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THE INFLUENCE OF PSYCHOLOGICAL WELL-BEING, ILL-HEALTH AND HEALTH SHOCKS ON SINGLE PARENTS' LABOUR SUPPLY[1]

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ABSTRACT

This paper proposes a discrete-choice behavioural model of labour supply to examine the role of ill-health on single parents' employment. The model provides estimates of individual preferences over a given set of labour market states and allows these preferences to be influenced by a measure of mental health, a latent health index purged of reporting bias and various measures of health shocks. Exploiting longitudinal data from the HILDA Survey, we find that psychological well-being, ill-health and health shocks significantly influence single parents' marginal disutility of work and marginal utility of income. Further, we apply behavioural microsimulation methods to estimate the likely labour supply responses among single parents in Australia from restricting eligibility to access disability support via the Australian Disability Support Pension (DSP) scheme. Our simulation exercise reveals that imposing tighter DSP eligibility rules has a moderate but positive effect on single mothers' employment.

Keywords: health, disability, wellbeing, health shocks, discrete choice, behavioural microsimulation, labour supply

JEL classification: C10, C25, C51, I10, I19, J01

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The findings and views reported in this paper do not necessarily represent those either of the Bankwest Curtin Economics Centre (BCEC), or Bankwest.

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1. Introduction

In the majority of the OCED countries single parents' labour force participation is consistently lower than that of individuals in couples with dependent children.[2] In Australia, where one-parent households represent 20 per cent of families with co-resident children aged below 18 years, this phenomenon is especially marked (Australian Bureau of Statistics, 2008): 52 per cent of sole parents with a youngest child aged 3 to 5 years are not in paid work. This proportion increases to 71.4 per cent for single parents having the youngest child aged between 0 and 2 years (Australian Bureau of Statistics, 2008). Lone parent households are also considered a vulnerable social group: they are more likely to be long-term welfare dependent (Staat and Wagenhals, 1996; Saunders and Tsumori, 2003) and are at a higher risk of child poverty (Bradbury, 2003; Gregg *et al*., 2009). Experiencing poverty and deprivation at an early-life stage could potentially have long-run detrimental effects on children's health and well-being (Poulton *et al*., 2002).

International evidence suggests that lone parents, particularly lone mothers, have poorer health status relative to parents living as couples (Neises and Gruneberg, 2005). Single mothers' ill-health is usually linked to a high prevalence of depressive disorders (Baker *et al*., 2002) and the incidence of a number of risk factors such as nicotine abuse (Dorsett, 1999; Shiapush *et al*., 2002) and poor nutrition (McIntyre *et al.*, 2003). Moreover, 45 per cent of single parents receiving the Parenting Payment in Australia report having mental health problems related to depression or anxiety (Butterworth, 2003). Despite their relevance, health-related factors have been neglected by the applied economic literature in the labour supply of single parents.

The main goal of this paper is to analyse the role of both physical and mental health status on the labour market behaviour of single parents. For this purpose we use a behavioural microsimulation model of labour supply. Here employment choices of single parents are represented using a utility maximising framework, and individuals face a budget constraint informed by a tax-benefit model that includes the major taxes and transfers of the Australian welfare system. Through this framework we are able to fully account for the employment effects provided by the welfare system and thus to identify better the effects of health on single parents' labour supply. The second goal is to use the model to evaluate the

[2] *OCED Family Database*, June 2009. Web-link: www.oecd.org/els/social/family/database

employment effects of health-related reforms. In particular, we focus on the effects of a restriction in the access to the Disability Support Pension (DSP) brought about by the introduction of the Welfare-to-Work package of reforms introduced by the Federal Government of Australia in July 2006.

This paper offers three key contributions to the literature. First, it investigates the effects of ill-health, health shocks and mental health on the labour supply of single parents. Second, it introduces health in the context of behavioural microsimulation modelling of labour supply. Finally, it represents the first attempt to evaluate the employment effect of a recent change in the Australian Disability Support Pension.

Estimates of the structural model reveal that both physical and mental health have a significant effect on single parents' preferences for work. For single mothers, better mental health status lowers the disutility derived from work. For both genders, ill-health and health shocks increase the aversion to the numbers of hours worked but also increase the marginal utility of income. Our counterfactual analysis, concerning the introduction of a stricter work-impairment assessment to access the Disability Support Pension, finds a moderate but positive effect on single mothers' labour supply, particularly in the lower part of the hours worked distribution.

2. Literature

Health and single parents' labour supply

In previous studies of single parents' labour supply, health is rarely at the centre of the analysis. The physical dimension of health is usually approximated with self-reported variables defining the presence of work-limiting health conditions whereas health shocks and mental health are invariably ignored. Early studies on single mothers' employment status in U.S. account for health simply in terms of disability or working-limiting health conditions and find that ill-health decreases labour force participation (Saks, 1975; Williams, 1975; Levy, 1977). Barr and Hall (1981) analyse work incentives and welfare dependency using American data from both the Aid to Families with Dependent Children Survey and the Survey of Economic Opportunity. They find that the probability of being welfare dependent increases for single mothers in poor health.

Two studies on the effect of Medicaid benefits on the employment status of single mothers also include health in their analysis (Blank, 1989; Moffit and Wolfe, 1992). Blank (1989) uses data from the National Medical Care Utilization and Expenditure Survey and accounts for disability status in measuring Medicaid insurance values. She defines single mothers' health using a measure of health limitations and the health of the mother's household using an indicator which takes four values increasing in ill-health. She concludes that both single mother's own ill-health and household's poor health significantly reduce hours worked.

Moffitt and Wolfe (1992) also examine the effect of Medicaid on the labour supply and welfare participation decisions of single mothers. They use data from the Survey of Income and Programme Participation (SIPP) and employ a five-point scale self-assessed measure of health as well as an indicator of functional limitations. They find that a lower health status decreases the probability of employment. Wolfe and Hill (1995) investigate the effect of health on the work effort of single mothers. In order to define single mothers' health, the authors use an index of health based on limitations in performing Activities of Daily Living and a measure of self-reported poor health. Using data drawn from the SIPP Survey, they estimate a reduced-form probit model of employment and find that the presence of health limitations decreases the probability of being employed for single mothers. This work also finds that children's disability decreases workforce participation of lone mothers.

Health and behavioural microsimulation models of labour supply

Behavioural microsimulation models of labour supply have almost entirely disregarded both health and the analysis of the effects of health-related reforms. Typically, behavioural microsimulation modelling is used to model labour supply responses to changes in direct taxes and benefits (Creedy and Duncan, 2002). This technique involves the use of an arithmetic tax-benefit model to simulate the budget constraint faced by each individual under different tax-benefit regimes and a theoretical model to represent individuals' labour supply. The theoretical model is also used to predict how individuals will respond to changes in the tax-benefit system. The purpose of these models is to provide a prediction of the differences in labour supply under alternative tax-benefit scenarios. A recent study by Cai *et al.* (2008) tested the validity of microsimulation as a method of policy evaluation. The authors look at the effect of the Australian New Tax System introduced in July 2000. They compare predicted labour supply responses obtained from microsimulation modelling and differences-in-difference *ex-post* evaluation techniques using the 1999-2000 Survey of

Income and Housing Costs data and the 1996-2001 Census data. Although some caution is required in comparing estimates produced by these two different approaches, they find that results were similar and consistent. Reviews of topical applications of behavioural microsimulation models of labour supply can be found in Creedy and Duncan (2002) and in Creedy and Kalb (2005). A taxonomy of microsimulation models is proposed by Bourguignon and Spadaro (2006).

3. Labour supply model

3.1 The optimisation problem

We adopt and build on the structural model of labour supply originally proposed by Keane and Moffitt (1998) and Blundell *et al.* (2000). According to this framework, single parents derive utility from net household income Y and leisure L. Hours worked are defined in terms of the difference between individual time endowment T and leisure L, $H = T - L$. Preferences can be described as:

$$U = U(Y, L; X) \tag{1}$$

with X representing individual characteristics that affect preferences. Individuals maximise their utility subject to the following budget constraint:

$$Y = WH + I - t(H, W, I; X) - CC(Z) \tag{2}$$

where W are gross hourly real wages, I is total household non-labour income, $t(H, W, I; X)$ is the tax system and $CC(Z)$ represents child care costs. The tax system $t(.)$ is formed by tax payments net of government transfers and benefits and is assumed to depend on hours worked, wages, household income earned from other assets and non-labour sources and individual demographic characteristics. Child care costs CC vary according to a set of individual characteristics Z .

Following Creedy and Duncan (2002), we consider that the choice of hours worked can be approximated by a finite set of k discretised points $H(.) \in \{H^1, H^2, ..., H^k\}$, according to the rule:

$$
\begin{aligned}
H(.) &= H^1 \quad if \;\; H \le H_1^B \\
&= H^2 \;\; if \;\; H_1^B < H \le H_2^B \\
&\;\;\ldots\ldots\ldots\ldots\ldots\ldots \\
&= H^{k-1} \; if \;\; H_{k-2}^B < H \le H_{k-1}^B \\
&= H^K \;\; if \;\; H > H_{k-1}^B.
\end{aligned}
$$

This results in k alternative values of $H(.)$. In our case, we choose to model twelve different categories of hours worked, $H(.) = \{0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55\}$. A discrete-choice approach to structural labour supply modelling has been previously applied in a number of studies (Callan and Van Soest, 1996; Bingley and Walker, 1997; Keane and Moffit, 1998; Duncan and Harris, 2002; Andrén, 2003; Brewer *et al.*, 2006; Labeaga *et al.*, 2008) and has the main advantage of reducing the complexities of non-linear tax-schedules, allowing for a more realistic non-convex budget constraint. It is thus the generally accepted approach in the estimation of individual labour supply functions.[3]

The individual now maximises her utility over the set of hours worked $H(.)$ as:

$$\underset{H(.)}{Max} \; U(Y[H(.)], T - H(.); X) \qquad for \; H(.) \in \{H^1, H^2, \ldots H^K\} \; . \tag{3}$$

Net household income is obtained for each category of hours worked included in the set as:

$$Y[H(.)] = WH(.) + I - t(H(.), W, I; X) - CC(Z). \tag{4}$$

3.2 Functional form and estimation

We choose to represent individual preferences using a direct quadratic utility function (Keane and Moffitt, 1998) of the form:

$$U_{H(.)} = \alpha_{yy} Y^2 + \alpha_{hh} H^2 + \alpha_{yh} YH + \beta_y Y + \beta_h H. \tag{5}$$

[3] For a comprehensive review and discussion of different labour supply modelling strategies see Blundell and MaCurdy (1999).

This function is tractable and flexible enough to allow for a wide range of behavioural responses (Stern, 1986). It also allows for diminishing returns of income and hours worked through the quadratic terms. Another attractive feature of this functional form is that it can be easily extended to represent couples' labour supply (Brewer *et al.*, 2005; Labeaga *et al*., 2008; Pacifico, 2009).

For estimation purposes, we assume the presence of random stochastic components specific to each labour market state (each hour band). These components can be interpreted simply as errors in perception of the alternative utilities or as unobserved alternative-specific utility factors. Importantly, these stochastic elements are not intended to reflect random preferences derived from unobserved individual characteristics (Brewer *et al*., 2005). The stochastic utility function becomes:

$$U^*_{H(.)} = \alpha_{yy}Y^2 + \alpha_{hh}H^2 + \alpha_{yh}YH + \beta_y Y + \beta_h H + \varepsilon_{H(.)} \qquad (6)$$

Observed heterogeneity can be introduced through the parameters β_y, β_h, α_{yy}, α_{hh}, letting:

$$\beta_y = \beta_{y0} + \beta^{'}_{y1}X \qquad (7)$$

$$\beta_h = \beta_{h0} + \beta^{'}_{h1}X \qquad (8)$$

$$\alpha_{yy} = \alpha_{yy0} + \alpha^{'}_{yy1}X \qquad (9)$$

$$\alpha_{hh} = \alpha_{hh0} + \alpha^{'}_{hh1}X\,. \qquad (10)$$

This allows the parameters of income and hours to be a linear function of individual socio-demographic and household characteristics. Following the literature (GIVE REFS!) the characteristics we choose to include are: dummies which define different education levels; the individual's age; the total number of dependent children, and the number of children aged between 0-4 years and between 5-14 years; and a series of measures that define physical and mental health status.[4]

[4] In the same fashion, this model can be expanded to account for individual unobserved random preference heterogeneity over income and hours worked. For example, individual unobserved heterogeneity can be introduced through the linear parameters of the utility function as: $\beta_y = \beta_{y0} + \beta^{'}_{y1}X + v_y$ and

Making the standard assumption that the alternative specific error terms $\varepsilon_{H(.)}$ independently follow a Type I Extreme Value distribution, the probability of choosing a certain state $H(.)$ = H_j, conditional on observable characteristics X is given by:

$$\Pr(H_{(.)} = H^j; X) = \Pr(U^*_{H^j} > U^*_{H^K}) \quad \forall\, j \neq k,\ k \in \{1, 2, .., K\}$$

$$= \frac{\exp[U(Y_{H^j}, T - H^j; X)]}{\sum_{k=1}^{K} \exp[U(Y_{H^k}, T - H^k; X)]} \tag{11}$$

where the terms $U^*_{H^j}$ and $U^*_{H^K}$ are stochastic utilities. The associated log-likelihood function, for an individual, is:

$$\ln L_i = \sum_{k=1}^{K} d_{ik} \ln\ [\Pr(H_{i(.)} = H; X_i)] \tag{12}$$

where d_{ik} is an indicator variable which takes value 1 when $H_{i(.)} = H^k$ and zero otherwise.

3.3 Modelling issues: unobserved wage rates and child care costs

In order to simulate behavioural responses for all individuals in the sample, we need to estimate expected wage rates for non-workers. In this way, we can obtain hourly wage rates that non-working individuals would command if they were in paid employment. We follow Creedy and Duncan (2002) and Duncan and Harris (2002) and estimate wage equations for single parents' outside paid employment using a Heckman selection model (1979) to account for potential selection bias. We predict (log-)wages for non-workers using the estimates from the Heckman model and employ a smearing estimator (Duan, 1983;

$\beta_h = \beta_{h0} + \beta_{h1}^{'} X + v_h$. In this case, the unobserved components v_y and v_h can be assumed to be jointly normally distributed. However, in our case, models augmented by these components and estimated through Simulated Maximum Likelihood failed to achieve convergence. For this reason, we choose to include only observed heterogeneity in our analysis. In any case, these additional correlation terms are often found to be either insignificant and/or to not significantly affect results.

Barrientos and Firinguetti, 1997) to transform these log predictions into actual wage predictions. We include among our controls age (using linear and quadratic terms) ethnicity (if Aboriginal or Torres Strait Islander), dummies for different education levels (whether the individual holds a first/post graduate degree, and a certificate or advanced diploma), industry of occupation (if blue collar and two different levels of white collar workers), geographical information (if living in a regional or remote area) and country of origin (if born overseas).[5]

Accounting for the costs of child care is essential when considering the labour supply of single parents (Doiron and Kalb, 2005). Given the importance of this cost component in individuals' labour supply decisions, we choose to model child care costs as part of the structure of the theoretical model. In this paper, we also impute child care costs for individuals who are not observed to be working.[6] Again, we predict child care costs for non-working individuals using a Heckman selection model, similar to the one described above. These costs are then directly subtracted from individuals' net incomes as per equation (2). In addition to the individual socioeconomic characteristics that we use to predict missing wages, predictions for this model are also based on age and number of children.[7]

4. Data

We use data from the first six waves of the Household, Income and Labour Dynamics in Australia (HILDA) survey (2001-2006). The survey collects very detailed information on individuals' income and earnings as well as information on various aspects of health and well-being. HILDA is Australia's first nationally representative household panel study and its design reflects closely other household panel studies such as the British Household Panel Survey, the German Socioeconomic Panel and the Panel Study of Income Dynamics. The initial sample was selected using a multi-stage approach with wave 1 consisting of 7682

[5] For a more robust identification of our two-step procedure, we impose some exclusion restrictions. In particular, we include in the probit selection equation two additional dummy variables defining marital status (whether the individual is divorced and/or widowed).

[6] This implicitly assumes that individuals who are working and are not paying for child care, are not actually facing any child care cost. That is, we assume that individuals who are in the labour market and are not observed to be paying for child care are actually leaving the care of their children to relatives, friends, neighbours or other members of their families while at work. This assumption is reinforced by the wealth of information on child care costs included in the survey questionnaire where individuals with children of various ages who are identified as primary care-givers are asked if they are paying for a nanny or a baby sitter to take care of their children during their work time. However, it might be possible that other forms of informal but paid child care arrangements are not captured by this framework.

[7] Estimates of unobserved wage rates and the child care costs are available upon request.

households corresponding to 19914 individuals.[8] Interviews are conducted annually with all adult members of each household and the original panel is automatically extended every year to include any children born or adopted by household members and following changes in the composition of the original households. Excluding individuals who are retired or self-employed as well as full-time students, the sub-sample used for our analysis is formed by 4632 single parents, 3067 women and 1565 men, over the six waves.

Using information contained in HILDA, we also build a stylised tax-benefit model which aims at reproducing the main aspects of the current Australian system. The rationale behind the construction of a tax-benefit model lies in the fact that we need to compute net incomes for each hours work band to inform the labour supply choices of individuals in our behavioural model. Details of the tax-benefit model are provided in the following section.

4.1 A stylised Tax-Benefit model

We generate the required net incomes using an arithmetical tax-benefit model that uses information on individuals' earnings contained in HILDA. The model is intended to be a stylised reproduction of the current Australian welfare system. In particular, we choose to model only the main taxes and transfers which might be relevant for our sub-sample of single parents. In our framework of analysis, this tax-benefit model is intended to be an instrument that allows us to generate more accurate budget constraints.[9]

The tax-benefit model generates individuals' net incomes starting from gross wages for individuals in work and imputed gross wages for non-working individuals. The simulated benefits are: Parenting Payment; Family Tax Benefit A; Family Tax Benefit B; Maintenance Income; Large Family supplement; Rent Assistance; Baby bonus; Child Care Benefits and the Disability Support Pension. The simulated taxes include income tax and the Medicare levy. All payment rates and thresholds for taxes and benefits are updated at 20th of March

[8] For details and explanations on the sampling procedures see Wooden and Watson (2007).

[9] It should be noted that this tax-benefit model proved to perform well when compared to predicted net incomes produced by the Static Incomes Model (STINMOD) of the National Centre for Social and Economic Modelling. STINMOD is a sophisticated static microsimulation model of Australian's income tax and transfer system and is currently used by a number of Australian Government departments to estimate the fiscal and distributional impact of policy reforms. The STATA codes of the tax-benefit model used in this paper are available upon requests.

2008 and computed using freely available information provided by the Australian government.[10]

Main taxes and benefits

Parenting Payment and Family Tax Benefits A and B are designed to help families with the costs of raising children. For single parents, eligibility and rates of Parenting Payment are subject to an assets test and depend on the number and age of dependent children. Rates of Family Tax Benefits A and B depend on an income test as well as on the number and age of dependent children. Maintenance Income applies whenever an individual is eligible to obtain more than the base rate of Family Tax Benefit A. Large Family Supplement concerns single parent households with three or more children and increases with the number of children. If living in a rented accommodation, Rent Assistance is computed according to a series of criteria including the amount of rent and household composition (number of dependent children). The Baby Bonus is paid following the birth or adoption of a baby.[11]

We approximate Child Care Benefit using variables already contained in the survey. This is mainly related to difficulties in computing from scratch child care benefit rates as it is not possible to precisely distinguish between what the government defines as "approved child care" and "registered child care" using information within the dataset.[12] The variables contained in HILDA include an estimate of the annual amount of dollars paid by the Government to a household with children. These estimates are based, among other factors, on the number of children, number of hours of care and parental income.[13] Income tax is computed using the 20th March 2008 thresholds. The Medicare levy is computed as 1.5 per cent of an individual's taxable income; in order to help funding Medicare, the national scheme that gives Australians access to health care, all resident taxpayers are subject to the Medicare Levy. Note that exemptions to the payment of the Medicare levy are for foreign

[10] All the relevant information is available at the Australian Government Centrelink website (http://www.centrelink.gov.au/) and at the Australian Department of Families, Housing, Community Services and Indigenous Affairs (FaHCSIA) website (http://www.fahcsia.gov.au/). For a comprehensive overview of the payment rates and thresholds in place since the 20th March 2008 in the Australian tax-benefit system see "A guide to the Australian Government payments", Family Assistance Office, Australian Government, 2008. Web-link: http://www.centrelink.gov.au/internet/internet.nsf/filestores/co029_0803/$file/co029_0803en.pdf

[11] Information on births and adoptions is available only from wave 2 onwards as part of the Major Life Events module of HILDA.

[12] Hence, the amounts of child care benefit received by the single parents households in our sample are the ones self-reported in the survey during the years 2001-2006.

[13] For more details, see the coding framework of HILDA, in the Derived Variables section of the Income-Benefits subject area.

residents and, more generally, all individuals who are not entitled to the Medicare benefits. Levy reductions are available for people on low incomes as well as for single parents.[14]

Disability support pension

Disability-related welfare dependency is a serious policy concern in Australia (Cai, 2006). This is mainly due to the growing trend of recipients of the Disability Support Pension (DSP), especially since the introduction of the Disability Reform Package in 1991.[15] In 1991, recipients accounted for 2.96 per cent of age-eligible individuals while this percentage rose to 5.15 in 2003 (Cai *et al*., 2007). As a consequence, options to encourage the exit from the DSP are considered of paramount importance for their favourable effect on both the government budget and the labour market. The DSP is given to individuals with an injury, illness or disability (whether physical or mental-health) who are aged 16 or over, not receiving Age Pension and are assessed as not being capable of working for the next two years. Prior to the introduction of the Welfare to Work reforms in July 2006, work incapacity was assessed as not being able to work for more than 30 hours per week for the following two years. The 2006 reform introduced more stringent eligibility criteria whereby work incapacity was measured as the inability to work for more than 15 hours per week within the two subsequent years. In this paper, we look at the labour supply effects of this change. In particular, we compare predictions of labour supply choices obtained from our structural model using net incomes from both rules (before and after the reform). Using data contained in HILDA, we define an individual's eligibility to the DSP using information on the occurrence of an injury or illness, the presence of long-term and mental health conditions, disability status and the observed amount of weekly hours worked.

4.2 Measures of health

HILDA is a rich source of health information. It includes the SF-36 Survey of Health, a multi-purpose health survey which contains 36 health-related questions. The SF-36 encompasses information on eight health dimensions, four of which relate to physical health

[14] For completeness of description of the Medicare levy, we should mention the existence of a Medicare levy surcharge, an extra tax paid by all Australian taxpayers who do not have private hospital cover and with income above the Medicare levy surcharge thresholds (50,000 dollars per year for individuals and 100,000 per year for families and couples in March 2008). The surcharge is computed at the rate of 1% of the annual taxable income. Given the lack information on private health insurance in our data (information that is available only in the fourth wave of the panel), we did not include the Medicare surcharge in our tax-benefit model.

[15] Through the introduction of this package in November 1991, the Disability Support Pension replaced an equivalent transfer named the Invalid Pension.

(physical functioning, physical limitations, bodily pain, general health perception) while the remaining relate to mental health (social functioning, emotional limitations, vitality and general mental health). In addition to the SF-36, HILDA also contains a variety of additional health measures. These questions are related to general self-assessed health status, long term conditions, and health-related lifestyles (such as alcohol and cigarette consumption and physical activity). From wave 2 onwards, HILDA also contains information on major life events, including sudden injuries and illnesses.

Measures of physical health

Self-assessed measures of health can be problematic when used to identify the causal effect of health on labour market outcomes (Anderson and Burkhauser, 1985; Bazzoli, 1985; Stern, 1989; Bound, 1991; Bound *et al*., 1999; Au *et al*., 2005; Disney *et al*., 2006). First, self-reported measures are based on non-comparable subjective judgements: individuals with the same underlying health may apply different thresholds when reporting their health status on a categorical scale (Lindeboom and van Doorslaer, 2004). Secondly, self-reported health might not be independent of labour market status (Garcia-Gomez and Lopez Nicholas, 2006). While measurement error caused by reporting heterogeneity will lead to an underestimation of the effect of health on labour market outcomes, endogeneity in the health-work relationship will lead to an upward bias (Bound, 1991; Bound *et al*., 1999). Thirdly, health problems can also be systematically overstated as a means of obtaining social security benefits such as disability benefits (Kerkhofs and Lindeboom, 1995) or simply to justify being outside the labour market (*i.e.*, justification bias).[16]

We deal with the problem of measurement error (reporting bias) of the self-reported measures of health using the latent variable approach originally proposed by Stern (1989) and Bound (1991) and subsequently applied in a number of empirical studies on the impact of health on work (more recently by Jones *et al.*, 2009; Brown *et al.*, 2010 and Garcia-Gomez *et al.*, 2010). This method involves estimating a model of self-assessed health as a function of more "objective" measures of health to obtain a latent health index. In our case, we regress the common five-point ordinal measure of self-assessed health (according to which health is defined as excellent/very good/good/fair/poor) onto a series of specific

[16] See Bound (1991) for a discussion of the various biases involved in the use of different types of health measures in the context of retirement models.

measures of health limitations using generalised ordered probit (GOP) models.[17] The indicators of health limitations are defined as dummy variables and identify the presence of functional limitations in performing a series of activities: vigorous and moderate activities; lifting groceries; climbing stairs; bending and kneeling; walking various distances; and bathing and dressing. We estimate GOP models separately for men and women and use the obtained latent health measures as proxies for physical health in our models of labour supply.

We also make use of an alternative indicator of physical health which defines the presence of long-term health conditions. Information on long-term health conditions is drawn from the question "do you have any long-term health condition, impairment or disability that restricts you in your everyday activities, and has lasted or is likely to last?". Accordingly, we create a dummy variable taking the value 1 in presence of long-term conditions.

Measure of mental health

Studies in the area of public health find that mental health problems are more frequent among single parents, especially lone mothers, than amongst individuals in couples (Neises and Gruneberg, 2005). In our analysis, we look at the effect of mental health on single parents' labour supply using the Mental Component Summary (MCS) contained in the SF-36 questionnaire of the HILDA survey. The MCS is an index of mental health built by combining information from four different SF-36 components: mental health, role emotional, social functioning and vitality (Ware and Gandek, 1998). This index ranges from 0 to 100 and is increasing in good health. The MCS has been shown to be reliable in screening for psychiatric disorders (Berwick *et al.*, 1991; Ware *et al.*, 1994) and depression (Ware *et al*., 1995).

Health shocks

Health shocks defined as unanticipated negative health deterioration can be useful instruments in the identification of the effect of health on labour supply. It is argued that accounting for health shocks could help to eliminate a potential source of endogeneity bias caused by individual health-related unobserved effects (Disney *et al*., 2006; Jones *et al*., 2009). We model health shocks in two different ways. First, we use information contained in

[17] GOP models accounts for reporting heterogeneity allowing for different mappings between the latent variable and the observed categorical health variable. In particular, GOP models allow the cut-points to depend on socio-economic characteristics. For a discussion on these issues see Lindeboom and van Doorslaer (2004).

the Life Events module of the HILDA Survey on the occurrence of a “serious injury or illness” within twelve months prior the interview. Accordingly, we create a dummy variable for the incidence of this event. Secondly, we define sudden (physical) health deterioration looking at differences between the values of the latent health index over different time periods. More precisely, to identify health shocks we include in our labour supply models a lagged measure of the latent health index together with the initial period value of the same latent measure. In this way we can interpret the estimated coefficient of lagged health as a deviation from some underlying health stock or a health shock. Similarly, we use lagged and initial values of the long-term health variable and interpret the lagged value as a deterioration of long-term conditions.

4.3 Descriptive statistics

Table 1 compares mean values of a series of household and individual socioeconomic characteristics between single parents and individuals living with a partner with children. The first columns in the upper and lower part of the table show mean values for pooled samples of men and women. The remaining columns present mean values for women and men separately.

(Table 1 around here)

In our sample, single parents are significantly younger, less educated and have a lower household income than individuals in couple with children. However, the difference in household income appears to be more concentrated in the female sub-sample. If we look at the pooled samples, single parents are observed to work on average around 17 hours less per week. The values of the SF-36 indices of general health and mental health are systematically lower for single parents. As these two indicators are increasing in good health, these indicate that single parents have a worse health status. Further, the presence of long-term health conditions and health shocks, defined as injuries or illnesses, are consistently more concentrated among single parents. Looking at household composition (number of children and age of the youngest child) reveals some important differences both between single parents and couples with children as well as between genders within the single parents’ sample. Two-parent households have a higher number of children who are on average older than the ones living in single parents families. Among single parents, lone fathers have the lower average number of children with the highest average age. This occurs despite the fact that single fathers are also the younger individuals within the single parents sub-sample. Ethnicity is also an important factor, especially among women, as 8 per cent of single mothers are of Aboriginal origin.

5 Results

5.1 Estimates

Estimates for the structural models of labour supply are reported separately for women and men in Tables 2a to 2b and Tables 3a to 3b, respectively. All tables display estimates of the parameters of the utility function allowing for observed heterogeneity to enter the linear and quadratic terms. Observed heterogeneity is introduced through a set of variables defining single parents': age (using a quadratic function); education (whether an individual holds a first degree/post-graduate qualification or an advanced diploma/certificate); number of children (total number of children, number of children aged between 0-4 years and between 5-14 years); and importantly, mental health and alternative measures of ill-health and health shocks.

Models 1 to 3 in Tables 2a and 3a were estimated using three different health measures: the SF-36 Mental Component Summary; a latent health index purged of reporting bias; and the presence of long-term health conditions. All these variables were lagged one period to avoid any potential reverse causation (simultaneity) bias. Specifications reported in Tables 2b and 3b (models 4 to 6) include the modelling of health shocks. In model 4 health shocks are defined using self-reported information on injuries or illnesses in the previous twelve months whereas ill-health is accounted through the initial period value of the latent health index (*i.e.*, the value of the latent health index at wave 1). Health shocks are included in Models 5 and 6 using both the initial and lagged values of latent health index (model 5) and of the long-term health variable (model 6). In these models, the lagged values of the health variables represent a health shock, in terms of a deviation from an individual's initial health stock.

In all models for both genders, the estimates appear to be broadly consistent with economic theory, suggesting increasing and diminishing marginal utility of income and decreasing marginal utility of hours worked. As our main interest is on the effects of ill-health and health shocks on the preferences for work, we concentrate on the coefficient estimates of the health variables. For women, our results suggest that a higher level of psychological well-being (*i.e.,* a higher mental health score) reduces the marginal disutility derived from working (model 1 in Table 2a). This means that single mothers with better mental health are less averse to a higher number of hours worked. Furthermore, ill-health increases both the marginal disutility of work and the marginal utility of income (models 2 and 3 in Table 2a). The positive impact of ill-health on the marginal utility of income appears to corroborate the hypothesis according to which for non catastrophic health-events, poor health lowers utility but increases the marginal utility of income (Evans and Viscusi, 1991a and 1991b). This interpretation is based on the assumption that a minor ill-health state can be though of as being equivalent to a drop in income or a "monetary loss". In this case, while a poorer health status lowers the level of utility, it increases the marginal utility of income. In one of our models for single mothers (model 3), ill-health has a statistically significant and negative effect on the square of the income term. This appears to suggest that ill-health also diminishes the speed at which the marginal utility of income decreases. Again, this result seems to be consistent with the previous interpretation on the higher value placed on marginal income by individuals in ill-health. For single mothers, unanticipated health shocks exert a positive effect on the marginal utility of income and increase the marginal disutility of work (model 6 in Table 2b). Moreover, deteriorations in an individual's health status appear to lower the rate at which the marginal utility of income decreases (models 6).

The same sequence of models estimated for the sub-sample of lone fathers reveals differences on the impact of health on the preferences for work. For single fathers, ill-health defined through the latent health index increases the marginal utility of income as well as the marginal disutility of work (model 2 in Table 3a). However, in contrast to single mothers, a higher mental health score diminishes the marginal utility of income. Coefficients for the mental health variable and the two ill-health variables, the latent health index and the long-term health dummy, are positive and significant for squared income and squared hours respectively. However, all these coefficients appear to be very small (models 1, 2 and 3 of Table 3a). Similarly to single mothers, health shocks increase the marginal utility of income and the marginal disutility of work (models 4 and 5 in Table 3b).

The effects of the other socioeconomic variables are consistent throughout all the models estimated for single mothers. According to our estimates, higher levels of education decrease the marginal disutility of work but also reduce the marginal utility of income. Single mothers having to take care of more young children (between 0 and 4 years of age) have a stronger marginal utility of income but are more adverse to hours worked. Further, the total number of children appears to impact on single mothers' work preferences in the same way: increasing the marginal utility of income (models 3, 4 and 6) and decreasing the marginal utility derived from work (all models in Tables 2a and 2b). In common with lone fathers, age exerts an effect mainly on the squared income term. For single fathers, the effect of education is not of clear interpretation: while holding an advanced diploma or certificate level of education decreases the disutility of work, higher levels of education (first degree or postgraduate qualification) do not have a statistically significant effect on the preferences over income and hours worked. In some models for single fathers (1 and 2 in Table 3a), a higher number of young children (aged between 0 – 4) decreases the marginal utility of income as well as increases the marginal disutility of work (model 4 in Table 3b). However in all estimated models, the total number of children appears mainly to lessen lone fathers' aversion to hours worked.

5.2 Model evaluation and predictions

In the light of the subsequent policy evaluation exercises, it is useful to first test the predictive abilities of the model. In this section, we evaluate the reliability of the model's predictions comparing the actual distributions of hours worked by single mothers and fathers with the predictions from our models. Following previous work on behavioural microsimulation (Duncan and Harris, 2002; Labeaga *et al*., 2008), we use re-sampling methods to account for the stochastic elements of the utility function. In particular, we draw repeated realisations from the state-specific error, the Type I Extreme Value Distribution, and add the average values of these draws to correct the models' predictions. The optimal number of draws is selected on the basis of its capacity of matching the observed hours' distributions. Results of this method of model evaluation are presented in Tables 4 for all the six estimated models.

(Table 4 around here)

The Table reports predictions separately for single mothers and lone fathers obtained using 1000 random draws and 100 draws respectively. Predictions show that the models estimated for single mothers tend to better match the empirically chosen outcomes. In particular, models 3 and 6 (which include long-term health conditions) appear to predict very closely the actual distribution of hours worked, especially for the first seven bands. In general terms, predictions obtained using the same models for the male sub-sample appear to be less accurate.

5.3 Policy simulation

As an example of the usefulness of behavioural microsimulation modelling for policy evaluation purposes, we simulate the likely employment effects of a change in the Australian Disability Support Pension (DSP) that occurred in July 2006. With the objectives of both reducing the number of individuals receiving the DSP and encouraging employment, the reform introduced stricter eligibility rules. According to this reform, access to the Disability Support Pension was limited only to those individuals with a physical, intellectual and psychiatric impairment that resulted in the inability to work for more than 15 hours per week within the next two years. Before the reform, access to the DSP was granted to all individuals that were incapable of working for more than 30 hours per week for the same period. In our analysis, we approximate these eligibility rules using information contained in HILDA on the incidence of injuries or illnesses, long-term health conditions, disability, mental health problems and the actual number of hours worked in a week in all jobs.

In order to measure the labour supply responses of single parents to this change, we compare predictions from our models before and after the introduction of this reform. More specifically, in our baseline scenario, the models are estimated using net incomes produced by the tax-benefit model using the computation rules of the DSP prior to the reform. Estimates of the simulated scenario are based on net incomes computed using the new eligibility criteria defined by the introduction of the reform. As for the other benefits and taxes in our stylised tax-benefit model, the payment rates used to compute the quantities of the DSP are the ones updated at the 20th of March 2008. At that date, subject to income and assets tests, the payment rate of the DSP received by a single parent was 546.80 dollars per fortnight. Payment is made only to Australian residents, aged 16 year or over but under pension age and with the inability to work due to ill-health as described above. Assuming full-take up and after the income and assets tests, in our baseline scenario DSP is transferred to the 12.9 per cent of our sub-sample of single mothers and to 10.4 per cent of single fathers. In the simulated scenario, DSP is received by the 11 percent of single mothers and by the 8.2 per cent of lone fathers.

(Table 5 about here)

Table 5 displays the labour supply responses following the introduction of the DSP reform. The upper part of the table shows the percentage changes in labour supply for each band of hours worked for all estimated models for single mothers. The lower part of the table contains the simulated changes for single fathers. The increased severity of the work-impairment assessment appears to mainly affect the lower part of the hours distribution, especially among lone mothers. Single mothers are found to move out from zero hours worked (between 0.36 and 2.1 per cent) and to move mostly into the 5 hour band (between 0.86 and 2.5 per cent). It should be noted that given the relatively small percentage of single mothers affected by the reform, the size of these effects are not negligible. Our simulation also shows that overall the reform appears to reduce the percentage of single mothers working in intermediate categories of hours (between 15 and 30 hours per week) and to marginally increase the percentages of single mothers choosing to work a higher number of hours (45 and 50 hours per week). The simulated labour supply responses of lone fathers to the reform appear to have broadly the same direction to the ones of single mothers, especially in the lower part of the hours distribution. However, all the percentage values are found to be smaller than the ones observed for single mothers.

6. Conclusions

The core objective of this paper was to examine the influence of mental and physical health on the labour supply of single parents. In order to perform this analysis, we estimated a behavioural microsimulation model of labour supply. The model allows us to both analyse the effect of a series of health variables on single parents' preferences for work and to evaluate the employment responses to the introduction of a recent reform of the Australian Disability Support Pension. This paper presents a number of original contributions. Unlike previous studies, it concentrates on the effects of health shocks and a measure of psychological well-being on single parents' employment. It also introduces individual's health and health shocks in the context of behavioural microsimulation modelling of labour supply. Moreover, it represents the first attempt to evaluate the employment effects of an important reform of the DSP.

We estimate single parents' preferences using a direct quadratic utility function and find that ill-health significantly impacts on individuals' marginal disutility of work and marginal utility of income. For single mothers, a higher level of mental well-being measured by the

SF-36 Mental Component Summary, decreases the aversion to hours worked. Also, ill-health and unanticipated health shocks, defined alternatively using self-reported information on long-term conditions and injuries and a latent health variable, increase their marginal disutility for work and marginal utility of income. Among single fathers, ill-health and health shocks influence preferences in the same direction while a better mental health status lowers the marginal utility of income. Overall, these results highlight the importance of health in shaping individuals' preferences on labour supply and thus the need to explicitly include health variables in this type of behavioural model. From a policy perspective, these findings also suggest that both mental and physical health must be considered when implementing policies targeted at increasing the productivity of single parents.

Furthermore, we use the behavioural microsimulation model to estimate the labour supply responses following a restriction in the eligibility criteria to access the DSP on our sample of single parents. According to this simulation exercise, limiting the access to the transfer only to individuals incapacitated to work for more than 15 hours per week has a small but positive impact on the lower part of the distribution of hours worked, especially among single mothers. This finding is important in the light of the current debate around welfare-to-work reforms in developed countries but also for the relevance of this particular transfer in Australia.

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Appendix C

Table 1: Descriptive statistics

Individuals in couples with children - mean values

Variable	**Women and men**	**Women**	**Men**
Age	40.396	39.669	41.195
Woman	0.524		
Aboriginal	0.016	0.017	0.015
Education 12	0.436	0.505	0.360
Education/certificate	0.317	0.246	0.394
Education/degrees	0.247	0.249	0.245
Household Income	88935.49	88001.19	89963.17
Weekly hours worked	39.234	31.886	45.616
Number of children	2.101	2.126	2.071
Age youngest child	12.407	12.595	12.194
General health	71.232	72.042	70.326
Mental Health	74.819	73.846	75.907
Long-term health	0.126	0.119	0.134
Health shocks	0.054	0.050	0.057
Regional or remote area	0.387	0.391	0.383
Born overseas	0.236	0.234	0.238
Observations	*35987*	*18850*	*17137*

Single parents - mean values

Variable	**Women and men**	**Women**	**Men**
Age	31.514	33.397	27.886
Woman	0.663		
Aboriginal	0.063	0.080	0.031
Education 12	0.566	0.551	0.596
Education/certificate	0.299	0.299	0.299
Education/degrees	0.135	0.151	0.105
Household income	66880.84	56829.23	86633.42
Weekly hours worked	22.119	18.085	30.058
Number of children	1.904	1.918	1.792
Age youngest child	7.540	7.283	9.585
General health	67.738	67.086	69.112
Mental Health	68.914	67.624	71.627
Long-term health	0.148	0.152	0.141
Health shocks	0.055	0.051	0.062
Regional or remote area	0.381	0.388	0.369
Born overseas	0.143	0.155	0.119
Observations	*4632*	*3067*	*1565*

Notes: self-employed, retired and full-time students are excluded; household income is the individualised household income from all sources of labour and non labour income, including government benefits and transfers, before taxes; weekly hours worked is the average amount of hours worked in all jobs in a week; general health status is the SF-36 index of health which can take values from 0 to 100 and is increasing in good health; health shocks are defined as the occurrence of injuries or illnesses.

Table 2a: Estimates of the labour supply models: health and labour supply – Single mothers

		Model (1)		Model (2)		Model (3)	
Income/100		2.472***	(0.875)	2.285***	(0.851)	2.539***	(0.868)
x	age	0.028	(0.040)	0.019	(0.040)	0.016	(0.042)
x	age squared	-0.048	(0.051)	-0.042	(0.052)	-0.047	(0.055)
x	education/certificate	-0.646**	(0.283)	-0.681**	(0.287)	-0.549*	(0.308)
x	education/degrees	-1.487***	(0.272)	-1.473***	(0.272)	-1.361***	(0.290)
x	child 0-4	0.460*	(0.253)	0.452*	(0.251)	0.130	(0.206)
x	child 5-14	0.011	(0.142)	0.042	(0.143)	-0.004	(0.135)
x	number of children	0.189	(0.130)	0.190	(0.130)	0.265*	(0.141)
x	mental health (t-1)	-0.004	(0.003)	-	-	-	-
x	latent health index (t-1)	-	-	0.111	(0.087)	-	-
x	long-term health (t-1)	-	-	-	-	0.850***	(0.308)
Hours		-0.538***	(0.177)	-0.406**	(0.167)	-0.558***	(0.180)
x	age	0.005	(0.009)	0.006	(0.009)	0.007	(0.010)
x	age squared	-0.007	(0.011)	-0.006	(0.011)	-0.004	(0.013)
x	education/certificate	0.112***	(0.038)	0.117***	(0.039)	0.104**	(0.043)
x	education/degrees	0.263***	(0.045)	0.263***	(0.045)	0.258***	(0.052)
x	child 0-4	-0.165***	(0.043)	-0.174***	(0.043)	-0.088***	(0.033)
x	child 5-14	-0.014	(0.030)	-0.023	(0.030)	-0.021	(0.026)
x	number of children	-0.050**	(0.025)	-0.048*	(0.025)	-0.055**	(0.027)
x	mental health (t-1)	0.002**	(0.001)	-	-	-	-
x	latent health index (t-1)	-	-	-0.035*	(0.020)	-	-
x	long-term health (t-1)	-	-	-	-	-0.184***	(0.058)
Income x hours		0.025***	(0.007)	0.024***	(0.007)	0.036***	(0.009)
Income squared/100		-0.223***	(0.044)	-0.214***	(0.041)	-0.238***	(0.041)
x	Age	0.001	(0.001)	0.001	(0.001)	0.002*	(0.001)
x	education/certificate	0.034*	(0.018)	0.037**	(0.018)	0.032*	(0.019)
x	education/degrees	0.095***	(0.015)	0.095***	(0.015)	0.094***	(0.016)
x	child 0-4	-0.034**	(0.015)	-0.033**	(0.015)	-0.015	(0.012)
x	child 5-14	-0.012*	(0.007)	-0.013*	(0.007)	-0.010	(0.007)
x	number of children	-0.001	(0.006)	-0.002	(0.006)	-0.007	(0.007)
x	mental health (t-1)	0.000	(0.000)	-	-	-	-
x	latent health index (t-1)	-	-	-0.003	(0.004)	-	-
x	long-term health (t-1)	-	-	-	-	-0.024**	(0.012)
Hours squared		0.002	(0.002)	0.001	(0.002)	0.002	(0.002)
x	Age	-0.000	(0.000)	-0.000	(0.000)	-0.000**	(0.000)
x	education/certificate	-0.001	(0.001)	-0.001*	(0.001)	-0.001*	(0.001)
x	education/degrees	-0.003***	(0.001)	-0.003***	(0.001)	-0.004***	(0.001)
x	child 0-4	0.003***	(0.001)	0.003***	(0.001)	0.001**	(0.001)
x	child 5-14	0.001	(0.000)	0.001*	(0.000)	0.001	(0.000)
x	number of children	0.000	(0.000)	0.000	(0.000)	0.001	(0.000)
x	mental health (t-1)	-0.000	(0.000)	-	-	-	-
x	latent health index (t-1)	-	-	0.000	(0.000)	-	-
x	long-term health (t-1)	-	-	-	-	0.001	(0.001)
Log-likelihood:		-2115.889		-2047.437		-1919.847	

Notes: *** p< 0.01, ** p < 0.05, * p< 0.1; robust standard errors in parentheses; N = 3067 in all models; Model 1 includes the lagged value of the SF-36 Mental Component Summary to measure mental health; Model 2 includes the lagged value of the latent health index obtained from generalised ordered probit models to define physical health status; Model 3 includes ill-health defined through the lagged value of a binary variable identifying the presence of long-term health conditions.

Table 2b: Estimates of the labour supply models: health shocks and labour supply – Single mothers

	Model (4)		Model (5)		Model (6)	
Income/100	1.238	(0.876)	1.643*	(0.910)	2.581***	(0.826)
x Age	0.066	(0.043)	0.046	(0.043)	0.017	(0.041)
x age squared	-0.105*	(0.055)	-0.078	(0.055)	-0.051	(0.055)
x education/certificate	-0.593**	(0.292)	-0.656**	(0.304)	-0.550*	(0.307)
x education/degrees	-1.431***	(0.257)	-1.361***	(0.280)	-1.329***	(0.280)
x child 0-4	0.448*	(0.236)	0.500*	(0.264)	0.128	(0.206)
x child 5-14	0.008	(0.144)	0.062	(0.151)	0.027	(0.138)
x number of children	0.257*	(0.140)	0.188	(0.149)	0.244*	(0.140)
x health shocks	1.648**	(0.716)	-	-	-	-
x latent health index (0)	0.198**	(0.100)	0.217*	(0.126)	-	-
x latent health index (t-1)	-	-	0.009	(0.081)	-	-
x long-term health (0)	-	-	-	-	0.154	(0.345)
x long-term health (t-1)	-	-	-	-	0.782**	(0.365)
Hours	-0.185	(0.179)	-0.242	(0.180)	-0.543***	(0.177)
x Age	-0.006	(0.010)	-0.001	(0.009)	0.006	(0.010)
x age squared	0.009	(0.013)	0.001	(0.012)	-0.003	(0.013)
x education/certificate	0.126***	(0.039)	0.131***	(0.041)	0.104**	(0.044)
x education/degrees	0.269***	(0.049)	0.257***	(0.051)	0.248***	(0.051)
x child 0-4	-0.187***	(0.044)	-0.199***	(0.048)	-0.095***	(0.033)
x child 5-14	-0.018	(0.031)	-0.023	(0.033)	-0.031	(0.026)
x number of children	-0.062**	(0.026)	-0.053*	(0.028)	-0.050*	(0.026)
x health shocks	-0.190**	(0.096)	-	-	-	-
x latent health index (0)	-0.047**	(0.020)	-0.046*	(0.025)	-	-
x latent health index (t-1)	-	-	-0.006	(0.020)	-	-
x long-term health (0)	-	-	-	-	-0.104*	(0.063)
x long-term health (t-1)	-	-	-	-	-0.122*	(0.065)
Income x hours	0.029***	(0.007)	0.028***	(0.007)	0.037***	(0.010)
Income squared/100	-0.206***	(0.036)	-0.217***	(0.042)	-0.249***	(0.040)
x Age	0.001	(0.001)	0.001	(0.001)	0.002**	(0.001)
x education/certificate	0.034*	(0.019)	0.038**	(0.019)	0.033*	(0.019)
x education/degrees	0.095***	(0.014)	0.090***	(0.016)	0.093***	(0.015)
x child 0-4	-0.029**	(0.013)	-0.033**	(0.015)	-0.014	(0.012)
x child 5-14	-0.010	(0.007)	-0.012	(0.008)	-0.010	(0.007)
x number of children	-0.006	(0.007)	-0.002	(0.008)	-0.006	(0.007)
x health shocks	-0.065**	(0.026)	-	-	-	-
x latent health index (0)	-0.003	(0.005)	-0.003	(0.006)	-	-
x latent health index (t-1)	-	-	-0.002	(0.004)	-	-
x long-term health (0)	-	-	-	-	0.012	(0.014)
x long-term health (t-1)	-	-	-	-	-0.031**	(0.014)
Hours squared	-0.000	(0.002)	-0.000	(0.002)	0.002	(0.002)
x Age	-0.000	(0.000)	-0.000	(0.000)	-0.000**	(0.000)
x education/certificate	-0.002**	(0.001)	-0.002**	(0.001)	-0.001*	(0.001)
x education/degrees	-0.004***	(0.001)	-0.003***	(0.001)	-0.003***	(0.001)
x child 0-4	0.003***	(0.001)	0.003***	(0.001)	0.002**	(0.001)
x child 5-14	0.001	(0.000)	0.001	(0.000)	0.001	(0.000)
x number of children	0.001	(0.000)	0.000	(0.000)	0.000	(0.000)
x health shocks	0.001	(0.001)	-	-	-	-
x latent health index (0)	0.000	(0.000)	0.000	(0.000)	-	-
x latent health index (t-1)	-	-	0.000	(0.000)	-	-
x long-term health (0)	-	-	-	-	0.000	(0.001)
x long-term health (t-1)	-	-	-	-	0.001	(0.001)
Log-likelihood:	-2070.867		-1869.282		-1914.345	

Notes: *** p< 0.01, ** p < 0.05, * p< 0.1; robust standard errors in parentheses; N = 3067 in all models; Model 4 includes the wave 1 value of the latent health index to define ill-health and a dummy variable that defines health shocks as the incidence of injuries or illnesses; Model 5 includes both the initial and lagged value of the latent health index; Model 6 contains both the initial and lagged value of the variable defining long-term health conditions.

Table 3a: Estimates of the labour supply models: health and labour supply – Single fathers

	Model (1)		Model (2)		Model (3)	
Income/100	8.875***	(2.521)	8.241***	(2.580)	11.785***	(2.883)
x Age	-0.053	(0.091)	-0.089	(0.092)	-0.144	(0.107)
x age squared	-0.065	(0.104)	-0.022	(0.099)	0.025	(0.113)
x education/certificate	-0.813	(1.048)	-0.860	(0.885)	-2.341	(1.719)
x education/degrees	0.179	(1.172)	0.787	(1.131)	-1.943	(1.799)
x child 0-4	-1.308**	(0.608)	-1.091*	(0.609)	-0.911	(0.745)
x child 5-14	0.061	(0.528)	0.172	(0.534)	0.114	(0.622)
x number of children	0.017	(0.424)	-0.119	(0.336)	-0.073	(0.520)
x mental health (t-1)	-0.016**	(0.007)	-	-	-	-
x latent health index (t-1)	-	-	0.278*	(0.167)	-	-
x long-term health (t-1)	-	-	-	-	-0.333	(0.582)
Hours	-1.239**	(0.483)	-1.092**	(0.475)	-1.592***	(0.528)
x Age	0.023	(0.022)	0.029	(0.021)	0.037*	(0.022)
x age squared	-0.020	(0.026)	-0.027	(0.024)	-0.034	(0.027)
x education/certificate	0.180**	(0.086)	0.145**	(0.071)	0.242	(0.237)
x education/degrees	-0.006	(0.136)	-0.111	(0.152)	0.248	(0.228)
x child 0-4	-0.068	(0.115)	-0.127	(0.116)	-0.317	(0.198)
x child 5-14	-0.160**	(0.072)	-0.177**	(0.071)	-0.331**	(0.135)
x number of children	0.097*	(0.053)	0.130**	(0.055)	0.252**	(0.125)
x mental health (t-1)	0.002	(0.002)	-	-	-	-
x latent health index (t-1)	-	-	-0.112***	(0.042)	-	-
x long-term health (t-1)	-	-	-	-	-0.176	(0.114)
Income x hours	-0.025**	(0.012)	-0.031***	(0.012)	-0.025**	(0.011)
Income squared/100	-0.343***	(0.051)	-0.235***	(0.047)	-0.299***	(0.070)
x Age	0.004***	(0.001)	0.004***	(0.001)	0.004***	(0.001)
x education/certificate	0.037	(0.032)	0.037	(0.028)	0.068	(0.047)
x education/degrees	0.022	(0.033)	0.003	(0.031)	0.079	(0.048)
x child 0-4	0.014	(0.022)	-0.001	(0.022)	-0.006	(0.027)
x child 5-14	-0.002	(0.012)	-0.006	(0.013)	-0.022	(0.015)
x number of children	0.004	(0.007)	0.008	(0.007)	0.012	(0.009)
x mental health (t-1)	0.001***	(0.000)	-	-	-	-
x latent health index (t-1)	-	-	-0.025***	(0.007)	-	-
x long-term health (t-1)	-	-	-	-	-0.023	(0.023)
Hours squared	0.006**	(0.003)	0.002	(0.003)	0.000	(0.004)
x Age	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
x education/certificate	-0.001	(0.001)	-0.001	(0.001)	0.001	(0.002)
x education/degrees	-0.001	(0.002)	-0.000	(0.002)	-0.001	(0.002)
x child 0-4	0.004**	(0.002)	0.005***	(0.002)	0.007***	(0.003)
x child 5-14	0.002*	(0.001)	0.002**	(0.001)	0.006***	(0.001)
x number of children	-0.001	(0.001)	-0.002	(0.001)	-0.004***	(0.001)
x mental health (t-1)	-0.000	(0.000)	-	-	-	-
x latent health index (t-1)	-	-	0.002***	(0.001)	-	-
x long-term health (t-1)	-	-	-	-	0.003*	(0.002)
Log-likelihood:	-301.541		-287.599		-276.203	

Notes: *** p< 0.01, ** p < 0.05, * p< 0.1; robust standard errors in parentheses; N = 1565 in all models;; Model 1 includes the lagged value of the SF-36 Mental Component Summary to measure mental health; Model 2 includes the lagged value of the latent health index obtained from generalised ordered probit models to define physical health status; Model 3 includes ill-health defined through the lagged value of a binary variable identifying the presence of long-term health conditions.

Table 3b: Estimates: health shocks and labour supply – Single fathers

	Model (4)		Model (5)		Model (6)	
Income/100	6.343**	(2.868)	8.547***	(2.642)	11.966***	(2.902)
x Age	-0.015	(0.095)	-0.092	(0.097)	-0.147	(0.110)
x age squared	-0.042	(0.102)	0.008	(0.105)	0.026	(0.121)
x education/certificate	-1.701	(1.098)	-0.964	(0.880)	-2.402	(1.647)
x education/degrees	-0.705	(1.010)	0.227	(1.204)	-2.027	(1.773)
x child 0-4	-0.200	(0.550)	-0.932	(0.635)	-0.898	(0.768)
x child 5-14	0.306	(0.458)	0.230	(0.575)	0.122	(0.636)
x number of children	-0.317	(0.324)	-0.196	(0.348)	-0.079	(0.518)
x health shocks	7.750*	(4.617)	-	-	-	-
x latent health index (0)	-0.152	(0.297)	-0.538	(0.345)	-	-
x latent health index (t-1)	-	-	0.426*	(0.225)	-	-
x long-term health (0)	-	-	-	-	-0.314	(1.266)
x long-term health (t-1)	-	-	-	-	-0.280	(0.697)
Hours	-0.546	(0.418)	-1.062**	(0.464)	-1.611***	(0.530)
x Age	0.009	(0.019)	0.030	(0.021)	0.038	(0.024)
x age squared	-0.009	(0.022)	-0.030	(0.024)	-0.035	(0.029)
x education/certificate	0.172*	(0.095)	0.126*	(0.073)	0.227	(0.210)
x education/degrees	0.180	(0.146)	-0.034	(0.212)	0.243	(0.214)
x child 0-4	-0.276***	(0.106)	-0.144	(0.116)	-0.317	(0.203)
x child 5-14	-0.254***	(0.074)	-0.182**	(0.072)	-0.338**	(0.135)
x number of children	0.209***	(0.066)	0.128**	(0.057)	0.252**	(0.119)
x health shocks	-0.794	(0.800)	-	-	-	-
x latent health index (0)	-0.152***	(0.043)	0.009	(0.057)	-	-
x latent health index (t-1)	-	-	-0.141**	(0.061)	-	-
x long-term health (0)	-	-	-	-	-0.053	(0.170)
x long-term health (t-1)	-	-	-	-	-0.161	(0.142)
Income x hours	-0.026**	(0.011)	-0.033***	(0.013)	-0.025**	(0.010)
Income squared/100	-0.196***	(0.047)	-0.223***	(0.048)	-0.303***	(0.071)
x Age	0.003***	(0.001)	0.004***	(0.001)	0.004***	(0.001)
x education/certificate	0.067*	(0.035)	0.043	(0.028)	0.071	(0.046)
x education/degrees	0.043	(0.032)	0.018	(0.031)	0.082*	(0.047)
x child 0-4	-0.019	(0.022)	-0.007	(0.024)	-0.007	(0.028)
x child 5-14	-0.018	(0.012)	-0.008	(0.013)	-0.022	(0.015)
x number of children	0.013*	(0.007)	0.009	(0.007)	0.012	(0.009)
x health shocks	-0.219	(0.138)	-	-	-	-
x latent health index (0)	-0.015*	(0.008)	0.017	(0.013)	-	-
x latent health index (t-1)	-	-	-0.033***	(0.012)	-	-
x long-term health (0)	-	-	-	-	0.011	(0.056)
x long-term health (t-1)	-	-	-	-	-0.023	(0.028)
Hours squared	-0.000	(0.003)	0.002	(0.003)	-0.000	(0.004)
x Age	0.000	(0.000)	-0.000	(0.000)	0.000	(0.000)
x education/certificate	-0.000	(0.001)	-0.000	(0.001)	0.001	(0.002)
x education/degrees	-0.002	(0.002)	-0.001	(0.002)	-0.001	(0.002)
x child 0-4	0.005***	(0.002)	0.005***	(0.002)	0.007***	(0.003)
x child 5-14	0.004***	(0.001)	0.002*	(0.001)	0.006***	(0.001)
x number of children	-0.002***	(0.001)	-0.001	(0.001)	-0.004***	(0.001)
x health shocks	-0.000	(0.005)	-	-	-	-
x latent health index (0)	0.003***	(0.001)	0.000	(0.001)	-	-
x latent health index (t-1)	-	-	0.003***	(0.001)	-	-
x long-term health (0)	-	-	-	-	0.001	(0.003)
x long-term health (t-1)	-	-	-	-	0.003	(0.003)
Log-likelihood:	-319.591		-269.479		-276.069	

Notes: *** p< 0.01, ** p < 0.05, * p< 0.1; robust standard errors in parentheses; N = 1565 in all models; Model 4 includes the wave 1 value of the latent health index to define ill-health and a dummy variable that defines health shocks as the incidence of injuries or illnesses; Model 5 includes both the initial and lagged value of the latent health index; Model 6 contains both the initial and lagged value of the variable defining long-term health conditions.

Table 4: Model predictions

Model predictions – Single mothers

Hours	Observed (%)	Models incorporating health (%) Model 1	Model 2	Model 3	Models incorporating health shocks (%) Model 4	Model 5	Model 6
0	42.48	45.29	43.56	42.93	44.71	44.65	42.97
5	3.76	7.92	6.36	4.76	6.79	7.13	4.73
10	5.04	8.00	6.42	5.04	6.78	7.71	5.04
15	5.16	9.11	7.72	5.92	7.51	8.31	5.91
20	5.61	9.22	7.90	6.44	7.84	8.54	6.43
25	5.5	8.48	6.92	6.09	7.32	7.77	6.10
30	5.78	7.65	6.27	5.16	6.29	6.68	5.18
35	10.71	6.14	4.89	4.14	5.19	5.61	4.15
40	8.43	5.43	4.15	3.23	4.28	4.60	3.24
45	3.59	4.86	3.62	2.54	3.65	3.71	2.55
50	2.25	4.37	2.98	2.12	3.30	3.28	2.12
55	1.68	4.19	2.68	1.93	3.24	3.30	1.92

Model predictions – Single fathers

Hours	Observed (%)	Models incorporating health (%) Model 1	Model 2	Model 3	Models incorporating health shocks (%) Model 4	Model 5	Model 6
0	28.88	28.47	26.45	26.92	27.67	29.77	23.41
5	2.56	5.70	2.58	7.41	7.16	8.22	3.83
10	2.66	4.25	1.63	6.50	5.55	5.20	2.95
15	2.76	5.02	1.80	7.30	6.53	6.17	3.77
20	3.28	5.96	2.70	7.77	7.19	7.06	4.15
25	2.00	7.53	5.00	10.45	8.53	8.32	6.90
30	2.82	10.13	6.63	12.90	10.50	10.75	9.44
35	14.18	12.22	8.80	15.55	12.77	12.10	12.02
40	18.95	13.62	10.44	17.35	14.32	13.64	13.78
45	9.06	12.37	10.22	17.33	14.44	14.29	13.77
50	5.79	13.34	9.54	16.32	14.41	14.43	12.77
55	7.07	14.47	10.94	15.84	15.61	16.16	12.31

Notes: predictions for the single mothers sub-sample are based on 1000 random draws while predictions for the single fathers sub-sample are based on 100 draws.

Table 5: Simulated labour supply responses (values in percentage change)

Single mothers

Hours	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
0	-1.159	-1.211	-1.161	-1.550	-2.105	-0.356
5	1.656	1.738	1.697	0.860	0.798	2.500
10	0.237	0.257	0.186	-0.399	-0.715	0.977
15	-0.251	-0.272	-0.249	-0.800	-0.879	0.569
20	-0.407	-0.427	-0.385	-0.915	-1.024	0.439
25	-0.296	-0.310	-0.276	-0.824	-0.862	0.523
30	-0.102	-0.112	-0.083	-0.644	-0.839	0.712
35	0.046	0.045	0.058	-0.505	-0.844	0.862
40	0.120	0.124	0.124	-0.452	-0.750	0.930
45	0.123	0.126	0.118	-0.468	-0.546	0.920
50	0.070	0.076	0.047	-0.534	-0.521	0.850
55	-0.024	-0.019	-0.076	-0.652	-0.592	0.734

Single fathers

Hours	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
0	-0.003	-0.006	-0.010	-0.002	0.002	-0.008
5	0.005	0.008	0.013	0.007	0.000	0.010
10	0.001	0.007	0.004	0.006	-0.004	0.005
15	0.006	-0.007	0.003	-0.010	-0.002	0.002
20	-0.011	-0.014	-0.042	-0.031	-0.006	-0.031
25	-0.025	-0.023	0.015	0.015	-0.026	-0.003
30	0.035	0.054	0.053	0.038	0.055	0.054
35	0.016	0.013	-0.013	-0.006	0.010	-0.005
40	-0.014	-0.021	-0.022	-0.014	-0.019	-0.021
45	-0.013	-0.024	-0.012	-0.008	-0.024	-0.013
50	-0.007	-0.003	-0.002	-0.001	-0.007	-0.003
55	0.011	0.015	0.013	0.006	0.017	0.013

The Bankwest Curtin Economics Centre is an independent economic and social research organisation located within the Curtin Business School at Curtin University. The Centre was established in 2012 through the generous support from Bankwest (a division of the Commonwealth Bank of Australia), with a core mission to undertake high quality, objective research on the key economic and social issues of relevance to Western Australia.

The Centre's research and engagement activities are designed to influence economic and social policy debates in state and Federal Parliament, regional and national media, and the wider Australian community. Through high quality, evidence-based research and analysis, our research outcomes inform policy makers and commentators of the economic challenges to achieving sustainable and equitable growth and prosperity both in Western Australia and nationally.

The Centre capitalises on Curtin University's reputation for excellence in economic modelling, forecasting, public policy research, trade and industrial economics and spatial sciences. Centre researchers have specific expertise in economic forecasting, quantitative modelling, microdata analysis and economic and social policy evaluation.

A suite of tailored and national economic models and methods are maintained within the Centre to facilitate advanced economic policy analysis: these include macroeconomic and time series models, micro(simulation) models, computable general equilibrium (CGE) models, spatial modelling methods, economic index analysis, and behavioural modelling methods.

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