model is similar to that in probit estimation. Using table 3 as our example, the marginal effect of the participation of a wife is 0.564, which means that a participating wife will make her husband 56.4 percentage points more likely to be in the labour force. After we drop the assumption of independence of the decision of the husband and the wife, we find that in the joint decision context, the participation of the wife still not only has an effect on the participation of her husband, but we also find that the effect is larger.

It is worth recalling the implications of the main difference between the probit and the bivariate probit estimates in intuitive terms. The probit estimates are based on the assumption that the decisions of the husband and the wife are made independently. We know that, if this assumption does not hold, the probit model will underestimate the relationship between the participation of the husband and that of his wife. In contrast, the bivariate probit does not make this restrictive assumption and produces estimates of the interdependence of the decisions. The significance of the

[1] In this context these two terms 'regression' and 'estimation' can be safely treated as synonyms.

bivariate probit estimates will be used as an indication of whether the independence assumption is supported by the data, and their size and sign will inform us about the way the income and substitution effects may be working in this particular part of the labour market.

Decomposition method

Table 2 shows that the labour force participation of both wives and husbands increased by over 10% over the 2001—11 period. Given that we are testing the extent to which the participation of the wives may influence the participation of their husbands, we are interested to know the extent to which the observed increase in the participation rates of husbands between 2001 and 2011 may be attributable to the observed increase in the participation rates of their wives. When asking this question, we recognise that there will be other factors that may have contributed to the observed increase in the participation of husbands, so we need to use a method that distinguishes between the effects of different factors on the observed overall change in participation.

For this purpose, we use the decomposition method developed by DiNardo, Fortin and Lemieux (1996). There are three categories of factors that may help to explain the increases in labour force participation: a spousal participation increase; a change in individual characteristics; and other unexplained effects not measured by our data, due to omitted (unobserved) variables. The DiNardo, Fortin and Lemieux (1996) econometric method allows us to quantify the individual contribution of each of these three categories of factors towards the observed overall increase in labour force participation of mature-aged Australian men.

A crucial part of the methodology used to decompose changes in participation rates is obtaining and using the appropriate counterfactual participation rates. Intuitively put, we want to be sure that we are making the right comparison, so that we only measure one change at a time. So, when we measure the effect of the 2002—11 change in the participation of the wives on the participation of the 2002 husbands, we need to exclude from the calculations the effect of the 2002—11 changes in the characteristics of the husbands and the unobservable factors.[2] If this were not done, we would be confusing the changes due to the composition of the husbands with the changes due to the participation of their wives. This amounts to using a counterfactual, which keeps the effect of the estimated characteristics and the estimated unobservables on the participation of the husbands at the 2002 level, but allows the wives' participation rate to change as it did in reality. The difference between this counterfactual participation probability of the husbands and the participation rate in 2002 can be correctly attributed to the effect of the increased labour force participation of their wives between 2002 and 2011. The econometric method by DiNardo, Fortin and Lemieux (1996) has been developed to calculate exactly this type of counterfactual estimate.[3]

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[2] The estimation methodology we employ below uses the lagged dependent variable as an explanatory variable. This reduces the useable sample by one wave and estimation is between 2002 and 2011. For reasons of comparability we refer to the sample period of 2002 to 2011, despite the fact that parts of the 2001 data are used for estimation.

[3] More specifically, the effect of the change in the characteristics of men is computed as the difference between the predicted participation rate of the 2011 sample using the probit or bivariate probit model and the counterfactual probability of the 2011 sample, assuming that the characteristics of men remained at their 2002 level, but setting the participation of their wives at their 2011 level. The effect of the change in the participation of the wives is calculated as the difference between the counterfactual probability, using the 2011 sample with men's characteristics at their 2002 values, but the participation of their wives at their 2011 level and the counterfactual probability of the participation of men for year 2011, keeping both the husbands' characteristics and the participation of their wives at the 2002 level. In all of this, the contribution of the unexplained effects due to unobservable factors is estimated as the difference between the counterfactual probability using the 2011 sample, when men's characteristics and wives' participation were both at the 2002 level, and the predicted probability of men's participation for the 2002 sample.

Estimation results

Probit and bivariate regression results

As discussed in the methodology section, we estimate the relationship between the labour force participation of the husband and that of his wife using a probit model, which assumes the two decisions are made independently, and a bivariate probit model, which assumes the two decisions are interdependent. Besides the participation status of wives, the estimation includes the husband's education dummy variables, age and the number of children in the household, whether the husband was not born in an English-speaking country, whether the husband has a long-term health condition, the age of the wife, a dummy variable indicating whether the husband is working in a major city in Australia, and a full set of state dummies. A full set of year dummies is also included.

The Household, Income and Labour Dynamics in Australia Survey is a panel survey containing longitudinal data; that is, repeated observations of the same individuals for several waves. However, we choose not to use the panel approach. The reason is that if a panel approach is employed, the following four different models need to be estimated: (1) random effects probit model; (2) dynamic random effects probit model; (3) random effects bivariate probit model; and (4) dynamic random effects bivariate probit model. While the first two models can be easily implemented, the latter two are recent developments in econometrics and are very complex. There is no statistical/econometric package or software to implement them. Due to the complexity and difficulty of implementing a panel approach for bivariate probit models, we regard the data as repeated cross-sections for ease of comparing estimation results with different models.[4]

The probit and bivariate probit estimation results are presented in table 3. All standard errors are clustered at the combined state and wave level in order to take into account the potential correlation between people surveyed in the same year and living in the same state. The probit model results show that there is a large positive and significant association between the labour force participation of the wife and that of her husband. The model estimates that the participation of the wife will increase the participation of her husband by 21.4 percentage points.

The probit model also shows that education is a significant determinant of Australian mature-aged men's participation. Compared with those with 12 years of schooling or fewer, a man aged 55—64 years with a university degree is 2.2% more likely to be in the labour force. Moreover, age has a negative impact on the participation decision, which is consistent with the expectation that older people have a stronger preference for leisure and are more likely to retire than younger people. We do not find a significant association between the number of children in the household and mature men's labour force participation decisions. If a man has a long-term health condition, he is 17 percentage points less likely to join the workforce. Interestingly, we find that husbands are more likely to participate in the labour force if their wives are older, which means that a younger wife is more likely to have a non-participating husband. One possible explanation for this finding is that a husband can expect his younger wife to be able to support his retirement longer, providing the husband with some financial security.

[4] A potential shortcoming of this analysis is that bias may be introduced in the estimation if we disregard the panel structure of the data. The results of dynamic estimations are presented in the next section.

Table 3 Probit and bivariate probit model estimates

	Probit		Bivariate probit			
			Husband		Wife	
	Coef.	*ME*	*Coef.*	*ME*	*Coef.*	*ME*
Wife in labour force	0.986***	0.214***	1.916***	0.564***		
	(0.033)	(0.022)	(0.117)	(0.055)		
Age	–0.114***	–0.013***	–0.087***	–0.009***	–0.034***	–0.009***
	(0.007)	(0.002)	(0.009)	(0.002)	(0.007)	(0.002)
Education:						
Year 12 and below						
Certificate or diploma	0.039	0.004	0.009	0.001	0.064*	0.017**
	(0.036)	(0.004)	(0.035)	(0.004)	(0.033)	(0.008)
University degree	0.240***	0.022***	0.162***	0.015***	0.139***	0.033***
	(0.054)	(0.006)	(0.050)	(0.005)	(0.048)	(0.009)
Number of children	0.036	0.004	0.041*	0.004	–0.017	–0.004
	(0.024)	(0.004)	(0.024)	(0.003)	(0.024)	(0.006)
Not born in English-speaking country	–.352***	–0.051***	–0.193***	–0.024***	–0.339***	–0.095***
	(0.057)	(0.013)	(0.059)	(0.009)	(0.044)	(0.016)
Long-term health condition	–0.846***	–0.170***	–0.647***	–0.113***	–0.294***	–0.082***
	(0.045)	(0.021)	(0.057)	(0.017)	(0.033)	(0.010)
Wife age	0.015***	0.002***	0.040***	0.004***	–0.074***	–0.008***
	(0.007)	(0.011)	(0.005)	(0.001)	(0.004)	(0.001)
Major city	0.111***	0.013**	0.103**	0.012**	–0.022	–0.008
	(0.042)	(0.005)	(0.044)	(0.005)	(0.041)	(0.010)
Wife's mother was employed when wife was 14					0.182***	0.050***
					(0.043)	(0.012)
Constant	6.071***		2.491***		6.301***	
	(0.389)		(0.691)		(0.293)	
ρ				–0.639*** (0.088)		

Note: * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The dependent variable is husband's participation in labour force. Standard errors clustered by wave*state are in parentheses. Sample included married men aged 55–64 years in 2001–11. Marginal effects are evaluated for men with the following characteristics: wife in labour force; 60 years old; with certificate or diploma; no children at home; born in an English-speaking country; no long-term health condition; wife aged 55; living in a major city in Victoria and in wave 2006. State of resident dummies and wave dummies are included in the regression.

The probit model assumes that the labour force participation decisions of a wife and her husband are independent of one another. As we consider this assumption of independence to be unrealistic, we model the interdependence using a bivariate probit model. The identification of the model (that is, the ability of the two equations to distinguish between the two simultaneous choices) relies on the availability of at least one variable that can influence the participation decision of the wife, but not that of her husband. This method is called the method of 'instrumental variables' (IV) and the variable we use is called the 'instrument'. The variable we use is a binary indicator of whether the mother of the wife was in paid employment when the wife was 14 years old. Our choice of instrument is based on evidence that a mother's employment preferences will influence her daughter's preferences through familial and intergenerational transmission of working preferences, as documented in Del Boca, Marilena and Silvia (2000), Neumark and Postlewaite (1998) and Morrill and Morrill (2013). At the same time it is sensible to expect that the employment status of the mother-in-law so many years ago (when the wife was only 14 years old) should not have any influence on the current participation of the husband (especially when the husband is aged between 55 and 64 years).

Table 3 also displays bivariate probit estimation results, where the labour force participation of a husband and a wife are jointly estimated in the form of two equations. The estimated correlation coefficient ρ, is a statistic that indicates the correlation between the unobservable characteristics in

the participation equations of husbands and wives. It is statistically significant, suggesting that the two participation decisions are made jointly.[5] The coefficient of the instrumental variable indicating whether a wife's mother was in paid employment many years ago is also positive and significant.[6] The estimation results show that the wives whose mother was employed when they were aged 14 years are on average five percentage points more likely to participate today.

The bivariate probit results shown in table 3 also suggest that whether the wife participates or not has a large, positive and significant effect on whether the husband participates. If a wife is in the labour force, her husband is about 56.4 percentage points more likely to participate. We note that this marginal effect is much larger than the estimates produced by Schirle (2008) for the US (21.9 percentage points), the UK (19.8 percentage points) and Canada (19.1 percentage points). We note that, when we model the interdependence of the decisions (bivariate probit model), the estimated effect of the participation of the wife on the participation of her husband is much larger than when we do not (probit model). We return to this point later.

Considering the effect of persistence in the labour force participation of husbands

The existing literature has shown that labour market status is highly likely to be persistent over time (Stewart 2007; Buddelmeyer, Lee & Wooden 2010). We find this also to be true for the labour force participation of mature-aged married men. The survey data show that the pairwise correlation coefficient between the participation of the husbands in two consecutive years is as high as 0.768, which means that if a husband was in the labour force in the last year, he is very likely to be in the labour force the following year.[7]

Ignoring the persistence in the labour force participation of mature-aged men may bias our estimates, because participation status is highly and positively correlated between consecutive periods and the participation of wives has a positive effect on that of their husbands. Without controlling for the persistence of the participation of husbands, the effect of the participation of the wives is likely to be overstated. In this section, we report the results when the persistence of husbands' participation is also included in the estimation.

Table 4 reports the same probit estimation results as table 3, but with the addition of a lagged labour force participation variable as a control (under the title *lagged husband participation*).[8] As expected,

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[5] This finding supports our choice of a decomposition methodology that controls for unobservables.

[6] The F-statistics on the excluded instrument are respectively 27.23 and 18.40. If we implement two-stage least squares (2SLS) estimation rather than bivariate probit estimation, the F-statistics on the excluded instrument obtained are respectively 43.20 and 31.18, far exceeding the rule-of-thumb threshold of ten suggested in Staiger and Stock (1997).This indicates that the instrument is not weak and has sufficient power in our specifications. The larger the F-statistics (usually should be larger than ten), the more precise the estimates obtained.

[7] A simple ordinary least squares (OLS) regression of the participation variable in period *t* on the participation status in period *t-1* (without using other controls) reveals that a mature-aged husband is 79% more likely to participate in the labour force if he participated in the previous period. The R^2 obtained from the simple regression shows that 59% of the variation of participation status in period *t* can be explained by the status in period *t-1*, which means that this is a strong fit, as in data like this a 0.59 R^2 is considered very high.

[8] We only include one lag in the dynamic models rather than employing higher-order dynamic models. The main reason is that the inclusion of further lags would seriously reduce our sample size, which is already reduced by the examination of only one age group from the complete HILDA sample. Furthermore, we note that the study of the dynamics itself (that is, of the behaviour of lags in estimation) is not the focus of the paper. We know that participation in one wave is highly correlated to participation in the previous wave. So including the one lag can not only capture the effect of the participation in the previous wave, but also partially capture the persistence in the waves before the previous wave.

the coefficient estimate of this variable turns out to be very significant and sizable. The dynamic probit regression shows that participating in the previous period will increase the participation propensity in the current period by 60.5 percentage points.[9] Correspondingly, in table 4 the effect of the participation of wives on the participation of husbands has substantially decreased from 21.4% (in table 3) to 7.9%.

Table 4 also displays the bivariate probit estimation results, including *lagged husband participation* as an explanatory variable. The estimate of the correlation between the influences of all factors that are not accounted for in the two equations (often called the 'unobservables'), ρ, becomes statistically insignificant after controlling for the persistence in the participation of husbands.[10] The bivariate probit models also show that participation in the previous period has a large and significant impact on the current period's participation in the labour force. The marginal effects of a wife in the labour force are considerably smaller than those reported in table 3. Table 3 shows that a husband is 56.4% more likely to participate in the labour market if his wife also participates, while table 4 shows that the magnitude of the marginal effect is much smaller (only 9.9%). Our findings on persistence also indicate the possibility that the results in Schirle (2008) may be overstating the effect of the participation of wives on the participation of their husbands in the US, UK and Canada, as the persistence of the labour force participation of mature-aged men was not modelled in that paper.

Given that the correlation between the unobservables in wives' participation and also husbands' participation is not statistically significant, the coefficient estimate of wives' participation from the dynamic probit model is very similar to that from the dynamic bivariate probit model. The coefficient estimates of other control variables are now also very similar. This result shows that, after controlling for the husband's previous year participation, the interdependence between the participation of husbands and wives becomes insignificant. This result suggests that the participation of the wives can be reasonably regarded as an exogenous factor in the decision of husbands to participate or not. A possible intuitive read of this result is that, while the data support the suggestion that the decision of a mature-aged husband to work or not may be influenced by whether his wife works, the data do not support the mirror suggestion that the decision of the wife of a mature-aged husband to work or not will be influenced by whether her husband works or not. The results show a gender-related lack of symmetry in the decision to work or not.

[9] The marginal effect of previous participation (0.605) is different from the pairwise correlation coefficient (0.768). The marginal effect measures how the participation in the previous wave affects the propensity to participate in the next wave, conditional on a set of observed variables. However, the correlation coefficient is a pairwise and unconditional statistic.

[10] The instrumental variable is not weak and has sufficient power in our specifications (F-statistic = 17.19, 10.94 respectively). If we implement the two-stage least squares estimation rather than a bivariate probit estimation, the F-statistics on the excluded instrument are respectively 30.77 and 23.08. The larger the F-statistics (should usually be larger than 10), the more precise the estimates obtained.

Table 4 Dynamic probit and dynamic bivariate probit model estimates

	Dynamic probit		Dynamic bivariate probit			
			Husband		Wife	
	Coef.	*ME*	*Coef.*	*ME*	*Coef.*	*ME*
Wife in labour force	0.650***	0.079***	0.773*	0.099*		
	(0.051)	(0.017)	(0.368)	(0.060)		
Lagged husband participation	2.228***	0.605***	2.182***	0.578***	0.962***	0.356***
	(0.056)	(0.039)	(0.161)	(0.085)	(0.036)	(0.018)
Age	–0.081***	–0.005***	–0.080***	–0.005***	–0.034***	–0.003
	(0.012)	(0.002)	(0.012)	(0.002)	(0.007)	(0.003)
Education:						
Year 12 and below						
Certificate or diploma	0.055	0.004	0.053	0.004	0.064*	0.014
	(0.047)	(0.004)	(0.049)	(0.004)	(0.033)	(0.012)
University degree	0.148**	0.009**	0.147**	0.008**	0.139***	0.008
	(0.069)	(0.004)	(0.069)	(0.004)	(0.048)	(0.014)
Number of children	0.022	0.001	0.022	0.001	–0.017	0.005
	(0.041)	(0.003)	(0.040)	(0.003)	(0.024)	(0.009)
Not born in English-speaking country	–0.213***	–0.018**	–0.206***	–0.016***	–0.339***	–0.052***
	(0.079)	(0.009)	(0.078)	(0.008)	(0.044)	(0.018)
Long-term health condition	–0.577***	–0.066***	–0.575***	–0.062***	–0.294***	–0.010
	(0.060)	(0.013)	(0.061)	(0.014)	(0.033)	(0.014)
Wife age	0.010	0.001	0.013	0.001	–0.074***	–0.024***
	(0.007)	(0.001)	(0.012)	(0.001)	(0.004)	(0.002)
Major city	0.095*	0.007	0.097*	0.007	–0.022	–0.022
	(0.055)	(0.005)	(0.055)	(0.005)	(0.041)	(0.016)
Wife's mother was employed when wife was aged 14 years					0.192***	0.061***
					(0.058)	(0.018)
Constant	6.071***		2.838**		4.826***	
	(0.389)		(1.116)		(0.470)	
ρ			–0.074 (0.213)			

Note: * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The dependent variable is husband's participation in labour force. Standard errors clustered by wave*state are in parentheses. Sample included married men aged 55–64 years in 2001–11. Marginal effects are evaluated for men with the following characteristics: wife in labour force; 60 years old; with certificate or diploma; no children at home; born in an English-speaking country; no long-term health condition; wife aged 55; living in a major city in Victoria and in wave 2006. State of residence dummies and wave dummies are included in the regression.

Summing up the regression results

Our probit estimation results have shown that the labour market participation of a wife is positively associated with the participation of her husband; that is, mature-aged husbands with wives who work are more likely to be working themselves. Our bivariate probit estimation went further and tested the proposition that part of the correlation between the husband's working and a wife may be due to the causal impact of the labour force participation of the wife on the participation of her husband. The bivariate probit results clearly suggest that the decision of a wife to work has a (positive) causal effect on her husband's decision to work. Our further analysis on the persistence of participation showed that employment is a persistent labour market state, in that people who are employed today are more likely to be employed tomorrow, the difference in the participation probability being present over and above the difference that can be explained by the conventionally observed characteristics of those who work and those who do not. The implication is that participation today (or lack of) causes *in itself* participation tomorrow (or lack of).

The next section develops these results in the context of one of the most important labour market trends of our times; namely, the ongoing increase in female labour force participation. The objective is to help us to form an understanding on whether the extent to which increasing female labour force participation may have had a beneficial effect on the participation of males, through the joint decision-making of couples.

Decompositions and their results

In this section, we use a methodology to decompose the change in labour force participation of mature-aged husbands that has been observed to have happened between two points in time into the parts attributed to:

- the change in the labour force participation of their wives
- the change in their characteristics measure in the data
- the change in all remaining factors that are not observed by our data.

We use the methodology originally proposed by DiNardo, Fortin and Lemieux (1996) and combine it with the estimates obtained in the previous section. Following the estimations presented in tables 3 and 4, table 5 presents two sets of estimates. The first panel is based on the simple probit model that assumes that the participation decision of wives and their husbands are independent of each other. The second panel is based on the bivariate probit model estimates that drop the assumption of independence. Both panels present estimates with and without persistence in the model. Given that one of our objectives is to compare the difference in the labour force participation of mature-aged husbands resulting from whether we have included in our estimation their past labour force participation, we decompose the estimated change in the participation of mature-aged husbands between 2002 and 2011 rather than between 2001 and 2011 (as there is no previous participation information for the first wave, 2001).

Decomposition results are based on the coefficient estimates in tables 3 and 4. We look at the decomposition results based on the probit estimates first. The result shows that the participation rates of mature-aged husbands would have been 6.8 points lower in 2011 had the participation rates of their wives not increased by 15 percentage points during the last decade, which means that about 59.1% of the total rise in mature-aged husbands' participation rate observed between 2002 and 2011 can be explained by the effect of the increasing participation of their wives.

Mature-aged husbands' participation rates would have been 0.7 percentage points lower if men's characteristics in 2011 had been the same as those in 2002. This only explains 6.1% of the increase in participation rates from 2002 to 2011, which is small but expected. Table 2 indicates that mature-aged men are slightly older in 2011 than in 2002, and the probit estimation results show that older men are less likely to be in the labour force. As a result, we expect that the change in age structure between 2002 and 2011 would be in part responsible for the lower participation rate of men in 2011. However, tables 2 and 3 also reveal that men in 2011 are better educated. Better-educated people are more likely to participate in the labour force, so the change in education levels has helped to drive up the labour force participation rate over time. The negative effect from the change in age structure and the positive effect from the better-educated men in 2011 combine to a positive effect of 0.7 percentage points in total. In addition, the unexplained effects, which estimate the contribution of factors omitted from the model, account for 35% of the increase in the participation rates of men.

Table 5 DiNardo, Fortin and Lemieux (1996) decomposition results

Based on probit estimates	Without persistence	With persistence
Predicted participation rate, 2002	0.603	0.608
Predicted participation rate, 2011	0.718	0.719
Total change	0.115	0.112
Effect of:		
Change in wives' participation	0.068	0.043
	(59.1%)	(38.4%)
Change in men's characteristics	0.007	0.063
	(6.1%)	(56.3%)
Unexplained effects	0.04	0.006
	(34.8%)	(5.44%)
Based on bivariate probit estimates	**Without persistence**	**With persistence**
Predicted participation rate, 2002	0.571	0.601
Predicted participation rate, 2011	0.688	0.717
Total change	0.117	0.116
Effect of:		
Change in wives' participation	0.094	0.044
	(80.3%)	(37.9%)
Change in men's characteristics	0.015	0.072
	(12.8%)	(57.8%)
Unexplained effects	0.008	–0.005
	(6.8%)	(–4.3%)

Note: Figures in parentheses are percentages of total change explained by the change in the factor.

When the lagged labour force participation of the husband is included in the estimation, the decomposition results based on probit model estimates show that the participation status of their wives accounts for only 38.4% of the observed increase in men's participation. Interestingly, the contribution made by the change in the characteristics of men increased from 0.7 percentage points to 6.3 percentage points. The effect of the participation of the husband in the previous period, which was a major component in the unexplained effects (and also a component in the contribution of wives because of the correlation between the past participation of husbands and the current participation of wives), is now primarily driven by the contribution of the change in the characteristics of mature-aged husbands.[11]

We now turn to a discussion on the results based on bivariate probit estimates. The counterfactual decomposition results change dramatically when we use the estimates from the bivariate probit model, in which the joint decision of labour force participation among older couples is part of the estimation. We show that the contribution of the change in the participation of wives accounts for 80.3% of the increase in the participation rates of their mature-aged husbands, much larger than the proportion obtained from the decomposition based on probit estimates. This is consistent with and probably driven by the regression results in table 3, where the estimated effect of the participation of

[11] We know that husbands' past and current participation is highly correlated (in the decomposition sample, 0.762) and wives' participation is also correlated with husbands' participation (0.406), so statistically, there is a correlation between husbands' past participation and wives' current participation. The decomposition sample shows a correlation coefficient of 0.374 between husbands' past participation and wives' current participation. As a result, part of the contribution of wives' participation to men's increase in participation in the past decade was due to the effect of the lagged husband participation.

the wives is much larger when we use the bivariate probit model estimation. The effects of the change in the characteristics of husbands are also larger. Notably, when the decomposition is based on bivariate probit model estimates, the proportion due to unobservable factors has declined substantially to around 0.8%, presumably because this model is more flexible and accounts for the joint decision-making of couples in a better and more realistic manner.

As the participation of a husband in the previous wave is positively correlated with both his wife's current participation and his current participation, we expect a decrease in the contribution of wives' participation when taking into consideration the effect of the persistence in the participation of mature-aged husbands. When we consider the effect of the persistence participation status over time using the bivariate probit model, the increase in the participation of wives between 2002 and 2011 accounts only for around 38% of the total increase in the participation of their mature-aged husbands in that period. This means that, if the participation of women had not increased during the last decade, the participation rate of their mature-aged husbands would have ended up being 4.4 percentage points lower in 2011. It should be noted that, just as the coefficient estimates are similar for the dynamic probit model and the dynamic bivariate probit model, the decomposition results are also very similar.

Conclusion

This paper investigated the relationship between the labour force participation of a husband and a wife. We used longitudinal data from the Household, Income and Labour Dynamics in Australia Survey for the period 2001—11. We estimated the participation relationship in several ways and tested which one was best supported by the data. We first assumed that the participation decisions of a husband and a wife are independent. We then carried out the same estimation, allowing for the decisions to be interdependent. Estimations suggested that the decisions are interdependent. We investigated further to find that the decision of the wife to participate has a causal influence on the decision of her husband to participate. We also investigated the interrelated decisions of the husband and the wife, allowing for the possibility that the decision of the husband may be persistent over time. We found that some of the estimated effect of the participation decision of the wife on the participation decision of her husband is absorbed by the estimated persistence of the husband, but not all. We conclude that there is sufficient and robust evidence to support the proposition that the participation decisions of wives influence positively those of their husbands.

The paper also examined the relationship between the female and male time trends in labour force participation in Australia using a methodology that has been tried and tested for the US, UK and Canadian labour markets. The decompositions of the relationship between the labour force decisions of wives and their mature-aged husbands have shown that the observed ongoing increase in participation of wives between 2002 and 2011 has been responsible for maintaining the high participation rates of their mature-aged husbands. More specifically, we show that, if the participation of women had not increased during the last decade, the participation rate of their husbands would have been 4.4 percentage points lower in 2011.

The paper illustrates the need to base policy deliberations on the joint modelling of the labour force participation decisions made by couples. However, joint modelling can impose significant analytical costs: it adds technical complexity to the analysis and requires high-quality data, which are not always available. This work highlights several such limitations. This paper also shows that choosing a naive and oversimplified (but easy to handle statistically) model, which assumes that husbands and wives make their labour force participation decisions independent of one another, is not realistic.

A further finding of the paper is that, while we find evidence that the labour force participation decision of wives is shown to influence directly the same decision by their mature-aged husbands, we do not find evidence of a mirror influence (that is, we do not find that the decisions of mature-aged husbands influence those of their wives). There may be several explanations for this lack of symmetry in our findings. It could be that the effect is too weak to be traced in the present set of data; that is, we would need more and/or better data for this investigation. It could also be that our assumption of symmetry is wrong and if we wish to trace the effect of the decisions of husbands on those of their wives we should be using a different model. The present investigation only highlights these possibilities and offers them as potential future research avenues for better-informed policy.

The paper also illustrates that policies that influence the participation of the wife in a couple should be aware of the possibility that both direct and indirect effects may be present. We have shown that one such indirect effect will manifest itself through the causal influence of the labour force participation of a wife on that of her mature-aged husband. In particular, this paper supports the view that the design of taxation and income support ought to consider explicitly the joint couple nature of

participation decisions and their outcomes, in order to reflect the interdependence of labour force participation decisions.

Finally, this paper offers a novel piece of evidence on the macroeconomic development of Australian employment rates, by alerting us to the positive impact of increasing female employment rates on male employment rates and by shedding new light on the complementarity between male and female employment rates.

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Appendix

Mathematical appendix explaining the econometric methods

Probit regression

Following Schirle (2008), we write the husband's labour force participation decision as:

$$\mathrm{L}_{\mathrm{it}}^{\mathrm{H}*} = U^H(C_{it}, L_{it}^H, X_{it}^H, L_{it}^W | L_{it}^H = 1) - U^H(C_{it}, L_{it}^H, X_{it}^H, L_{it}^W | L_{it}^H = 0) \quad (1)$$

where C_{it} denotes the normal consumption goods, X_{it}^H is the vector of the husband's individual characteristics, and L_{it}^H and L_{it}^W respectively represent the labour force participation status of the husband and his wife. If the utility U^H from participating in the workforce $U^H(C_{it}, L_{it}^H, X_{it}^H, L_{it}^W | L_{it}^H = 1)$ exceeds the utility from non-participation$U^H(C_{it}, L_{it}^H, X_{it}^H, L_{it}^W | L_{it}^H = 0)$, the husband will decide to join the labour force.

Suppose equation (1) takes a linear form, we can write the model as:

$$\mathrm{L}_{\mathrm{it}}^{\mathrm{H}*} = \gamma^H L_{it}^W + X_{it}\beta^H + \varepsilon_{it} \quad (2)$$

which can be estimated using the probit model. The sign of the parameter b^H shows whether a wife's participation in the labour force will increase her husband's participation or not.

Bivariate probit regression

Now consider that husbands' and wives' labour supply decisions are jointly determined and their supply decisions are described by the latent variables $\mathrm{L}_{\mathrm{it}}^{\mathrm{H}*}$ and L_{it}^{W*}. Similarly, using linear specifications, a couple's participating decisions can be described as:

$$\mathrm{L}_{\mathrm{it}}^{\mathrm{H}*} = \gamma^{\mathrm{H}} L_{it}^{W*} + X_{it}\beta^H + \varepsilon_{it}^H \quad (3)$$

$$\mathrm{L}_{\mathrm{it}}^{\mathrm{W}*} = X_{it}\beta^H + Z_{it}^W\delta^W + \varepsilon_{it}^W \quad (4)$$

Equations (3) and (4) can be regarded as the normal two-stage least squares estimation problem. We expect b^H to be positive if the shared leisure effect dominates the income effect. It should be noted that the identification of the model relies on the exclusion of Z_{it}^W from the husband's equation (3). This implies that we need to find at least one variable that affects a wife's labour participation, but not her husband's.

In this analysis, Z_{it}^W is defined as a binary variable which is equal to 1 if the wife's mother was employed when the wife was 14 years old and 0 otherwise. The logic behind the choice of the instrument is that a mother's employment preferences will affect her daughter's, through familial and intergenerational transmission of working preferences. However, the mother-in-law's employment status many years ago (when the wife was only aged 14 years) should not affect her daughter's husband's current participation in the labour force (when the husband is aged between 55 and 64 years) in the same way, if at all.

The DiNardo, Fortin and Lemieux (1996) decomposition method

We follow the work of DiNardo, Fortin and Lemieux (1996) and Schirle (2008) to decompose the change in mature-aged men's participation rates during the last decade in Australia.

The decomposition consists of two stages. In each stage of the decomposition, counterfactual participation rates are created to represent what the participation rate in 2011 would have been had each factor had remained at its 2002 levels. We begin by adjusting the 2011 participation rate for changes in mature-aged men's characteristics and follow this by adjusting this participation rate for changes in the likelihood of married women to participate in the labour force.

Let *t* denote year 2011 and *s* denote year 2002. The probability that a husband participates in the labour force at time *t* is given by:

$$\mathrm{P_t}(L^H = 1) = \sum_{X^H} \sum_{l^W} P_t(L^H = 1, X^H = x^H, L^W = l^W)$$

The first stage of the decomposition gives the counterfactual probability of labour force participation of year 2011, had mature-aged men's characteristics X^H remained at the 2002 level, with the wives' participation status L^W still at the 2011 level. The counterfactual probability is given by:

$$\mathrm{P_{1t}}(L^H = 1) = \sum_{X^H} \sum_{l^W} P_t(L^H = 1, X^H = x^H, L^W = l^W) * \varphi_{X^H|L^W}$$

where the reweighting function $\varphi_{X^H|L^W} = \mathrm{P_s}(X^H = x^H|L^W = l^W)/P_t(X^H = x^H|L^W = l^W)$ captures the changes that have occurred in the distribution of mature-aged men's characteristics between year s and year t.

For the second stage of the decomposition, a second counterfactual probability is created that also accounts for changes in mature-aged wives' likelihood to participate in the labour force. That is, the counterfactual probability is:

$$\mathrm{P_{2t}}(L^H = 1) = \sum_{X^H} \sum_{l^W} P_t(L^H = 1, X^H = x^H, L^W = l^W) * \varphi_{X^H|L^W} * \varphi_{L^W}$$

where the second reweighting function $\varphi_{\mathrm{L^W}} = P_s(L^W = l^W)/P_t(L^W = l^W)$captures the changes in mature-aged wives' participation decisions. This second counterfactual probability represents the probability that a mature-aged man will be a labour force participant in the year 2011, keeping the mature-aged man's characteristics X^H and his wife's participation status L^W, both at their 2002 levels.

The decomposition relies on the estimation of the two reweighting $\varphi_{X^H|L^W}$ and φ_{L^W}. Using Bayes's rule, the first reweighting function is equal to $\frac{\mathrm{P(T=s|X^H=x^H, L^W=l^W)}}{\mathrm{P(T=t|X^H=x^H, L^W=l^W)}} * \frac{\mathrm{P(T=s|\ L^W=l^W)}}{\mathrm{P(T=t|\ L^W=l^W)}}$.

$P(T = t|X^H = x^H,\ L^W = l^W)$ is the predicted probability obtained from a probit regression of the time dummy (T = t) on covariates X^H and the wife's participation variable L^W. Probability $P(T = t|\ L^W = l^W$ is similarly estimated using a probit model with the wife's participation L^W as the only covariate.

The second reweighting function $\varphi_{\mathrm{L^W}} = P_s(L^W = l^W)/P_t(L^W = l^W)$ is equal to $Ps(\mathrm{L^W} = 1)/Pt(\mathrm{L^W} = 1)$ when $\mathrm{L^W} = 1$, and is equal to $Ps(\mathrm{L^W} = 0)/Pt(\mathrm{L^W} = 0)$ when $\mathrm{L^W} = 0$. As $\mathrm{L^W}$ is a binary variable, $Ps(\mathrm{L^W} = 1)$ is the participation rate of wives in years. Other probabilities are estimated in a similar way.

With the two reweighting probability variables, we can obtain the counterfactual estimates and quantify and decompose the contributions of (i) men's characteristics, (ii) their wives' labour force participation, and (iii) unexplained effects, to the total observed change in mature-aged men's participation rates in Australia during the last decade.

Literature informing the study

A comprehensive literature review was not undertaken for this study. Instead the approach taken was to undertake a selective overview in relation to health and pension benefits as two determinants of retirement decisions, as well as the labour force trends by gender.

Factors determining labour force participation in Australia

Health

Using the Australian Bureau of Statistics (ABS) 1998 Survey of Disability, Ageing and Carers, Wilkins (2004) examines the effects of disability on four labour market outcomes: not in the labour force, unemployed, part-time employed and full-time employed. Disability is found to significantly affect labour force status, on average decreasing the probability of labour force participation by one-quarter for males and one-fifth for females.

Using data from the Household, Income and Labour Dynamics in Australia Survey, Cai and Kalb (2006) found that better health increases the probability of labour force participation for all four groups consisting of males aged 15—49, males aged 50—64, females aged 15—49 and females aged 50—60. The effect is larger for the older groups and for women. Similarly, using data from HILDA, Cai (2010) employed a simultaneous equation model to explore the relationship between health and labour force status. His findings support the suggestion that health has a positive and significant effect on labour force participation for both males and females. As for the reverse effect, it is found that labour force participation has a negative effect on male health but a positive effect on female health.

Using the pooled data for adults from the 2001 and 2004—05 Australian National Health Surveys, Zhang, Zhao and Harris (2009) examined the impact of several chronic diseases on the probability of labour force participation in Australia. They showed that the impacts of chronic conditions on the probability of labour force participation vary significantly by gender and by age group. The effects are much larger for older workers than for younger workers. The effects of mental illnesses are found to be much stronger for males than females for both age groups.

Cai, Mavromaras and Oguzoglu (2013) use HILDA Survey data to differentiate the effect of long-term health conditions and the effect of unexpected health shocks on labour supply. They show that health problems influence both the decision to work and, for those who decide to work, the number of hours they work. They find strong gender differences, commensurate to the more general labour supply gender differences in the Australian labour market.

Pension benefits

Merrilees (1983) uses time-series econometric methods to disentangle the causes of the decline in the labour force participation rate of males aged 65 years and over during 1972—76 in Australia. The study finds that most of decline in the participation rate during 1972—76 resulted from the more generous age pension benefits.

Gendered trends in labour force participation in Australia

Male

Borland (1995) uses the data from the ABS Labour Force Survey and the Income Distribution Survey to investigate the evolution of male labour market participation in Australia between 1964 and 1994. He finds that aggregate data show a trend of declining participation of men. Borland (1995) attributes

the declining trend to the decreasing participation among mature-aged men and men with lower levels of education.

Female

Using pooled cross-section data derived from the International Social Science Surveys/Australia, Evans and Kelley (2008) find that female labour force participation increased significantly over the 1980s and 1990s. Their multivariate analysis reveals compositional changes and the trend of women working more than their predecessors. Among the compositional changes, rising education levels and falling fertility are suggested to be the main factors leading to higher participation rates.

Austen and Seymour (2006) use the ABS Education Survey data for the 1984—99 period to examine the generational change in the labour force participation of women in Australia. They identify a significant cohort effect, which implies that the participation rate of younger cohorts of women is higher than those for earlier cohorts. They also find that the generational changes in participation differ by education level.

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