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ARTICLE

Health and occupation: the limits to older adults' work hours

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Abstract

More people are working into older age, raising questions about how many hours they can work before their health becomes compromised. This paper models work-hour tipping points for mental health and vitality among older Australian workers aged 50–70 years. We use longitudinal data from the Household, Income and Labour Dynamics in Australia (HILDA) survey, 2005–2016 (about 44,900 observations), and bootstrapping Three Stage Least Squares (3SLS) estimation techniques to adjust for reverse and reciprocal relationships between wages, work hours and health. Our approach corrects for heteroscedasticity in the system equation error terms, and we estimate models on the relatively healthy older adults who have remained employed into older age. Among these older workers we observe weekly thresholds of 39–40 hours beyond which mental health and vitality decline. This average, however, hides variability in work-hour limits linked to overall health and occupation. Thus, weekly tipping points for blue- and pink-collar jobs are 7–9 hours lower compared to white-collar jobs, and even wider gaps (11 hours) are apparent for workers with poorer physical functioning, which becomes common as people age. Our modelling reveals that age is not the biggest limiting factor for how many hours older adults can work, rather their health and the types of jobs are critical, and likely widen the gap in who ages successfully or not.

Keywords: older workers; work hour–health limit; mental health; vitality; labour market outcomes

Introduction

In their seminal article, Rowe and Kahn (1997) defined successful ageing as the avoidance of disease and disability, the maintenance of high physical and cognitive function, and sustained engagement in social and productive activities. These dimensions defined the outcomes for individuals, but not the changes in social structures and processes that would enable them. More recently, Rowe and Kahn (2015) called for clarity on how social institutions need to change, especially if

they are to preserve and promote the human capital of individuals (including their wealth and health) to support and sustain a successful longer life. The labour market is a critical institution for successful ageing, because employment into older age offers opportunities for both social and productive engagement and both could benefit health across multiple dimensions (Zaidi *et al.*, 2013; Arpino and Bordone, 2018). However, employment could also undermine successful ageing, or only offer these benefits (and their health consequences) to a selected few, having a more uneven role in successful ageing than previously theorised.

This paper seeks to understand the limits of employment as an agent of successful ageing. We focus on work hours – a largely unregulated and unchanged aspect of employment that is important for health and wellbeing *and* closely connected to power relations and social inequity (Nyland, 1990). We ask how many hours can older adults work before their health is compromised, and how mightthe relationship between hours, earnings and health interacts with and compound inequity in later life.

Hours, health, income and inequity in the ageing workforce

Ninety years ago, the International Labour Organization (ILO) set 48 hours as the maximum weekly work-hour threshold, arguing that hours worked beyond this were harmful to health. Subsequently, many countries set thresholds that were considerably lower, redefining standards for the full-time working week. In Australia, for example, the Australian Fair Work Act dictates that employees should not exceed 38 hours per week except for reasonable additional hours. Importantly, national and global working-hour thresholds evolved in the context of a younger workforce, when life expectancies and retirement ages were considerably lower. However, workforce composition has changed since these thresholds were set, and one key change is age. In Australia, a country ranked fifth in terms of life expectancy (Organisation for Economic Co-operation and Development (OECD), 2017*a*), boys born in 2014–2016 can expect to live past 80 years and girls past 84 years, three decades longer than boys or girls born when the ILO set its working-time standard. The percentage of people aged 50 and over rose from 22.1 per cent in 1970 to 33.5 per cent in 2019 in Australia, similar to the demographic change seen across the OECD (23.2 and 36.5%, respectively) (OECD, 2016). Similarly, life expectancy has steadily increased for all OECD countries by an average of 10 years since 1970 (OECD, 2017*a*). As a result, rising numbers of older adults are in the workforce needing the income earned to support a longer life, yet there is virtually no evidence on how long they can work to earn it.

Longer lives do not necessarily mean heathier lives, and there is very little age-focused analysis or debate on many hours workers could and should work as they age (ILO, 2011). Furthermore, longer lives do not mean more equal lives in terms of financial or health status. Indeed, it is becoming apparent that there are 'two worlds of ageing', reflecting inequities in both health and wealth (Crystal *et al.*, 2017). Employment is a critical contributor to these health and wealth inequities, because jobs which offer good pay, autonomy, flexibility and prestige generally are white collar, office based and health protective. These higher-status jobs, accompanied by better pay and conditions, are far more likely to have health-protective effects

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and offer a pathway to successful ageing (Marmot *et al*., 1991, 1997; Hemingway *et al*., 1997; Rowe and Kahn, 2015) coupled with financial security over the life-course. They are defining a group of workers who, as they age, have relatively good health, are financially secure, and the jobs they continue to work in offer health-protective conditions and minimal physical demands. In contrast, insecure, low-paid, low-autonomy and inflexible jobs are more common among pink- (*e.g.* hospitality and care) and blue- (*e.g.* trades, construction) collar sectors. These are jobs which involve physical as well as mental demands, and they are often poorly paid. This combination is likely to generate accumulating (and also compounding) health and financial risks which will undermine successful ageing. Many of these workers, therefore, have neither optimal health nor savings, comprising a group of less-healthy and less-wealthy older workers in jobs which pose continuing health risks as they age.

Work hours are critical to understanding ageing, health and inequity in the context of employment. Put simply, people exchange their time for income in the labour market, with longer hours usually yielding more income and shorter hours the converse (O'Neill and O'Reilly, 2010). However, the ability to work longer hours, or full time, depends on health (as well as industry and job type), a well-documented process termed health selection (McDonough and Amick, 2001; Kim and DeVaney, 2005; Wagenaar *et al*., 2012; Subhasree, 2018). Long hours can also harm health, as the ILO regulations attest. There are, therefore, reciprocal relationships between work hours, income and health; they interact over the lifecourse and all contribute to inequity. Ageing adds another dimension to the interplay between health, work hours and earnings. As people age, health generally declines, but this decline is uneven and socially patterned in extent and timing (Kim and DeVaney, 2005; Benzeval *et al*., 2011; Subhasree, 2018). In the context of an ageing workforce, an average decline in capacity to work the same hours as younger counterparts may be expected. However, this average can hide wide differences in work hour–health thresholds (the number of hours someone can work before compromising their health), which map to social and health inequity, widening the 'two worlds' further. Thus, older workers with poorer health status – most likely to be working in blue- and pink-collar jobs (Ravesteijn *et al*., 2018) – may be more constrained in terms of how long they can work, even while their financial need is greater. If this is the case, older-age employment systematically disadvantages the least healthy and most poorly paid, because working more hours to earn (needed) income differentially compromises their health.

This paper tests the hypothesis that as workers age their capacity to work full-time work hours without compromising their health declines. We further hypothesise that these work hour–health tipping points vary among older workers, aligning with markers of social and health inequity linked to occupation and health status. Because health, work hours and earnings form a system with interacting, reciprocal relationships, we also model it as such, using simultaneous methods to estimate multiple and interacting pathways with longitudinal date. This approach addresses the complex processes shaping health and social outcomes in an ageing workforce, maximising the robustness of estimates, and addresses tensions and conflicts between key elements of successful ageing (work hours, earnings and health).

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How work hours affect health

How work hours affect health is a key question for health economists and social epidemiologists, who have largely focused on the health risk from long work hours (*e.g.* Dembe *et al.*, 2005; Virtanen *et al.*, 2011; Amagasa and Nakayama, 2013; Bannai and Tamakoshi, 2014; Milner *et al.*, 2015). Most studies assume a linear relationship – the more hours worked the worse the health effects. However, work hours are likely to have a complex and inverted U-shaped relationship with health, which more recent research is starting to model. Up to a point, working is generally beneficial, after which additional hours become harmful. Employment is an important source of social inclusion as well as income, both key in the protection of health (Dooley, 2003; Dooley and Prause, 2009; Karsten and Klaus, 2009). Conversely, un- or underemployment negatively affects health (Dooley *et al.*, 2000; Milner *et al.*, 2017). Recent estimates from the United States of America (USA) and Australia suggest that an average work week of around 39 hours appears to be the limit beyond which health declines (*e.g.* Kleiner and Pavalko, 2010; Dinh *et al.*, 2017). Milner *et al.* (2015) considered the effect of long work hours on mental health by occupational skill level, and among the highly skilled, white-collar jobs, found longer work hour–health limits of closer to 49 hours.

These and other studies, including systematic reviews, have demonstrated the detrimental impacts of long hours on both physical health and mental health, supporting the presence of work hour–health tipping points (*e.g.* Sparks *et al.*, 1997). Lepinteur (2019) and Lee and Lee (2016) used quasi-natural experimental data to examine the causal effect of work hours on injuries, death rate, job satisfaction and leisure satisfaction. They made use of exogenous work-hour reductions introduced by the labour law reforms in Portugal, France and Korea, where work hours were reduced from 44 to 40 hours in Portugal and Korea, and from 39 to 35 hours in France. They found highly significant and positive effects of work-hour reduction on population health outcomes. However, these studies, and the work-hour policies they inform, generally consider the workforce in terms of averages. Very few studies consider different ages as well as jobs in the workforce, and both age and job type are likely to challenge how many hours people can work before they compromise their health.

Older people's health and labour market outcomes

A key assumption is that longer lives translate directly and universally into healthier lives and the potential to age successfully. In reality, the relationship between life expectancy and years lived without disability is complex and socially patterned. Thus, in the USA nearly half of recent gains in life expectancy are spent living with disability for both men and women. Furthermore, inequality in health and longevity is clearly documented in older populations (Buck and Maguire, 2015). This affects older adult employment in three ways. First, it means that older people with disadvantaged social histories have difficulty finding and retaining a job (Kachan *et al.*, 2015; Taskila *et al.*, 2015; Welsh *et al.*, 2016). Second, because the work–health–age relationship is dynamic and reciprocal, people whose health

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deteriorates are much more likely to leave the labour market or reduce their work hours, a health selection phenomenon that drives earnings, wealth accumulation and social status (West, 1991; Kröger *et al.*, 2015). Finally, poor health can be a function of poor-quality jobs, whereby low pay and poor conditions combine to impair health, be it physical or mental (Butterworth *et al.*, 2013), thus the work–health–age relationship depends on job history and quality.

Halleröd and Gustafsson (2011), for example, through an analysis of Swedish panel data over 16 years, describes the way jobs and occupations are pivotal to the way health selection and inequity unfolds over time. Prestigious, well-paid jobs are related to good health at the outset (likely reflecting class gradients in education and opportunity) and to slower deterioration in health when ageing. In contrast, people with poor health may seek low-hour or intermittent employment, and this can generate a downward spiral away from well-paid and health-protective jobs (Kim and DeVaney, 2005). This spiral is especially marked among older workers who reduce work hours (or exit altogether) in response to chronic conditions, mental and physical – evidence that work-hour thresholds are lower when health is less than optimal (Pit *et al.*, 2013).

There is, therefore, a close interplay between ageing, health and labour market outcomes, and social resources which unfold and reinforce each other over the lifecourse. This suggests that relationships between health, inequity and workforce participation strengthen among older workers, limiting how and for whom employment supports successful ageing (Zaidi *et al.*, 2013; Daley and Woods, 2014). We propose that there is a weekly work-hour limit beyond which health outcomes such as mental health and vitality deteriorate, depending on age group and occupation or job (white, pink and blue collar). In this paper, we focus on older workers aged 50–70 and stratified by age, occupation and health status.

Our research aims to answer the following research questions (RQ):

RQ1: What is the relationship between weekly work hours and health outcomes (mental and vitality) for older workers who remain in the workforce?
RQ2: Do mental health and vitality work-hour tipping points vary by age and occupation?
RQ3: Do these work hour–health tipping points vary according to older workers' physical health-related status?

We found that the estimated tipping points for older workers (aged 50–70) were almost identical to those of the younger group (aged 25–49) for both mental health and vitality. However, the work-hour limit depends heavily on the type of job, and on physical health status. Our analysis demonstrates the protective health effects of white-collar working conditions, as these workers were able to work 7–9 hours longer than their blue- and pink-collar counterparts, without compromising their health. We also showed how important health status is for work hour–health tipping points, as there was a large disparity in work hour–health limits between those with poor health and those with good health. Our findings indicate it is health, not age, that is one of the most important factors for determining retention among older-age adults, as well as productivity and capacity to work.

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Data and empirical method

Data

We used 12 waves of the Household, Income and Labour Dynamics in Australia (HILDA) survey data. HILDA is a nationally representative household-based panel study that began in 2001. Each wave has more than 7,000 households with more than 17,000 household members. Response rates have been consistently high (>90%; Summerfield, 2011). The survey asks respondents about their employment, family circumstances, health and socio-economic characteristics through face-to-face interviews and self-completed questionnaires. We used data from Waves 5–16 as they contained measures of work conditions important to our modelling; some of the variables were not collected before Wave 5.

We limited the sample to employed adults aged 50–70, defined as older adults who worked in any wave (as long as they worked, they were included in our analysis sample) *and* who had data on mental health, vitality, wages, work hours and covariates. The maximum number of observations is 29,643 spanning 12 years (2005–2016). Due to missing data, attrition and recruitment of new respondents, the number of observations varies across waves, creating an unbalanced panel. As we used partner's employment and education as either control variables or instruments in models, the sample is further restricted to older workers with at least one partner employed. We tested our results by extending the sample to cover coupled and non-coupled observations in a sensitivity analysis.

Estimation method

Simultaneity between health, wages and work time – a modified Three Stage Least Squares (3SLS) approach

Health is both an input and an outcome of work hours and income, because healthy people are more likely to work longer hours and earn better wages (Doan *et al.*, 2020), while unhealthy people reduce their work hours or leave the labour market. In turn, work hours and income can affect health (O'Reilly and Rosato, 2013). This creates a reciprocal effect or simultaneity across work hours, wage income and health that challenges conventional approaches such as Ordinary Least Squares (OLS). OLS estimates are likely to be upward biased because of the correlation between the error terms in the work hours and health equations, as well as being unable to disentangle the reciprocal relationships between work hours and health. Some confounders or unobservable factors can also affect work hours and health outcomes, *e.g.* time spent in physical activity may affect both an individual's work hours and their health, and the relationship between them. For these reasons, OLS estimation likely biases work hour and health associations, as evidenced by our sensitively tests (analyses available on request).

Viewing wages, hours and health as part of a system with reciprocal effects, we followed the Two Stage Least Squares (2SLS) technique used by Grossman and Benham (1974) and 3SLS to estimate the relationships among the three variables (Dinh *et al.*, 2017). The advantage of 3SLS over 2SLS is that it can correct for correlation between-equation error terms (Zellner and Theil, 1962). However, both methods assume the error terms are homoscedastic and non-autocorrelated, and

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this can lead to inconsistent estimates of standard errors. Although this can be addressed by applying a Generalized Method of Moments (GMM) (Baum *et al.*, 2003), GMM models require large sample sizes to be reliable, and place high demands on computer storage and speed when there are multiple panels (as in our data). To overcome the disadvantages of GMM and conventional 3SLS, we employed a bootstrapping estimation technique to a 3SLS approach. The 3SLS bootstrapping estimation can produce unbiased and consistent estimates of coefficients and their standard errors. We applied this model to the couple sample and three sub-samples stratified by age, occupation and health status. We also conducted a sensitivity analysis which used the whole sample (coupled and non-coupled) with different instruments.

Empirical estimation model

The 3SLS bootstrapping estimation as applied to a three-equation simultaneous model is as follows:

$$H_{i,t} = \alpha_0 + \alpha_t + \alpha_1 H_{i,t\text{-}1} + \alpha_2 \ln W_{i,t} + \alpha_3 T_{i,t} + \alpha_4 T_{i,t}^2 + \sum_{j=5}^{n} a_j Xh_{j,i,t} + e_{i,t} \quad (1)$$

$$T_{i,t} = \beta_0 + \beta_t + \beta_1 T_{i,t\text{-}1} + \beta_2 \ln W_{i,t} + \beta_3 H_{i,t} + \sum_{j=4}^{k} \beta_j Xt_{j,i,t} + u_{i,t} \quad (2)$$

$$\ln W_{i,t} = \gamma_0 + \gamma_t + \gamma_1 H_{i,t} + \gamma_2 T_{i,t} + \sum_{j=3}^{m} \gamma_j Xw_{j,i,t} + v_{i,t}. \quad (3)$$

In this simultaneous equation system, the dependent variables are health ($H_{i,t}$: mental health, vitality), weekly work hours ($T_{i,t}$) and log of hourly wage rate ($\ln W_{i,t}$) of individual i in year t. We also controlled for a set of covariates (X_h, X_t, X_w) in the corresponding equations. The time-specific effects on health, work hours and wages were captured in α_t, β_t, γ_t. The lagged dependent variable is also entered as a predictor to adjust for large variation between observations due to its historical trend and auto-correlation (Arellano and Honore, 2001). The error terms (e, u, v) capture measurement errors and unobserved factors. Details of variables used in each equation are described below.

In health Equation 1, apart from work hours (T) and wage rate in logarithm (lnW), we added work hours squared (T^2) to test for non-linear relationships between work hours and health. We also included potential work experience, ethnicity, marital status, work flexibility, work intensity, employment type, occupation, gender, smoking, drinking, and lag of physical activity and lag of general health (all likely to be predictors of health). We added urbanity, state and year dummies to capture the differences in health due to geographic and time factors. In this paper, we focused on mental health and vitality rather than general or physical health because we used weekly work hours. The effects of work hours on mental

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health and vitality are likely to be observed in a relatively short period of time, whereas any impacts on general health and physical functioning may take several years before they become observable.

The potential endogenous variables of Equation 1 were weekly work hours and wage rate. Instruments for these variables should be correlated with work hours and wage rate but not correlated with the error term of this equation (*i.e.* the excluded instruments have no direct effect on health outcome). The potential instruments were partner's employment status, partner's education and household non-wage income. We assume that these variables were likely to directly influence an individual's employment, work hours and wages, but only indirectly affect their health. We acknowledge that these instruments may violate the exclusion restriction, Cov(z, error terms) = 0. Under the 3SLS approach, we are unable to directly test this possibility, however, we provide first-stage F-statistics and instrumental variable (IV) test results for the excluded instruments we used (*see* Table S1 in the online supplementary material). These tests are equivalent to the weak instrument and relevant IV tests (for relevance conditions) – Cragg-Donald Wald F-statistics in 2SLS/IV models (Finlay *et al.*, 2013). The very high F-values (ranging from 92.6 to 604) for the first-stage estimates (significantly greater than 10, a commonly used threshold for weak IV and relevance restriction test) and the test results for excluded instruments being jointly equal to zero in the first stage (all statistically significant at the 1% level) suggest that our instruments satisfy the relevance condition.

In work-hour Equation 2, we included both wage rate (log) and health on the right-hand side of the equation. We also controlled for marital status, gender, *prior* general health, occupation, location, state and year dummies. The potential instruments for the work-hour equation must have no direct effect on work hours, but be correlated with wages and health. We therefore used lag of log wage, lag of health outcome and socio-economic status such as financial distress as instruments.

In wage Equation 3, we followed the Mincerian earnings equation (Mincer, 1974) to build the wage model. This equation included education and potential experience (its squared term was not added as our sample includes older people (aged 50–70), the non-linear relationship between age or experience with income no longer exists). Gender, ethnicity, location, state and year dummies were also included to capture wage differences across groups, states and years. The prior health (or lagged health) variable was included to capture the influence of workers' health on their productivity and wages. The health variable also represents job-related hazards which may sometimes attract additional pay as a result (Haveman *et al.*, 1994). Work hours were also added in the wage equation as a predictor for wage rate, via wage premiums, overtime and penalty rates. Longer work hours lead to longer (equivalent) work experience that can alter wage rate. Commonly used instruments for the wage equation are those that predict education, but do not directly affect wages. These include father's education, mother's education, sibling's education, partner's education and parents' socio-economic status. In our case, partner's education level was a stronger predictor of other partner's education than father's education and mother's education, and we selected it as our excluded instrument.

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Variables and measures

Dependent variables

Five items from the Medical Outcomes Survey 36-item Short Form (SF-36) were summed to assess *mental health* (Ware, 2000). Three items assess nervousness and depression ('Have you been a very nervous person?', 'Have you felt so down in the dumps that nothing could cheer you up?' and 'Have you felt downhearted and blue?') and the other two happiness and calm ('Have you felt calm and peaceful?' and 'Have you been a happy person?'). *Vitality* was constructed from four questions to assess energy, fatigue and exhaustion ('Feel full of life', 'Have a lot of energy', 'Felt worn out' and 'Felt tired'). Item responses ranged from 1, 'none of the time', to 6, 'all of the time'. The raw scale scores for both measures were calculated by summing and then transforming to a 0–100 scale, with a higher score meaning better health. *Weekly work hours* were measured by respondents' reported hours worked in all jobs. *Hourly wage rate* (log wage) was calculated by dividing weekly wages and salary from all jobs by weekly work hours. All the monetary variables in this paper were discounted to the 2016 price.

Covariates and variables

The covariates, variables and their definitions are presented in Table 1.

- Stratification and interaction variables.
  In models for occupation (a '*white*' dummy variable: white- *versus* pink/blue-collar workers), the white-collar group includes managers, professionals, clerical and administrative workers, and the pink/blue-collar group includes the remaining occupations. The white-collar jobs are high-status/well-paid jobs, while pink/blue-collar jobs are lower-status jobs which are often physically demanding (Schreuder *et al.*, 2008). The '*white*' dummy variable was interacted with work hours and its squared term to capture the shift of the coefficients between the occupations. We created four categories for age comparisons of the estimates: younger workers (aged 25–49), older workers (aged 50–70) and then two subgroups of older workers (50–59 and 60–70 years) (Table 2).

We also model for health status using physical function distribution cut-offs at the 20th percentile (pc), 30th pc and median to see if the mental health and vitality tipping point varies by workers' physical health status. Physical health impacts of work hours are likely to be chronic, cumulative and longer term and so require different models to 3SLS. However, we expected that mental health and vitality tipping points would be at least partly a function of physical health status, and it is important to estimate this because of the 'healthy worker' bias implicit in older employed samples. For example, Medic *et al.* (2017) showed that sleep disruption causes short-term effects on mental health-related health including increased stress responsivity, somatic pain, reduced quality of life, emotional distress and mood disorders, and cognitive, memory and performance deficits. However, it takes a much longer time to affect physical health outcomes. The long-term consequences of sleep disruption include dyslipidemia, cardiovascular disease and weight problems.

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Table 1. Covariate and variable definition and coding

Variable	Definition
Unpaid work hours	Hours usually spent each week caring for own and other's children (on a regular, unpaid basis), caring for disabled/elderly relatives, doing domestic errands, outdoor tasks and housework, cooking and laundry
General health	Scored (worst) 0–100 (best), five items (*e.g.* I get sick easier than other people)
Physical functioning	Scored (worst) 0–100 (best), ten items (*e.g.* vigorous activities, climbing several flights of stairs, walking 100 metres)
Experience	Potential work experience, age minus school years minus 6
Sex	Male = 1, female = 0
Marital status	Married or co-habiting = 1, otherwise = 0
Urban	Yes = 1, no = 0
Education (self and partner's)	Seven groups: Year 11 or below (1) to post-graduate (7)
Equivalised household non-wage income	Household income all sources excluding own salary/wages, adjusted with OECD-modified equivalence scale (1 household head, 0.5 each additional adult and 0.3 each child)
Financial distress	Scored (best) 0–100 (worst), computed from six items (*e.g.* 'Could not pay electricity, gas or telephone bills on time')
Partner's employment	Employed = 1, otherwise = 0
Partner's work hours	Weekly hours all jobs
Work flexibility	Scored 0–100, from three items (*e.g.* 'I have a lot of freedom to decide when I do my work')
Work intensity	Scored 0–100, from three items (*e.g.* 'I have to work fast in my job')
Job control	Coded 1 (lowest) to 7 (high job control)
Occupation	ANZSCO one-digit occupation includes managers, professional, clerical, technician and trade, machinery operators, labourers, community and personal service workers, or sales workers
Employment type	Three categories: fixed-term, casual, on-going or permanent
Physical activity	High = 1 (more than three times of moderate or intensive activity > 30 minutes per week); low = 0 (all other categories)
Smoking	Never, past, current
Alcohol drink	Four categories: never drink, rarely drink/no longer, moderate drinker, heavy drinker
Ethnicity	Nine dummy variables: Non-Indigenous Australian, Indigenous/ Torres Strait Islander, New Zealander, European, Middle East and North African, East and South-East Asian, South and Central Asian, American, and Central and Southern African
State	Eight states and territories
Year	12 years, 2005–2016

Notes: OECD: Organisation for Economic Co-operation and Development. ANZSCO: Australian and New Zealand Standard Classification of Occupations.

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Table 2. Sample characteristics by age, occupation and health strata (employed people sample)

	Age				Age 50–70			
					Occupation		Health strata	
	25–49	50–59	60–70	50–70	White collar	Pink and blue collar	<30th pc PF	>50th pc PF
	Weighted means							
Mental health	74.6	76.5	80.3	77.6	78.0	76.9	71.6	80.6
Vitality	61.1	62.7	65.0	63.3	63.6	63.0	52.3	69.3
Weekly work hours	38.9	38.3	32.7	36.8	37.8	35.4	36.0	37.8
Weekly wage (Aus $)	1,220	1,185	913	1,112	1,276	893	960.5	1,228.4
Hourly wage (Aus $)	31.5	31.8	30.1	31.3	35.9	25.3	27.9	33.9
Log hourly wage	3.4	3.4	3.4	3.4	3.56	3.24	3.33	3.5
Unpaid work hours	22.7	21.4	21.0	21.3	21.3	21.3	19.1	22.2
General health	72.4	69.6	69.7	69.6	70.6	68.3	56.3	76.7
Experience	18.2	35.8	45.3	38.3	37.6	39.2	39.3	37.6
Sex	0.53	0.52	0.58	0.54	0.48	0.62	0.48	0.57
Marital status	0.72	0.79	0.77	0.78	0.81	0.75	0.74	0.81
Urban	0.89	0.87	0.82	0.86	0.86	0.86	0.85	0.86
Education (%):								
(1) Postgraduate – masters or doctorate	7.5	6.3	6.0	6.2	10.0	1.2	4.9	7.3
	6.9	8.2	7.5	8.0	12.4	2.2	6.1	9.4

(*Continued*)

Table 2. (*Continued.*)

	Age				Age 50–70			
					Occupation		Health strata	
	25–49	50–59	60–70	50–70	White collar	Pink and blue collar	<30th pc PF	>50th pc PF
(2) Graduate diploma, graduate certificate								
(3) Bachelor or honours	21.6	14.1	12.1	13.6	19.0	6.3	11.9	14.7
Tertiary education	35.9	28.6	25.5	27.8	41.4	9.6	23.0	31.4
(4) Advanced diploma, diploma	10.6	11.6	11.9	11.7	13.8	8.9	11.0	12.3
(5) Certificate III or IV	24.0	25.6	23.8	25.1	15.4	38.1	25.5	24.6
(6) Year 12	14.2	10.0	8.3	9.5	9.6	9.4	10.3	9.2
(7) Year 11 and below	15.2	24.3	30.4	25.9	19.9	33.9	30.4	22.4
Equivalised household non-wage income (thousands Aus $)	12.6	17.5	32.8	21.6	24.9	17.1	18.8	23.4
Financial distress	5.8	3.5	2.4	3.2	2.4	4.5	5.4	2.3
Partner's employment status	0.83	0.82	0.64	0.78	0.80	0.74	0.5	0.59
Partner's work hours	32.0	30.6	21.1	28.1	29.7	25.8	28.6	27.8
Work intensity	68.7	66.3	61.9	65.2	68.2	61.1	64.2	65.67
Work flexibility	59.2	59.2	63.5	60.3	64.0	55.3	58.1	61.6
Job control	4.2	4.3	4.5	4.34	4.61	3.98	4.1	4.5
White-collar job	0.57	0.57	0.58	0.57	1.00	0.00	0.53	0.60

Type of employment contract (%):	100	100	100	100	100	100	100	100
(1) Fixed-term contract	10.2	9.0	8.7	8.9	10.5	6.9	8.5	9.2
(2) Casual employment	14.8	13.6	24.2	16.1	10.1	23.6	18.8	14.0
(3) Permanent/ongoing contract	74.9	77.5	67.1	75.0	79.5	69.4	72.6	76.7
Physical activity	0.095	0.11	0.13	0.11	0.096	0.139	0.06	0.15
Smoking (%):	100	100	100	100	100	100	100	100
Never	54.1	49.4	51.3	49.9	54.7	43.4	48.9	51.0
Past	24.8	34.5	37.7	35.3	34.4	36.6	35.4	34.9
Current	21.2	16.1	11.1	14.8	11.0	20.0	15.7	14.2
Alcohol use (%):	100	100	100	100	100	100	100	100
Never	7.4	7.3	9.5	7.9	6.0	10.5	12.2	6.1
Rarely	27.4	25.9	24.8	25.6	23.3	28.7	31.1	23.1
Moderate	55.3	60.2	60.3	60.2	65.9	52.4	50.2	64.7
Heavy	9.9	6.6	5.4	6.3	4.8	8.4	6.6	6.1
Observations	44,928	21,456	8,187	29,643	17,328	12,315	9,435	15,785

Notes: Means were adjusted for sample weights. Ethnicity, state and year dummies were used in the models but are not shown. <30th pc PF: a group whose general health is below the 30th percentile of physical functioning distribution for employed people aged 50–70. >50th pc PF: a group whose physical functioning is on or above the 50th percentile of physical functioning distribution.

In our models, we were aware of potential reverse causality between general health and our health outcome variables (mental health and vitality). As such, we controlled for *prior* general health to avoid such possible reverse causality biases. We use physical functioning to stratify for health status.

Descriptive statistics

Table 2 displays differences in some key variables across age, occupation and health status groups. In relation to younger workers (25–49), older workers (50–70) have slightly better mental health and vitality, but worse general health, they worked about 2 hours less each week, and spent 1.4 hour less on unpaid work. They were better off in terms of non-wage income and financial distress, and they smoked and drank less.

White-collar workers worked longer hours than their pink- and blue-collar counterparts and received a significantly higher weekly wage (Aus $1,276 *versus* $917). They had higher non-wage income, were more educated and faced less financial distress than pink- or blue-collar counterparts. White-collar workers also enjoyed more favourable working conditions including flexible work, and job security (fixed-term and permanent jobs) and job control, and they smoked and drank less than their pink/blue-collar counterparts. Workers with better health (physical functioning) were more advantaged than the poorer health status group in almost all aspects, even though they had quite similar paid hours and work experience.

Empirical results

Work-hour heath tipping points by age

In Table 3, only the summarised estimates for work hours and its squared term were reported to remain succinct (for full set of estimates, *see* Table S2 in the online supplementary material). A non-linear relationship between work hours and health (mental health and vitality) was found. The estimates of work hours and its squared terms are highly statistically significant ($p < 0.001$). An inverted U-shaped relationship was observed due to the positive coefficient of work hours and negative coefficient of its squared terms (the tipping point is where the first derivative of the health function equals zero, solution to this problem is the value of work hours or tipping point). Accordingly, the tipping point for mental health was 39.4 and 39.8 hours for the groups aged 25–49 and 50–70, respectively (Table 3; Figure 1). The vitality tipping point was 38.8 and 39 hours for the groups aged 25–49 and 50–70, respectively (Table 3; Figure 1, bottom panel). The thresholds for both groups were close to the overall workforce (25–64 years) estimations (*see* Dinh *et al.*, 2017). Overall, the estimated tipping points for both age groups were almost identical with no significant difference for both mental health and vitality. Table S1 in the online supplementary material provides the first-stage estimates and IV test results.

Sub-age group analysis was undertaken for the 50–59 and 60–70 age groups. All estimates of work hours and its squared terms were statistically significant except for squared work hours for the 60–70 age group. Significance declined by age group due to reduced sample size. The tipping point for the 60–70 age group was slightly lower (3–4 hours per week) than for the 50–59 age group. This was somewhat less

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Table 3. Summary of work hour–health tipping points, by age

	Mental health				Vitality			
	25–49	50–70	50–59	60–70	25–49	50–70	50–59	60–70
Tipping points (hours)	39.4	39.8	41.0	38.4	38.8	39.0	40.0	36.0
Work hours	1.2063***	0.6998***	0.5977**	0.4764*	1.7934***	0.9740***	0.8334***	0.6830*
	(0.4225)	(0.1757)	(0.2545)	(0.3471)	(0.3278)	(0.1998)	(0.2975)	(0.3999)
Work hours^2	−0.0153***	−0.0088***	−0.0073**	−0.0062	−0.0231***	−0.0125***	−0.0104***	−0.0095*
	(0.0055)	(0.0023)	(0.0033)	(0.0049)	(0.0042)	(0.0027)	(0.0038)	(0.0055)
Observations	25,807	12,096	9,271	2,825	25,803	12,096	9,271	2,825
R^2	0.3438	0.4039	0.4122	0.3722	0.3846	0.4564	0.4631	0.4765
p	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: Bootstrapped standard errors (SE) in parentheses with 1,000 replications. Apart from the model specification in Equations 1–3 and variables mentioned in the 'Variables and measures' section, the health equation was further adjusted for work flexibility, work intensity, ethnicity, marital status, employment contract type, work experience, gender, unpaid time, occupation, lag of general health status, smoking and drinking status, lag of physical activity, and state, urbanity and year dummies. The work-hour equation was controlled further for marital status, gender, lag of general health, occupation, and state, urbanity and year dummies. The wage equation was controlled further for education level, work experience, ethnicity, gender, and state, urbanity and year dummies. Tables 4, 5 and 8 also have the same set of covariates.
Significance levels: * $p < 0.01$, ** $p < 0.05$, *** $p < 0.01$.

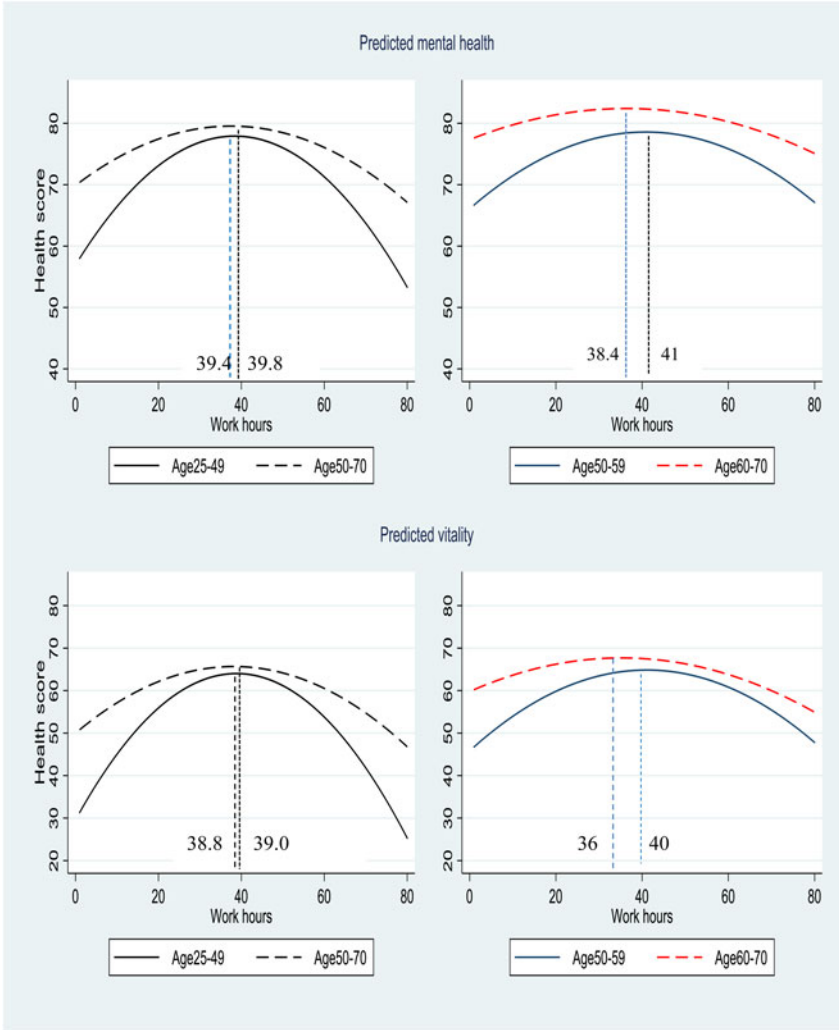

Figure 1. Work hour–health tipping points by age.

than we anticipated as we expected deteriorating physical health amongst those age 60–70 would significantly reduce their work hour–health limit.

The predicted health curves for the older subgroups were above younger group curves for both mental health and vitality, suggesting that they have better mental health and vitality compared to the youngest group (25–49 years) across all work hours (Figure 1).

Work hour–health tipping points by occupation

Table 4 and Figure 2 display the work hour–health threshold by occupation (white-collar *versus* pink/blue-collar workers) (for full set of estimates, *see*

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Table 4. Summary of work hour–health tipping points among workers aged 50–70, by occupation

	Mental health		Vitality	
	Overall	White/pink and blue collar	Overall	White/pink and blue collar
Tipping point (hours)	39.8	46/37.3	39	44/37
Work hours	0.6998***	1.2536***	0.9740***	1.9366***
	(0.1548)	(0.3743)	(0.2153)	(0.3781)
Work hours^2	−0.0088***	−0.0164***	−0.0125***	−0.0264***
	(0.0021)	(0.0051)	(0.0028)	(0.0051)
Work hours × White collar		−0.9214***		−1.5485***
		(0.3193)		(0.3353)
Work hours^2 × White collar		0.0131***		0.0220***
		(0.0046)		(0.0046)
Observations	12,096	12,096	12,096	12,096
R^2	0.4039	0.3929	0.4573	0.4298
p	0.0000	0.0000	0.0000	0.0000

Note: *See* Notes of Table 3.
Significance level: *** $p < 0.01$.

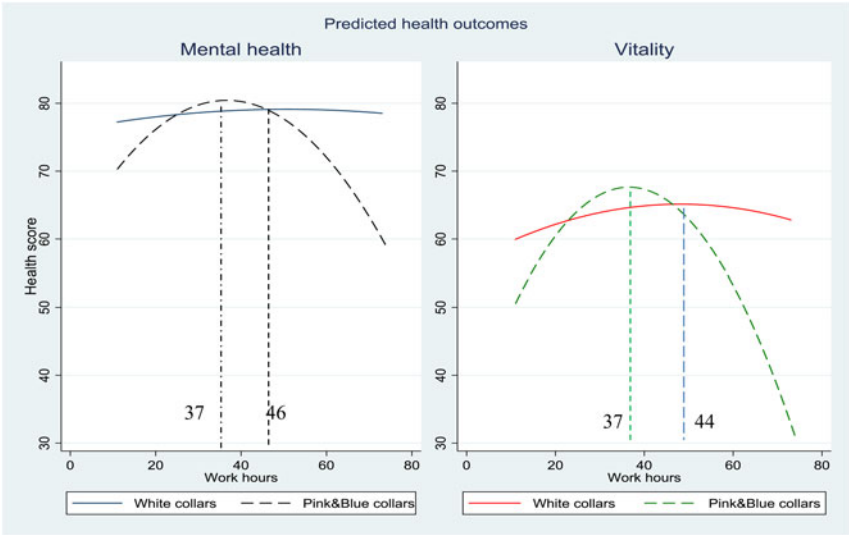

Figure 2. Work hour–health tipping points by occupation.

Table S3 in the online supplementary material). The work hour–health tipping point for white-collar workers aged 50–70 was 44 and 46 hours for vitality and mental health, respectively, compared to 37 and 37.3 hours for pink/blue-collar

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workers. The large difference (around 8 hours) in tipping points between white- and blue/pink-collar occupations was considerably greater than differences between age subgroups.

More interestingly, the curvilinear relationship is stronger for pink/blue-collar workers than white-collar workers, suggesting that longer work hours have a greater effect (in both positive and negative directions) on their mental health and vitality (Figure 2).

Work hour–health tipping points by health status

Work hour–health tipping points for health subgroups – relatively poor health (under the 20th pc, under the 30th pc) and better health (over the 50th pc or above the median health) – for physical functioning are displayed in Table 5 and Figure 3 (for full set of estimates, *see* Table S4 in the online supplementary material). Those in the groups of <20th pc and <30th pc health distribution (physical functioning) were considered to have relatively poor health, with those in the >50th pc group health were considered to have relatively good health or 'better health', compared to the 50–70 group average. Our estimates show a large difference in tipping points between those with relatively poor health and those with better health. The gap was 7 hours for mental health and 11 hours for vitality when stratified by physical functioning (Table 5). Further, workers with relatively poor health (physical functioning) had significantly lower predicted mental health and vitality scores (lower curves) (Figure 3).

Health selection bias and sensitivity analysis

Health selection

Our sample likely represents a particularly healthy group due to health selection (which increases as people age) and is not representative of the population aged 50–70. Consequently, our work-hour–health limit estimates may be inflated and not generalisable to older adults who have already exited the labour market. Therefore, we performed some exploratory analysis, comparing our (relatively healthy) employed sample to counterparts not in the labour market after they turned 50.

Simple estimates in Table 6 show clear health gaps between our sample and non-working counterparts, with employed people aged 50–70 reporting better health for all health measures. Furthermore, the standard deviations for the non-working group were larger, indicative of health variation within this group.

Using a longitudinal logistic model, all prior health measures strongly affected the probability of labour market participation for those aged 50–70, thereby supporting the occurrence of health selection (Table 7).

Sensitivity analyses

To test the robustness of our estimates, some model specifications were altered. First, we excluded work hours from the wage equation (Equation 3), to be in line with the labour supply and wage equation in labour economics literature,

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Table 5. Estimated tipping points for mental health and vitality by physical functioning status (ages 50–70)

	Mental health			Vitality		
Health distribution	Relatively poor <20th pc	Relatively poor <30th pc	Relatively good >50th pc	Relatively poor <20th pc	Relatively poor <30th pc	Relatively good >50th pc
Tipping point (hours)	37	39	44	32.3	36	43.4
Work hours	0.5104***	0.4253***	0.4305***	0.4716**	0.3965**	0.3840***
	(0.1939)	(0.1575)	(0.1393)	(0.1901)	(0.1782)	(0.1465)
Work hours^2	−0.0069**	−0.0054**	−0.0054***	−0.0073***	−0.0055**	−0.0051***
	(0.0028)	(0.0021)	(0.0019)	(0.0028)	(0.0025)	(0.0019)
Work hours × Over 20th pc	−0.0380			0.0711		
	(0.0826)			(0.0830)		
Work hours^2 × Over 20th pc	0.0016			0.0010		
	(0.0016)			(0.0016)		
Work hours × Over 30th pc		0.0199			0.1383**	
		(0.0537)			(0.0539)	
Work hours^2 × Over 30th pc		0.0004			−0.0007	
		(0.0010)			(0.0011)	
Work hours × Over 50th pc			0.0245			0.1543***
			(0.0441)			(0.0388)
Work hours^2 × Over 50th pc			0.0002			−0.0011
			(0.0008)			(0.0008)

(*Continued*)

Table 5. (*Continued.*)

Health distribution	Mental health			Vitality		
	Relatively poor <20th pc	Relatively poor <30th pc	Relatively good >50th pc	Relatively poor <20th pc	Relatively poor <30th pc	Relatively good >50th pc
Observations	12,189	12,189	12,189	12,189	12,189	12,189
R^2	0.4162	0.5179	0.5230	0.4894	0.4923	0.4954
p	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: *See* Notes of Table 3. pc: percentile.
Significance levels: ** $p < 0.05$, *** $p < 0.01$.

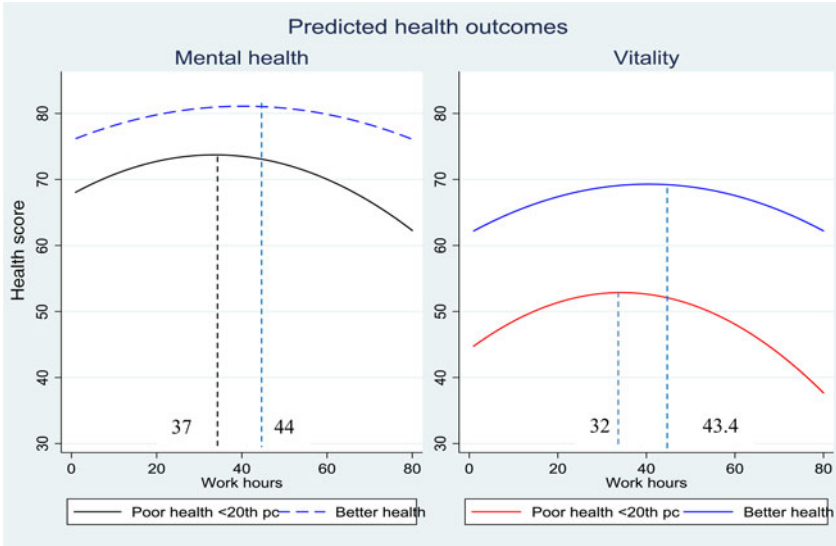

Figure 3. Work hour–health tipping points by physical functioning status.
Note: pc: percentile.

Table 6. Health differences between working and non-working, aged 50–70

	Non-working	Working	Difference (*p*)
	Mean values (standard deviations)		
Mental health (0–100)	72.1 (19.3)	77.6 (15.3)	5.5 (<0.0001)
Vitality (0–100)	56.7 (21.9)	63.3 (18.6)	6.6 (<0.0001)
Physical health (0–100)	68.4 (26.5)	84.2 (18.8)	15.8 (<0.0001)
General health (0–100)	57.2 (24.2)	69.6 (19.0)	12.4 (<0.0001)
Long-term health conditions (yes = 1)	0.57 (0.49)	0.24 (0.43)	−0.33 (<0.0001)
Health restriction (yes = 1)	0.47 (0.50)	0.13 (0.34)	−0.34 (<0.0001)

Source: Authors' estimation from the Household, Income and Labour Dynamics in Australia (HILDA) survey, 2005–2016, adjusted for sample weights.

resulting in almost no change to tipping points. Second, as contemporary weekly work hours may not capture the regularity of working long (or short) hours, we used '*percentage of time spent in jobs in last 12 months*' to approximate *actual* annual work hours, which yielded similar results (available upon request). Third, the use of partner's employment and individual characteristics, such as education, as either covariates or instruments in the main analysis restricted the sample to coupled people. Thus, to improve generalisability, partner's variables were excluded, and our sample expanded to include both coupled and non-coupled people aged 50–70. We used lags of log wage, non-wage income, financial distress index, lags

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Table 7. Health conditions and working status, longitudinal (Random Effect) logistic model, aged 50–70

	(1)	(2)	(3)	(4)	(5)	(6)
Fair and poor health (yes = 1)	−1.1437***	−0.9717***	−0.5541***			
	(0.0832)	(0.0854)	(0.1000)			
Mental health (lag)		0.0199***	0.0141***	0.0141***	0.0162***	0.0170***
		(0.0022)	(0.0023)	(0.0023)	(0.0022)	(0.0022)
General health (lag)			0.0197***	0.0263***		
			(0.0025)	(0.0021)		
Health restriction (yes = 1)					−1.5091***	
					(0.0791)	
Physical functioning (lag)					0.0188***	0.0212***
					(0.0018)	(0.0018)
Long-term health condition (yes = 1)						−0.9517***
						(0.0682)
Constant	31.52***	30.25***	28.72***	28.28***	27.57***	27.47***
	(0.7043)	(0.7113)	(0.7218)	(0.7102)	(0.7182)	(0.7189)
Prob > χ^2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	38,512	38,360	37,992	38,401	38,421	38,434
No. of individuals	6,928	6,923	6,910	6,915	6,920	6,920

Notes: Standard errors in parentheses. Models also controlled for lags of net wealth, financial distress, non-wage income, age, unpaid time, marital status, gender, education level, ethnicity, state and year dummies.
Significance level: *** $p < 0.01$.

Table 8. Summary of estimated tipping points for mental health and vitality using the whole working sample

	Mental health		Vitality	
	25–49	50–70	25–49	50–70
Tipping point (hours)	38	40	38.7	41.5
Work hours	1.6100***	0.9857***	2.0128***	0.7477***
	(0.2848)	(0.2230)	(0.2951)	(0.1480)
Work hours^2	−0.0214***	−0.0123***	−0.0260***	−0.0090***
	(0.0036)	(0.0030)	(0.0037)	(0.0020)
Observations	27,667	15,119	27,281	14,805
R^2	0.2613	0.3512	0.3479	0.4792
p	0.0000	0.0000	0.0000	0.0000

Note: *See* Notes of Table 3.
Significance level: *** $p < 0.01$.

of health outcomes and lags of weekly work hours as instruments in the first stage of estimation. Tipping points remained relatively unchanged (Table 8 *versus* Table 2).

Fourth, one may argue that individual mental health/vitality may also affect choice of occupation and job characteristics (flexibility, intensity). That is, these job characteristics are not exogenous to mental health and vitality, particularly in the long term. For example, a person may move from their main occupation/job in the long term due to economic structure change or a significant change to their health status, but may not in the short term, which is our current paper's focus. To consolidate our findings, we have tried models with lags of the occupation and job characteristics to make sure they are exogenous in the health equation; the estimated tipping point did not change much (a small change in tipping point may be due to a shrunk sample size). Financial distress affects mental health in the very short term, and may also affect work hours, likely over a longer timeframe as people need time to adjust their work hours. We also tried models with lags of financial distress as an instrument in the work-hour equation, and the results did not change much (results available upon request). Finally, we explored Tobit models and propensity score matching to estimate tipping points on the non-working 50–70 years group. These models required extensive imputation of all employment-related data, problematic for both approaches. Under the matching or propensity score matching approach, however, we were able to estimate tipping points that covered the whole sample. These were between 1 and 2 hours per week lower, likely due to the poorer health status of the non-working group. These results supply suggestive evidence that our estimates, because they are based on a selected, healthy 50–70 years sample, are over-estimating the population work hour–health tipping points. They confirm the stratified models by health status which showed that among the less than optimally healthy older adults, tipping points are considerably lower (*see* Table 5; Figure 3).

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Findings summary, discussion, contribution, study limitations and conclusion

Findings summary and discussion

Using Australian population-representative data to estimate work hour–health thresholds for older workers (aged 50–70), we found that their estimated tipping points were almost identical to those of younger workers (aged 25–49) for both mental health and vitality. We find, on average, working a full-time week of 39–40 hours does not compromise older workers' mental health or vitality. Thus, many older-age adults can work as long as younger adults. Our study supplies further evidence that an ageing workforce has potential to be equally productive, and employment needs to be re-engineered to enable this (Riley and Riley, 1994). However, there are important caveats and contexts to these findings; we further show that the work hour and health relationship depends heavily on the type of job, and on the physical health status of an older worker.

Our estimates show that among the optimally healthy, a full-time working week appears to be both feasible and health supporting, and good health enables older adults to maintain similar levels of engagement as to when they were younger. For these older adults, extended employment can be a potential pathway for financial security as well as better engagement socially, and underscores the significance of labour markets as key institution for successful ageing (Zaidi *et al.*, 2013; Rowe and Kahn, 2015). However, optimal health is found among only a proportion of all older adults and is closely related to occupational history, status and earnings. Among the less-healthy, lower-status older workforce, large gaps in work-hour capabilities were observed. When we stratified by physical functioning we found that, for these older adults, their working week was shortened by between 7 and 11 hours and they were also earning, hour for hour, lower wages. Less-healthy workers therefore face a dilemma as they age: working longer hours to increase financial security confronts them with further health trade-offs. For the growing group of less than optimally healthy older adults, employment offers a mixed bag of supports for successful ageing.

Similarly, occupation had a significant influence on work hour–health thresholds, due to variation in work environments and health demands that connect jobs with earnings and status. Blue- and pink-collar occupations are usually associated with more physically demanding and hazardous environments (Ravesteijn *et al.*, 2018), offering less pay, control, flexibility and security (Costa and Sartori, 2007; Eurofound, 2017), all of which negatively impact health. By contrast, higher-status white-collar jobs generally offer greater job security, control and higher wage rates (Matthews and Weaver, 1996; Schreuder *et al.*, 2008). Our analysis demonstrates the protective health effects of white-collar working conditions, as these workers were able to work between 7 and 9 hours longer than their blue- and pink-collar counterparts without compromising health. As is the case for older workers with poorer health, the value of extending employment to support successful ageing is qualified by the job conditions and status of workers. There is a major challenge emerging for successful ageing if it is to be widespread and fair, as contemporary labour markets are increasingly polarising into 'good' and 'bad' jobs (with a corresponding polarisation in income and health). The structural lag in this instance is selective, unequal and increasingly pernicious to the already vulnerable. Our findings

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indicate that age-integrated reform needs to target employment inequality if it is to achieve a structural change that addresses population ageing (Riley and Riley, 1994).

A key context and caveat to our findings is that all models were estimated on relatively healthy older workers who are not representative of the population. When we stratified by health status among those who were working (an imperfect solution to deal with health selection), we showed how important health status is for work hour–health tipping points, as there was a large disparity in work hour–health limits between those with poor health and those with good health. We further show how important poor health is for workforce exit in a series of regressions, and our exploratory work reported in the sensitivity analyses indicate that tipping points would be considerably lower if they were not estimated on optimally healthy mature-age adults. Together, our findings indicate it is health and job status, not age, that are the most important factors for determining retention among older-age adults, as well as their productivity and capacity to work. It is vital to recognise that good health and good jobs are requirements for remaining in the labour market and enabling successful ageing.

Contribution

This study represents the first demonstration of work hour–health tipping points for older Australian workers. It consists of an in-depth analysis by age, occupation and health status to illustrate the complex and dynamic relationship between work time, wages and health as they relate to extended working lives and population ageing. We used 3SLS to deal with reverse and reciprocal relationships and applied the bootstrapping 3SLS estimation technique to address heteroscedasticity in the equation errors. This enabled us to estimate a system of three simultaneous equations of health, work hours and wages, in what we believe to be the most robust way possible. Although the HILDA data are insufficient to control for sample selection bias, we were able to demonstrate the health selection bias in our estimates by conducting a series of extra analyses that found large differences in health outcomes between our analysis sample and the excluded sample. These findings provide further evidence of the impact of poor health on labour market participation amongst older workers, and the need for reforms of both the labour markets and the health system to redress it.

Our approach combines political economy and sociological insights into structural processes in labour markets (work hours and job status) with epidemiological and econometric methods and theory on work and health relationships. This interdisciplinary analysis sheds light on social inequality processes as they relate to a key institution – the labour market – in the context of ageing. Our findings support current theory on the critical role of employment as a mechanism for successful ageing, but challenge assumptions that it offers a pathway for all. We also show that two key elements of successful ageing – mental and physical health and continued engagement in social and productive activities – are neither simply nor equally related. They can be in conflict, for example, when mature-age adults are working hours that compromise their health, if their health is already deteriorating or if they work in poor-quality jobs. Re-engineering labour markets to be age-integrated requires making them more equal and more health promoting in the jobs and conditions they offer (Rowe and Kahn, 2015).

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Study limitations and future research

The 3SLS approach with the bootstrapping estimation technique was used to address simultaneity, reciprocal relationships and heteroscedasticity in the error terms. This approach enables us to estimate robustly tipping points for the work hour–health relationship because it can address reciprocal relationships. However, inferences on causality cannot be made from this model because the 3SLS model does not allow us to test the exclusion restriction. Furthermore, the estimated tipping points are likely upward biased due to health selection (as suggested by sensitivity tests using OLS, fixed-effects approaches), which may have an increasingly strong effect on an older workforce, thus making the employed sample non-representative of the overall population aged 50–70.

Unlike previous studies, we adjusted for time spent in care and domestic work in our modelling, which is likely to affect overall work hour–health tipping points (Dinh *et al.*, 2017). However, time in unpaid work (*e.g.* caring) remains highly gendered even among older workers, and likely contributes to differences in tipping points by gender. These complex connections between time on and off the job, age, gender and care-giving are therefore worthy of future research. Furthermore, the impact of accumulated work time over long periods (annual hours rather than weekly hours as used in this study) could provide greater insight into health impacts and associations with chronic, physical health conditions including overweight and obesity which may take several years to become evident. Finally, our study does not address the role played by motivations and incentives, from employers in particular, to reward or limit older workers' work hours.

Conclusion

A predicament is arising for older workers. They are experiencing longer life expectancies, but retirement policies encouraging older workers to remain employed into older age do not take into account the importance of having optimal health and jobs to do so. As we have shown, health status and occupation significantly influence weekly work-hour thresholds beyond which mental health and vitality amongst older workers decline. Poor health amongst older workers reduces the work-hour threshold by 7–11 hours for mental health and vitality, respectively, when compared to the capabilities among those in good general health. The work-hour threshold for older blue- and pink-collar workers is 7–8 hours less than for their white-collar counterparts. These gaps in work hour–health thresholds indicate that 'older workers' are not a monolithic group, with important differences in weekly work-hour abilities according to health status and occupation type.

Across the OECD, life expectancies are increasing, and longer working lives are being encouraged and promoted as the way to resource them. However, simply extending the pension eligibility age, or implementing policies which treat older workers as uniformly able to extend their working lives, fails to recognise the complexity and inequalities of factors influencing labour participation for these workers. Those in high-status and high-paying jobs may well be able to work longer into older age, but those in less-privileged and poorer-paid occupations, with poorer health, are unlikely be able to fulfil this policy expectation. If the agenda to promote older-worker employment is to be achieved, and achieved equitably, the focus on

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changing the retirement age as a mean to address the costs of an ageing population must be shifted. Instead, addressing poor health and poor working conditions, which generate increasing work hour–health tradeoffs as people age, should be a priority for employment and ageing policy.

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References

Amagasa T and Nakayama T (2013) Relationship between long working hours and depression: a 3-year longitudinal study of clerical workers. *Journal of Occupational and Environmental Medicine* **55**, 863–872.

Arellano M and Honore B (2001) Panel data models: some recent developments. In James H and Edward L (eds), *Handbook of Econometrics*. Amsterdam: Elsevier, pp. 3229–3296.

Arpino B and Bordone V (2018) Active ageing typologies: a latent class analysis of the older Europeans. In Zaidi A, Harper S, Howse K, Lamura G and Perek-Bialas J (eds). *Building Evidence for Active Ageing Policies: Active Ageing Index and its Potential*. Singapore: Palgrave Macmillan, pp. 295–311.

Bannai A and Tamakoshi A (2014) The association between long working hours and health: a systematic review of epidemiological evidence. *Scandinavian Journal of Work, Environment & Health* **40**, 5–18.

Baum C, Schaffer M and Stillman S (2003) Instrumental variables and GMM: estimation and testing. *Stata Journal* **3**, 1–31.

Benzeval M, Green MJ and Leyland A (2011) Do social inequalities in health widen or converge with age? Longitudinal evidence from three cohorts in the West of Scotland. *BMC Public Health* **11**, 947.

Buck D and Maguire D (2015) *Inequalities in Life Expectancy Changes Over Time and Implications for Policy*. Available at https://www.kingsfund.org.uk/sites/default/files/field/field_publication_file/inequalities-in-life-expectancy-kings-fund-aug15.pdf.

Butterworth P, Leach L, McManus S and Stansfeld S (2013) Common mental disorders, unemployment and psychosocial job quality: is a poor job better than no job at all? *Psychological Medicines* **43**, 1763–1772.

Costa G and Sartori S (2007) Ageing, working hours and work ability. *Ergonomics* **50**, 1914–1930.

Crystal S, Shea G and Reyes M (2017) Cumulative advantage, cumulative disadvantage, and evolving patterns of late-life inequality. *The Gerontologist* **57**, 910–920.

Daley J and Woods D (2014) *The Wealth of Generations* (Report No. 2014-13). Grattan Institute. Available at https://grattan.edu.au/wp-content/uploads/2014/12/820-wealth-of-generations.pdf.

Dembe E, Erickson B, Delbos G and Banks M (2005) The impact of overtime and long work hours on occupational injuries and illnesses: new evidence from the United States. *Occupational & Environmental Medicine* **62**, 588–597.

Dinh H, Strazdins L and Welsh J (2017) Hour-glass ceilings: work-hour thresholds, gendered health inequalities. *Social Science & Medicine* **176**, 42–51.

Doan T, Strazdins L and Leach L (2020) Cost of poor health to the labour market returns to education in Australia: another pathway for socio-economic inequality. *European Journal of Health Economics* **21**, 635–648.

Dooley D (2003) Unemployment, underemployment, and mental health: conceptualizing employment status as a continuum. *American Journal of Community Psychology* **32**, 9–20.

Dooley D and Prause J (2009) *The Social Costs of Underemployment: Inadequate Employment as Disguised Unemployment*. Cambridge: Cambridge University Press.

Dooley D, Prause J and Ham-Rowbottom K (2000) Underemployment and depression: longitudinal relationships. *Journal of Health and Social Behavior* **41**, 421–436.

Eurofound (2017) *Sixth European Working Conditions Survey – Overview Report (2017 Update)*. Luxembourg: Publications Office of the European Union.

Finlay K, Magnusson M and Schaffer E (2013) *Weakiv: Weak-instrument-robust Tests and Confidence Intervals for Instrumental-variable (IV) Estimation of Linear, Probit and Tobit Models*. Available at http://ideas.repec.org/c/boc/bocode/s457684.html.

Grossman M and Benham L (1974) Health, hours and wages. In Perlman M (ed). *The Economics of Health and Medical Care* (International Economic Association Series). London: Palgrave Macmillan, pp. 205–233.

Halleröd B and Gustafsson J (2011) A longitudinal analysis of the relationship between changes in socio-economic status and changes in health. *Social Science & Medicine* **72**, 116–123.

Haveman R, Wolfe B, Kreider B and Stone M (1994) Market work, wages, and men's health. *Journal of Health Economics* **13**, 163–182.

Hemingway H, Nicholson A, Roberts R, Stafford M and Marmot M (1997) The impact of socioeconomic status on health functioning as assessed by the SF-36: the Whitehall II study. *American Journal of Public Health* **87**, 1484–1490.

International Labour Organization (ILO) (2011) *Working Time in the Twenty-first Century: Discussion Report for the Tripartite Meeting of Experts on Working-time Arrangements, 17–21 October 2011*. Geneva: International Labour Office.

Kachan D, Fleming LE, Christ S, Muennig P, Prado G, Tannenbaum SL, Yang X, Caban-Martinez AJ and Lee DJ (2015) Health status of older US workers and nonworkers, National Health Interview Survey, 1997–2011. *Preventing Chronic Disease* **12**, E162.

Karsten P and Klaus M (2009) Unemployment impairs mental health: meta-analyses. *Journal of Vocational Behaviour* **74**, 264–282.

Kim H and DeVaney A (2005) The selection of partial or full retirement by older workers. *Journal of Family and Economic Issues* **26**, 371–394.

Kleiner S and Pavalko K (2010) Clocking in: the organization of work time and health in the United States. *Social Forces* **88**, 1463–1486.

Kröger H, Pakpahan E and Hoffmann R (2015) What causes health inequality? A systematic review on the relative importance of social causation and health selection. *European Journal of Public Health* **25**, 951–960.

Lee J and Lee K (2016) Can working hour reduction save workers? *Labour Economics* **40**, 25–36.

Lepinteur A (2019) The shorter workweek and worker wellbeing: evidence from Portugal and France. *Labour Economics* **58**, 204–220.

Marmot M, Smith G, Stansfeld S, Patel C, North F, Head J, White I, Brunner E and Feeney A (1991) Health inequalities among British civil servants: the Whitehall II study. *The Lancet* **337**, 1387–1393.

Marmot M, Bosma H, Hemingway H, Brunner E and Stansfeld S (1997) Contribution of job control and other risk factors to social variations in coronary heart disease incidence. *The Lancet* **350**, 235–239.

Matthews D and Weaver N (1996) Comparison of perceived job security of college professors versus white-collar and blue-collar workers. *Psychological Reports* **79**, 367–370.

McDonough P and Amick B III (2001). The social context of health selection: a longitudinal study of health and employment. *Social Science & Medicine* **53**, 135–145.

Medic G, Wille M and Hemels ME (2017) Short- and long-term health consequences of sleep disruption. *Nature and Science of Sleep* **9**, 151.

Milner A, Smith P and LaMontagne A (2015) Working hours and mental health in Australia: evidence from an Australian population-based cohort, 2001–2012. *Occupational & Environmental Medicine* **72**, 573–579.

Milner A, King L, LaMontagne A, Aitken Z, Petrie D and Kavanagh M (2017) Underemployment and its impacts on mental health among those with disabilities: evidence from the HILDA cohort. *Journal of Epidemiology and Community Health* **71**, 1198–1202.

Mincer J (1974) *Schooling, Experience, and Earnings*. New York, NY: National Bureau of Economic Research.

Nyland C (1990) Capitalism and the history of work-time thought. In Hassard J. (ed.), *The Sociology of Time*. New York, NY: Springer, pp. 130–151.

O'Neill OA and O'Reilly C (2010) Careers as tournaments: the impact of sex and gendered organizational culture preferences in MBA's income attainment. *Journal of Organizational Behaviour* **31**, 856–876.

O'Reilly D and Rosato M (2013) Worked to death? A census-based longitudinal study of the relationship between the numbers of hours spent working and mortality risk. *International Journal of Epidemiology* **42**, 1820–1830.

Organisation for Economic Co-operation and Development (OECD) (2016) *Historical Population Data and Projections (1950–2050)*. Available at https://stats.oecd.org/Index.aspx?DataSetCode=POP_PROJ#.

Organisation for Economic Co-operation and Development (OECD) (2017*a*) *Health at a Glance 2017: OECD Indicators*. Paris: OECD Publishing.

Pit S, Shrestha R, Schofield D and Passey M (2013) Partial and complete retirement due to ill-health among mature age Australians. *Public Health* **127**, 561–571.

Ravesteijn B, van Kippersluis H and van Doorslaer E (2018) The wear and tear on health: what is the role of occupation? *Health Economics* **27**, 69–86.

Riley W and Riley W (1994) Age integration and the lives of older people. *The Gerontologist* **34**, 110–115.

Rowe J and Kahn R (1997) Successful ageing. *The Gerontologist* **37**, 433–440.

Rowe J and Kahn R (2015) Successful aging 2.0: conceptual expansions for the 21st century. *Journals of Gerontology: Series B* **70**, 593–596.

Schreuder J, Roelen A, Koopmans C and Groothoff W (2008) Job demands and health complaints in white and blue collar workers. *Work* **31**, 425–432.

Sparks K, Cooper C, Fried Y and Shirom A (1997) The effects of hours of work on health: a meta-analytic review. *Journal of Occupational and Organizational Psychology* **70**, 391–308.

Subhasree R (2018) Effect of health on retirement of older Americans: a competing risks study. *Journal of Labor Research* **39**, 56–98.

Summerfield M (2011) *HILDA User Manual – Release 9*. Melbourne: Melbourne Institute of Applied Economics and Social Research, University of Melbourne.

Taskila T, Shreeve V, Laghini M and Bevan S (2015) *Living Long, Working Well: Supporting Older Workers with Health Conditions to Remain Active at Work*. London: The Work Foundation.

Virtanen M, Ferrie JE, Singh-Manoux A, Shipley MJ, Stansfeld SA, Marmot MG, Ahola K, Vahtera J and Kivimäki M (2011) Long working hours and symptoms of anxiety and depression: a 5-year follow-up of the Whitehall II study. *Psychological Medicine* **41**, 2485–2494.

Wagenaar F, Kompier A, Houtman L, van den Bossche N and Taris W (2012) Employment contracts and health selection: unhealthy employees out and healthy employees in? *Journal of Occupational and Environmental Medicine* **54**, 1192–1200.

Ware J (2000) SF-36 health survey update. *Spine* **25**, 3130–3139.

Welsh J, Strazdins L, Charlesworth S and Kulik C (2016) Health or harm? A cohort study of the importance of job quality in extended workforce participation by older adults. *BMC Public Health* **16**, 1–14.

West P (1991) Rethinking the health selection explanation for health inequalities. *Social Science & Medicine* **32**, 373–384.

Zaidi A, Gasior K, Hofmarcher M, Lelkes O, Marin B, Rodrigues R, Schmidt A, Vanhuysse P and Zolyomi E (2013) *Active Ageing Index 2012: Concept, Methodology and Final Results*. Vienna: European Centre.

Zellner A and Theil H (1962) Three-stage least squares: simultaneous estimation of simultaneous equations. *Econometrica* **30**, 54–78.

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