The effect of chronic pain on life satisfaction: evidence from Australian data

by

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Abstract:

This paper investigates the relationship between chronic pain and life satisfaction using the Household, Income and Labour Dynamics of Australia Survey (HILDA). We estimate the economic consequences of chronic pain by looking at the negative impact on life satisfaction and by examining the persistence of the effect over multiple years. Chronic pain is associated with poor health conditions, disability, decreased participation in the labour market and lower quality of life. We calculate the compensating income variation of chronic pain, based on the measurement of chronic pain, the life satisfaction of individuals and the income of households. Linear Probability Fixed effects and Logit with fixed effects with individual threshold (Ferrer-i-Carbonell and Frijters, 2004) are used to control for characteristics of individuals that do not vary over time. Further, we investigate whether individuals who experience chronic pain exhibit adaptation and recovery in life satisfaction after 3 or 5 years. Our results show that chronic pain has a large negative effect on life satisfaction and that the compensating income variation is substantial. A gender difference is observed however, with the negative effect on life satisfaction persisting amongst men, with some adaptation found for women.

1. Introduction

Evaluation of the worth of new and existing health care interventions requires some knowledge regarding individuals' evaluations of their health improvements. Cost-effectiveness and cost-utility analyses help to compare different types of interventions in terms of their effectiveness and health-related quality of life but provide only limited information on the contribution to individuals' overall welfare.

One way to assess the welfare changes associated with health improvements is to analyse individuals' willingness to pay for specific interventions. However, there are difficulties in quantifying health-related benefits with this kind of methodology (Labelle and Hurley, 1992). In particular, existing methods for calculating willingness to pay are based on preference measurement, which can be done by observing individual behaviour and deducing preferences (revealed preferences) or by directly asking individuals to state their preferences (hypothetical preferences) (see for example Chuck et al., 2009). However, both methods have their limitations, either because of potential sample selection, or because individuals are asked to consider hypothetical situations of which they have no personal experience, which can mean responses may be subject to a variety of biases (Groot and Maassen van den Brink, 2004).

To overcome some of these limitations, a different methodology, Compensating Income Variation, has been developed and applied in the literature to value the consequences of a variety of health- problems, such as migraine (Groot and Maassen van den Brink, 2004), cardio-vascular disease (Groot and Maassen van den Brink, 2006), chronic disease (Ferrer-i-Carbonell and van Praag, 2002) informal care (Mentzakis et al, 2012), and disability (Oswald and Powdthavee, 2008), as well as to evaluate the economic effects of other major life events (see for example Clark and Oswald, 2002, Van Praag and Ferrer-I-Carbonell, 2004, Groot and Maassen van den Brink, 2007, and Carroll et al., 2009).

In the health applications, individual life satisfaction is estimated as a function of various individual characteristics, such as household income, health and other factors affecting welfare, such as marital status and education. The results from the estimation are used to calculate an income-health trade off, keeping life satisfaction constant. This trade off, or compensating income variation, represents the monetary compensation needed by an individual with a particular health problem to have the same level of life satisfaction of an individual without the same health problem. Whilst the literature in this field suggests that it is feasible to produce valuations, a question remains however over the validity of the estimates generated. In particular, estimates can be unstable when different model specifications are used (Groot and Maassen van den Brink, 2004). Moreover, a somewhat neglected feature of the existing studies is that they make little attempt to capture explicitly the influence of health dynamics, such as adaptation. This is important as life satisfaction levels for people with chronic conditions might be expected to change over time due to a re-framing of the problem, that is, over time, people adapt to their condition (a phenomenon also called 'habituation' or 'response shift' (Galenkamp et al., 2012). Also, it is possible that different people exhibit different tendencies to adapt to changes in health, for example, the response to chronic disease may differ between men and women, as demonstrated by Hasmi and Davis (2009), who find that women demonstrate more adaptation to some forms of pain. More generally, much work in psychology shows that happiness levels bounce back after a negative life shock (Oswald and Powdathee, 2008), although Easterlin (2005) observes that adaptation is usually incomplete and that there are different levels of habituation across different domains in life.

In the health context, if adaptation is present and leads to additional changes in life satisfaction over and above those that can be attributed to changes in health, and if such adaptation is more prevalent in particular population groups, then knowledge of the magnitude of the effect is important in the generation of estimates of compensating income variation.

We address these issues by considering the condition of chronic pain. This is defined as "pain that extends beyond expected healing time" or as "constant daily pain for a period of three months or more in the last six months" (Merskey & Bogduk, 1994). Chronic pain is considered here as it is associated with large increased health care costs, productivity costs and negative welfare consequences for the individual, their family and society as a whole (Philips, 2009; Christensen et al., 2011; and Philips and Harper, 2011). Costs are large in part because many people are affected, for example, the Institute of Medicine of the National Academies Report (2011) indicates that chronic pain affects around one-half of all adult Americans, whilst in Australia, it is suggested that approximately 30% of Australians are affected (Pfitzer Health report, 2011). For Australia, the total cost of pain is estimated at A$34.2 (US$36.2) billion in 2007, or A$10,847 (US$11,465) for each person with chronic pain (Access Economics, 2007). Productivity costs form the largest share of total costs, with pain playing a central role in individuals' dynamics of employment and being a key determinant of self-reported work disability (Kapteyn et al., 2008). People with persistent pain are more than twice as likely to have difficulty working (Schofield et al., 2012) or to lose hours of productive time at work (Stewart et al., 2003).

Chronic pain is also well-suited to examine the influence of adaptation on life satisfaction in general and measures of compensating income variation in particular. Measures of subjective well-being such as questions on life satisfaction have been widely used in social sciences and psychology, as well as in some economic studies (see for example Clark and Oswald, 1994; Frey and Stulzer, 2000; Winkelman, 2005). A problem with these measures is that individuals' responses to these questions are related to individual personality characteristics that are unobserved or unmeasured, and this may lead different individuals to attach a different meaning to the definition of terms such as "totally satisfied with your life". This is compounded by a condition such as chronic pain, where adaptation to the condition is possible. Indeed, the bedrock of "treatment" in chronic pain is the development of self-management approaches, many of which are based on cognitive behavioural therapy (CBT). Such therapeutic approaches encourage adaptation through the development of positive thoughts, feelings and attitudes towards adverse circumstances.

The objective of this paper therefore is to analyse the relationship between chronic pain and life satisfaction of adult individuals, using data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. We examine whether the impact of chronic pain on life satisfaction is lessened over time through adaptation, and assess the consequences of adaptation for estimates of compensating variation.

The rest of this paper is organized as follows. Section 2 analyses the data and briefly presents pain and well-being indicators. Section 3 discusses the estimation methods and Section 4 presents the main results. Section 5 concludes.

2. Data

This paper uses data from ten waves of the Household, Income and Labour Dynamics in Australia (HILDA) Survey, which is a representative longitudinal study of the Australian population that started in 2000. A total of 13,969 individuals in 7,682 households were interviewed in wave 1 through a combination of face-to-face interviews and self-completion questionnaires, for all members of households aged 15 years old and over (Wooden and Watson, 2002). HILDA is an indefinite life panel survey with a strong focus on family formation, income and work. All members of the households interviewed in wave 1 form the basis of the sample and they were interviewed in each subsequent wave. The sample has then been extended and now includes any new household members resulting from changes in the composition of the original households.

HILDA includes two different measures of pain. First, at each wave, individuals are asked whether they have any long term health conditions, with chronic pain as one of the possible alternatives that can be selected. Second, respondents are asked about the amount of bodily pain they had in the last 4 weeks and they can select one of the following alternatives: no pain at all; very mild; mild; moderate; severe; very severe. The focus of our paper is on chronic pain and therefore we decided to use the first indicator as our main variable of interest. Sensitivity tests have been run using the responses about bodily pain in the last 4 weeks and results are very similar.

Respondents are asked to report their life satisfaction at each wave in HILDA. They answer the following question: How satisfied are you with your life? and answers are on a scale from 0 (totally dissatisfied) to 10 (totally satisfied). Life satisfaction has been defined as ‘a feeling of contentment and lack of dissatisfaction with all areas of one’s life’ (Ardelt 1997), and is commonly used as a measure of well-being (Mentzakis et al. 2012; Veenhoven 2007; Diener and Suh 1997).

Further, we use an extensive set of control variables, to account for other factors that may influence life satisfaction. In the first specification of the model we only include lagged chronic pain and logarithm of household income. In the second specification, we also control for health limitations (other long term conditions), and in the third specification we include a wider set of independent variables. These include: a set of life events that took place in the last 12 months (personal injury or illness, victim of physical violence, other shocks, such as death of a family member, friend, or victim of a property crime) and a number of socio-demographic characteristics, such as age[1], education, marital status, living arrangements, smoking status, presence and age of children, employment status, geographic remoteness. The complete list of variables included in our model is reported in Table 1. Our final sample includes around 72,000 observations of around 15,000 individuals with non-missing information on chronic pain, health conditions and other essential information on the individual and family characteristics (the selected observations were not significantly different from the original data in terms of their observable characteristics).

Table 2 presents the distribution of pain and life satisfaction across the estimation sample. The percentage of individuals with low life satisfaction is generally quite low in the estimation sample (around 2.5%) but increases substantially when we separately look at the people affected by chronic pain (9%). In the estimation sample, around 6% of individuals (more than 5,000 observations) have pain.

Table 1 here

Table 2 here

Table 3 presents descriptive statistics on the other independent variables included in our model, by chronic pain status. Individuals with chronic pain are more likely to be out of the labour force, have lower education and income, and are generally affected by various chronic health conditions, especially motor impairments (limited use of arms, feet or legs, difficulty gripping things, any condition that restricts physical activity), long term health conditions (arthritis, asthma, heart disease, Alzheimer's disease, dementia etc.) and other conditions (loss of consciousness, learning difficulties, shortness of breath, results of a head injury).

Table 3 here

3. Estimation

Our model builds upon previous literature (Groot and Maassen van den Brink, 2004 and 2006, Carroll et al. 2009), and we assume an underlying indirect life satisfaction function (LS*). We assume that life satisfaction is influenced by income Y, health status H and other individual characteristics X:

$$LS^* = LS^* (Y, H, X) \quad (1)$$

where H indicated chronic pain and Y is the logarithm of annual household income.

Life satisfaction is measured through individuals' responses to the Cantril 0-10 scale, which has been shown to be adequate and reliable in measuring self-reported well-being (MacIntosh, 2001).

The major challenge for such analyses is that of establishing causal connections between chronic pain and life satisfaction, given that people with chronic pain may have unobserved characteristics that

[1] We follow Frijiters et al., 2004 and do not control simultaneously for age, time and fixed-effects. We therefore drop (linear) age as a covariate and note that the time dummies will include age effects.

also affect their life satisfaction and other outcomes. Furthermore, people with chronic pain may be systematically different from those who did not experience such condition, and reporting of chronic pain might be affected by individuals' overall perceptions of their own lives and therefore by their own life satisfaction. The risk of endogeneity and suggests that we should think of OLS as providing an upper bound to the causal effects.

Nonetheless, the effect of chronic pain on life satisfaction may be estimated correctly through OLS if several assumptions hold. First, the "selection on observables" assumption must be satisfied (see Heckman, 1979). This means that all variables that predict both chronic pain attendance and life satisfaction should be included in our model. These variables are sometimes called "confounding variables" because if they are not appropriately controlled for, their effect on the outcomes is confounded with the effect of the causing variable of interest (see Angrist & Krueger, 1999). Second, the model must be correctly specified: this is problematic, because functional form assumptions are difficult to test when we include many independent variables.

We cannot, in this data, address the selection on unobservables problem. There is simply no quasi-experimental variation across our sample to exploit. However, we can go some way towards addressing the other problems. Firstly, we use the timing of the events and analyse the effect of chronic pain at t-1 on life satisfaction at t. Second, we try to lower the upper bound provided by OLS estimation, through the inclusion of a more detailed set of independent variables. Lastly, we exploit fixed effects estimation, to gain more reliable estimates of the effect of chronic pain on life satisfaction, by taking into account individual unobserved traits and characteristics that do not vary over time. That is, life satisfaction is assumed to be a linear function of income, chronic pain and other individual characteristics:

$$LS_{it} = \alpha + \beta_{1t} H_{it} + \beta_{2t} \log Y_{it} + \beta_{3t} X_{it} + \beta_4 P_{i\,t-1} + \varepsilon_{it} + c_i \qquad (2)$$

Where ε_{it} is an idiosyncratic individual error term, which is assumed to be normally distributed (with variance normalised to be equal to 1) and c_i is an individual fixed effect that takes into account time-invariant unobserved heterogeneity. The variance of the idiosyncratic error term is normalised to be equal to 1.

Equation 2 is estimated using a linear model with individual fixed effects, and therefore we take into account individual-specific factors such as personality, cultural background, etc. that do not vary over time. These factors may affect the perception of life satisfaction, as well as reporting of chronic pain, which may also be a function of the degree of pain experienced in the past. For example, if a person is intrinsically pessimistic and tends to over-report chronic conditions, the fixed effects estimator should take this into account. In our analysis, we also take into account the possibility of unobserved random shocks that affect chronic pain and life satisfaction. For this reason, we control for health conditions, as well as for other negative life events (such as being the victim of violence, property crime, death or serious illness of a family member or close friend, etc.).

Finally, we test our main results by using a model where we dependent variable is collapsed into a binary format with a threshold value of life satisfaction smaller or equal to 4. The drawback of this approach is that the effect of chronic pain on life satisfaction is only identified by individuals who change chronic pain and life satisfaction status and this implies a significant data loss. This problem can be solved by the Ferrer-i-Carbonell and Frijters (2004) estimator and its approximation (see Kassenboehmer and Haisken-DeNew, 2009) which applies individual specific threshold to collapse the data into a binary format. We follow Kassenboehmer and Haisken-DeNew (2009) and use the individual's mean life satisfaction as threshold.

The latent variable specification of the model estimated can be written as:

$$LS_{it} = \alpha + \beta_{1t} H_{it} + \beta_{2t} \log Y_{it} + \beta_{3t} X_{it} + \beta_4 P_{i\,t-1} + \varepsilon_{it} + c_i \tag{3}$$

A binary variable Z_{it} is generated as follows:

$$Z_{it} = \begin{cases} 0 \; if \; LS^*_{it} \leq \overline{LS^*_i} \\ 1 \; if \; LS^*_{it} \geq \overline{LS^*_i} \end{cases} \tag{4}$$

Where $\overline{LS^*_i} = \frac{\sum_{i=1}^{T} LS^*_{it}}{T}$

The variable z_{it} is equal to 1 if individual's life satisfaction is above the individual's threshold. On this variable, Chamberlain (1980) conditional logit estimator can be applied so that the coefficients are estimated conditional on the number of ones in the dependent variable. Following Chamberlain (1980), the joint probability function of each set of T observations of $z_{it} = s_{it}$ ones and zero leads to the following Log-Likelihood function which can be maximised by standard programmes:

$$LL = ln\left[\prod_{i=1}^{n} \frac{\exp(\beta\prime \sum_{i=1}^{T} x_{it} z_{it})}{\sum_{d \epsilon Bi} \exp(\beta\prime \sum_{i=1}^{T} x_{it} d_i)}\right] = \sum_{i=1}^{n} ln\left[\frac{\exp(\beta\prime \sum_{i=1}^{T} x_{it} z_{it})}{\sum_{d \epsilon Bi} \exp(\beta\prime \sum_{i=1}^{T} x_{it} d_i)}\right] \tag{5}$$

Where x_{it} represents a vector of explanatory variables, z_{it} the dependent life satisfaction binary variables and d = (d_1, …..d_T) indicates the combinations of s_i ones and T- s_i zeros for each individual, composing Bi so that $\sum_{i=1}^{T} z_{it} = s$.

Because the coefficients are estimated conditional on the number of ones, the heterogeneity term can be removed. Observations without variation across the individual threshold of life satisfaction do not contribute to the likelihood function and covariates that do not vary over time cannot be distinguished from the individual effect ci and are drop out.

Following Groot and Maassen van den Brink (2004 and 2006), we use the parameter estimates from (2) to calculate the compensating income variation (CIV) of chronic pain, i.e. the amount of money needed to compensate someone affected by chronic pain and make her/him as well-off as someone without pain. We define Y(X, LS, H=1) as the income needed by someone with chronic pain (H=1) and characteristics X to achieve a certain level of life satisfaction LS and Y(X, LS, H=0) as the income needed by an individual with the same characteristics but no chronic pain (H=0) to achieve the same level of life satisfaction LS. The implied monetary compensation (or compensating income variation, CIV) that a person with chronic pain would need to receive to obtain the same level of life satisfaction in the absence of chronic pain is calculated by multiplying the equivalence scale of chronic pain by the equivalised income of the individual. The equivalence scale ES is defined as:

$$ES = \frac{Y(X, LS, H = 1)}{Y(X, LS, H = 0)} \tag{6}$$

Equation (6) can be re-written as:

$$\log ES = \log C(X, LS, H = 1) - \log C\ (X.LS, H = 0) = -\frac{\beta_1}{\beta_2} \tag{7}$$

This corresponds to the percentage of additional income for someone with chronic pain to attain the same level of life satisfaction of a person without pain. For example, the daily/monthly compensating income variation (CIV) can be obtained by multiplying the ES by the average daily/monthly income observed amongst those with chronic pain.

4. Results

The main results from our model are presented in Table 4-6. We present results for the whole estimation sample, as well as for men and women separately. In order to show the stability of our results, we present results from three different specifications of the OLS model, as well as LPM with random and fixed effects and Logit model with individual threshold of life satisfaction and fixed effects.

First of all, we progressively increase our set of independent variables in the OLS estimation, in order to capture factors that could be correlated with chronic pain, such as long term health conditions and life events. Second, there might be unobserved time invariant factors correlated both with chronic pain and life satisfaction. If this is the case, the random effects estimator will be inconsistent. Accordingly, in Table 4 we also present fixed effects panel estimates, which are consistent under the assumption that there are no omitted time-varying factors that are also correlated with the chronic pain variable. As expected, the point estimates from fixed effects are lower than in the OLS and random effects model. We performed a Hausman test and this showed that the hypothesis that the difference in coefficients is not systematic could be rejected and therefore the fixed effects estimates are preferred[2].

As already explained, the fixed effects estimates only control for time-invariant effects and it is possible that other time-varying variables affect both chronic pain and life satisfaction or that reverse causality affect the main results. In this data, there is no quasi-experimental variation that could be exploited and it would be very difficult to devise instruments with the power to predict chronic pain

[2] Chi-squared statistics = 522.16 and p-value=0.000

without having an effect on individuals' life satisfaction. Therefore, we interpret our results as strong associations between chronic pain and life satisfaction, without definitively proving that the process is causal.

Chronic pain has a large, negative and significant effect on life satisfaction for people in our sample. As expected, the size of the coefficient decreases when we add more independent variables and individual fixed effects. However, the coefficient of lagged chronic pain is still significantly different from zero in our preferred specification, when we include individual fixed effects, and results are similar when we estimate the model using logit fixed effects.

Chronic pain appears to have a slightly stronger negative effect on women's life satisfaction: for a 45 year old man (approximately the average age of the individuals in our sample), chronic pain reduces life satisfaction by around 0.08 points on a 0-10 scale. For a woman of similar age the effect is 0.12 points on a 0-10 scale.

Table 4 and 5 here

Our results also show a small, positive effect of income on life satisfaction and this is consistent with previous studies using the compensating income variation approach (Mentzakis et al. 2012; Groot and Maassen van den Brink 2004 and 2006).

The independent variables included in the model follow range of other studies of life satisfaction (see for example Blanchflower and Oswald, 2008; Wooden et al., 2009, Green, 2011) and the main findings on these variables are generally consistent with previous literature investigating the determinants of life satisfaction (see for example Winkelmann and Winkelmann 1998, Clark et al. 2001; Frey and Stutzer 2000; Frijters et al. 2004). Life satisfaction is negatively affected by long term health conditions, while education does not seem to play a very important role in our sample. Labour force participation definitively increases life satisfaction, with respect to unemployment. Not surprisingly, married individuals generally exhibit higher levels of life satisfaction, while negative life events, such as personal injury, illness or death of a family member or close friend and being a victim of violence, have a strong negative effect on individual life satisfaction. People living in a rental property are less satisfied than people who own their house, while people living in inner regional areas seem more satisfied than people living in major cities. The negative effects of being unemployed, separated or widowed on life satisfaction is stronger for men, while women's life satisfaction is negatively affected by the presence of very young children.

Table 6 here

The compensating income variation associated with chronic pain for the complete sample is presented in Table 7 and is estimated as AUS$165 per day. Compared to an individual without chronic pain with an average equivalised[3] daily disposable income of approximately $108, an individual with chronic pain needs an extra $165 to achieve the same level of life satisfaction. The CIV is equal to $94 for men and $233 for women.

Table 7 here

Lastly, we investigate whether people with chronic pain exhibit adaptation to their condition and whether there is a difference in adaptation between men and women. We follow Oswald and Powdthaee (2008) and we study whether happiness levels adapt, by creating a variable "Past chronic pain from t-3 to t-1", which takes values between zero and unity[4]. An individual who had chronic pain for one previous year in the last three years, for example, will have the value 1/3 for his or her past chronic pain from t-3 to t-1. More specifically, the variable "Past chronic pain from t-3 to t-1" will be equal to:

- 1/3 if the respondent experienced chronic pain in one out of three years
- 2/3 if the respondent experienced chronic pain in two out of three years
- 1 if the respondent experienced chronic pain every year

This variable is then introduced in the model separately (Model 1) and interacted with chronic pain (Model 2). Results from the estimation are reported in Table 6.

Table 6 here

In Model 1, for example, the long-run effect of chronic pain is 0.221 for the whole sample, 0.143 for women and 0.324 for men. In Model 2, a person with chronic pain in the present wave but who did not have chronic pain in the last three years experiences a life satisfaction penalty of 0.148 points. A person who had chronic pain for one additional year in the past has a combined penalty of -0.148-0.244/3+0.235/3 = -0.151. A person who had chronic pain for two additional years in the last three would have a life satisfaction penalty of -0.148-2/3 (0.244)+2/3 (0.235) = -0.155. The decrease in life satisfaction for a person who had chronic pain for every year in the last three years in addition to chronic pain today is equal to -0.148-0.244+0.235= -0.157. These data show that the negative effect of chronic pain on life satisfaction does not fade and is actually stronger the longer the individual has experienced the condition. Oswald and Powdthaee (2008) analyse adaptation to disability and severe disability (limiting day-to-day activities) and show that individuals' life satisfaction adapt to the first type of condition (the longer the experience of disability, the less emotionally painful current disability appears to be) but not to the most severe disability: three full years of this type of disability produces only mild happiness adaptation. Finally, note that a person with no chronic pain today but with a history of chronic pain in one of the three previous waves still experiences a penalty of -0.244/3 = - 0.081.

[3] Equivalised income has been calculated using the modified OECD scale: weights of 1 for the first adult, 0.5 for subsequent adults (age 14 and over) and 0.3 for each child. See Clark et al. (2005).

[4] We also implemented a discounting procedure, to account for potential greater adaptation in t-3 relative to t-2 and t-1, and t-2 relative to t-1. There was however very little difference in the parameter estimates, and so we choose to report the present estimates for comparability purposes.

Interestingly, women seem to react to chronic pain better than men. The effects reported above are 0.117, 0.097 and 0.077 for women and 0.193, 0.230, 0.266 for men, showing a mild adaptation for women's life satisfaction and a worsening in men's happiness.

5. Discussion

This paper analyses the relationship between chronic pain and life satisfaction, using the Household, Income and Labour Dynamics Survey of Australia. Fixed effects have been used in the present analysis to control for characteristics of individuals that do not vary over time. To the best of our knowledge, this is the first study to consider the application of the Compensating Income Variation method to chronic pain, as well as explore the impact of differential adaptation between men and women on the resulting estimates. We find that chronic pain has a large negative effect on life satisfaction and that the compensating income variation is substantial. The negative effect on life satisfaction is persistent and individuals with chronic pain do not show significant adaptation to their condition. A gender difference is observed however, with the negative effect on life satisfaction persisting amongst men, but with some adaptation found amongst women.

The negative association between chronic pain and life satisfaction is not entirely unexpected if one considers the various transmission channels through which chronic pain can affect individual well-being. First of all, many forms of chronic pain cannot be effectively treated by standard medical care, and treatment is mostly focused on delivery of self-management strategies (Martin et al 2013), but their effectiveness is uncertain (Boyers et al 2013) and uptake is variable (Schofield et al 2011). Second, chronic pain has been found to increase the chances of leaving the labour market and this may imply a drop in income, as well as a negative effect on individual perceived role in the society. Even if we control for income and employment status in our model, the negative effect of chronic pain may go through a variety of factors, such as individual perception of her/his own role, self-esteem, lack of personal contacts, etc. Lastly, chronic pain may increase individual stress and therefore increase the chances of family conflicts, and other problems in individual relationships. Taken together therefore, it suggests a need for development of effective chronic pain prevention strategies, as well as better chronic pain management, through encouragement of self-management approaches which teach adaptation.

Our results show that individuals with chronic pain would require additional $3,200 (around 3,000 USD) per month to be as well off as someone without pain, and men seem particularly affected by the incidence of pain, and less able to adapt to it over time. Women's CIV is slightly lower and the effect on their life satisfaction decreases when they experience chronic pain for a prolonged period of time.

The implied compensation value is comparable with previous estimates of other chronic conditions, e.g. Groot and Maassen van den Brink (2004 and 2006) estimate CIV for migraine of US$ 1,400 per month (1993 prices) and £4,000 per month for cardiovascular disease amongst males (1996-2000 prices). The reasons for these differences in magnitude are unclear, as different data sources, health conditions and estimation models have been utilized. Further work using additional data, to exploit exogenous random variation in chronic pain and monetary compensation (e.g court awards for workplace or road traffic injuries resulting in chronic pain), would permit greater insight into the validity of our estimates and those of previous authors. We urge caution therefore in the interpretation of our results and any comparison with other studies.

The explanation for the difference between men and women may arise as the effect of chronic pain on individual life satisfaction can be mediated through a variety of different factors. Whilst the persistent experience of pain, and the associated difficulty in finding an appropriate treatment, are likely to worsen psychological well-being for both, as already shown in previous studies, chronic pain has severe negative adverse consequences on individual labour market participation and productivity. Literature from health sciences has shown that women experience higher pain incidence but generally show less pain-related anxiety (Frot et al., 2004) and greater adaptation (Hashmi and Davis, 2009). Further, chronic pain may have a different effect for women as opposed to men through the labour market consequences, due to social norms, self-esteem and perceived role in society. Whilst prolonged experience of pain may inhibit social interactions, personal relationships, and levels of stress, self-management can be used to help ameliorate these consequences, and it may be that men and women exercise different choices over the extent to which they engage in self-management strategies. Women have been found to be more proactive in managing chronic diseases and integrating self-care into their daily life (Mathew et al., 2012). The potential explanations for the differences are many and complex, and we leave that as a challenge for future research.

Tables

Table 1 - Independent variables

Characteristics	***Variable***
Education	3 groups: University (or post-graduate) qualification (omitted) ; Certificate or Diploma; High School or lower qualification
Marital Status	4 groups: Married (or cohabiting) (omitted); Divorced (or separated); Widow; Single
Age* ?Age squared	In years at the interview
Long term health conditions	Binary variables for long term or chronic health conditions (see Appendix for details)
Household income	Logarithm of household disposable income
Children in the household	3 groups: age 0-4; 5-9; 10-14
Remoteness	3 groups: Major city (omitted); Inner Regional Areas; Outer Regional Areas (including remote and very remote Australia)
Life events	Personal injury or illness
	Victim of physical violence
	Other events (incl. property crime, illness of a family member, death of a friend or family member)

**Not included in the Fixed effects model

Table 2 – Distribution of chronic pain and life satisfaction

Variables/categories	***Frequency***	***Percent***
Overall life satisfaction levels		
Least satisfied (0-4)	1,627	2
5	2,789	4
Satisfied (6-10)	68,063	94
Chronic pain t-1		
No	68,220	94
Yes	4,259	6

	Life satisfaction (%)		
Pain	***Least Satisfied (0-4)***	***5***	***Satisfied (6-10)***
No chronic pain t-1	2	4	94
Chronic pain t-1	9	10	81

Note: The sample is that used for the analyses with fixed effects in Table 4 below, with 72,479 person-year observations. The means are unweighted.

Table 3: Descriptive statistics of independent variables

Variable	All	No chronic pain	Chronic pain
Equivalised yearly income (Mean- SD)	39,434 (26,609)	39,998 (26,749)	30,402 (22,415)
Marital Status (%)			
Single	21	22	11
Separated/Divorced	9	9	16
Married Or Cohabiting	64	64	62
Widow	5	5	10
Employment Status (%)			
Employed	65	67	32
Unemployed	3	3	2
Out of the L force	31	30	65
Housing tenure (%)			
Owned	73	73	67
Rented	24	24	28
Other living arrangements	3	3	4
Educational Qualification (%)			
University (or post grad.) qualification	22	22	15
Certificate or Diploma	30	30	30
High School or Lower Education	47	46	53
Remoteness (%)			
City		62	56
Inner regional area	25	25	29
Outer regional area	13	13	14
Age (Mean – SD)	45 (17.9)	44(17.8)	56(15.8)
Male (%)	46	46	42
Children 0-4 (%)	14	14	6
Children 5-9 (%)	14	14	7
Children 10-14 (%)	17	17	10
Life events (%)			
Personal illness or injury	8	8	22
Victim of violence	1	1	2
Other life events	33	32	43
Health conditions (%)			
Sensory problems	7	6	28
Motor impairments	19	12	100
Mental illness	4	3	22
Long term conditions (Arthritis, Asthma, heart disease, Alzheimer's disease, dementia, etc.)	11	9	48
Other problems	14	8	80

Table 4: Results - The effect of chronic pain on life satisfaction – Overall sample

	All sample					
	OLS Model 1	OLS Model 2	OLS Model 3	LPM RANDOM EFFECTS	LPM FIXED EFFECTS	LOGIT FIXED EFFECTS (*Binary outcome: low life satisf.*)
Chronic pain t-1	-0.749 (0.021)**	-0.394 (0.023)**	-0.403 (0.024)**	-0.226 (0.021)**	-0.104 (0.022)**	0.142 (0.049)**
Log household income	0.080 (0.007)**	0.033 (0.007)**	0.101 (0.008)**	0.041 (0.008)**	0.041 (0.010)**	-0.087 (0.022)**
Control for Health status	No	Yes	Yes	Yes	Yes	Yes
Control for Age	No	No	Yes	Yes	No	No
Control for Employment, Marital Status and other factors	No	No	Yes	Yes	Yes	Yes
N. Observations	81,776	81,776	72,479	72,479	72,479	61,697

Note: Standard errors are in brackets + indicates that the underlying coefficient is significant at 10% level, * at 5% and **at 1%.

Table 5: Results - The effect of chronic pain on life satisfaction – By gender

	Men						Women					
	OLS Model 1	OLS Model 2	OLS Model 3	LPM RANDOM EFFECTS	LPM FIXED EFFECTS	LOGIT FIXED EFFECTS (*Outcome: low life satisf.*)	OLS Model 1	OLS Model 2	OLS Model 3	LPM RANDOM EFFECTS	LPM FIXED EFFECTS	LOGIT FIXED EFFECTS (*Outcome: low life satisf.*)
Chronic pain t-1	-0.744 (0.032)**	-0.394 (0.036)**	-0.440 (0.037)**	-0.209 (0.031)**	-0.084 (0.033)**	0.090 (0.074)	-0.758 (0.021)*	-0.396 (0.031)**	-0.378 (0.032)**	-0.237 (0.028)**	-0.117 (0.030)**	0.177 (0.064)**
Log household income	0.108 (0.009)**	0.062 (0.010)**	0.113 (0.012)**	0.048 (0.012)**	0.045 (0.014)**	-0.106 (0.033)**	0.064 (0.008)*	0.018 (0.009)*	0.093 (0.011)**	0.036 (0.011)** +	0.037 (0.014)**	-0.074 (0.029)*
Control for Health status	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Control for Age	No	No	Yes	Yes	No	No	No	No	Yes	Yes	No	No
Control for Employment, Marital Status and other factors	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
N. Observations	38,417	33,764	33,764	33,764	33,764	28,517	43,359	38,715	38,715	38,715	38,715	33,180

Note: Standard errors are in brackets + indicates that the underlying coefficient is significant at 10% level, * at 5% and **at 1%.

Table 6: Results – Fixed effects estimation – Other variables

Independent variables	All Sample	Women	Men
Education – Certificate or Diploma	-0.067	-0.054	-0.073
	(0.054)	(0.071)	(0.083)
Education – High school or lower qualification	0.018	0.002	0.051
	(0.049)	(0.064)	(0.077)
Health Conditions			
Sight	0.034	-0.022	0.084
	(0.032)	(0.047)	(0.043)+
Hearing	-0.040	-0.045	-0.039
	(0.027)	(0.045)	(0.034)
Speech	-0.106	-0.055	-0.164
	(0.086)	(0.132)	(0.111)
Loss of consciousness	-0.243	-0.118	-0.445
	(0.062)**	(0.081)	(0.098)**
Difficulties understanding	-0.049	-0.013	-0.066
	(0.052)	(0.082)	(0.067)
Problem with arms	-0.042	0.011	-0.113
	(0.032)	(0.044)	(0.048)*
Difficulties gripping things	-0.029	-0.061	0.024
	(0.033)	(0.043)	(0.054)
Problem with legs	-0.095	-0.088	-0.105
	(0.026)**	(0.036)*	(0.036)**
Nervous or emotional condition	-0.382	-0.388	-0.376
	(0.030)**	(0.039)**	(0.048)**
Condition that restricts physical activity	-0.076	-0.119	-0.021
	(0.018)**	(0.026)**	(0.026)
Disfigurement or deformity	0.057	0.160	-0.041
	(0.066)	(0.098)	(0.089)
Mental health condition	-0.322	-0.412	-0.212
	(0.047)**	(0.066)**	(0.068)**
Difficulties breathing	-0.012	0.007	-0.034
	(0.029)	(0.039)	(0.044)
Effects of head injury	-0.167	-0.033	-0.282
	(0.058)**	(0.085)	(0.078)**
Restrictive condition (despite being treated)	-0.082	-0.085	-0.077
	(0.019)**	(0.027)**	(0.028)**
Other condition	-0.018	-0.019	-0.015
	(0.017)	(0.024)	(0.026)
Rent	-0.061	-0.043	-0.082
	(0.019)**	(0.027)	(0.027)**
Other housing	-0.001	-0.011	0.011
	(0.035)	(0.048)	(0.051)
Unemployed	-0.159	-0.125	-0.199
	(0.028)**	(0.040)**	(0.040)**
Out of the labour force	-0.004	0.039	-0.075
	(0.017)	(0.022)*	(0.027)**
Separated	-0.431	-0.406	-0.453
	(0.034)**	(0.046)**	(0.050)**
Widow	-0.349	-0.306	-0.450
	(0.056)**	(0.067)**	(0.109)**
Single	-0.215	-0.264	-0.150
	(0.028)**	(0.039)**	(0.040)**
Has children between 0 and 4	-0.036	-0.080	0.009
	(0.020)+	(0.028)**	(0.028)
Has children between 5 and 9	0.023	0.036	0.004
	(0.018)	(0.026)	(0.027)

Has children between 10 and 14	0.023	-0.008	0.061
	(0.017)	(0.024)	(0.024)*
Inner regional area	0.099	0.093	0.106
	(0.029)**	(0.041)*	(0.042)*
Outer regional area (incl. remote)	-0.032	-0.055	-0.005
	(0.041)	(0.058)	(0.057)
Life events in the past 12 months			
Personal illness or injury	-0.152	-0.190	-0.110
	(0.016)**	(0.023)**	(0.022)**
Victim of violence	-0.267	-0.267	-0.260
	(0.037)**	(0.054)**	(0.051)**
Other events	-0.029	-0.034	-0.022
	(0.009)**	(0.013)**	(0.013)+
Constant	7.752	7.854	7.616
	(0.116)**	(0.160)**	(0.170)**
Observations	72,479	38,715	33,764
Number of individuals	15,086	7,917	7,169

Note: Standard errors are in brackets + indicates that the underlying coefficient is significant at 10% level, * at 5% and **at 1%.

Table 7 – Equivalence Scale and CIV

	Equivalence Scale	Standard Errors	Compensating Income Variation (in Australian Dollars)
Sample			
All	2.53	0.81	165
Men	1.87	0.94	94
Women	3.13	1.40	233

Table 8 – Adaptation and chronic pain

	All sample		Women		Men	
Independent variables	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Chronic pain	-0.098**	-0.148**	-0.081**	-0.138**	-0.117**	-0.157**
	(0.020)	(0.025)	(0.028)	(0.034)	(0.031)	(0.036)
Past chronic pain (3 years)	-0.123**	-0.244**	-0.062	-0.198**	-0.207**	-0.299**
	(0.037)	(0.049)	(0.050)	(0.067)	(0.056)	(0.072)
Chronic pain*Past chronic pain (3 years)		0.235**		0.259**		0.190**
		(0.063)		(0.086)		(0.095)

Note: Standard errors are in brackets + indicates that the underlying coefficient is significant at 10% level, * at 5% and **at 1%.

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