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# Losing Ground, Losing Sleep: Economic Vulnerability, Local Economic Conditions and Sleep Quantity

Francisco Perales  
Institute for Social Science Research,  
The University of Queensland

Stefanie Plage  
School of Social Science  
The University of Queensland

No. 2015-06  
May 2015



Australian Government  
Australian Research Council

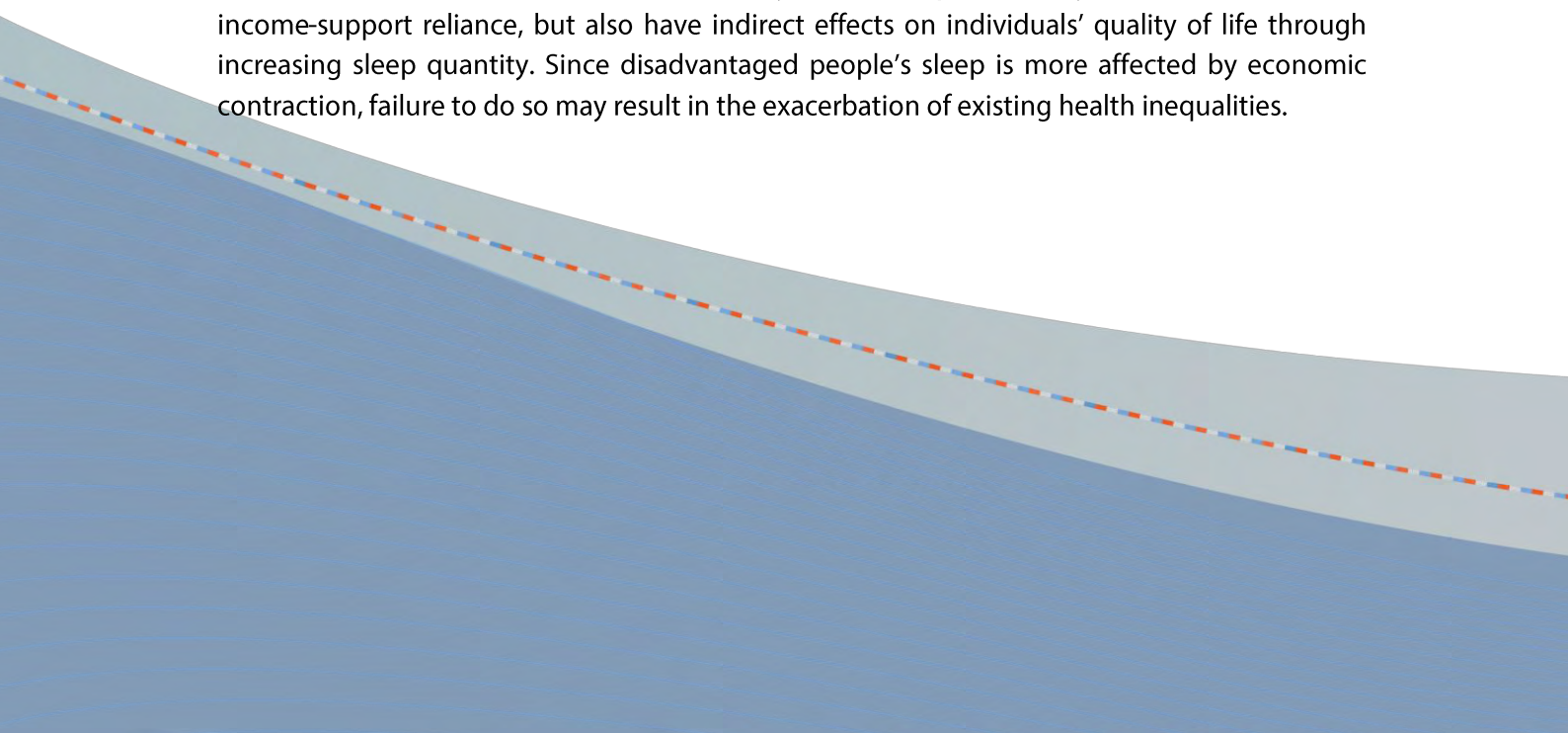
## NON-TECHNICAL SUMMARY

Medical research has demonstrated that healthy sleep has benefits for people's health and wellbeing. However, little is known about the reasons why some people sleep better or more than others. In this paper we pay attention to the ways in which suffering from material deprivation, having financial difficulties and having experienced a worsening in one's personal economic circumstances affect sleep duration. We also consider the role of economic conditions in the local area in which people live, including the degree of unemployment and any changes in the degree of unemployment in the previous year.

We argue that individuals who are exposed to these factors can experience sleep loss and unhealthy sleeping habits through financial worry, uncertainty and stress. We also posit that economic contraction should have a stronger effect on the sleep of economically vulnerable individuals. This is because the degree of financial anxiety resulting from economic contraction may differ between people with high resources (who have access to 'safety nets' that can help them counteract personal economic losses) and disadvantaged people (for whom even minor changes to current financial circumstances may be sufficient to push them below subsistence level). We test these premises using data from a large, nationally representative, Australian household survey.

Our results are in-line with our expectations and indicate that people who experience financial hardship or live in deprived areas sleep fewer hours than comparable people who do not experience financial hardships and live in affluent areas. Furthermore, the effect of local economic conditions on sleep quantity is much stronger amongst economically vulnerable individuals: disadvantaged people seem to lose sleep due to harsh economic conditions in their local area, whereas advantaged people remain unaffected.

These findings have important implications. Since poor sleep is associated with health issues and low productivity at work, disproportionate reductions in sleep quantity through financial anxiety amongst individuals who are already disadvantaged may lead to the reproduction of inequality. We conclude that it is important for policymakers to devise interventions to manage the financial stress experienced by individuals in disadvantaged areas or areas experiencing economic recession as a means to enhance population health. Policies aimed at improving local economic conditions per se will not only result in higher employment rates or reduced income-support reliance, but also have indirect effects on individuals' quality of life through increasing sleep quantity. Since disadvantaged people's sleep is more affected by economic contraction, failure to do so may result in the exacerbation of existing health inequalities.



## ABOUT THE AUTHORS

**Francisco Perales** is Research Fellow in Family Dynamics at the Life Course Centre at the Institute for Social Science Research (The University of Queensland). His recent research has been on social disadvantage, gender inequalities, life course transitions, subjective wellbeing, and the use of household panel surveys within sociology. Recent publications include articles in gender attitudes and divisions of labour in *Social Forces* and *Social Science Research* and inequalities in wellbeing by sexual identity in *Social Indicators Research*. Email: [f.perales@uq.edu.au](mailto:f.perales@uq.edu.au)

**Stefanie Plage** is a PhD Candidate at the University of Hamburg. She is a sociologist currently working in the Griffith Centre for Cultural Research (Griffith University) and in the School of Social Science (The University of Queensland). Her recent work includes diverse research topics ranging from clinical governance in the hospital to cosmopolitanism in contemporary Australia. Email: [s.plage@uq.edu.au](mailto:s.plage@uq.edu.au)

**ACKNOWLEDGEMENTS:** This research was supported by the Australian Research Council Centre of Excellence for Children and Families over the Life Course (project number CE140100027). The views expressed herein are those of the authors and are not necessarily those of the Australian Research Council. This paper uses unit record data from the HILDA Survey. The HILDA Project was initiated and is funded by the Australian Government Department of Social Services (DSS) and is managed by the Melbourne Institute of Applied Economic and Social Research (Melbourne Institute). The findings and views reported in this paper, however, are those of the authors and should not be attributed to either DSS or the Melbourne Institute.



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(ARC Centre of Excellence for Children and Families over the Life Course)  
Institute for Social Science Research, The University of Queensland  
St Lucia, Qld 4072, Telephone: +61 7 334 67477  
Email: [lcc@uq.edu.au](mailto:lcc@uq.edu.au), Web: [www.lifecoursecentre.org.au](http://www.lifecoursecentre.org.au)

## **Abstract**

There is strong evidence that maintaining healthy sleeping habits has important benefits and an emerging social-epidemiological literature on the social determinants of sleep. We contribute to this literature by focusing on individual-level economic vulnerability and local economic conditions. We hypothesize that experiencing financial hardship or living in an area with worsening economic circumstances can result in sleep loss and unhealthy sleeping habits through financial worry, uncertainty and stress. We also posit that economic contraction should have a stronger effect on the sleep of economically vulnerable individuals. We test these premises empirically using multilevel regression models of sleep quantity and data from a large, nationally representative, Australian household survey. Our results indicate that economic conditions are associated with individuals' sleep time: people who live in deprived areas and those who experience individual-level economic vulnerability sleep fewer hours than comparable people who live in affluent areas and do not experience financial hardships. Furthermore, the effect of local economic conditions on sleep quantity is much stronger amongst economically vulnerable individuals.

**Keywords:** Australia; sleep; social disadvantage; deprivation; economic contraction; recession

## **1. Introduction and background**

Sleep is a fundamental part of human existence, and we spend almost one third of our lives asleep. Maintaining healthy sleeping habits has well-known benefits for human development, performance and wellbeing, including cognitive and behavioural functioning (Banks and Dinges, 2007), memory processing and learning (Diekelmann and Born, 2010), and hormonal balance and healthy metabolism (Leprout and van Cauter, 2010). There is also a growing evidence base showing that poor sleep leads to all-cause mortality (Grandner et al., 2010), obesity (Taheri et al., 2004) and diabetes (Buxton and Marcelli, 2010), and research unveiling associations between sleep and work-related productivity (Lamberg, 2004), absenteeism (Rahkonen et al., 2011), and motor-vehicle accidents (Roth and Ancoli-Israel, 1999).

Academic knowledge on sleep has been overwhelmingly driven by the medical disciplines, but a body of social-epidemiological literature on sleep is rapidly emerging (Henry et al., 2013). This has expanded the focus of inquiry from the physiological outcomes of sleep and sleep disorders to its social context and consequences (Williams, 2008, Williams and Crossley, 2008). This paper is embedded within this literature, and concerned with how micro-level economic vulnerability and macro-level economic contraction influence individuals' sleep time. Our main argument is that the experience of economic vulnerability at the personal level and poor or impoverished local economic conditions should reduce individuals' sleep time through financial stress and worry, and that simultaneous exposure to both individual- and local-level economic circumstances should exacerbate the effects. We theorize and test this link using contemporary survey data from Australia.

In doing so, this study contributes to the existing body of knowledge in several ways. First, we are amongst the first to focus on how economic contraction affects sleep quantity, and the first to consider the potential moderating effect of individual-level economic vulnerability. In doing this, we respond to recent calls by sleep researchers for more studies taking a social-epidemiological perspective (Henry et al., 2013) and examining socio-economic status (SES) as a determinant of sleep (Arber et al., 2009), as well as calls by economic contraction researchers for studies that expand the focus from job losers to the general population and consider subgroup heterogeneity in impacts (Goldman-Mellor et al. 2010; Suhrcke and Stuckler, 2012). Second, we add to a small group of studies demonstrating that indicators of economic vulnerability (i.e. financial hardship or difficulties) are important predictors of sleep patterns and habits, over and above more traditional and indirect measures of SES such as income, education and employment (Burgard and Ailshire, 2009; Lallukka et al., 2012).

Third, unlike most prior studies, we use a large, national dataset. This enhances the generalizability of our findings and our ability to examine ‘rare’ subpopulations. Fourth, we focus on a country, Australia, on which socio-epidemiological research on adult sleep is virtually inexistent (see Soltani et al., 2012 for an exception), and so our findings are useful to broaden international comparisons. Fifth, from a public health perspective, socio-economic factors are malleable, and so our results have the potential to inform social policies and interventions aimed at promoting healthy sleeping habits and improving population health (Bassett and Moore, 2014).

## **2. Economic conditions, socio-economic deprivation and sleep**

Socio-economic deprivation, financial uncertainty and financial instability (from here on referred to as indicators of economic vulnerability) are associated with psychosomatic symptoms and depression, psychological distress and nonspecific physiological illness (Butterworth et al., 2009; Hale et al., 2013). Across disciplines, authors refer to these symptoms using terms such as financial worry or stress, emotional strain, demoralization, entrapment, lack of control, powerlessness, hopelessness, and feelings of uncertainty and apprehension (Arber et al., 2009; Bassett and Moore, 2014; Burgard and Ailshire, 2009; Dávalos and French, 2009; Fryer, 2013; Goldman-Mellor et al., 2010; Hale et al., 2013; Lallukka et al., 2012; Sargent-Cox et al., 2011). In turn, these responses are known predictors of insomnia and unhealthy sleeping habits. This is because coping with these experiences has been argued to lead to chronic activation of the physiological stress response (e.g. increasing blood pressure and reducing emotional wellbeing) (Arber et al., 2009) and to trigger the release of stress hormones that promote mental and physiological arousal and impair sleep (Hale et al., 2013). Individuals may be particularly affected by rapid deterioration in economic vulnerability, because uncertainty about future income sources and maintenance of current income sources should be more acute. Therefore, we hypothesize that, all else being equal:

*H1. Sleep quantity will be lower amongst economically vulnerable individuals, and individuals who experienced a rapid worsening in their economic circumstances.*

In this regard, research has shown that healthy sleeping habits, sleep quality and the prevalence of sleep disorders are patterned by SES, whereby suboptimal outcomes are typically more prevalent amongst individuals with low SES (Adams, 2006; Arber et al., 2009; Krueger and Friedman, 2009; Soltani et al., 2012). However, this literature has been largely confined to basic measures of SES, such as education, employment status, occupation or income, with few studies considering more direct indicators of financial difficulties and material deprivation (see Lallukka et al., 2012 for an exception).

Substantial research demonstrates that the economic environment to which individuals are exposed can alter their behaviors and attitudes, regardless of their personal economic circumstances (Grusky et al., 2011). There is ample evidence on the financial consequences of economic contraction (Jenkins et al., 2012), as well as growing evidence on its consequences in other domains, including family formation and divorce (Cherlin et al., 2013; Sobotka et al., 2011), intimate partner violence (Anderberg et al., 2015), social trust (Owens and Cook, 2013), educational aspirations (Taylor and Rampino, 2014), subjective wellbeing (Deaton, 2012), suicide (Reeves et al., 2014), and mental health (Sargent-Cox et al., 2011). Despite an established body of knowledge on the health effects of economic contraction (see reviews by Catalano, 1991 and Suhrcke and Stuckler, 2012), very little attention to date has been paid to its potential downstream consequences on sleep.

Life-course epidemiology underscores the importance of macro-level institutions and conditions of the local environment in affecting and moderating individual outcomes (Basset and Moore, 2014). Unlike pollution and noise, which are direct-contextual pathways, we posit that economic contraction affects sleep quantity through indirect-cognitive pathways. When economic uncertainty is high, people draw upon local conditions to infer the likelihood of deterioration in their own personal circumstances. This can be an emotionally straining process that may result in stress and psychosomatic symptoms similar to those emerging from actual economic deprivation, and thus has the potential to lead to sleep loss. These symptoms need not be restricted to job losers, as negative effects of economic contraction on mental health extend to employed individuals (Modrek et al., 2013) and, in particular, to those who perceive their employment situation as precarious or anticipate employer lay-offs (Burgard and Ailshire, 2009; Ferrie et al. 1998). We thus expect that, *ceteris paribus*:

*H2. Sleep quantity will be lower amongst individuals who live in areas with poor economic conditions, and areas with worsening economic conditions.*

Empirical evidence in this regard is scarce and mixed. Dregan and Armstrong's (2009) results suggested a relationship between sleep loss through worry and macro-economic circumstances in the UK in the recession period of the early 1990s, but Hyypäe, Kronholm and Alanen (1997) found little evidence of changes in sleep behaviour during the same recession in Finland. In the US, Aguiar et al. (2013) actually found modest increases in sleep time of around 20 minutes per week between the pre-GFC period (2006-2008) and the initial GFC period (2009-2010), attributed to reductions in market-time work.

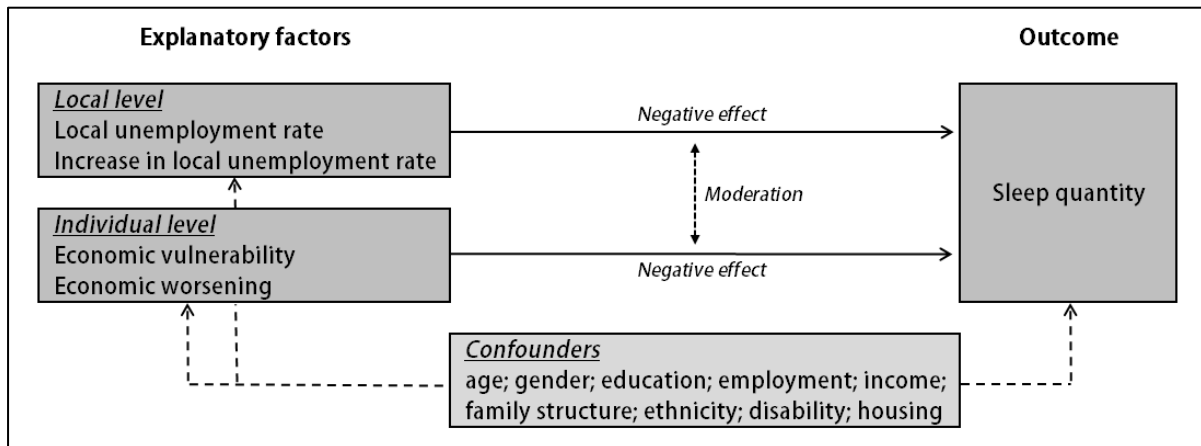
The degree of financial anxiety resulting from economic contraction is nevertheless likely to vary across population groups with differential access to protective assets. People with high resources have access to 'safety nets' (such as savings, support networks and sellable assets) that can help them counteract any contraction-related personal economic losses. For people who are already disadvantaged, however, even minor income shocks and changes to current financial circumstances may be sufficient to push them below subsistence level. We thus further hypothesize that:

*H3. The negative effect of local economic conditions on sleep quantity will be stronger amongst the economically vulnerable.*

There is to our knowledge no empirical evidence on this, though analogies can be drawn from findings in cognate fields of inquiry. For example, Dooley and Catalano (1984) report that the mental health of low SES people is more affected by recession than that of middle or upper SES people, whereas Zwysen (2014) found that economic contraction has more detrimental effects on the labour market outcomes of young people from disadvantaged family backgrounds.

Our theoretical propositions are summarized in the diagram in Figure 1, inspired by Basset and Moore (2014).

**Figure 1.** Conceptual model of the association between individual-level economic vulnerability, local economic conditions, and sleep quantity



### 3. The Australian economic environment

Australia has one of the highest *per capita* gross domestic products in the world and is one of the fastest growing developed economies. Yet there are important nuances that warrant analyses of the associations between economic conditions and sleep in Australia.

First, despite its good general economic health, Australia has high levels of income inequality (Leigh, 2013) and relative poverty, with 15% of the population living below 50% of the median income (OECD, 2011). Furthermore, the Australian economy has been characterized as a ‘two-speed economy’, with growth disproportionately driven by the ‘mining boom’ and many non-mining territories recently experiencing some form of recession (Garton, 2008).

Second, recent research indicates that, depending on the definition used, between 1% and 5% of Australians experience deep, multiple or entrenched socio-economic disadvantage (McLachlan et al., 2013). This type of poverty goes beyond income, and involves multidimensional forms of material deprivation and social exclusion (Saunders, 2011). Hence, despite these people comprise a relatively small share of the Australian population, they have attracted substantial academic attention and policy concern.

Third, the Global Financial Crisis (GFC) had non-negligible economic consequences, stalling first and reversing later one of the fastest growth periods in the history of Australia. The national unemployment rate in Australia was in constant decline from 1993 (11%) until the emergence of the GFC in 2008 (4%). Since 2008, it has grown to the current rate – as of April 2015 – of 6.5%, which is higher than that of countries such as the US (5.6%) and the UK (5.5%). Furthermore, some commentators forecast that the effects of the GFC are yet to

fully hit Australia, with any coming recession likely to hit disadvantaged people the hardest (Commonwealth of Australia, 2015).

Fourth, regardless of the country's actual economic health, prevailing media discourses are pessimistic (Sargent-Cox et al., 2011). In recent years there have been major job cuts in the public sector in states such as Victoria and Queensland, parliamentary debate about record-high public debt, socially inequitable tax increases, and controversial budget cuts to social protection and welfare. The degree of public concern is reflected in social attitude data. For instance, when asked about "*the most important issue for Australia today*" in the 2011 Australian Survey of Social Attitudes, the top answer given by respondents was 'the economy' (34% of respondents), ahead of 'health care' (26%), 'education' (13%), 'the environment' (9%), 'immigration' (6%), 'crime' (6%), 'poverty' (3%) and 'terrorism' (<1%). Regardless of the true economic status of Australia, these perceptions of economic contraction may have elicited financial stress amongst the public (Deaton, 2012; Sverke and Hellgren, 2002).

#### **4. Data and sample**

We are interested in the associations between economic vulnerability, local economic conditions and sleep quantity. To examine these, we use data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey (Summerfield et al., 2013). The HILDA Survey is a large, ongoing household panel survey comprising the period 2001 to 2013. This collects information from all household members aged 15 and over on an annual basis through a mixture of face-to-face interviews and self-complete questionnaires. The HILDA Survey's sample is largely representative of the Australian population and its sample size is substantial, with 17,501 respondents participating in the last available sweep.

A module asking a range of questions about sleep was included for the first time in Wave 13 (2013). This was administered to all survey participants as part of a self-complete questionnaire. The questionnaire items were based on questions previously included in the Wisconsin Sleep Cohort Study and the UK Household Longitudinal Study (*Understanding Society*). Given our focus on sleep, we restrict our analyses to Wave 13 of the HILDA Survey and, because our interest is in employment-related economic conditions, we exclude individuals outside usual working ages, i.e. age 20-70 (n=3,353) or who are economically inactive (n=3,316). A few respondents with missing information on sleep quantity (n=73) or

the control variables (n=26) were also excluded. Our final analytical sample comprises between 9,329 and 10,733 individuals – depending on the number of missing cases in the key explanatory variables.

The outcome variable is a measure of sleep quantity, namely the respondent's total number of sleep hours in a usual week. This variable is derived in-house by the HILDA Survey team using information from several questions asking respondents about the number of sleep hours they get from night sleep and daytime naps in weekdays and weekends. Implausible values, where individuals slept fewer than 20 or more than 84 hours per week (0.6%), were coded as missing. The distribution of the resulting sleep quantity outcome variable is roughly normally distributed, as shown in Figure A1 in the Appendix. This has a mean of 49.63, a median of 50 and a standard deviation of 8.13.

There are two sets of explanatory variables of interest: (i) individual-level measures of economic vulnerability, and (ii) measures of the economic conditions in the local area. The individual-level measures of economic vulnerability include material deprivation, self-perceived lack of prosperity given current needs and financial responsibilities, and self-reported financial worsening. *Material deprivation* is captured by a dummy variable taking the value one if the respondent experienced any of the following in the previous year: “*Could not pay electricity, gas or telephone bills on time*”, “*Could not pay the mortgage or rent on time*”, “*Pawned or sold something*”, “*Went without meals*”, “*Was unable to heat home*”, “*Asked for financial help from friends or family*” or “*Asked for help from welfare/community organisations*”. 22% of people in the sample reported at least one of these hardships. *Lack of prosperity* is captured via a dummy variable taking the value one when individuals report that their financial prosperity (given current needs and financial responsibilities) is “very poor” or “poor”, and the value zero when they report it to be “just getting along”, “reasonably comfortable”, “very comfortable” or “prosperous”. 2% of the sample scored a value of one in this variable. *Financial worsening* is measured by a dummy variable taking the value one if the respondent chooses “*a major worsening in finances*” as one of last year's major life events, and the value zero otherwise. The share of respondents doing so was 3%.

These three measures are complementary: the ‘material deprivation’ variable captures moderate levels of socio-economic deprivation; the ‘lack of prosperity’ variable approximates more extreme (or at least rarer forms of) socio-economic deprivation; and the ‘financial worsening’ variable captures rapid decreases in personal economic resources. These are all self-assessed measures of financial conditions. While this might entail measurement error due

to heterogeneity in reporting across individuals, some have argued that self-assessments are desirable in this sort of research. This is because the indirect-cognitive pathways through which economic instability affects sleep operate through subjective perceptions rather than objective conditions (Lallukka et al., 2012).

We use two measures of local economic conditions: local unemployment rates and increases in the local unemployment rate. Information on local unemployment was retrieved from official statistics published by the Australian Bureau of Statistics (ABS) and merged to the HILDA Survey data using local area identifiers. To delimit geographical areas, we use the Statistical Area Level 4 (SA4) of the 2011 Australian Standard Geographical Classification (ASGC). In Australia, there are 106 SA4s with populations in the range of 100,000 to 500,000. 87 of these have representation in Wave 13 of the HILDA Survey, with sample sizes ranging from 8 to 342. The mean size is 125, and the standard deviation is 7. We choose the SA4 level of the 2011 ASGC because it approximates the local labour market, it provides sufficient variability in local economic conditions, and it yields sufficiently large numbers of areas and respondents per area in the HILDA Survey.

*Local unemployment rates* give the percentage of individuals within the local area in which the respondent resides who are unemployed, where ‘unemployed’ refers to people without work, actively seeking work, and currently available for work. This is by far the most widespread measure of economic contraction (or the business cycle) in the literature, as it is accessible and comparable, and provides a good reflection of the economy (Dooley and Catalano, 1984). The local unemployment rates in the HILDA Survey range from 1.3 to 15.6. *Increases in the local unemployment rate* are operationalized using a variable measuring the difference in local unemployment between the month in which the respondent’s interview took place (July 2013 to February 2014) and the same month one year before (July 2012 to February 2013). This is calculated as the current minus the previous year’s rate, and ranges from -7.2 to 14.4 (though, in 97.5% of cases, the score ranges between -5 and +5).

Summary statistics on these and other model variables are presented in Table A1 in the Appendix.

## 5. Modelling and analytical strategy

Since our data has a hierarchical structure with individuals as Level 1 units (n=9,329-10,733) and local areas as Level 2 units (n=87) we fit multilevel models that account for this clustering (Goldstein, 2011). The model to be fitted can be expressed as:

$$S_{ai} = D_{ai}\beta + C_i\gamma + X_{ai}\delta + \varepsilon_{ai} + \mu_a \quad (1)$$

where the  $a$  and  $i$  subscripts denote local area and individual, respectively;  $S$  is an outcome variable measuring total weekly sleep hours;  $D$  is a variable (or set of variables) capturing individual-level economic vulnerability;  $C$  is an area-level measure (or set of measures) of local economic conditions;  $X$  is a vector of control variables; and  $\beta$ ,  $\gamma$ , and  $\delta$  are coefficients (or vectors of coefficients) to be estimated. The model has two error terms:  $\varepsilon$  is the usual stochastic error in regression, whereas  $\mu$  is a random intercept capturing unobserved effects in the local area. Additionally, the standard errors in the models are robust to the nesting of observations within households in the HILDA Survey.

The control variables in the  $X$  vector include an encompassing set of factors that, based on previous international literature, may confound the associations between sleep, economic vulnerability and local economic conditions in Australia. These include respondent's gender [male/female], age in years (and its square), partnership status [single/partnered/divorced, separated or widowed], number of children under age 5 [none/one/two/three or more], highest educational qualification [degree or higher/professional qualification/secondary school or below], employment status [full-time employee/part-time employee/self-employed worker/unemployed/full-time student], ethnic and migrant background [Non-Indigenous Australian/Indigenous Australian/Migrant from English-speaking country/Migrant from non-English-speaking country], house tenure [owned outright/mortgage/rental], and household financial year disposable regular income (in 10,000s).

To test Hypotheses 1 and 2, we estimate regression models including the control variables and different permutations of the measures of individual-level economic vulnerability and local economic conditions. In a final set of models, we include interaction terms between the individual- and area- level measures of economic conditions to address Hypothesis 3.

## 6. Empirical evidence

### 6.1 Bivariate associations

Table 1 shows the bivariate associations between variables capturing individual-level economic vulnerability, local economic conditions, and sleep quantity. Individuals who experience material deprivation sleep fewer hours than those who do not ( $\bar{x}_1=48.89$ ,  $\bar{x}_2=49.97$ ). The difference is small but, as indicated by the non-overlapping 95% confidence intervals, statistically significant ( $p(\bar{x}_1-\bar{x}_2)<0.05$ ). Similarly, individuals who report a lack of financial prosperity sleep fewer hours than those who report a prosperous financial situation ( $\bar{x}_1=46.88$ ,  $\bar{x}_2=49.70$ ,  $p(\bar{x}_1-\bar{x}_2)$ ), and individuals who experienced a worsening in financial circumstances sleep fewer hours than those who did not ( $\bar{x}_1=47.89$ ,  $\bar{x}_2=49.79$ ,  $p(\bar{x}_1-\bar{x}_2)<0.05$ ). The pairwise correlations between sleep quantity and local unemployment rates ( $r=-0.05$ ,  $p<0.001$ ) and increases in the local unemployment rate ( $r=-0.02$ ,  $p<0.05$ ) are negative and statistically significant, indicating lower sleep quantity amongst people who live in high unemployment areas or in areas with growing unemployment rates.

**Table 1.** Bivariate associations between local economic conditions, individual-level economic vulnerability, and sleep quantity

	Sleep quantity				
	Mean	95% CI	Pearson's $r$	$p$	Observations
<u>Individual-level economic vulnerability</u>					
Material deprivation					
Yes	48.89	[48.48-49.29]			2,052
No	49.97	[49.79-50.15]			7,295
Lack of prosperity					
Yes	46.88	[45.64-48.12]			258
No	49.70	[49.55-49.85]			10,501
Financial worsening					
Yes	47.89	[46.75-49.02]			292
No	49.79	[49.63-49.96]			9,101
<u>Local economic conditions</u>					
Local unemployment rate			-0.05	<0.001	10,751
Increase in local unemployment rate			-0.02	0.018	10,751

Notes: Australia. HILDA Survey, 2013. Economically active individuals age 20-70.

### 6.2 Multilevel regression models

Bivariate results are largely supportive of Hypotheses 1 and 2, though effect sizes are sometimes small. However, the magnitude, sign and statistical significance of these associations is only tentative. Gathering more robust evidence requires multivariate analyses

that control for factors (such as age, employment status, education, income or disability) which, if unaccounted, may give rise to spurious relationships or suppress true relationships between the variables of interest. To accomplish this we use random-intercept, multilevel regression models of sleep quantity which control for a comprehensive set of potential confounders as well as unobserved local-area traits. Results from these models are presented in Table 2.

Models 1 and 2 estimate the effects of local unemployment rates and increases in local unemployment rates on sleep quantity separately. A percentage-point increase in the unemployment rate in the local area in which an individual resides is associated with a decrease in weekly sleep hours of about 10 minutes (Model 1,  $\beta=-0.163$ ,  $p<0.001$ ). Each percentage-point increase in the local unemployment rate is associated with a decrease in weekly sleep hours of about 5 minutes (Model 2,  $\beta=-0.085$ ,  $p<0.1$ ). When placed in the same regression model (Model 3), the estimated coefficient on the local unemployment rate remains largely unchanged ( $\beta=-0.168$ ,  $p<0.01$ ), but the coefficient on increases in the local unemployment rate loses magnitude and statistical significance ( $\beta=0.009$ ,  $p>0.1$ ). This is unsurprising, as the two variables are highly correlated ( $r=0.57$ ,  $p<0.001$ ), and suggests that sleep quantity is more responsive to current economic conditions than to recent changes in those conditions.

Models 4 to 6 examine the relationships between individual-level economic vulnerability and sleep quantity, using one measure at a time. Results indicate that material deprivation (Model 4,  $\beta=-1.217$ ,  $p<0.001$ ), lack of financial prosperity (Model 5,  $\beta=-2.305$ ,  $p<0.001$ ), and financial worsening (Model 6,  $\beta=-1.536$ ,  $p<0.01$ ) all reduce the number of weekly sleep hours; by about 73, 138 and 92 minutes, respectively. When considered jointly in Model 7, material deprivation ( $\beta=-0.989$ ,  $p<0.001$ ) and lack of financial prosperity ( $\beta=-1.698$ ,  $p<0.001$ ) retain relatively large, negative and statistically significant effects on sleep quantity, whereas the coefficient on financial worsening is no longer statistically significant ( $\beta=-0.751$ ,  $p>0.1$ ). This suggests that sleep quantity is more responsive to current experience of material or financial deprivation than to a recent worsening in economic circumstances.

Perhaps surprisingly, household income had no statistically significant, independent effect on sleep quantity in the models. This is nevertheless consistent with arguments stressing the importance of probing beyond income when examining health-related quality of life (Butterworth et al., 2009). The coefficients on the control variables were largely consistent with expectations.

**Table 2.** Random-intercept multilevel regression models of weekly sleep quantity

	1	2	3	4	5	6	7
<u>Local economic conditions</u>							
Local unemployment rate	-0.163***		-0.168**	-0.175***	-0.162***	-0.176***	-0.174***
Increase in local unemployment rate		-0.085(*)	0.009				
<u>Individual-level economic vulnerability</u>							
Material deprivation				-1.217***			-0.989***
Lack of prosperity					-2.305***		-1.698*
Financial worsening						-1.536**	-0.751
Household income (in 10,000s)	-0.004	-0.001	-0.005	-0.018	-0.007	-0.010	-0.020
<u>Controls</u>							
Female	0.600***	0.599***	0.600***	0.714***	0.583***	0.682***	0.692***
Age	-0.332***	-0.332***	-0.332***	-0.353***	-0.317***	-0.352***	-0.341***
Age squared	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***
Number of children below age 5							
None ( <i>reference category</i> )							
One	-1.678***	-1.677***	-1.679***	-1.713***	-1.695***	-1.730***	-1.737***
Two	-3.717***	-3.710***	-3.718***	-3.853***	-3.725***	-3.822***	-3.843***
Three or more	-3.901**	-3.887**	-3.904**	-4.146**	-3.908**	-4.163**	-4.157**
Partnership status							
Single ( <i>reference category</i> )							
Partnered	0.503*	0.478*	0.505*	0.510*	0.469(*)	0.474(*)	0.490(*)
Divorced, separated or widowed	-1.399***	-1.419***	-1.397***	-1.436***	-1.377***	-1.473***	-1.409***
Education							
High ( <i>reference category</i> )							
Medium	-0.488**	-0.522**	-0.487**	-0.323(*)	-0.467**	-0.410*	-0.326(*)
Low	-1.220***	-1.267***	-1.217***	-1.172***	-1.201***	-1.338***	-1.191***
Employment status							
Employed full-time ( <i>reference category</i> )							
Employed part-time	0.812***	0.817***	0.813***	1.012***	0.845***	0.956***	1.051***
Unemployed	0.989*	0.942*	0.992*	0.921(*)	1.219*	0.742	1.190*
Self-employed	0.838***	0.842***	0.837***	1.008***	0.850***	0.938***	1.014***

Full-time student	1.103**	1.115**	1.104**	1.366***	1.185**	1.133**	1.416***
Ethnic and migrant background							
Australian, non-Indigenous ( <i>reference category</i> )							
Indigenous Australian	0.186	0.145	0.189	0.516	0.192	0.089	0.456
Migrant from English-speaking country	-0.261	-0.229	-0.262	-0.192	-0.269	-0.245	-0.207
Migrant from Non-English-speaking country	-0.362	-0.396	-0.363	-0.251	-0.357	-0.189	-0.225
Chronic health condition	-1.064***	-1.067***	-1.064***	-0.965***	-1.022***	-0.975***	-0.933***
Housing tenure							
Owns outright ( <i>reference category</i> )							
Mortgage	-0.073	-0.086	-0.071	0.033	-0.065	-0.062	0.026
Rental	-0.512*	-0.513*	-0.513*	-0.192	-0.473*	-0.359	-0.159
N (individuals)	10,733	10,733	10,733	9,329	10,733	9,375	9,305
N (local areas)	87	87	87	87	87	87	87
R <sup>2</sup>	0.046	0.045	0.046	0.054	0.048	0.050	0.055

Notes: Australia. HILDA Survey, 2013. Y=Total number of weekly sleep hours. Economically active individuals age 20-70. Model coefficients. Standard errors adjusted to account for clustering within households. Significance levels, two-tailed tests: (\*) p<0.1, \* p<0.5, \*\* p<0.01, \*\*\* p<0.001.

Altogether, results from our multivariate, multilevel regression models support Hypotheses 1 and 2: controlling for a large set of potential confounders and allowing for area-level unobserved effects, both local economic conditions and individual-level economic vulnerability are associated with lower sleep quantity. Individual-level economic vulnerability has stronger negative effects on sleep than poor local economic conditions, and current experience of deprivation and exposure to poor local economic conditions are more detrimental than a recent worsening in circumstances.

### 6.3 Multilevel regression models, cross-level interactions

Hypothesis 3 posed that local economic conditions should have a stronger negative effect on the sleep quantity of economically vulnerable individuals. To test this, we estimate models which include cross-level interactions between the variables capturing individual-level economic vulnerability and local economic conditions.

In Models 7 to 9 in Table 3, we interact the variable capturing local unemployment rates with each of the three economic vulnerability measures, one at a turn. The coefficients on the interaction terms in Model 8 ( $\beta=-0.314$ ,  $p<0.01$ ), Model 9 ( $\beta=-0.712$ ,  $p<0.05$ ), and Model 10 ( $\beta=-0.634$ ,  $p<0.05$ ) are all negative and statistically significant, which indicates that interactive effects exist. To aid their interpretation, these are represented visually in Figure 2. In all three graphs, local unemployment rates have little to no effect on sleep quantity amongst individuals who do not experience either form of economic vulnerability (blue lines). However, for individuals who experience any of the three forms of hardship (red lines) the pattern is striking: local unemployment rates have a large negative effect on sleep quantity. For example, a person experiencing material deprivation (left graph) in a local area with a 2% unemployment rate would sleep 50 hours per week. That is as much as an otherwise similar person not experiencing material deprivation. However, a person experiencing material deprivation in a local area with a 14% unemployment rate would sleep 45 hours per week. This is a 5-hour difference in weekly sleep hours with respect to both non-deprived individuals in either sort of area and deprived individuals in low unemployment areas. The analogous statistics are even more shocking for lack of prosperity (middle graph) and financial worsening (right graph), of 10 and 9 hours respectively. These results demonstrate that the previous results masked substantial heterogeneity in the effects of local economic conditions on sleep across economically vulnerable and more affluent individuals.

It could be argued that the local unemployment rate may be capturing other unobserved local area factors affecting sleep (such as population density, noise or pollution), rather than financial stress. This argument is more difficult to maintain for increases in the local unemployment rate. Thus, in Models 10 to 12 in Table 3 we interact the individual-level economic vulnerability variables with the variable capturing *increases* in the local unemployment rate, controlling for the actual local unemployment rate. The coefficients on the interaction terms in Model 11 ( $\beta=-0.290$ ,  $p<0.01$ ) and Model 13 ( $\beta=-0.652$ ,  $p<0.05$ ) are relatively large, negative and statistically significant, whereas that in Model 12 ( $\beta=-0.395$ ,  $p=0.18$ ) is negative and seemingly large, but not statistically significant. We attribute this to the model being overly demanding, given the small number of individuals who report a lack of financial prosperity. The interaction effects have been plotted in Figure 3 for ease of interpretation. Though the magnitude of the associations is not as impressive as in Figure 2, the pattern is nonetheless marked and highly consistent: (i) the sleep quantity of individuals who are not economically vulnerable is unaffected by increases in the local unemployment rate, (ii) in areas with decreasing unemployment, the sleep quantity of economically vulnerable individuals is not statistically different than that of more affluent individuals, and (iii) the sleep quantity of economically vulnerable individuals decreases markedly with increases in the local unemployment rate. Overall, these results are consistent with Hypothesis

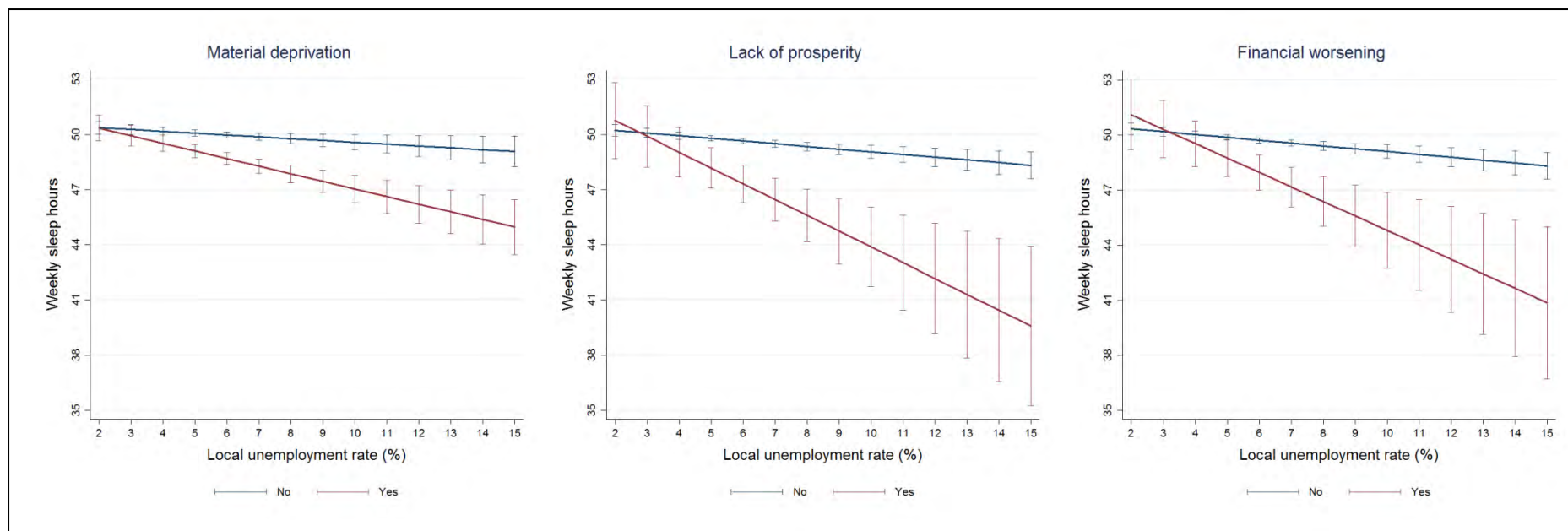
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**Table 3.** Random-intercept multilevel regression models of weekly sleep quantity with cross-level interactions

	8	9	10	11	12	13
<u>Main effects</u>						
Local unemployment rate	-0.099(*)	-0.146**	-0.155***	-0.153**	-0.170**	-0.158**
Increase in local unemployment rate				0.032	0.021	-0.010
Material deprivation	0.602			-1.107***		
Lack of prosperity		1.950			-2.114***	
Financial worsening			2.041			-1.383*
<u>Cross-level interactions</u>						
Local unemployment rate * Material deprivation	-0.314**					
Local unemployment rate * Lack of prosperity		-0.712*				
Local unemployment rate * Financial worsening			-0.634*			
Change in local unemployment rate * Material deprivation				-0.290**		
Change in local unemployment rate * Lack of prosperity					-0.395	
Change in local unemployment rate * Financial worsening						-0.652*
<u>Controls</u>						
	Yes	Yes	Yes	Yes	Yes	Yes
N (individuals)	9,329	10,733	9,375	9,329	10,733	9,375
N (local areas)	87	87	87	87	87	87
R <sup>2</sup>	0.055	0.049	0.051	0.055	0.048	0.051

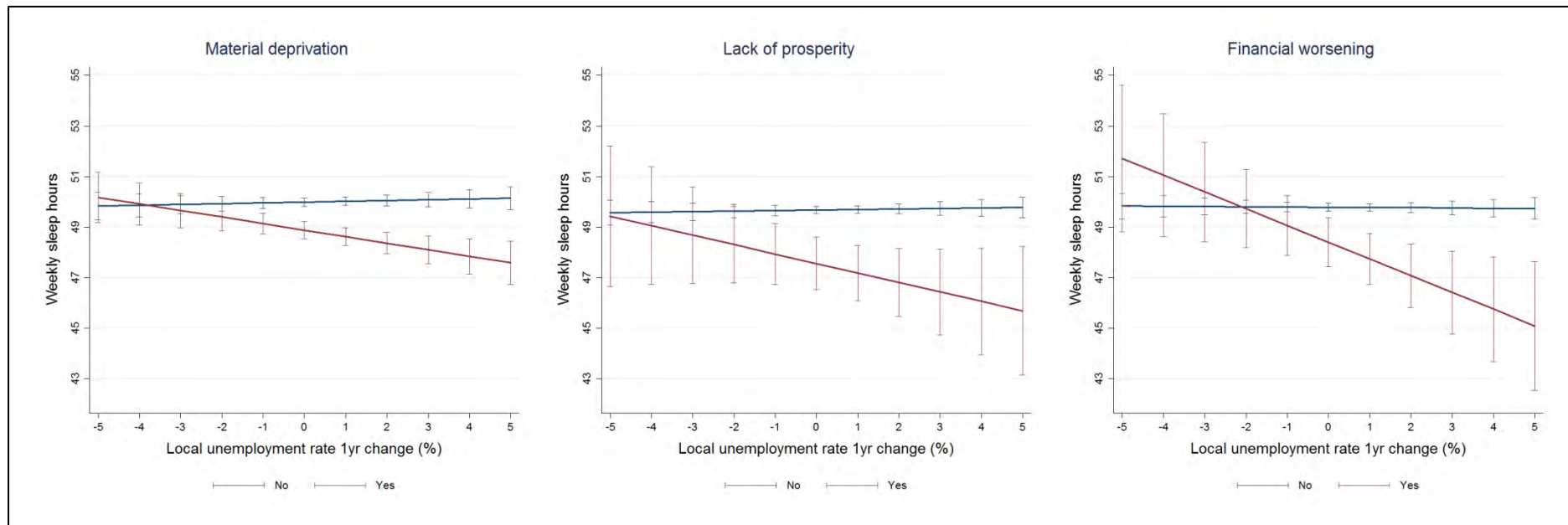
Notes: Australia. HILDA Survey, 2013. Economically active individuals age 20-70. Y=Total number of weekly sleep hours. Controls as in Table 1. Model coefficients. Standard errors adjusted to account for clustering within households. Significance levels, two-tailed tests: (\*) p<0.1, \* p<0.5, \*\* p<0.01, \*\*\* p<0.001.

**Figure 2.** Interactions between local unemployment rate and measures of economic vulnerability



Notes: Australia. HILDA Survey, 2013. Economically active individuals age 20-70. Based on Models 8 to 10 in Table 2. Vertical bars denote two-tailed 90% confidence intervals.

**Figure 3.** Interactions between increase in local unemployment rate and measures of economic vulnerability



Notes: Australia. HILDA Survey, 2013. Economically active individuals age 20-70. Based on Models 11 to 13 in Table 3. Vertical bars denote two-tailed 90% confidence intervals.

## 7. Conclusion and discussion

In this paper we have examined the intersections between individual-level economic vulnerability, local economic conditions and individuals' sleep quantity, using multilevel regression models and nationally representative Australian survey data.

Key results are consistent with each of our three research hypotheses and indicate that, *ceteris paribus* (i) economically vulnerable individuals sleep less than more affluent individuals, (ii) individuals who live in high unemployment areas sleep slightly less than individuals who live in other areas, (iii) current individual- and local-level economic circumstances affect sleep quantity more than a worsening in such circumstances, and (iv) the sleep quantity of individuals who are economically vulnerable is much more sensitive to poor or worsening local economic conditions.

Experiencing material deprivation, financial lack of prosperity, and financial worsening were associated with decreases in weekly sleep quantity of 73, 138 and 92 minutes, respectively. These effect sizes are reasonably large when compared to reductions associated with having one child under the age of 5 in the household relative to having none (about 100 minutes), having school-level rather than degree-level qualifications (73 minutes), or having a chronic health condition (63 minutes). It must also be borne in mind that the effects of these economic vulnerability indicators is net of traditional measures of SES, including employment, education, and income. Amongst the latter, it was interesting that income was never an important or even statistically significant predictor of weekly sleep quantity. The magnitude of the average effects for local economic conditions was modest, with each percentage-point difference in local unemployment and increases in local unemployment being associated with decreases of 10 and 5 minutes in weekly sleep quantity, respectively.

However, the models with interactions between individual- and local-level economic circumstances painted a less rosy picture for people who experience economic vulnerability. For those experiencing material deprivation, financial lack of prosperity, and financial worsening each percentage-point increase in local unemployment brought about decreases of 25, 51 and 47 minutes in weekly sleep time, respectively. Given that the minimum amount of healthy sleep for adults is 49 hours per week, as per the newly revised US National Sleep Foundation recommendations (Hirshkowitz et al. 2105), our results indicate that economically deprived individuals fall below recommended sleep levels when local unemployment is higher than 4-5%.

These findings have important implications. Since poor sleep is associated with health issues and low productivity at work, disproportionate reductions in sleep quantity through financial anxiety amongst individuals who are already disadvantaged may lead to the reproduction of inequality. This is consistent with claims that inappropriate sleep might be partially responsible for established associations between SES and health (Moore et al., 2002) and neighborhood disadvantage and health (Hale et al., 2013). Our findings also hint that it is important for policymakers to devise interventions to manage the financial stress experienced by individuals in disadvantaged areas or areas experiencing economic recession as a means to enhance population health. They also suggest that policies aimed at improving local economic conditions *per se* will not only result in higher employment rates or reduced income-support reliance, but also have indirect effects on individuals' quality of life through increasing sleep quantity. Since disadvantaged people's sleep is more affected by economic contraction, failure to do so may result in the exacerbation of existing health inequalities.

This study is nevertheless not without shortcomings. First, as most previous research on the social determinants of sleep using large national samples, our analyses rely on cross-sectional data. Hence, the reported results need to be interpreted with caution and taken as associations rather than effects. New research using longitudinal methods would enable closer estimation of *causal* relationships and examination of over-time sleep loss, instead of contemporary sleep quantity. This would naturally require the availability of suitable panel data. Second, time-use reports from survey data may not be as accurate as time-use reports from time-diary data (Wolfson et al., 2003). Hence, there may be measurement error due to poor recall in sleep quantity reports. Third, we use general measures of the local unemployment rate. It is however possible that people's financial anxiety is less sensitive to the economic performance of spatially proximate others, and more sensitive to the economic performance of individuals with similar traits. If this was the case, then gender-, occupation- or industry-specific unemployment rates might be more strongly associated with sleep than overall local unemployment rates. Fourth, the channels through which economic contraction affects sleep remain opaque in our analyses. The observed effects might be driven by the financial stress produced by job losses, increased anxiety and distress amongst employed individuals who increasingly fear for their jobs, or cumulative stress amongst the employed due to increased workloads, reduced ability to choose 'good' jobs, and decreased job autonomy following from task restructuring after redundancies (Goldman-Mellor et al., 2010, Fryer, 2013). Social contagion and group solidarity effects may also be at play: in times of economic contraction

people are likely to empathize with the situation of significant others who may have lost their jobs or be likely to. More research on these issues is warranted.

To conclude, our research stresses the importance of conceptualizing sleep as a social issue and highlights the critical role of socio-economic circumstances and cultural norms (Henry et al., 2013). Future research could move beyond our findings by focusing on countries which have experienced a more marked period of economic recession than Australia (such as Spain or Greece) or by examining the specific social and psycho-biological mechanisms driving the observed associations between macro-economic conditions, individual-level economic vulnerability and sleep.

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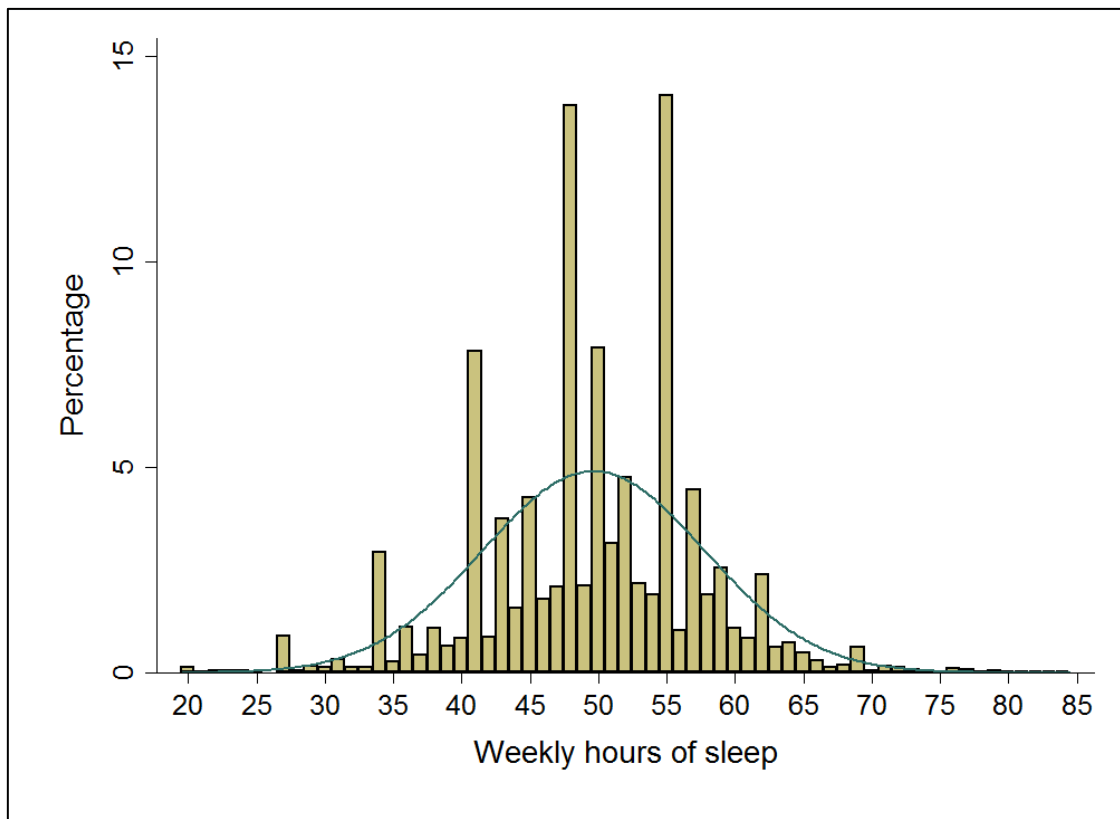
## 9. Appendix

**Table A1.** Means and standard deviations for model variables

	Mean	SD	Min.	Max.
<u>Outcome variable</u>				
Weekly hours of sleep	49.63	8.13	20	84
<u>Local economic conditions</u>				
Local unemployment rate	5.69	1.98	1.3	15.6
Increase in local unemployment rate	0.42	2.04	-7.2	14.4
<u>Individual-level economic vulnerability</u>				
Material deprivation	0.22		0	1
Lack of prosperity	0.02		0	1
Financial worsening	0.03		0	1
Household income (in 10,000s)	10.53	6.88	0	171
<u>Controls</u>				
Female	0.48		0	1
Age	40.37	13.09	20	70
Number of children below age 5				
None	0.85		0	1
One	0.11		0	1
Two	0.04		0	1
Three or more	<0.01		0	1
Partnership status				
Single	0.21		0	1
Partnered	0.70		0	1
Divorced, separated or widowed	0.09		0	1
Education				
High	0.31		0	1
Medium	0.36		0	1
Low	0.17		0	1
Employment status				
Employed full-time	0.58		0	1
Employed part-time	0.18		0	1
Unemployed	0.05		0	1
Self-employed	0.14		0	1
Full-time student	0.05		0	1
Ethnic and migrant background				
Australian, non-Indigenous	0.76		0	1
Indigenous Australian	0.02		0	1
Migrant from English-speaking country	0.09		0	1
Migrant from Non-English-speaking country	0.12		0	1
Chronic health condition	0.20		0	1
Housing tenure				
Owns outright	0.27		0	1
Mortgage	0.41		0	1
Rental	0.32		0	1

Notes: Australia. HILDA Survey, 2013. Economically active individuals age 20-70.

**Figure A1.** Histogram of total weekly hours of sleep



Notes: Australia. HILDA Survey, 2013. Economically active individuals age 20-70.