

Labour Market Effects of Bushfires and Floods in Australia: A Gendered Perspective*

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We study the labour market effects of bushfires and floods within Australia over the past two decades, focusing on gender as a determinant of vulnerability. Whilst floods unambiguously increased the labour supply of both genders (creating around 13,500 jobs per year), the likelihood of female employment is particularly vulnerable to bushfires, falling by 1.6 percentage points (or around 5,000 jobs per year). This effect is partially explained by industry sector, with bushfires lifting overall male employment through industries including mining and transport, while reducing more female-dominated services sector participation. We also examine intra-household dynamics, finding strong evidence for an ‘added worker’ effect.

1 Introduction

Climate change has been named one of the biggest threats of the twenty-first century (Costello *et al.*, 2009) and is predicted to increase the frequency and severity of natural disasters. Each year natural disasters cost Australia an average of

\$38 billion (Deloitte Access Economics, 2021)¹ and impact around 20,000 individuals.² As well as the costly direct effects of natural disasters, including property destruction and adverse health impacts, bushfires and floods also represent one of the most frequent and severe sources of exogenous shock for regional labour markets.

Natural disasters can generate adverse effects for local economies through: reducing firm productivity by destroying productive capital or disrupting supply chains; demolishing part of the housing stock; and dampening consumer spending as individuals save for reconstruction (Boustan *et al.*, 2020). While these effects are generally more pronounced within developing contexts where social security systems remain underdeveloped (Belasen & Polachek, 2009; Kirchberger, 2017), large effects of natural disasters on employment have also been well documented within advanced country settings, including Australia (Groen & Polivka, 2010; Ladds *et al.*, 2017; Groen *et al.*, 2020).

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¹ <http://australianbusinessroundtable.com.au/our-research>.

² According to the EM-DAT global database on natural disasters: <https://www.emdat.be/>.

This paper seeks to systematically examine the effects of nearly two decades of bushfires and floods on individual labour market outcomes within Australia. In contrast to many existing studies which have commonly examined the effects of natural disasters at the state or national level (Ladds *et al.*, 2017; Ulubaşoğlu *et al.*, 2019),³ our paper explores the labour market effects of these events at a finer level of geographic detail. We exploit exogenous variation in the timing and Statistical Area Level 4 (SA4-level) location of disaster occurrence to study the effects of bushfires and floods on a range of individual labour market outcomes. Our study also incorporates a broader range of outcome measures, including both the intensive and extensive margins of employment participation and individual earnings. This allows us to provide a more nuanced analysis of the mechanisms through which natural disasters impact local labour markets.

Importantly, we are also able to assess the importance of gender as a determinant of individual labour market vulnerability following bushfires and floods. It is well documented by the international literature that women face greater economic vulnerability, including reduced levels of labour force participation, in the aftermath of natural disasters (Enarson, 2000; Hazeleger, 2013). While gendered labour market vulnerability is typically more pronounced in developing country settings, women continue to face labour market disadvantage in many developed countries. Within Australia, women have lower levels of labour force participation and are more likely to be employed in casual jobs where it may be easier for employers to reduce hours or to cut jobs in the wake of a bushfire or flood (Pennington & Stanford, 2020). While gendered disadvantage in the Australian labour market has been well studied (Cassells *et al.*, 2009; Borland & Coelli, 2016), there remains a shortage of Australian studies examining the gendered effects of natural disasters. Through explicitly including a gendered focus, our study contributes critical evidence on the gendered burden of climate change.

Our paper also considers several mechanisms through which bushfires and floods may generate

gendered consequences in regional labour markets. Firstly, we research whether different gendered responses to natural disaster might reflect the sectoral nature of these events. We expect that demand for reconstruction services will stimulate employment and wages growth in typically male-dominated industries such as construction and engineering. In contrast, we expect job losses and reductions in hours worked to be more pronounced in sectors vulnerable to reduced discretionary spending such as hospitality and tourism where females generally account for a greater share of labour supply (Dolfman *et al.*, 2007; Belasen & Polachek, 2008).

Secondly, we examine the role of intrahousehold dynamics among mixed-sex couples in explaining the labour market effects of bushfires and floods. Natural disasters may temporarily increase domestic work, including filing insurance claims, rebuilding or relocating, and providing care to dependent children or relatives suffering from injury. Within coupled households, this may be associated with the primary carer temporarily reducing their labour force participation to take on these duties. A competing hypothesis is an 'added worker' effect, whereby household members may temporarily increase their labour supply in the event that the household head loses their job. This 'added worker' response acts as a form of spousal earnings insurance, enabling the smoothing of intertemporal household income and consumption. Given that women are more likely to have lower levels of labour force participation (compared to men) prior to disaster exposure, we expect any 'added worker' effect to be most pronounced for the female labour supply reflecting a greater capacity to respond.

To identify the occurrence of bushfires and floods, we use data from the Australian Institute for Disaster Resilience (AIDR) Emergency Management Hub, which provides coverage of each natural disaster within Australia going back to the nineteenth century. Using information on disaster type, date of occurrence, and suburb-level location, we map two decades of bushfires and floods to SA4 level using geographic concordances provided by the Australian Bureau of Statistics (ABS). We then merge our disaster exposure variables with individual-level data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey, which is an ongoing nationally representative longitudinal study of Australian households. We use detailed

³ An important exception is a recent paper by Johar *et al.* (2020), which examined the consequences of property damage due to natural disasters using individual-level longitudinal data.

demographic information, as well as labour force and earnings outcomes, for financial years from 2002 to 2019.

We define individuals as being impacted by a disaster event if they report residing in a disaster-affected SA4 region at the time of bushfire or flood occurrence and remain in this region in consecutive survey years. We compare these individuals to a national cohort who do not experience a natural disaster over our study window.⁴

Our baseline specification uses a two-way fixed-effects model to estimate the causal effects of bushfires and floods, controlling for covariates using fixed effects for individual, SA4 region, year and an individual's age, as well as linear state-time trends. We use a dummy variable for bushfire or flood exposure, and also incorporate the one- and two-year lags of these variables,⁵ and cluster our robust standard errors at SA4 level.

We find that bushfires and floods have different effects on Australian labour markets, highlighting the need for policy-makers to adapt policy to each disaster type. We estimate that floods unambiguously raise the labour supply for both men and women, including the likelihood of employment by 1.3 percentage points (ppts) and by 1.8 ppts at one-year lag. In contrast, bushfires reduce the likelihood of female employment by 1.6 ppts while generating a lagged increase in the likelihood of male employment (1.8 ppts at one-year lag and 1.6 ppts at two-year lag). A possible explanation for the contrasting effects of bushfires and floods is that floods tend to occur in areas with relatively higher population density. This may mean that floods are more likely to have a creative destruction effect with greater stimulatory spending on rebuilding and recovery.

To interpret our results in terms of their relative economic magnitude, we apply our statistically significant average treatment effects to regional

labour market data provided by the ABS.⁶ Over the period of our analysis, we find that floods lead to the creation of an average 13,498 jobs per year, equivalent to an additional 20 million hours or \$1.7 billion in additional gross domestic product (GDP). Floods also boosted labour force participation by 1.1 ppts (1.5 ppts after a one-year lag), an additional 11,321 individuals per year. Meanwhile, in an average year, bushfires boosted male employment by 9,873 jobs or around 16.5 million hours (\$1.3 billion in additional GDP) while reducing female employment by 4,780 jobs or 6 million hours (\$495 million of forgone GDP).

We find some evidence for differences in the effects of bushfires and floods across economic sectors, with fires raising the relative likelihood of employment in mining (by 6.4 ppts) and transport (6.0 ppts), which tend to be more male-dominated. Bushfires did not have a significant impact on the relative likelihood of employment in industries with a higher female composition, but generated lagged reductions at the intensive margin of employment, lowering relative average hours worked in trade (by 8.5%), banking and insurance (8.0%), and services (6.8%). Taken together, these results are consistent with a sectoral reallocation of labour supply towards more male-dominated industries, while labour supplied to more female-dominated industries contracts along the intensive margin. This goes some way towards explaining the relatively greater labour market vulnerability of women following bushfires. We also find that bushfires reduced average hours worked in transport (by 12.2%) and construction (5.9%), although this may be consistent with an expansion of the labour supply at the extensive margin in these sectors.

Floods were found to increase relative employment levels in the services sector (by 5.5 ppts) and raise average hours worked in mining (9.0%) and manufacturing (8.6%). In contrast, floods lowered relative employment levels in the transport sector by 9.8 ppts, with this normalising after a one-year lag. These effects of floods are quite different from those of bushfires, particularly with respect to the services sector. A possible reason for this is a higher population density in flood-prone areas, compared to the more sparsely populated areas that experience bushfires. A

⁴ In our robustness checks, we relax the requirement that an individual must remain residing within a disaster-affected SA4 region in consecutive survey years, and find similar effects.

⁵ In our robustness section, we replace our binary disaster variable with a severity-weighted measure of disaster occurrence and show that our results remain robust.

⁶ In our analysis, we assume that employment occurs at average hours for that state, gender and year, and average total levels of labour productivity.

greater population density may lead to increased demand for the services sector, such as insurance, temporary accommodation, or public administration and safety in the aftermath of a flood, which may in turn support increased employment in these industries. In contrast, demand for these services may remain relatively dampened following bushfires. This may also explain why we observe an increase in female labour force participation following a flood (with much of this likely to be driven by the services sector) while female employment declines following a bushfire.

Turning to intrahousehold dynamics among mixed-sex couples, we find no evidence that natural disasters increased female housework. We do, however, find evidence in support of an ‘added worker effect’, with this being strongest for women. Among females whose partner had lost their job in the aftermath of a bushfire, we find a relative increase in the likelihood of labour force participation (by 3.6 ppts), employment (3.6 ppts), and average hours worked (23.4%). Meanwhile for men, partner job loss following a bushfire was associated with relative increases in their likelihood of employment (2.5 ppts), and lagged relative increases in both the likelihood of participation (2.3 ppts) and average working hours (6.6%). The ‘added worker’ effect was less pronounced following a flood, perhaps reflecting a lower number of individuals whose partner experienced job loss. However, partner job loss was associated with increased participation at the intensive margin, with relative average hours increased by 7.5% (13.3% for women).

Our results contribute important evidence on the labour market effects of bushfires and floods within Australia, and expand on existing literature through incorporating a wider range of indicators and estimating these effects at a finer level of geographic precision. Our paper also contributes an important perspective on the gendered burden of climate change, a topic which has critical relevance for policy-makers but which has thus far been neglected within Australia. The aim of our paper is not to comprehensively estimate gendered vulnerability to natural disasters, but to shed light on the relative labour market vulnerability experienced by men and women in the aftermath of these events. Finally, our paper provides new evidence into the mechanisms through which these effects of bushfires and floods are transmitted to the labour market. We highlight the sectoral nature of these effects and find evidence that mixed-sex couples may

respond to natural disasters by temporarily increasing their labour supply in the event that one breadwinner loses their employment.

Our paper is organised as follows. In Section II we briefly review the existing literature as it relates to our present study. Section III then provides an overview of our data sources, Section IV outlines the methods used, and Section V provides our results and a discussion. We present our robustness checks in Section VI, and Section VII concludes our paper with possible directions for future research.

II Background

There is no dearth of papers which have documented the economic shocks generated by natural disasters, including dampened consumer spending, increased demand for reconstruction services following property damage, and lowered levels of productivity due to the destruction of productive capital and the disruption of supply chains (Botzen *et al.*, 2019; Boustan *et al.*, 2020).

Many of these papers have been conducted at the macroeconomic level using cross-country panel regressions to study the effects of temperature, rainfall and increased disaster exposure on a single indicator such as GDP or the unemployment rate (Dell *et al.*, 2012; Cavallo *et al.*, 2013; Hsiang & Jina, 2014). These papers offer conflicting evidence on the effects of natural disasters, with results ranging from long-lasting effects on national incomes to near-immediate recovery (Botzen *et al.*, 2019). In contrast to these studies, our paper analyses the effects of many disaster events within a single country (Australia), which allows us to exploit heterogeneity in the timing and location of natural disasters while holding core institutional features of the economy constant.

A common feature of these cross-country studies is the use of large geographic regions as a unit of analysis. Existing studies within Australia have generally been no exception, with most conducted at the national or state level (Ladds *et al.*, 2017; Ulubaşoğlu *et al.*, 2019). In one such recent paper, Ulubaşoğlu *et al.* (2019) investigated the effects of bushfires and floods on sectoral economic output using state-level variation in disaster occurrence. They found that bushfires did not have a significant effect on sectoral gross value added; however, floods lowered output in agriculture, mining, construction and financial services. In contrast to these papers, our present study uses individuals as a

unit of analysis to study the effect of natural disasters at the regional (SA4) level. This approach allows us to identify more accurately the local area effects of disaster exposure, and to provide a more nuanced analysis of the mechanisms through which these effects are transmitted in local labour markets.

Recently, a significant international literature has sought to estimate the individual-level effects of large-scale single disaster events. These studies have often taken the form of event studies of specific events, in terms of their effects on existing residents (Deryugina, 2017; Deryugina *et al.*, 2018; Groen *et al.*, 2020). One of the most studied disaster events was Hurricane Katrina in 2005 (Gallagher & Hartley, 2017; Deryugina *et al.*, 2018; Deryugina & Molitor, 2018; Groen *et al.*, 2020; Franklin & Labonne, 2019). While it is important to study these major events, most disasters are not as severe as these outliers, and findings from these events may overstate the average effect of a bushfire or flood. Our data allow us to study all occurrences of bushfires and floods within Australia over the past two decades, and to interpret our results in terms of the average effects of natural disasters within a given year.

A large number of studies have also focused on the labour market as an important vehicle for the transmission of natural disasters to the real economy, including floods (Xiao, 2011; Xiao & Feser, 2014), tornadoes (Ewing *et al.*, 2003, 2009), wildfires (Davis *et al.*, 2014; Nielsen-Pincus *et al.*, 2014) and hurricanes (Belasen & Polachek, 2009; Deryugina *et al.*, 2018). Of these labour market studies, our paper is most comparable in approach to those existing studies which have been conducted at the individual level. For example, Franklin and Labonne (2019) studied the occurrence of typhoons using individual panel data from the Philippines and found that workers experienced reductions in hours worked and hourly wages, but no significant effect on layoffs. Kirchberger (2017) used an instrumental variables approach to estimate the labour market effects of earthquakes in Indonesia and provided evidence that agricultural wages rose following an earthquake as labour supply substituted into construction, thus raising the marginal product of labour in the agricultural sector. In the United States following Hurricane Katrina, Belasen and Polachek (2009) report findings that worker earnings in affected counties increase more rapidly while employment growth occurs more slowly than in neighbouring unaffected counties.

To our knowledge, within Australia, Johar *et al.* (2020) is the sole attempt to focus a study on the economic effects of natural disasters at the individual level. They quantified the effects of property damage due to natural disasters on a range of individual economic and health outcomes, finding that residential destruction on average has no impact on overall employment status or household income, but increases financial hardship and risk aversion. However, their analysis did not extend to considering the labour market effects of bushfires and floods for residents of the affected region, which is the focus of our present study.

Of the existing individual-level studies, including the paper by Johar *et al.* (2020), few have explored in detail the gendered nature of these effects. Nonetheless, the international literature provides clear evidence that women are often exposed to greater economic vulnerability following disaster occurrence, with many studies highlighting the reduced levels of female participation in the labour market (Enarson, 2000; Hazeleger, 2013). While gendered labour market vulnerability is typically more pronounced in developing country settings, women continue to face labour market disadvantage in developed countries (Borland & Coelli, 2016). Within Australia, women have lower levels of labour force participation and are more likely to be employed in casual jobs where it may be easier for employers to reduce hours or to cut jobs in the wake of a bushfire or flood (Enarson, 2000; Pennington & Stanford, 2020).

In seeking to explain varied labour market responses to natural disasters, many studies have focused on sector of employment. Typically, these studies have found that most post-disaster employment growth occurs in male-dominated industries such as construction and engineering, while job losses occur elsewhere (Dolfman *et al.*, 2007; Belasen & Polachek, 2008). Dampened discretionary consumer spending as households save for reconstruction often means that job losses and reductions in working hours are most pronounced in sectors such as hospitality and tourism, where women generally account for a greater share of the labour supply (Dolfman *et al.*, 2007; Belasen & Polachek, 2008). While the sectoral nature of bushfires and floods has been studied in Australia, Ulubaşoğlu *et al.* (2019) use gross value added as their dependent measure which conflates both labour and capital market effects, meaning that this may

not directly link to the economic well-being of households in disaster-affected regions.

Intrahousehold dynamics among mixed-sex couples may also partly explain the labour market effects of natural disasters. Natural disasters may temporarily increase domestic work, including filing insurance claims, rebuilding or relocating, and providing care to dependent children or relatives suffering from injury. Within couples, this may be associated with the primary carer taking time temporarily out of the labour force to take on these duties. Existing gender norms theory provides weight to this effect, and shows that such reductions in labour force participation are more likely to affect women (Zamarro & Prados, 2021).

A competing hypothesis is that other household members may temporarily increase their labour force participation in response to job loss by the primary breadwinner. This 'added worker' response is a transitory way of smoothing intertemporal income and consumption or hedging against increased uncertainty, consistent with family utility maximisation (Mincer, 1962, 1966; Ashenfelter, 1980; Killingsworth & Heckman, 1986). Within Australia, Gong (2011) studied the 'added worker' effect and found strong evidence that married women increased their rates of full-time employment and their working hours following involuntary job loss by their partner. More recent work on 'added worker' effects suggests that household wealth dynamics are another important determinant of female labour participation (García-Pérez & Rendon, 2020).

Our paper contributes to this literature by estimating the regional labour market effects of bushfires and floods within Australia, using individual-level data over nearly two decades of disaster occurrence. Importantly, we separately identify these effects for men and women, thereby providing important evidence on the gendered burden of climate change. We also shed light on potential mechanisms which may explain the relative differences in labour market vulnerability faced by men and women, including the roles of industry composition and intrahousehold dynamics.

III Data

(i) Natural Disaster Data

We use data on natural disasters from the AIDR Emergency Management Knowledge Hub, which provides the most extensive historical accounts of

disaster events for Australia.⁷ These data cover each disaster beginning from the nineteenth century, including the type of disaster, date of occurrence, and a suburb-level event description. We compile this information at the suburb level for disasters occurring within Australia between 2002 and 2019 (financial years) before mapping to SA4 regions based on geographic concordances from the ABS. We choose to examine these effects at SA4 level as these regions are constructed to reflect the greatest degree of interconnectivity between labour supply and demand.⁸

We observe sufficiently large variation in the timing and location of disaster occurrence at the SA4 level to exploit the exogeneity of disaster occurrence to infer the average causal effects of bushfires and floods on individual labour market outcomes.⁹ Over our period of analysis, 37 SA4 regions (42%) experienced at least one bushfire and 26 SA4 regions (30%) experienced at least one flood.¹⁰ At state level, we find that NSW and Victoria are the most exposed to bushfires over this period, while Queensland is the most exposed to floods.

(ii) Individual Data

We merge our disaster exposure variable with individual-level data from the HILDA Survey, which is an ongoing nationally representative longitudinal study of Australian households. The initial HILDA survey was conducted in 2001 and included 7,682 households and 19,914 individuals in a nationally representative survey of the adult population. The number of surveyed individuals grows as subsequent waves track and record every additional household member. Each annual wave of HILDA contains detailed demographic data including on level of educational attainment, residential location, marital status, age and

⁷ Data are publicly accessible at <https://knowledge.aidr.org.au/>.

⁸ [https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1270.0.55.001July%202,016Main%20FeaturesStatistical%20Area%20Level%204%20\(SA4\)10016](https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1270.0.55.001July%202,016Main%20FeaturesStatistical%20Area%20Level%204%20(SA4)10016).

⁹ In our robustness section, we show that disaster occurrence is plausibly exogenous to an individual's demographic status, education, labour market and health outcomes.

¹⁰ Excluding non-spatial SA4 special purpose codes comprising Migratory–Offshore–Shipping and No Usual Address codes for each state and territory, there are currently 89 SA4 regions in Australia.

gender, as well as detailed labour force and earnings data.

Importantly, HILDA has a high response rate (96.4% in Wave 18 (financial year 2019)) and a low attrition rate (e.g., 75.9% of Wave 11 respondents were also included in Wave 18). These features mean that the longitudinal data provided by HILDA retain representativeness and are suitable for individual-level analysis of longitudinal labour force outcomes. Importantly, HILDA enables us to track individual labour market outcomes over a longer longitudinal period than is available in other Australian labour force data. The repeated panel nature of this data is also unique in the context of Australia. These factors allow controls for endogeneity and unobserved individual heterogeneity, which are important in analysing labour force outcomes and earnings dynamics.

We use data from Wave 1 to Wave 18 (financial years 2002–19),¹¹ providing an unbalanced sample of 43,770 unique individuals (387,695 person-year observations). We restrict our sample to ages 19–65 years, representing the working-age population that is likely to have completed schooling.¹² We further limit our sample to individuals who either experience only one disaster during the sample period (as our treatment group), and those who experience no natural disaster (as our control group). These restrictions give us an analysed sample of 204,922 person-year observations. Finally, since our model specification uses a lagged treatment variable, only individuals that appear in at least two consecutive years are included in the analysed samples. This brings our final sample to 154,950 observations, of which 51% identified as women.

We merge our final sample from HILDA data with our consolidated disaster database based on SA4-level location and the date of disaster occurrence. Specifically, we define an individual as experiencing a natural

disaster if they are residing in a natural disaster-affected SA4 region at the date of exposure. We limit our treatment group to individuals who report living in the same SA4 region in consecutive years (i.e. the survey year prior to disaster occurrence and the year post disaster occurrence).¹³ Of our sample, 5,232 (around 28% of total unique individuals in the sample) lived in a disaster-affected region at some point over our period of analysis, with 2,285 (12%) experiencing a flood and 3,664 (19%) exposed to a bushfire.

Table 1 presents the lifetime (observed survey year) average values of the demographic and labour market characteristics of our sample. Those experiencing a bushfire or flood were generally slightly older and more likely to be men compared to those who did not experience a natural disaster; however, they had a lower educational attainment (approximately 4% fewer had a bachelor's degree)¹⁴ and were more likely to be married (approximately 4% more). From this, there are no clear systematic differences between those who experienced a natural disaster during our period of analysis and those who did not. We also provide summary statistics by gender and disaster exposure in Table S1.

(iii) *Mixed-Sex Couples Sample*

Out of 154,950 analysed observations, 89,896 observations are identified when our sample is restricted to mixed-sex couples. Of this restricted sample, 3,004 unique individuals (around 20% of the sample) had experienced a bushfire during their lifetime in the survey, while 1,856 (13%) had experienced a flood. In terms of individual characteristics, those who were exposed to disaster were slightly older, less educated and more likely to be married compared to partnered individuals who did not experience a disaster during the observed period. Apart from these characteristics, there are no significant differences between individuals in our restricted sample who experienced a disaster compared to those who did not. See Table S2 for complete summary statistics for mixed-sex partnered observations.

¹¹ We restrict our sample to these years so as to exclude any potential bias introduced from the Covid-19 pandemic.

¹² In Table S10, we show baseline results using an alternative age group (25–55 years.) This more restricted age selection is to exclude university students or early retirees so as to ensure our results are not sensitive to the inclusion of these cohorts. From this restricted sample, our results are less precisely estimated (particularly for males), although coefficient signs are consistent. This could be explained by the fact that with a more restricted age group, male observations are dropped significantly compared to women.

¹³ In our robustness section, we relax the requirement that individuals must reside in the disaster-affected SA4 region in consecutive years to allow for migration. We find similar results to our baseline specification.

¹⁴ In our robustness section, we show that our results are robust to the inclusion of educational attainment in our model.

TABLE 1
Descriptive Statistics

	(1) Experienced bushfire	(2) Experienced flood	(3) Did not experience natural disaster
Age of individual	42.74 (12.19)	42.38 (12.08)	41.40 (13.87)
Male	0.492 (0.500)	0.498 (0.500)	0.497 (0.500)
Has college degree or more	0.523 (0.499)	0.529 (0.499)	0.567 (0.495)
Married	0.669 (0.470)	0.671 (0.470)	0.626 (0.484)
Number of persons in household	3.007 (1.389)	2.864 (1.358)	2.922 (1.444)
Employed (=1)	0.742 (0.438)	0.743 (0.437)	0.750 (0.433)
LF participant (=1)	0.776 (0.417)	0.774 (0.418)	0.784 (0.411)
Average working hours per week	38.03 (14.61)	38.20 (14.69)	37.16 (14.65)
Total weekly salary	0.894 (1.023)	0.849 (0.896)	0.899 (0.974)
Household labour income	105.4 (88.10)	94.62 (79.16)	111.7 (99.08)

LF, labour force.

Notes: Standard deviation in parentheses. Sample is drawn from HILDA Waves 1–18. We restrict sample to ages 19–65 years to represent working-age population. Sample must appear in two consecutive years. Financial amounts, including income and government support, are shown in thousands of real (CPI adjusted in 2019) Australian dollars.

IV Method

(i) Baseline Model

To investigate the causal effects of bushfires and floods, we use a two-way fixed-effects model, which is similar in spirit to a generalised difference-in-difference approach. This approach is commonly used to evaluate the effects of natural disasters (Cavallo *et al.*, 2013; Hsiang & Jina, 2014; Loebach & Korinek, 2019; Ulubaşoglu *et al.*, 2019; Johar *et al.*, 2020). Our baseline model can be written as

$$\begin{aligned}
 Y_{i,s,t} = & \beta_0 + \beta_1 \text{Fire}_{i,s,t} + \beta_2 \text{Fire}_{i,s,t-1} \\
 & + \beta_3 \text{Fire}_{i,s,t-2} + \beta_4 \text{Flood}_{i,s,t} \\
 & + \beta_5 \text{Flood}_{i,s,t-1} + \beta_6 \text{Flood}_{i,s,t-2} \\
 & + \text{age}_i + \sigma_g + \sigma_g \\
 & \times \tau_t + \gamma_i + \tau_t + \epsilon_{i,s,t}, \quad (1)
 \end{aligned}$$

where Y is the outcome of interest for individual i in period t , who resided in SA4 s . We are interested in estimating the effects of SA4-level

disaster exposure both in the year that disaster occurred and in the 2 years following disaster occurrence, and consider these effects separately for bushfires and floods. We use dummy-coded disaster variables, Fire and Flood, representing bushfires and floods respectively. We assign a value of 1 if an individual is residing in an SA4 region that experiences a disaster, for the full year of disaster exposure, and 0 otherwise. This identification strategy relies on exploiting the exogenous variation in the time and location of disaster occurrence. This plausible exogeneity is shown in Table S4, where we highlight that observed demographics, employment status, earnings, educational attainment and mental health have little explanatory power for future disaster exposure.

We control for time-invariant individual effects through individual fixed effects (γ_i), common time-varying shocks that impact all individuals in a given year through a year fixed effect (τ_t), state-level time-invariant characteristics (σ_g) and state-time trends to account for location-specific labour market trends ($\sigma \times t$) such as the resources boom which impacted regions in Western Australia

throughout our period of analysis. Given that an individual's employment and earnings outcomes are expected to follow a life-cycle pattern, we also add linear controls for an individual's age. We use robust standard errors clustered at SA4 level. This follows the same approach used by most studies of natural disasters, including studies in Australia by Ulubaşoglu *et al.* (2019) and Johar *et al.* (2020).

Our outcomes of interest include an individual's overall labour force status through dummy variables for labour market participation, employment and unemployment; and job quality through dummy variables for whether an individual is employed full-time or part-time. We also consider the effect of bushfires and floods on an individual's intensive margin of employment (through log-transformed hours worked in all jobs variables) and earnings (including log-transformed variables for hourly earnings).

(ii) Sectoral Industry Effects

Next, we explore whether the labour market effects from our baseline model vary across economic sectors. To do this, we add to our baseline model an interaction term between an individual's single-digit industry of employment and SA4-level disaster exposure. The industry type categorisation follows the one-digit International Standard Industrial Classification of All Economic Activities (ISIC) that groups activities into nine broad economic sectors.¹⁵ Our model becomes

$$\begin{aligned}
 Y_{i,s,t} = & \beta_0 + \beta_1 \text{Fire}_{i,s,t} + \beta_2 \text{Fire}_{i,s,t-1} \\
 & + \beta_3 \text{Fire}_{i,s,t-2} + \beta_4 \text{Flood}_{i,s,t} \\
 & + \beta_5 \text{Flood}_{i,s,t-1} + \beta_6 \text{Flood}_{i,s,t-2} \\
 & + \beta_7 \text{Fire}_{i,s,t} \times \text{industry}_{i,s,t} \\
 & + \beta_8 \text{Fire}_{i,s,t-1} \times \text{industry}_{i,s,t-1} \\
 & + \beta_9 \text{Fire}_{i,s,t-2} \times \text{industry}_{i,s,t-2} \\
 & + \beta_{10} \text{Flood}_{i,s,t} \times \text{industry}_{i,s,t} \\
 & + \beta_{11} \text{Flood}_{i,s,t-1} \times \text{industry}_{i,s,t-1} \\
 & + \beta_{12} \text{Flood}_{i,s,t-2} \times \text{industry}_{i,s,t-2} \\
 & + \text{age}_{i,t} + \sigma_s + \sigma_s \times \tau_t + \gamma_i \\
 & + \tau_t + \epsilon_{i,s,t}.
 \end{aligned} \quad (2)$$

Again, the disaster variable and interaction term are estimated separately for both bushfires and floods, as is our vector of control variables. In

this specification, the average treatment effect is measured by the coefficients for the year of disaster occurrence, and for the 2 years following disaster occurrence. This treatment estimates the incremental effect of natural disasters according to an individual's industry of employment, relative to an agricultural industry reference group.

(iii) Intrahousehold Dynamics

We also explore whether intrahousehold dynamics among mixed-sex couples could explain the relative labour market vulnerability of men and women following natural disaster. Firstly, we consider the possibility that increased domestic work take-up in the aftermath of natural disaster is associated with a temporary reduction in labour force participation. To test this effect, we use time-allocation data from HILDA, which asks individuals about their time spent on unpaid caring or domestic responsibilities. We modify Equation (1) by replacing the outcome to be the number of total hours spent on domestic work (including in caring roles).

A competing hypothesis that we test for is that among mixed-sex couples, individuals may temporarily increase their labour supply in the event that their partner loses employment. To test for this 'added worker' effect, we use an interaction term which dummy-codes whether an individual's partner lost their employment with SA4-level disaster exposure (separately for bushfires and floods). Our treatment effects can be interpreted as the change in an individual's labour force status if their partner lost employment (treatment), relative to the rest of the population residing in a disaster-affected region (control). Specifically, we use the following equation:

$$\begin{aligned}
 Y_{i,s,t} = & \beta_0 + \beta_1 \text{Fire}_{i,s,t} + \beta_2 \text{Fire}_{i,s,t-1} \\
 & + \beta_3 \text{Fire}_{i,s,t-2} + \beta_4 \text{Flood}_{i,s,t} \\
 & + \beta_5 \text{Flood}_{i,s,t-1} + \beta_6 \text{Flood}_{i,s,t-2} \\
 & + \beta_7 \text{Fire}_{i,s,t} \times \text{partnerlostjob}_{i,s,t} \\
 & + \beta_8 \text{Fire}_{i,s,t-1} \times \text{partnerlostjob}_{i,s,t-1} \\
 & + \beta_9 \text{Fire}_{i,s,t-2} \times \text{partnerlostjob}_{i,s,t-2} \\
 & + \beta_{10} \text{Flood}_{i,s,t} \times \text{partnerlostjob}_{i,s,t} \\
 & + \beta_{11} \text{Flood}_{i,s,t-1} \times \text{partnerlostjob}_{i,s,t-1} \\
 & + \beta_{12} \text{Flood}_{i,s,t-2} \times \text{partnerlostjob}_{i,s,t-2} \\
 & + \text{age}_{i,t} + \sigma_s + \sigma_s \times \tau_t + \gamma_i \\
 & + \tau_t + \epsilon_{i,s,t}.
 \end{aligned} \quad (3)$$

¹⁵ As adopted by the International Labour Organisation. For details, see <https://ilostat.ilo.org/>.

V Results

(i) Baseline Results

Effects of bushfires

Table 2 summarises the result of our baseline specification. Bushfires were found to have no statistically significant overall effects on an individual's labour force status; however, this may be attributed to the contrasting effects for men and women. While bushfires, as presented in Panel C column (1), generated persistent increases in a male's likelihood of employment (1.8 ppts at one-year lag, and 1.6 ppts at two-year lag), they lower the likelihood of female employment, as seen in Panel B column (1), by 1.6 ppts.

To provide a sense of the magnitude of these results, we apply our estimated treatment effects to SA4-level labour market data from the ABS.¹⁶ Our approach is not intended to provide a comprehensive estimation of the costs of natural disasters to Australian labour markets, but to provide an economic interpretation of our statistically significant average treatment effects found.

We find that over the period from 2002 to 2019, bushfires led to the loss of around 86,000 female jobs, or an average of 4,780 jobs per year. Assuming these jobs were at average levels of hours and productivity,¹⁷ this equates to an annual average of 6 million hours or \$495 million in forgone GDP. Meanwhile, bushfires generated an additional 177,714 male jobs or an average of nearly 10,000 jobs per year. On average each year, this equates to an additional 16.5 million hours of male employment or \$1.4 billion in GDP. These findings highlight the relatively more pronounced labour market vulnerability faced by women following a bushfire.

As depicted in Table 2 Panel C column (3), bushfires also increased the likelihood of full-

time employment for men, by 1.5 ppts at one-year and two-year lags; reduced the male unemployment rate by 1.1 ppts; and increased male labour force participation (Table 2 Panel C column (5)) by 1.0 ppts (two-year lag). These results suggest that initially additional male labour supply is mobilised from the pool of unemployed, before the overall likelihood of labour force participation is increased. We also find that bushfires reduced male consumption, with this effect statistically significant 2 years on from occurrence (29.0%, see Table 2 Panel C column (8)).

Effects of floods

In contrast to bushfires, we find that floods unambiguously increase the labour supply for both men and women, including the likelihood of employment, by 1.3 ppts and 1.8 ppts at one-year lag (see Table 2 Panel A column (1)). Over our period of analysis, this is equivalent to an average of 13,498 additional jobs per year, or around 20 million hours (\$1.7 billion in additional GDP). We also find that floods raised an individual's likelihood of participating in the labour force by 1.1 ppts, and 1.5 ppts after a one-year lag (see Table 2 Panel A column (5)), equivalent to an average of 11,321 additional individuals participating in the labour force each year. A possible explanation for this difference in the effects of bushfires and floods is that floods tend to occur in regions with relatively higher population density, which may be more likely to experience greater stimulatory spending on rebuilding and recovery, and thereby 'creative destruction'.

The effect of floods on employment was more pronounced for men than for women, with the male likelihood of employment increased by 1.6 ppts, and 1.9 ppts after a one-year lag (see Table 2 Panel C column (1)), equivalent to a total male employment effect of around 7,529 additional jobs per year. In contrast, floods lead to a lagged increase in female employment of 1.8% (Table 2 Panel B column (1)), or an average of nearly 4,000 female jobs per year.

We observe gendered differences in the mobilisation of this additional labour supply, with male jobs more likely to be filled from the male pool of unemployed while females were more likely to enter employment from outside the labour force. This is reflected in a reduction in the likelihood of male unemployment by 1.0 ppts (Table 2 Panel C column (4)) and an increased in the likelihood of female participation by 2.0%, or 4,406 additional females (Table 2 Panel B column (5)).

¹⁶ See Table RM1 at <https://www.abs.gov.au/statistics/labour/employment-and-unemployment/labour-force-australia-detailed/latest-release/>.

¹⁷ For each disaster, we assume that additional jobs occur at average hours for that gender, year and state/territory, based on data from the ABS. To monetise this figure, we use GDP per hour worked from the OECD (<https://data.oecd.org/lprdy/gdp-per-hour-worked.html>) converted to 2020 Australian dollars (<https://data.oecd.org/conversion/purchasing-power-parities-ppp.html>). We conduct this estimation separately for each disaster in our sample, and then sum to totals.

TABLE 2
Indirect Effects of Natural Disasters on Labour Market Outcomes

	(1) Employed (=1)	(2) Employed part-time (=1)	(3) Employed full-time (=1)	(4) Unemployed (=1)	(5) LF participant (=1)	(6) Log working hours	(7) Log hourly wage	(8) Log individual consumption
Panel A. Overall								
Fire	-0.004 (0.007)	0.000 (0.005)	-0.004 (0.007)	0.001 (0.004)	-0.003 (0.006)	-0.010 (0.009)	-0.004 (0.010)	-0.026 (0.078)
Flood	0.013** (0.006)	0.013* (0.008)	-0.000 (0.008)	-0.003 (0.003)	0.011* (0.006)	0.003 (0.011)	0.002 (0.008)	-0.027 (0.073)
Fire $t-1$	0.010 (0.007)	0.005 (0.006)	0.006 (0.006)	-0.004 (0.003)	0.006 (0.007)	-0.007 (0.010)	-0.006 (0.008)	-0.010 (0.071)
Flood $t-1$	0.018*** (0.005)	0.007 (0.007)	0.012* (0.006)	-0.004 (0.003)	0.015*** (0.005)	-0.010 (0.009)	-0.009 (0.011)	0.075 (0.105)
Fire $t-2$	0.005 (0.006)	-0.007 (0.006)	0.012** (0.006)	-0.003 (0.003)	0.002 (0.006)	0.002 (0.007)	0.004 (0.007)	-0.189*** (0.063)
Flood $t-2$	0.009 (0.007)	0.016* (0.009)	-0.008 (0.009)	-0.003 (0.004)	0.006 (0.005)	-0.028*** (0.009)	0.016* (0.009)	-0.041 (0.104)
N	154,950	154,950	154,950	154,950	154,950	114,738	103,409	154,950
Adj. R^2	0.589	0.421	0.606	0.205	0.590	0.585	0.654	0.538
Panel B. Female								
Fire	-0.016** (0.008)	-0.005 (0.008)	-0.012 (0.010)	0.007 (0.006)	-0.009 (0.006)	-0.021 (0.018)	0.014 (0.010)	-0.067 (0.115)
Flood	0.010 (0.011)	0.013 (0.013)	-0.004 (0.010)	-0.000 (0.004)	0.010 (0.011)	0.004 (0.015)	0.024* (0.014)	-0.026 (0.097)
Fire $t-1$	0.003 (0.008)	0.004 (0.009)	-0.001 (0.009)	0.001 (0.005)	0.004 (0.009)	-0.019 (0.014)	-0.004 (0.011)	0.132 (0.094)
Flood $t-1$	0.018** (0.008)	0.019* (0.011)	-0.002 (0.011)	0.003 (0.005)	0.020** (0.008)	-0.016 (0.013)	-0.005 (0.012)	0.058 (0.196)
Fire $t-2$	-0.005 (0.010)	-0.015 (0.009)	0.010 (0.009)	-0.001 (0.004)	-0.006 (0.010)	-0.004 (0.013)	-0.001 (0.009)	-0.101 (0.102)
Flood $t-2$	0.015 (0.011)	0.024 (0.016)	-0.010 (0.013)	-0.005 (0.006)	0.010 (0.008)	-0.039*** (0.019)	0.021 (0.015)	-0.016 (0.144)
N	80,567	80,567	80,567	80,567	80,567	55,391	51,089	80,567
Adj. R^2	0.564	0.387	0.528	0.166	0.557	0.531	0.603	0.547
Panel C. Male								
Fire	0.009 (0.010)	0.004 (0.007)	0.005 (0.009)	-0.007 (0.005)	0.002 (0.009)	0.000 (0.007)	-0.021 (0.013)	0.017 (0.117)
Flood	0.016** (0.008)	0.013* (0.007)	0.004 (0.012)	-0.005 (0.005)	0.011 (0.007)	0.003 (0.011)	-0.019* (0.011)	-0.035 (0.138)

TABLE 2
(continued)

	(1) Employed (=1)	(2) Employed part-time (=1)	(3) Employed full-time (=1)	(4) Unemployed (=1)	(5) LF participant (=1)	(6) Log working hours	(7) Log hourly wage	(8) Log individual consumption
Fire $t-1$	0.018** (0.009)	0.004 (0.007)	0.015*** (0.005)	-0.011** (0.004)	0.007 (0.008)	0.003 (0.010)	-0.007 (0.012)	-0.174 (0.117)
Flood $t-1$	0.019** (0.009)	-0.006 (0.008)	0.026** (0.012)	-0.010* (0.005)	0.009 (0.009)	-0.005 (0.011)	-0.012 (0.014)	0.101 (0.132)
Fire $t-2$	0.016** (0.006)	0.001 (0.006)	0.015** (0.007)	-0.006 (0.005)	0.010* (0.006)	0.007 (0.008)	0.009 (0.013)	-0.290*** (0.110)
Flood $t-2$	0.001 (0.009)	0.007 (0.008)	-0.006 (0.008)	0.000 (0.005)	0.002 (0.007)	-0.016* (0.009)	0.010 (0.019)	-0.068 (0.123)
N	74,383	74,383	74,383	74,383	74,383	59,347	52,320	74,383
Adj. R^2	0.612	0.374	0.604	0.244	0.625	0.550	0.690	0.518
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

LF, labour force.

Notes: Standard errors in parentheses. * $P < 0.10$, ** $P < 0.05$, *** $P < 0.01$. Sample is drawn from HILDA Waves 1–18. We restrict sample to ages 19–65 years (working-age population and who have completed schooling) who appear in at least two consecutive years. Regressions control for covariates using fixed effects for individual, age, year and state, and state-year linear time trends. Standard errors are clustered at SA4 level.

Meanwhile, floods did not significantly impact either the male likelihood of participation (see Table 2 Panel C column (5)) or the female likelihood of unemployment (see Table 2 Panel B column (4)). The increase in female labour force participation is consistent with initial increases in female hourly earnings (2.4%) inducing employment growth as women are encouraged to enter the labour market (see Table 2 Panel B column (7)).

We also find gendered differences in the take-up of part-time employment following floods. While floods increased the male likelihood of full-time employment after a one-year lag (2.6 ppts), female employment was more likely to be part-time (1.9 ppts), as seen in Table 2 Panel C column (3) and Panel B column (2), respectively. However, both men and women experienced a decline in their average hours worked 2 years on from flood exposure, with this effect larger among women (3.9%) than for men (1.6%, see Table 2 Panels B and C column (6)).

(ii) Sectoral Industry Effects

Effects of bushfires

We find that bushfires and floods have different sectoral effects for labour markets, as summarised in Table 3. For example, we find that relative to agricultural employment, bushfires raised the likelihood of employment in the mining (by 6.4 ppts) and transport (6.0 ppts) sectors (see Table 3 column (1)). These industries tend to be male dominated, with men accounting for more than three quarters of employment. This goes some way to explaining why bushfires increase male employment while reducing female employment, consistent with a potential sectoral reallocation favouring male labour.

Consistent with this relative restructuring of labour supply towards male-dominated sectors, we find that bushfires reduce participation in female-dominated sectors at the intensive margin of employment. As seen in Table 3 column (4), relative average hours were reduced in the trade sector (by 8.5%, and 10.5% at one-year lag), the services sector (6.8% at one-year lag), and the banking and insurance sector (8.0% at one-year lag). We also find that bushfires persistently reduced the relative likelihood of full-time employment in trade (by 9.5 ppts, and 8.5 ppts at one-year lag) and services (3.7 ppts, and 5.2 ppts at one-year lag) as seen in Table 3 column (3). These results were not accompanied by an

increase in employment to these sectors, suggesting that labour supply to these sectors contracts along the intensive margin following bushfire exposure. These results may also reflect a preference among female workers for changing to part-time hours following a bushfire.

We also find that bushfires reduced relative average hours worked in transport (by 12.2% at one-year lag) and construction (5.9% at one-year lag), although this is perhaps consistent with an expansion of labour supply in these sectors occurring at part-time hours (see Table 3 columns (2) and (4)). Individuals employed in manufacturing, traditionally also a male-dominated sector, also became relatively less likely to work full-time (by 6.0 ppts, see Table 3 column (3)) and more likely to work part-time (by 7.1 ppts, see Table 3 column (2)).

We find that bushfires were also associated with an increase in the hourly returns to labour supply in several sectors, with these displaying no definite pattern across gender composition. Specifically, as depicted in Table 3 column (5), bushfires increased average hourly earnings in the trade (by 10.4%, and 12.7% at one-year lag), services (10.3%), banking and insurance (12.8% at one-year lag), mining (17.1% at one-year lag), and manufacturing (9.9% at one-year lag).

Effects of floods

Floods were found to increase the relative likelihood of employment, as depicted in Table 3 column (1), in the services sector (by 5.5 ppts at one-year lag). It is likely that women accounted for much of this employment growth, with the services sector traditionally having a higher share of female employment representation than other sectors in our analysis.

Floods had mixed effects on more male-dominated sectors. We find that floods reduced the relative likelihood of employment (by 9.5 ppts) in the transport sector, although normalisation occurred after a one-year lag (see Table 3 column (1)). Meanwhile, floods were found to increase relative average hours worked in both the mining (9.0%) and manufacturing (8.6%) sectors (see Table 3 column (4)), while increasing the likelihood of full-time employment, as seen in Table 3 column (3), in manufacturing (8.7 ppts), and transport (8.7 ppts at one-year lag).

Floods were also found to generate a lagged increase in relative hourly returns to labour in both the construction (11.9%) and trade (15.9%)

TABLE 3
Indirect Effects of Natural Disasters on Labour Market by Industry

	(1) Employed (=1)	(2) Employed part-time (=1)	(3) Employed full-time (=1)	(4) Log working hours	(5) Log hourly wage	(6) Log individual consumption
Energy × Fire	−0.025 (0.121)	−0.006 (0.039)	−0.023 (0.123)	0.081 (0.074)	−0.100 (0.073)	−0.566 (0.736)
Mining × Fire	0.064* (0.036)	0.021 (0.037)	0.044 (0.046)	−0.018 (0.057)	0.025 (0.094)	−0.232 (0.695)
Manufacturing × Fire	0.014 (0.029)	0.071** (0.035)	−0.060* (0.033)	−0.010 (0.044)	0.078 (0.058)	0.064 (0.510)
Construction × Fire	0.009 (0.025)	0.044 (0.032)	−0.039 (0.031)	−0.033 (0.048)	0.069 (0.057)	0.100 (0.344)
Trade × Fire	−0.010 (0.023)	0.082*** (0.029)	−0.095*** (0.028)	−0.085** (0.034)	0.104** (0.052)	0.126 (0.291)
Transport × Fire	0.060* (0.034)	0.057 (0.039)	−0.014 (0.045)	−0.072 (0.058)	0.026 (0.068)	0.067 (0.529)
Bank/Insurance × Fire	−0.019 (0.041)	−0.020 (0.032)	−0.022 (0.039)	−0.047 (0.059)	0.033 (0.086)	−0.084 (0.574)
Services × Fire	0.017 (0.018)	0.050* (0.026)	−0.037* (0.022)	−0.022 (0.039)	0.103* (0.055)	0.188 (0.298)
Energy × Fire $t-1$	−0.021 (0.034)	0.020 (0.034)	−0.044 (0.057)	−0.044 (0.037)	0.105 (0.063)	−0.817 (0.680)
Mining × Fire $t-1$	−0.014 (0.049)	0.019 (0.025)	−0.030 (0.062)	0.006 (0.046)	0.171* (0.086)	0.623 (0.802)
Manufacturing × Fire $t-1$	0.022 (0.023)	0.039 (0.027)	−0.029 (0.033)	−0.042 (0.034)	0.099* (0.059)	0.442 (0.543)
Construction × Fire $t-1$	0.019 (0.021)	0.038 (0.030)	−0.022 (0.033)	−0.059* (0.032)	0.074 (0.068)	0.310 (0.603)
Trade × Fire $t-1$	−0.019 (0.026)	0.065*** (0.024)	−0.085*** (0.032)	−0.105*** (0.030)	0.127** (0.061)	0.301 (0.572)
Transport × Fire $t-1$	0.034 (0.031)	0.089** (0.037)	−0.055 (0.052)	−0.122*** (0.045)	0.109 (0.068)	1.030 (0.655)
Bank/Insurance × Fire $t-1$	−0.019 (0.033)	−0.018 (0.046)	0.002 (0.059)	−0.080* (0.045)	0.128* (0.068)	0.282 (0.748)
Services × Fire $t-1$	0.001 (0.021)	0.051** (0.023)	−0.052* (0.030)	−0.068*** (0.021)	0.089 (0.058)	0.773 (0.531)
Energy × Fire $t-2$	−0.025 (0.055)	−0.021 (0.068)	−0.006 (0.074)	0.025 (0.035)	−0.036 (0.089)	0.323 (0.595)
Mining × Fire $t-2$	−0.033 (0.052)	0.025 (0.052)	−0.057 (0.058)	−0.017 (0.058)	0.087 (0.086)	0.229 (0.857)
Manufacturing × Fire $t-2$	−0.011 (0.029)	0.035 (0.035)	−0.048 (0.034)	−0.023 (0.043)	−0.026 (0.059)	−0.158 (0.541)
Construction × Fire $t-2$	0.009 (0.035)	0.016 (0.035)	−0.010 (0.033)	−0.025 (0.042)	−0.001 (0.066)	0.102 (0.474)
Trade × Fire $t-2$	−0.006 (0.032)	0.021 (0.033)	−0.030 (0.034)	−0.047 (0.040)	−0.014 (0.059)	−0.081 (0.445)
Transport × Fire $t-2$	0.002 (0.039)	0.026 (0.049)	−0.027 (0.045)	−0.024 (0.049)	−0.062 (0.055)	0.202 (0.555)
Bank/Insurance × Fire $t-2$	−0.071 (0.058)	−0.032 (0.048)	−0.038 (0.054)	−0.016 (0.062)	0.014 (0.080)	0.202 (0.543)
Services × Fire $t-2$	−0.007 (0.027)	0.006 (0.026)	−0.015 (0.032)	−0.001 (0.039)	−0.032 (0.052)	0.119 (0.435)
Energy × Flood	−0.004 (0.032)	−0.041 (0.053)	0.035 (0.040)	0.019 (0.055)	0.048 (0.050)	0.681 (1.119)

TABLE 3
(continued)

	(1) Employed (=1)	(2) Employed part-time (=1)	(3) Employed full-time (=1)	(4) Log working hours	(5) Log hourly wage	(6) Log individual consumption
Mining $\times$ Flood	-0.037 (0.053)	-0.085 (0.053)	0.047 (0.038)	0.090* (0.048)	-0.021 (0.069)	0.197 (1.217)
Manufacturing $\times$ Flood	0.004 (0.038)	-0.085* (0.049)	0.087*** (0.026)	0.086* (0.047)	-0.076 (0.071)	0.142 (0.512)
Construction $\times$ Flood	-0.010 (0.045)	-0.051 (0.052)	0.037 (0.051)	0.023 (0.046)	-0.033 (0.057)	0.298 (0.946)
Trade $\times$ Flood	-0.003 (0.035)	-0.031 (0.050)	0.025 (0.042)	0.015 (0.059)	-0.030 (0.057)	0.401 (0.592)
Transport $\times$ Flood	-0.095* (0.050)	-0.064 (0.062)	-0.033 (0.043)	0.017 (0.049)	-0.031 (0.068)	-0.023 (0.931)
Bank/ Insurance $\times$ Flood	-0.007 (0.052)	0.043 (0.066)	-0.050 (0.070)	-0.033 (0.063)	0.065 (0.084)	0.540 (0.906)
Services $\times$ Flood	0.008 (0.032)	-0.011 (0.044)	0.016 (0.029)	-0.002 (0.041)	-0.008 (0.066)	0.545 (0.600)
Energy $\times$ Flood $t-1$	-0.005 (0.064)	-0.032 (0.061)	0.023 (0.090)	0.020 (0.077)	0.167 (0.111)	1.394 (0.867)
Mining $\times$ Flood $t-1$	0.008 (0.048)	-0.024 (0.057)	0.031 (0.060)	0.033 (0.064)	0.051 (0.115)	0.837 (1.066)
Manufacturing $\times$ Flood $t-1$	0.045 (0.043)	-0.017 (0.054)	0.061 (0.041)	-0.011 (0.060)	0.095 (0.086)	-0.168 (0.588)
Construction $\times$ Flood $t-1$	0.020 (0.030)	-0.048 (0.051)	0.063 (0.045)	-0.006 (0.060)	0.119* (0.071)	0.439 (0.617)
Trade $\times$ Flood $t-1$	0.015 (0.029)	-0.009 (0.048)	0.020 (0.044)	-0.021 (0.045)	0.159** (0.076)	0.536 (0.588)
Transport $\times$ Flood $t-1$	0.062 (0.039)	-0.029 (0.056)	0.087* (0.048)	-0.014 (0.067)	0.127 (0.102)	0.767 (0.691)
Bank/ Insurance $\times$ Flood $t-1$	-0.000 (0.042)	0.024 (0.053)	-0.026 (0.067)	-0.089 (0.081)	-0.026 (0.121)	1.047 (0.873)
Services $\times$ Flood $t-1$	0.055** (0.022)	0.010 (0.049)	0.042 (0.048)	-0.015 (0.058)	0.095 (0.074)	0.836 (0.590)
Energy $\times$ Flood $t-2$	-0.036 (0.109)	0.031 (0.071)	-0.051 (0.117)	-0.066 (0.128)	0.141 (0.135)	0.993 (1.179)
Mining $\times$ Flood $t-2$	-0.137 (0.101)	0.110 (0.115)	-0.231* (0.121)	-0.083 (0.184)	0.222 (0.229)	1.488 (1.092)
Manufacturing $\times$ Flood $t-2$	-0.006 (0.051)	0.046 (0.070)	-0.032 (0.068)	-0.018 (0.115)	0.107 (0.114)	-1.233 (0.785)
Construction $\times$ Flood $t-2$	-0.004 (0.039)	0.027 (0.064)	-0.014 (0.060)	-0.016 (0.129)	0.112 (0.127)	-1.129 (0.732)
Trade $\times$ Flood $t-2$	0.010 (0.044)	0.045 (0.060)	-0.018 (0.067)	-0.035 (0.099)	0.134 (0.114)	-0.547 (0.718)
Transport $\times$ Flood $t-2$	0.013 (0.051)	0.056 (0.080)	-0.044 (0.083)	-0.059 (0.121)	0.126 (0.139)	-1.099 (0.848)
Bank/ Insurance $\times$ Flood $t-2$	0.015 (0.061)	0.100 (0.075)	-0.062 (0.075)	-0.031 (0.145)	0.146 (0.148)	-0.829 (0.692)

TABLE 3
(continued)

	(1)	(2)	(3)	(4)	(5)	(6)
	Employed (=1)	Employed part-time (=1)	Employed full-time (=1)	Log working hours	Log hourly wage	Log individual consumption
Services $\times$ Flood $t-2$	-0.007 (0.041)	0.028 (0.070)	-0.020 (0.065)	-0.027 (0.115)	0.102 (0.117)	-0.813 (0.616)
<i>N</i>	98,267	98,267	98,267	90,286	81,392	98,267
Adj. R^2	0.266	0.482	0.546	0.600	0.668	0.535

Notes: Standard errors in parentheses. * $P < 0.10$, ** $P < 0.05$, *** $P < 0.01$. Sample is drawn from HILDA Waves 1–18. We restrict sample to ages 19–65 years (working-age population and who have completed schooling) who appear in at least two consecutive years. Regressions control for covariates using fixed effects for individual, age, year, and state, and state-year linear time trends. Standard errors are clustered at SA4 level.

sectors (see Table 3 column (5)). This is perhaps consistent with labour supply shortages in these industries.

The sectoral effects of floods found are quite different from those of bushfires, most notably for the services sector. A possible reason for this is a higher population density in flood-prone areas, compared to the more sparsely populated areas that experience bushfires. A higher population density may lead to increased demand for services, such as insurance, temporary accommodation, or public administration and safety in the aftermath of a flood, which may in turn support increased employment in these sectors. In contrast, demand for these services may remain relatively dampened following bushfires. This may also explain why we observe an increase in female labour force participation following a flood, with much of this likely driven by the services sector, while female employment declines following a bushfire.

(iii) Intrahousehold Dynamics

Effect on domestic work

We find no evidence to suggest that natural disasters increase the total time spent by females on domestic duties (Table S3). However, our survey data are collected annually, so it is possible that any short-term effect on female housework is transitory and has normalised by the time our sample is next observed. We do, however, find that floods contemporaneously increased male time spent on domestic work by 1.065 h per week with this effect being statistically significant.

Evidence for an ‘added worker’ effect

In contrast to our hypotheses that women may temporarily take time out of the labour force to take on additional domestic responsibilities, we find strong evidence of an ‘added worker’ effect whereby household members were more likely to increase their labour supply if their partner had lost their job following natural disaster exposure.

Our overall results, as depicted in Table 4 Panel A, are consistent with an ‘added worker’ effect at the intensive margin of employment, with relative average hours increased after a fire by 18.7% and after a flood by 7.5% among those whose partners had lost their job (see Table 4 column (6)). We also find that floods had a lagged effect of increasing the relative likelihood of full-time employment (by 10.6 ppts, see Table 4 column (3)) after a one-year lag and of employment (2.3 ppts, see Table 4 Panel A column (1)) after a two-year lag.

As expected, the evidence of an ‘added worker’ effect was most pronounced for females. This may reflect a lower level of female labour force participation prior to disaster occurrence, translating to a greater ability to respond through increasing labour supply. The ‘added worker’ effect was strongest for women following a bushfire, as reported in Table 4 Panel B, with results indicating this effect at both the extensive and intensive margins of participation. Among females whose partner had lost their job in the aftermath of a bushfire, we find a relative increase in the likelihood of labour force participation (by 3.6 ppts, see Table 4 Panel B column (5)), employment (3.6 ppts, see Table 4 Panel B

TABLE 4
Partner Sample Only: Added Worker Effect of Natural Disasters on Labor Market Outcomes

	(1) Employed (=1)	(2) Employed part-time (=1)	(3) Employed full-time (=1)	(4) Unemployed (=1)	(5) LF participant (=1)	(6) Log working hours	(7) Log hourly wage	(8) Log individual consumption
Panel A. Overall								
Partner lost job × Fire	0.019 (0.012)	0.023 (0.070)	-0.004 (0.071)	0.000 (0.000)	0.019 (0.012)	0.187*** (0.057)	-0.063 (0.055)	-0.082 (0.855)
Partner lost job × Flood	-0.059 (0.067)	0.013 (0.058)	-0.072 (0.073)	0.002 (0.001)	-0.057 (0.067)	0.075*** (0.034)	-0.118 (0.077)	-0.549 (0.810)
Partner lost job × Fire <i>t</i> -1	-0.001 (0.029)	-0.040 (0.051)	0.038 (0.043)	-0.001 (0.001)	-0.001 (0.029)	0.005 (0.056)	0.094* (0.049)	0.110 (0.665)
Partner lost job × Flood <i>t</i> -1	0.010 (0.010)	-0.097 (0.062)	0.106* (0.063)	-0.000 (0.001)	0.010 (0.010)	0.061 (0.055)	0.041 (0.089)	-1.416*** (0.497)
Partner lost job × Fire <i>t</i> -2	0.007 (0.005)	0.013 (0.040)	-0.006 (0.040)	0.000 (0.001)	0.007 (0.005)	0.057 (0.048)	-0.008 (0.033)	-0.351 (0.806)
Partner lost job × Flood <i>t</i> -2	0.023** (0.010)	0.105 (0.077)	-0.079 (0.079)	0.000 (0.001)	0.023** (0.010)	-0.016 (0.059)	0.039 (0.092)	0.332 (0.972)
<i>N</i>	89,896	89,896	89,896	89,896	89,896	86,067	86,067	89,896
Adj. <i>R</i> ²	0.676	0.566	0.572	0.175	0.685	0.586	0.652	0.548
Panel B. Female								
Partner lost job × Fire	0.036** (0.018)	0.114 (0.135)	-0.079 (0.129)	0.001 (0.001)	0.036** (0.018)	0.234** (0.101)	-0.080 (0.082)	-2.188** (1.038)
Partner lost job × Flood	-0.072 (0.069)	-0.089 (0.117)	0.017 (0.115)	0.001 (0.002)	-0.070 (0.069)	0.133** (0.058)	-0.086 (0.111)	-0.439 (1.246)
Partner lost job × Fire <i>t</i> -1	-0.018 (0.048)	-0.043 (0.088)	0.025 (0.073)	0.001 (0.001)	-0.017 (0.048)	-0.039 (0.098)	0.089* (0.053)	-0.197 (1.041)
Partner lost job × Flood <i>t</i> -1	0.006 (0.011)	-0.058 (0.158)	0.063 (0.158)	-0.000 (0.001)	0.005 (0.011)	0.055 (0.090)	-0.073 (0.122)	-0.793 (0.961)
Partner lost job × Fire <i>t</i> -2	0.004 (0.006)	0.046 (0.070)	-0.042 (0.070)	-0.000 (0.001)	0.004 (0.007)	0.104 (0.066)	0.008 (0.041)	-0.933 (1.349)
Partner lost job × Flood <i>t</i> -2	0.025 (0.020)	0.082 (0.121)	-0.053 (0.129)	0.000 (0.001)	0.025 (0.020)	0.054 (0.094)	0.004 (0.092)	1.778 (1.307)
<i>N</i>	45,855	45,855	45,855	45,855	45,855	44,504	44,504	45,855
Adj. <i>R</i> ²	0.565	0.517	0.517	0.103	0.575	0.544	0.604	0.558
Panel C. Male								
Partner lost job × Fire	0.005 (0.017)	-0.022 (0.074)	0.029 (0.080)	-0.000 (0.000)	0.005 (0.017)	0.160*** (0.054)	-0.061 (0.073)	1.244 (1.224)
Partner lost job × Flood	-0.038 (0.072)	0.092 (0.067)	-0.131 (0.099)	0.001 (0.002)	-0.037 (0.072)	0.045 (0.035)	-0.134** (0.066)	-0.807 (1.968)

TABLE 4
(continued)

	(1) Employed (=1)	(2) Employed part-time (=1)	(3) Employed full-time (=1)	(4) Unemployed (=1)	(5) LF participant (=1)	(6) Log working hours	(7) Log hourly wage	(8) Log individual consumption
Partner lost job × Fire	0.025** (0.012)	-0.023 (0.023)	0.047** (0.022)	-0.002 (0.002)	0.023* (0.012)	0.066* (0.038)	0.100 (0.062)	0.279 (1.072)
Partner lost job × Flood	0.018 (0.014)	-0.110** (0.054)	0.127** (0.063)	-0.000 (0.001)	0.017 (0.015)	0.066 (0.051)	0.129 (0.085)	-2.024*** (0.694)
Partner lost job × Fire	0.008 (0.012)	-0.038*** (0.014)	0.047** (0.018)	0.001 (0.001)	0.009 (0.012)	0.009 (0.032)	-0.033 (0.041)	0.375 (1.004)
Partner lost job × Flood	0.026* (0.013)	0.085 (0.088)	-0.057 (0.088)	-0.000 (0.001)	0.026* (0.014)	-0.038 (0.067)	0.066 (0.142)	-0.906 (1.313)
N	44,041	44,041	44,041	44,041	44,041	41,563	41,563	44,041
Adj. R ²	0.734	0.503	0.570	0.235	0.742	0.555	0.692	0.527
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

LF, labour force.

Notes: Standard errors in parentheses. * $P < 0.10$, ** $P < 0.05$, *** $P < 0.01$. Sample is drawn from HILDA Wave 1 to Wave 18. We restrict sample to be between 19 and 65 years old (working age population and who have completed schooling) who appear in at least two consecutive years. Regressions control for covariates using fixed effects for individual, age, year, and state, and state-year linear time trends. Standard errors are clustered at SA4 level.

column (1)), and average hours worked (23.4%, see Table 4 Panel B column (6)).

Meanwhile, for males, following a bushfire, partner job loss was associated with a lagged increase in relative participation levels at both the extensive and intensive margins, as summarised in Table 4 Panel C. At the extensive margin, we find that bushfires increased the relative male likelihood of employment by 2.5 ppts (see Table 4 column (1)) and of participation by 2.3 ppts after a one-year lag (see column (5)). We also find these effects at the intensive margin, with males relatively more likely to be employed full-time (4.7 ppts at one-year and two-year lags, see column (3)) and relative average working hours increased by 6.6% (one-year lag, see Table 4 column (6)).

The 'added worker' effect was not as pronounced following floods, perhaps reflecting a lower likelihood of partner job loss. However, we do find that women whose partner lost their job following a flood experienced a relative increase in their average hours worked (by 13.3%, Table 4 Panel B column (6)). Meanwhile, males observed lagged relative increases in their likelihood of full-time employment (12.7 ppts at one-year lag) and employment (2.6 ppts at two-year lag), as seen in Table 4 Panel C columns (3) and (1), respectively.

VI Robustness

(i) Exogeneity of Treatment Assignment

The validity of our results relies on the assumption that disaster occurrence is exogenous. Residing in a bushfire-exposed area or a flood-exposed area should not be determined by other individual characteristics, household characteristics, or potential labour market outcomes. A violation of this requirement would suggest some kind of endogenous treatment or selection bias.

To test the exogeneity of our treatment assignment, we adapt the approach used by Johar *et al.* (2020), by regressing a linear probability model of treatment assignment on several key individual characteristics, household characteristics and potential outcomes. Similar to Equation (1) and the approach used by Johar *et al.* (2020), we also control for year fixed effects, state fixed effects, linear state-time trends and individual fixed effects.

The results are summarised in Table S4. Overall, we do not find that any of the covariates

correlate with the probability of being exposed to a bushfire or flood. This suggests that our treatment is exogenous and provides a degree of confidence that there is no selection bias into the treatment group.

(ii) Placebo

We also employ several robustness checks to address potential concerns over the validity of our results. The first of these is a placebo test, in which we replace the disaster exposure variables in our baseline equation with their one- and two-year lead indicators. This can be thought of as a test of conditional parallel pre-trends of our outcome measures between those who later experienced a disaster and those who did not. If our model and group selection is correctly specified, we would expect the results of this test to be statistically insignificant.

From Tables S5, we find that this assumption is satisfied for our key variables on individual labour market status using our overall sample, which provides a level of confidence in causally interpreting these results.

However, our placebo test picks up several potential biases for the male and female samples. The affected results include the likelihood of female participation following a bushfire, the likelihood of male full-time employment and average working hours following a bushfire, and the likelihood of male part-time employment following a flood. This may suggest anticipation effects associated with bushfires, with males increasing their working hours and women reducing their labour force participation. Such anticipation effects may violate the parallel pre-trends assumption for these outcomes. Of these, we only find statistically significant treatment effects for male full-time employment following a bushfire, and male part-time employment following a flood.

(iii) Allowing Migration Following Disaster Exposure

Our third robustness check varies our treatment assignment by relaxing the requirement that individuals reside in the disaster-affected region in consecutive survey years. While our baseline model can be interpreted as capturing the effect of natural disasters on individuals who continue residing in the disaster-affected region, several studies have shown that disasters can induce significant migration (Boustan *et al.*, 2017). The

inclusion of migrants in our model may vary our estimated treatment effects.

Table S9 summarises the results. We find that results from this treatment assignment support our identified treatment effects, but are generally smaller in magnitude. This suggests that the labour market response induced by natural disasters is most pronounced for the immediate affected region. In this specification, we also identify a number of new statistically significant results, including an increased likelihoods of labour force participation and employment 2 years on from a fire, reduced average working hours 1 year on from a flood, and an increased likelihood of male full-time employment following a bushfire.

(iv) *Controlling for Other Covariates*

As our next robustness check, we separately incorporate several covariates into our baseline model. These covariates are potentially important confounding factors for an individual's labour force status and earnings.

Firstly, there is the possibility of a sorting mechanism whereby individuals with lower levels of education may tend to live in disaster-prone regions. To test this, we include a categorical variable measuring an individual's highest level of educational attainment in our baseline model. From our results, as presented in Table S6, we find that our results are robust to the inclusion of this control. We do find smaller magnitudes of the treatment effects except for the effect of fires on male consumption; however, the signs on these coefficients remain consistent with our baseline effects.

Secondly, given our focus on labour market outcomes for individuals, occupation may play an explanatory role in determining the effect of natural disasters on individuals. To account for this, we include a control for an individual's broad level occupational group. Since our results from the interaction between industry sector and disaster type are significant in Table 3, we expect that controlling for occupation would also alter several results compared to the baseline results. From our results, as presented in Table S7, we find that, overall, inclusion of occupation type variables leads to several treatment effects becoming not statistically significant, including for the likelihood of being employed and of working part-time or full-time. These changes could be observed for both male and female samples. The results suggest the importance of

examining detailed industry-specific treatment effects as discussed in Section ii.

Finally, we also run a version of our baseline model to control for disaster severity, to ensure that our results are not driven by small-scale disaster events that have little impact on regional populations. We define our measure of disaster severity as the number of HILDA respondents reporting direct property damage within a disaster-affected SA4 region per 1,000 respondents. Given the availability of self-reported property damage from HILDA, we limit our sample period to the financial years 2010–19. This also helps to ensure that our baseline results are not driven by the choice of sample time period, although this means that this specification is not directly comparable to our baseline. As presented in Table S8, we find that overall our baseline results are generally robust over this specification. We do find that the contemporaneous effects of bushfires on the likelihood of female employment and of floods on average hourly female wages lose their statistical significance. However, after controlling for severity, we find that bushfires generated a significant lagged decrease in female consumption.

VII *Conclusion*

In our paper, we study the labour market effects of bushfires and floods within Australia over the past two decades, focusing on the relative vulnerability of men and women. We find that the effects of bushfires and floods differ, necessitating that policy-makers adapt their policy to each disaster type. While we find that floods unambiguously increase the labour supply among both men and women, bushfires have different consequences for men and women. Importantly, we find that the labour force status of women is most vulnerable to bushfires, lowering the likelihood of female employment by 1.6 ppts, equivalent to 4,780 female jobs or 6 million hours of lost work per year.

We find that these differences across gender can partially be explained by different responses across industry sector, with bushfires increasing the relative likelihood of employment in male-dominated industries, including mining and transport. On the other hand, bushfires are associated with a relative reduction in the average hours worked in industries with a higher female composition, including trade, banking and insurance, and services. These results are consistent with a structural reallocation of labour

supply towards male-dominated sectors, while labour supplied to more female-dominated sectors contracts along the intensive margin. The sectoral analysis of these effects contributes important evidence for policy-makers seeking to appropriately design and target disaster-recovery support.

In contrast to bushfires, we find that floods generate persistent increases in both the male and female labour supply, raising the likelihood of both employment (by 1.3 ppts, and 1.8 ppts at one-year lag) and labour force participation (1.1 ppts, and 1.5 ppts at one-year lag). This equates to an annual average of an additional 13,498 jobs or potentially 20 million hours, and an average of 11,321 additional individuals participating in the labour force each year. A possible reason for this difference between bushfires and floods is that floods tend to occur in regions with higher-density population, which potentially supports creative destruction through additional spending on rebuilding and related services such as insurance, temporary accommodation and public safety. We find that the services sector experienced the strongest relative employment growth of any industry following floods (5.5 ppts), with much of this employment growth likely to be contributed by women. We also document gendered differences in the mobilisation of this additional labour supply, with males more likely to enter employment from the pool of unemployed while females entered employment from outside the labour force.

As well as highlighting the important gendered and sectoral dimensions of natural disasters, our paper contributes new evidence on the role played by intrahousehold dynamics among mixed-sex couples. We find no evidence that natural disasters increase female domestic work, but do find evidence consistent with an 'added worker' effect following disaster occurrence, whereby partnered individuals are likely to increase their labour supply in the event that one breadwinner loses their job. We find that this effect is strongest following bushfires, with increased participation at both the extensive and intensive margins, while it is only observed at the intensive margin following floods. We also find that the 'added worker' response is strongest for women, perhaps consistent with lower levels of labour force participation and a greater ability to respond by increasing their labour supply.

Our paper contributes to other labour market studies on natural disasters, documenting these

effects within the Australian economy at a finer level of geographic detail and incorporating a wider range of indicators than in existing studies. Importantly, we contribute an important perspective on the gendered burden of climate change in terms of the relative labour market vulnerability faced by men and women, a topic which has critical relevance for policy-makers but which has thus far been neglected within Australia. Our findings provide insight into the design and targeting of post-disaster policy supports, highlighting in particular the vulnerability of women in the aftermath of bushfires. We also provide new evidence for the mechanisms through which the effects of bushfires and floods are transmitted to the labour market. We shed light on the importance of the industry sector, including the relative vulnerability of the services, trade, and banking and insurance sectors following bushfires and of the transport sector following floods. We also provide novel estimates that suggest members of mixed-sex couples may respond to natural disasters by temporarily increasing their labour supply in the event that one breadwinner loses their employment.

With climate change amplifying both the frequency and significance of natural disasters, this remains a critical and rich area for further research. One such topic warranting further exploration is the persistence of these effects for both individuals and affected communities within Australia, in terms of long-term recovery or scarring effects. Such research should not only be limited to the labour market, but also extend to individual health, migration and human capital outcomes. Secondly, while our paper contributes initial evidence on the sectoral nature of these effects, more work is required to more precisely capture these effects for affected communities. Further research on these topics will add to understanding on these issues, enabling improvements to post-disaster policy supports and increasing the resilience of disaster-prone Australian communities.

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Conflict of Interest

The authors declare they have no conflicting interests.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Tables S1. Descriptive statistics.

Table S2. Descriptive statistics – partnered sample.

Table S3. Indirect effects of natural disasters on division of labor within HH.

Table S4. Robusness: Johar specification.

Table S5. Placebo check: indirect effects of natural disasters on labor market outcomes.

Table S6. Robustness check: control for education.

Table S7. Robustness check: control for occupation.

Table S8. Robustness check: control for severity.

Table S9. Robustness: allowing migration.

Table S10. Indirect effects of natural disasters on labor market outcomes – sample restricted to 25–55 years.

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