Modelling the cost of ill health in Health&WealthMOD (Version II): lost labour force participation, income and taxation, and the impact of disease prevention

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ABSTRACT: This paper provides a detailed description of the construction of Health&WealthMOD (Version II). It is Australia's only microsimulation model of health and illness and their impacts on labour force participation, income, wealth and government revenue and expenditure. In this paper, we describe Health&WealthMOD (Version II) and its architecture, the application of the model, and some of the results it has produced.

Keywords: Health&WealthMOD, cost of ill health, lost labour force participation, income, taxation, disease prevention

1. INTRODUCTION

In 2007, work commenced on constructing a microsimulation model of the economic impacts of premature retirement due to ill health. The proposed process for the development of this model and some early related analysis were published in 2009 (Schofield, Passey et al. 2009). In this paper we provide context for the policy imperatives and environment in which this model is built, a detailed description of the construction of the model in its final form and a summary of its earliest applications.

Successive government reports have identified population ageing and labour shortages as the two major challenges for the sustainability of the Australian Government budget balance as they will limit economic growth and taxation revenue (Commonwealth of Australia 2002; Productivity Commission 2005; Schofield and Rothman 2006; Commonwealth of Australia 2007). The Intergenerational Reports (IGR) in 2002 and 2007, and the Productivity Commission's report on the Economic Impacts of Ageing in 2005 (Costello 2002; Productivity Commission 2005; Schofield and Rothman 2006; Costello 2007), all indentified the emerging labour shortages as our population ages as a major challenge for Australia. In response to the emerging labour shortages and their wider impacts on the economy, the Australian government, like other national governments who are facing the similar pressures (Meyhew and Rijkers 2004), promoted deferred or gradual retirement as a way of combating future labour shortages and increasing taxation revenue to support an ageing population (Howard 2003; Costello 2005).

The importance of the relationship between health and early retirement has been noted by the former Treasurer (Costello 2004). As such, an understanding of the health reasons for early retirement is just as important in supporting longer employment and better health in old age as economic arrangements such as reducing age discrimination in the workplace or providing economic incentives to work longer. Labour shortages are now becoming a priority for government, not just unemployment. Indeed, about 50% of men and 20% of women retire early as a result of their own ill health according to the ABS Retirement and Retirement Intentions Survey (Australian Bureau of Statistics 1998).

While there is now a significant body of work estimating the physical burden of disease and related health costs in Australia, it has been identified that indirect costs, that is, costs beyond those to the health system, are rarely included (Australian Institute of Health and Welfare 2004). This is surprising given that a number of studies have concluded that indirect costs are, for a number of conditions, greater than the direct costs to the health system (Begley, Annegers et al. 2001; Taylor, Pezzullo et al. 2006).

Although a few international studies have been undertaken to assess the economic impacts of various individual diseases (Moore, Mao et al. 1997; Henriksson and Jonsson 1998; Begley, Annegers et al. 2001; World Health Organisation 2005), they have been quite limited in their scope (for example, excluding superannuation and asset accumulation) and somewhat crude in the methods used, mostly as a result of using highly aggregated data. For example, estimates of lost income have assumed that all persons included in the study would, without illness, have achieved average earnings and paid an average amount of tax (Access Economics 2005). This generalisation does not take into account evidence that both income and type of illness differ by age, sex, education and occupation. For example, a higher degree is related to 100% higher earnings in later working life (Johnson and Lloyd 2000). In addition, the estimates are based at a single point in time, and as there is no age distribution underlying the data, there has been no capacity to estimate the accumulated lost earnings or wealth accumulation from retirement through to traditional retirement age or losses from the retirement income stream. A further limitation of these types of studies is that there is no distributional information about the extent of incapacity and therefore it is difficult to estimate the probability of intervention leading to potential workforce participation.

Health&WealthMOD (Version II) is the final version of Australia's first microsimulation model of health and illness. It simulates labour force participation, income, wealth and government revenue and expenditure and the impacts that interventions can have on both individuals and on government. In a previous paper we described at the outset how we intended to build Health&WealthMOD (Schofield, Passey et al. 2009). As is typical of innovative new applications of microsimulation the model was significantly refined and in this case the methods for imputing cost effective health interventions were much more complex than originally anticipated. In this paper, we will give a description of Health&WealthMOD (Version II) and its architecture in its final form with a particular focus on changes to the original model design, the application of the model, and some of the results it has produced.

2. METHODS

There were four main steps in the development of Health&WealthMOD (Version II): developing the base population, benchmarking, building Health&WealthMOD (Version II), and linking with STINMOD.

The base population of Health&WealthMOD (Version II) was the Survey of Disability, Ageing and Carers (SDAC) conducted by the Australian Bureau of Statistics (ABS) in 2003 (Australian Bureau of Statistics 2005). The SDAC was reweighted to represent the population in 2009.

The base population of Health&WealthMOD (Version II) is synthetically matched with STINMOD a tax-benefit model (Lambert, Percival et al. 1994) to impute detailed income and wealth data. It is not possible to exactly match individuals between STINMOD and the SDAC for a number of reasons. Both are based on survey information and there will be few respondents in common on both data sources. Further, the data was collected at different points in time, meaning that even for the few individuals that may be in common, some variables will no longer be the same between the SDAC and the surveys underpinning STINMOD, or will have changed due to the ageing and uprating process which ages STINMOD data to 2009 e.g. age, income, labour force status and income unit type. Finally, within Australia, exact matching between ABS surveys is prohibited. As a result of these constraints, income and wealth information was imputed onto the base population of Health&WealthMOD (Version II) by synthetically identifying persons with similar characteristics on STINMOD and "donating" their income, tax and wealth information onto Health&WealthMOD (Version II).

For synthetic matching, the matching variables that are common to both datasets and strongly related to the modelling area were identified, i.e. income in this case. Nine variables: labour force status, income unit type, type of government pension/support, income quintile, age group, sex, hours worked per week, highest educational qualification and home ownership were chosen as matching variables. These variables were found to have the strongest association with income.

The synthetic matching process consisted of two main steps. In the first step, the person records in both STINMOD and Health&WealthMOD (Version II) were grouped into homogeneous cells, based on the first four matching variables. The remaining five matching variables were ranked in each cell based on how much variation in income was explained by each matching variable as measured by R^2 of linear regression model for income. Separate regression models were fitted with one matching variable as a predictor in each model and the R^2 of each model was noted. The records in each cell were further grouped into homogeneous cells based on the matching variable that explained the highest variation in income. The process continued until either the matching variables were exhausted or there were no more than two records left in the cell. Thus, not all matching variables were used in creating homogeneous cells.

In the second step, each person within a group (as defined by a cell in the SDAC dataset) was synthetically linked with the closest matching person, with replacement based on the matching variables in the same group in STINMOD using the method commonly known as unconstrained matching (Rässler 2002). Under this process, the same record in STINMOD could be synthetically matched with multiple SDAC records. All variables on each record were matched within 5% accuracy with the exception of age, which had 6% accuracy (Table 1). Among the SDAC records that were synthetically matched with the STINMOD records of different age groups, most are synthetically matched within one age group apart, with only 1.5% of SDAC records being synthetically matched with the STINMOD records where age groups are more than one group apart.

Table 1 Percentage of SDAC records matched with the STINMOD records of different group in Health&WealthMOD (Version II)

Variable	Total Number of records	Number of records matched with different group	Percentage of records matched with different group
Sex	8864	129	1.46%
Income Unit Type	8864	0	0.00%
Labour force status	8864	1	0.01%
Age group	8864	530	5.98%
Income quintile	8864	57	0.64%
Hours worked per week	8864	70	0.79%
Pension/benefit	8864	0	0.00%
Highest Education	8864	110	1.24%
Home ownership	8864	107	1.21%

The linking of STINMOD output with the SDAC base population of Health&WealthMOD (Version II) provided a single database that contained information on health conditions, income, tax, and government benefits. Health&WealthMOD (Version II) was then used to compare income, tax, wealth, and government benefits between people with various chronic conditions and between those who are retired and other groups, such as those in full employment and part-time employment.

An additional development in Health&WealthMOD (Version II) was the estimation of the level of retirement income that could be obtained by converting superannuation[1] and other savings into an income stream of each person in the base data when they are aged 65 years.

To estimate savings and income for each person to the age of 65 years, respondents were assumed to continue earning at the same level, with an adjustment to increase earnings in line with long term average earnings growth rate less inflation (the real earnings growth rate), based on Average Weekly Ordinary Times Earnings (AWOTE) trend data (Australian Bureau of Statistics 2009) and inflation as measured by the change in the Consumer Price Index (CPI) (Australian Bureau of Statistics 2009)

All superannuation was assumed to be invested in an accumulation fund. To grow this fund balance to age 65 years, the occurrence and level of voluntary contributions were modelled based on a person's age and sex. The detailed description of the derivation of these probabilities can be found in Harding *et al*. (2009) The superannuation return used in the model is the net return for a balanced fund[2] over the 10 years to June 2009 as measured by superratings.com.au (SR50 Balanced (60-76) Index. Real growth rates were calculated using the 20-year average consumer price index to indicate the inflation to be subtracted from the average growth rates.

Growth was calculated for superannuation, housing, shares and cash using: Housing index (based on ABS House Price Index for eight capital cities Tables 1 and 9 from June 1989 to June 2009(Australian Bureau of Statistics 2009), 5.97%; Australian Stock exchange All Ordinaries Index June 1989 – June 2009(Reserve Bank of Australia 2009), 4.88% ; CPI June 1989 – June 2009, 2.85%; and, AWOTE May 1989 – May 2009, 4.45% (Australian Bureau of Statistics 2009; Australian Bureau of Statistics 2009; Australian Bureau of Statistics 2009).

For cash deposits, two different rates were used. The low rate was applied to cash deposits below $5 000 and used an average interest rate paid by banks or building societies on a transaction account of $5000 over the last ten years. For cash deposits over $5 000, the average interest rate on a 3-month bank term deposit of $10 000 was used (Reserve Bank of Australia 2009).

The estimate of savings available at age 65 should include savings that a person makes from their income each year, and changes in the values of asset owned. Long term trend analysis of HILDA(Wooden and Watson 2007) panel data found that the level of personal additional savings when expressed as a percentage of disposable income were close to zero(median equals -0·5 per cent). Based on this, it was decided to assign an additional savings rate of zero to each person for this paper. The changing value of an asset was calculated based on the value of the asset and the investment return assigned to that type of asset.

In Health&WealthMOD (Version II) the facility was developed to assess the percentage reduction in the prevalence of various diseases that would have been achieved if a cost-effective intervention had been introduced. Health&WealthMOD (Version II) can have information from other models of interventions, for example a discrete time microsimulation model which models a cohort of Australian people free from a certain disease. Such a model may allow people to progress from a non-diseased to diseased state. Parameters such as eligibility for screening, participation rates of GPs, and participation rates of patients could all be built in and reduction in disease prevalence for each year recorded.

In order to estimate the impacts of interventions on increased labour force participation and additional incomes we first estimate the reduction in the number of disease cases (i.e. extra number of disease-free persons) in each year of the intervention for each 5 year age group cohort by applying the percentage reduction in prevalence in each year from for the respective age cohort to the number of self reported disease cases in each year for the same age cohort. The number of additional persons in the labour force each year is then calculated by applying age group specific differences in the probability of labour force participation of those without a disease and of those with the disease to the extra number of disease-free persons of the same age group. The total extra person years in the labour force for each cohort can then multiplied by the adjusted difference in median incomes of those who were in the labour force and had no disease, and of those who were not in the labour force and had the disease to estimate the additional income that would have been accumulated by each cohort over the time period of the intervention. For comparison between cohorts, it is possible to estimate the number of extra persons and the additional incomes per year adjusted for the number of years each cohort is eligible for screening and intervention in the time period.

3. CONCLUSIONS

The role of labour force participation of older workers is a key driver of Australian Government policy. The IGR in 2002 and 2007 and the Productivity Commission's report on the Economic Impacts of Ageing in 2005 (Costello 2002; Productivity Commission 2005; Schofield and Rothman 2006; Costello 2007), all indentified the emerging labour shortages as our population ages as a major challenge for Australia. According to the former treasurer, "the whole economic agenda of the government at the moment is drawn from the IGR" (Davis 2006) and "in practically every portfolio area – health, education, family benefits, welfare, superannuation, pensions – the IGR now provides the overall architecture within which we operate" (Costello 2007). The current Australian government's public health platform, "Fresh Ideas, Future Economy", calls for prevention of chronic disease to increase labour force participation.
Health&WealthMOD (Version II) provides estimates lost labour force participation due to illness, the associated costs and how health interventions could improve the economic circumstances of both individuals and government.

Health&WealthMOD (Version II) has been utilised to estimate the total number of people retired early due to ill health, to identify the diseases that most contribute to premature retirement and to estimate the loss of personal income and government losses including lost taxation revenue and additional income support payments. The illnesses keeping most people out of the labour force are back injuries, arthritis, mental illness and depression. About 660,000 persons were estimated to be lost to the workforce due to premature retirement related to ill health, with a corresponding estimated loss of about $12 - $15 billion GDP per annum in 2003 (Schofield, Shrestha et al. 2008).

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Notes

1 Superannuation is the Australian term for private retirement pension plans. Compulsory contributions are made to superannuation by a person's employer and voluntarily contributions can be made by the employee.
2 60% to 75% invested in the share market and the remainder in low risk investments

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