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Natural disasters, home damage, and the eroding locus of control

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Research Summary

Why was the research done?

Natural disasters have demonstrably profound social and economic consequences on a global scale. As concerns over the increasing frequency and intensity of natural disasters escalate, research examining their psychological impacts has gained significant momentum. However, a critical gap exists in our understanding of how natural disasters influence individuals' locus of control. Locus of control, defined as the belief in one's ability to influence life outcomes, has been shown to be associated with various socio-economic outcomes and may play a crucial role in shaping coping mechanisms and resilience. Investigating how natural disasters impact individuals' perception of control over their lives is vital for developing effective disaster preparedness and recovery strategies.

What were the key findings?

This study aims to address this gap by being the first to investigate the causal effects of natural disaster-induced home damage on locus of control. Utilizing Australian longitudinal data, we implement an individual fixed effects instrumental variables approach leveraging time-varying, exogenous exposure to local natural disasters to address confounding factors. Our findings provide compelling evidence: natural disaster-induced home damage significantly diminishes individuals' perception of control, especially for those at the lower end of the locus of control distribution. The effect is disproportionately heightened for women, older individuals, wealthier households, those without prior insurance, urban or inland residents, and those in historically cyclone-free regions.

What does this mean for policy and practice?

The results presented in this study have significant methodological and policy implications. Methodologically, our findings highlight the importance of adequately addressing the endogeneity of self-reported natural disaster-related home damage when quantifying its impacts on locus of control. This study also demonstrates the benefits of examining the effects of natural disaster exposure beyond the mean of the locus of control distribution. Our novel finding of the negative and substantial impacts of weather-related home damage on internal locus of control indicates that locus of control can be altered under specific conditions. From a policy perspective, this insight offers valuable guidance for developing effective policies and interventions to support affected populations, especially those disproportionately impacted by natural disasters.

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Natural disasters, home damage, and the eroding locus of control

Ha Trong Nguyen[*, †] Francis Mitrou[†]

The catastrophic consequences of natural disasters on social and economic systems are extensively documented, yet their influence on individuals' sense of control over their life outcomes remains unexplored. This study pioneers an investigation into the causal effects of natural disaster-related home damage on the locus of control. Utilizing Australian longitudinal data, we implement an individual fixed effects instrumental variables approach leveraging time-varying, exogenous exposure to local natural disasters to address confounding factors. Our findings provide compelling evidence: natural disaster-induced home damage significantly diminishes individuals' perception of control, especially for those at the lower end of the locus of control distribution. The effect is disproportionately heightened for women, older individuals, wealthier households, those without prior insurance, urban or inland residents, and those in historically cyclone-free regions. This newfound understanding offers opportunities for developing targeted interventions and support mechanisms tailored to address the specific needs and vulnerabilities of individuals following natural disasters.

Keywords: Natural Disasters; Locus of Control; Housing; Australia

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1. Introduction

Natural disasters have demonstrably profound social and economic consequences on a global scale (Dell *et al.* 2014; Carleton & Hsiang 2016). As concerns over the increasing frequency and intensity of natural disasters escalate, research examining their psychological impacts has gained significant momentum (Currie & Rossin-Slater 2013; Nguyen & Mitrou 2024a). However, a critical gap exists in our understanding of how natural disasters influence individuals' Locus of Control (LoC). Locus of control, defined as the belief in one's ability to influence life outcomes (Rotter 1966), has been shown to be associated with various socio-economic outcomes (Almlund *et al.* 2011; Heckman & Kautz 2012) and may play a crucial role in shaping coping mechanisms and resilience. Investigating how natural disasters impact individuals' perception of control over their lives is vital for developing effective disaster preparedness and recovery strategies, especially as we enter an era of climatic uncertainty with forecasts of increased climate-induced extreme weather events.

This study aims to address this gap by being the first to investigate the causal effects of natural disaster-induced home damage on locus of control. In doing so, it intersects with two main lines of research. The first, and highly established, line focuses on the social and economic impacts of natural disasters (Dell *et al.* 2014; Carleton & Hsiang 2016; Botzen *et al.* 2019). Within this research area, our study closely aligns with the growing body of work evaluating the effects of natural disasters on various psychological aspects, including risk preferences (Cameron & Shah 2015; Hanaoka *et al.* 2018; Bourdeau-Brien & Kryzanowski 2020), religious beliefs (Belloc *et al.* 2016; Bentzen 2019), mental health (Currie & Rossin-Slater 2013; Baryshnikova & Pham 2019), and life satisfaction (Gunby & Coupé 2023; Nguyen & Mitrou 2024a). However, no study has yet explored the impacts of natural disasters on LoC, which constitutes the specific focus of this research.

This study also aligns with a burgeoning body of literature investigating the relationship between LoC and various life outcomes. Prior empirical research demonstrates that individuals with an internal LoC, who believe their outcomes are contingent on their own actions, exhibit superior results in areas such as labour market success, finances, health, and education. For instance, individuals with an internal LoC tend to have higher wages (Cobb-Clark 2015), engage in more intensive job searches when unemployed (Caliendo *et al.* 2015), adopt healthier behaviours (Cobb-Clark *et al.* 2014; Kesavayuth *et al.* 2020), save more money (Cobb-Clark *et al.* 2016), purchase greater insurance coverage (Antwi-Boasiako 2017; Bonsang & Costa-Font 2022), hold more risky assets (Salamanca *et al.* 2020), and invest more in education (Coleman & DeLeire 2003; Caliendo *et al.* 2022) compared to those with an external LoC. Additionally, research suggests that individuals with a stronger internal LoC exhibit greater coping abilities in the face of negative events, such as job losses, health shocks, local crimes or natural disasters (Buddelmeyer & Powdthavee 2016; Schurer 2017; Etilé *et al.* 2021; Awaworyi Churchill & Smyth 2022; Güzel *et al.* 2024).

It is important to note that, consistent with established theoretical models and earlier empirical evidence (Rotter 1966; Borghans *et al.* 2008; Heckman & Kautz 2012; Cobb-Clark & Schurer 2013), these prior studies largely treat LoC as a fixed and exogenous variable within the analysed timeframe. However, recent studies utilizing panel data have shown that LoC can be influenced by certain life events, including changes in employment status or health (Elkins *et al.* 2017; Preuss & Hennecke 2018; Marsaudon 2022; Clark & Zhu 2024). This present study uniquely contributes to this field by investigating whether exposure to natural disasters causally influences individuals' LoC.

To quantify the causal effects of natural disaster-induced home damage on individuals' LoC, this study leverages longitudinal data from the Household, Income and Labour Dynamics in Australia (HILDA) survey, which contains a self-reported measure of natural disaster-related home damage and person-level LoC. We address the potential endogeneity of self-reported natural disaster-related home damage by employing an individual fixed effects instrumental variables (FE-IV) approach. This approach exploits within-individual time variation in exogenous exposure to local cyclones as an instrument for natural disaster-related home damage. We apply this FE-IV model to explore the heterogeneous effects of home damage across the distribution of LoC, in addition to the average effect.

The study yields three main sets of findings. First, we observe a statistically significant negative impact of cyclone-induced home damage on internal LoC, meaning cyclone-induced home damage significantly diminishes individuals' sense of control over their life outcomes. This effect is most pronounced in the quantile FE-IV regressions, where individuals near or below the median of the LoC distribution experience a substantial reduction in LoC following natural disaster-related home damage. Moreover, the magnitude of this negative effect is greatest for those at the lower end of the LoC distribution, where weather-related home damage reduces their LoC by 0.23 standard deviations.

Second, our comprehensive analysis reveals significant heterogeneity in the impact of cyclone-induced home damage on LoC across various sociodemographic and regional groups. This heterogeneity varies along the LoC distribution, with a general trend indicating a more pronounced negative effect for women, older individuals, those residing in wealthier households or households without prior residential insurance, urban or inland residents, and individuals located in areas not historically prone to cyclones.

Third, our findings demonstrate robustness to a battery of sampling and specification tests. Furthermore, the study underscores the importance of addressing the endogeneity of self-reported natural disaster-related home damage when estimating its impact on LoC. Additionally, and importantly, our results highlight the value of examining the effects of natural disaster exposure beyond the mean of the LoC distribution. Focusing solely on the average impact would risk overlooking the severe consequences of natural disasters on individuals' LoC, particularly for those at the lower end of the LoC distribution.

The remainder of this paper is organized as follows. Section 2 provides a detailed description of the primary data source used in the analysis. Section 3 details the econometric models employed to quantify the causal impact of weather-related home damage on individuals' LoC. Section 4 presents the key empirical results of the study. Section 5 documents the findings from various sensitivity tests conducted to assess the robustness of the results. Section 6 explores the potential heterogeneity in the impacts of weather-related home damage on LoC across different subgroups. Finally, Section 7 concludes the paper by summarizing the main findings and discussing their implications.

2. Data and sample

2.1. Data

Our primary data source is the Household, Income and Labour Dynamics in Australia (HILDA) survey. This nationally representative survey tracks individuals from private households over time, offering comprehensive individual and household-level data, including residential information, health outcomes, and labour market experiences (Summerfield *et al.* 2023). A key advantage of HILDA is its ability to follow individuals who relocate, thus preserving the sample's representativeness. This feature allows us to employ an individual fixed effects model to robustly examine the impact of natural disaster exposure on locus of control. We use the most recent release of HILDA survey, covering the period from 2001 to 2022.

2.2. Natural disaster exposure measure

Individuals are classified as directly impacted by a natural disaster if they report that their residence sustained damage or destruction due to a weather-related disaster, such as a flood, bushfire, or cyclone, within the preceding 12 months. This categorization is based on responses to a survey question asking, “Did any of these events occur to you in the past 12 months?”

specifically prompting, “A weather-related disaster (e.g., flood, bushfire, cyclone) damaged or destroyed your home”. Australian research has frequently used this variable as a proxy for direct exposure to natural disasters, examining its effects on mental health (Baryshnikova & Pham 2019), economic outcomes (Johar *et al.* 2022), life satisfaction (Gunby & Coupé 2023; Nguyen & Mitrou 2024a), and residential responses (Nguyen & Mitrou 2024c). This measure is available only from Wave 9 onwards (Summerfield *et al.* 2023).

2.3. Locus of control measure

The locus of control measure in the HILDA survey is constructed from respondents’ responses to seven statements. These statements are: (1) “I have little control over the things that happen to me”, (2) “There is really no way I can solve some of the problems I have”, (3) “There is little I can do to change many of the important things in my life”, (4) “I often feel helpless in dealing with the problems of life”, (5) “Sometimes I feel that I’m being pushed around in life”, (6) “What happens to me in the future mostly depends on me”, and (7) “I can do just about anything I really set my mind to do”.

The first five statements (1-5) measure external control, while the last two (6-7) refer to internal control. For each statement, respondents indicate their level of agreement or disagreement on a scale from 1 (“Strongly disagree”) to 7 (“Strongly agree”). To ensure consistency of responses across all seven statements, the responses to the first five statements are reverse-coded so that a higher score indicates a greater sense of control. Following prior Australian research using the same HILDA data (Cobb-Clark & Schurer 2013; Buddelmeyer & Powdthavee 2016; Elkins *et al.* 2017), a summary score is constructed by aggregating the reverse-coded scores from the first five statements with the scores from the last two statements. Thus, the summary score of LoC ranges from 7 to 49, with a higher score indicating a greater sense of personal control over life outcomes, and vice-versa. Furthermore, to facilitate interpretation of the results, this LoC summary score is standardized to have a mean of zero and a standard deviation of one (Elkins *et al.* 2017).[1] A higher score on this standardized LoC measure still indicates a greater sense of control over life. In the current release of HILDA, the LoC measure is only available in Waves 3, 4, 7, 11, 15 and 19.

2.4. Sample

The unit of analysis in this paper is the individual, as both the LoC and natural disaster exposure measures are recorded at the individual level. We restrict the sample to survey waves that include both LoC and natural disaster exposure measures. Consequently, our sample encompasses three HILDA waves: 11, 15, and 19. Additionally, we require individuals to be observed at least twice within the study period, as our primary empirical model relies on individual fixed effects. By combining these restrictions, the final sample size consists of 39,367 individual-year observations from 14,744 unique individuals across nine years of data, spanning from 2011 to 2019, to examine the impact of weather-related home damage on LoC.

3. Empirical model

We employ the following econometric model to investigate the effects of weather-related home damage on locus of control Y of individual i at time t:

$$Y_{it} = \alpha_1 + \beta_1 D_{it} + X_{it}\gamma_1 + \delta_i + \varepsilon_{1it} \qquad (1)$$

where D_{it} is a binary variable capturing whether the individual's home was damaged or destroyed by a weather-related event. X_{it} is a set of time-variant explanatory variables. δ_i captures individual time-invariant unobservable factors and ε_{1it} denotes the usual idiosyncratic term. α_1, β_1 and γ_1 are parameters to be estimated.

[1] Because we will use different samples throughout this paper, for comparability purposes, the summary score of LoC is standardized using all valid LoC summary scores of all individuals observed in Release 22 of HILDA. This approach may result in means or standard deviations of the standardized scores that are not exactly zero or one, respectively, for certain samples, including the main sample.

In equation (1), β_1 is the parameter of interest, which captures the effect of home damage on the individual's locus of control. While the above individual fixed effects (FE) regression model (1) controls for individual time-invariant unobserved characteristics, such as genetic factors or residential preferences, it cannot deal with issues associated with reverse causality, unobservable time-variant factors correlating with both LoC and home damage, and measurement errors (Wooldridge 2010). Specifically, it is unclear whether self-reported home damage changes the individual's locus of control or individuals with a different sense of control have differential tendency to report weather-related home damage. There is also a concern that there are some individual unobservable time-variant factors, such as health shocks, correlate with both LoC and home damage at the same time. Moreover, while the respondent was asked to report any home damage, the magnitude of such a damage, if any, is not reported. These factors, in isolation or combination, can lead to bias in the FE estimates (Wooldridge 2010; Nguyen *et al.* 2024).

As such, the estimate of β from equation (1) may not capture the true causal impact of home damage on one's locus of control. We employ the following auxiliary equation in an instrumental variables (IV) approach to investigate whether the individual i reports any weather-related home damage:

$$D_{it} = \alpha_2 + \sigma Z_{it} + X_{it}\gamma_2 + \delta_i + \varepsilon_{2it} \qquad (2)$$

where Z_{it} is an instrumental variable, ε_{2it} is an error term, and α_2, σ and γ_2 are vectors of parameters to be estimated. X_{it} and δ_i are defined as in Equation (1).

We follow Nguyen and Mitrou (2024c, 2024a) in employing a variable indicating whether an individual was affected by any cyclone in the previous year as an instrument to identify the home damage equation (2). This variable is considered a suitable instrument for several reasons. First, previous Australian research by Nguyen and Mitrou (2024c), demonstrates that cyclones, particularly those of greater severity and closer proximity to homes, substantially increase self-reported weather-related home damage. Second, the instrument is theoretically robust: the plausibly exogenous exposure to cyclones directly impacts individuals' self-reported home damage, indirectly influencing their LoC. This argument is further supported by the data, as cyclones are explicitly mentioned as a natural disaster event causing home damage in the questionnaire prompt. Third, this instrument varies over time for the same individuals, facilitating its application in individual fixed-effects models, which effectively control for both time-invariant and time-variant individual unobservable factors. Fourth, we will empirically assess the strength of this instrument against concerns of correlation with individual time-varying unobservable factors by controlling for some time-variant variables, including income and health.

Following the methodology outlined by Nguyen and Mitrou (2024c), we determine an individual's exposure to cyclones within a given year by considering both the distance to the cyclone's eye and its category. This is achieved by linking the HILDA data to a publicly available historical cyclone database from the Australian Bureau of Meteorology (BOM). We connect these datasets by aligning the cyclone path and timing from the historical cyclone database with the individual's residential postcode centroid and interview date from HILDA.

In the baseline regressions, we adopt a single cyclone exposure measure indicating whether the individual’s residential postcode was affected by any cyclone within a 100 km radius of the cyclone's eye in the year prior to the survey, using this as a cyclone exposure-based instrument. This approach is selected to maximize the number of individuals identified as affected by such cyclones and to establish a strong instrument, ensuring the reliability of our analysis. In robustness checks, we will employ alternative instruments constructed using the individual’s exposure to cyclones with varying levels of severity.

We include a parsimonious number of individual and household-level time-variant variables in X_{it}. These variables encompass the individual's age (and its square), marital status, education, the number of household members, and major city residency. To address potential temporal differences in outcomes, we separately control for survey year and quarter dummies. Moreover, we account for regional differences by including state/territory dummies in both equations. Additionally, we control for variations in local socio-economic environments that may influence individual behaviors by incorporating regional unemployment rates and the relative socio-economic disadvantage index (SEIFA). Appendix Table A1 presents variable description and summary statistics.

Utilizing multiple observations per individual, we employ an individual fixed-effects (FE) regression methodology in both equations. This analytical approach effectively mitigates concerns regarding individual heterogeneity, encompassing factors such as residential location preferences. The inclusion of individual fixed effects is imperative to account for unobservable time-invariant characteristics, a critical consideration given empirical evidence indicating that regions prone to natural disasters often exhibit greater levels of socioeconomic disadvantage (Dell *et al.* 2014; Botzen *et al.* 2019).

We employ an Ordinary Least Squares (OLS) method to estimate the individual fixed-effects equation (1) and conduct a two-stage least squares (2SLS) regression method for the fixed-effects instrumental variable (FE-IV) model. The estimates of β_1 from these empirical models capture the treatment effects of weather-related home damage on LoC at the mean. Departing from regression at the mean, our study explores quantile treatment effects, enabling an examination of how the treatment effect varies across different points of the LoC distribution (Koenker & Bassett 1978; Firpo *et al.* 2009). By analysing treatment effects at various quantiles, we gain insights into the differential impact of weather-related home damage on individuals, thereby informing the development of more targeted and efficacious policy interventions.

To estimate the quantile regression equation (1), we employ an unconditional quantile regression (UQR) method proposed by Firpo *et al.* (2009). This selection is preferred over the conditional quantile regression method developed by Koenker and Bassett (1978) as it provides a means to recover the marginal impact of explanatory variables on the unconditional quantile of Y without necessitating the rank-preserving condition (Firpo 2007; Firpo *et al.* 2009). Furthermore, to estimate the quantile IV regression equations (1) and (2), we utilize a recently developed quantile regression for panel data (QRPD) method by Powell (2020, 2022), which employs a Generalized Method of Moments (GMM) estimator to estimate treatment effects along the distribution of the outcome variable. Powell's method (2022) aligns with our research aims, as it accommodates both individual fixed effects and instrumental variable methods within a quantile fixed-effects instrumental variable (FE-IV) framework.

4. Results

4.1. Descriptive results

Table 1 unveils stark differences in key characteristics between individuals who reported weather-related home damage and those who did not. While only 1.99% of individuals in the main sample experienced home damage due to weather-related disasters, this still represents the substantial number of 782 affected individuals forming the "treated" group, ensuring sufficient data to capture the impact of home damage, if any, on LoC. Compared to individuals who did not report weather-related home damage (the "control" group), treated individuals tend to be younger, less educated, and more likely to be born in Australia. They also face greater socio-economic challenges, residing in areas with lower socio-economic advantage. Notably, they are significantly more likely to have been within 100 km of any cyclone's eye. This pattern aligns with the global trend that disadvantaged individuals and locations are more likely to encounter higher natural disaster risk (Dell *et al.* 2014; Botzen *et al.* 2019), highlighting the importance of accounting for individual fixed effects when analysing the impacts of natural disasters.

Furthermore, Table 1 reveals a striking disparity in LoC between the groups. Treated individuals report a significantly lower sense of control compared to their unaffected counterparts. This disparity is visually evident in Figure 1, where treated individuals are over-represented at the lower end of the locus of control distribution.[2] However, as discussed in Section 3, this difference may not stem solely from weather-related home damage but rather reflect pre-existing factors influencing both home damage and LoC. The subsequent analysis directly addresses this critical issue.

4.2. Regression results

Table 2 presents estimates of the home damage variable derived from four regression models at the mean: a pooled regression without controlling for individual fixed effects (reported in Column 1), an individual FE model (Column 2), an IV model without controlling for individual fixed effects (Columns 3 and 4), and an individual FE-IV model (Columns 5 and 6). The pooled regression results (Column 1) reveal a negative and statistically significant (at the 1% level) association between home damage and LoC. This negative correlation suggests that individuals whose homes were damaged or destroyed by a weather-related disaster report a lower sense of control over their lives. By contrast, the individual FE estimate is not statistically significant, indicating no noticeable association between home damage and LoC.

The estimates from the two IV regression models at the mean unveil two notable findings. First, the estimates of the cyclone exposure variable from the first-stage regressions, reported in

[2] Figure 1 displays the distribution of LoC for both the treated and control groups, demonstrating substantial variations in this outcome. These variations enable an examination of the differential impacts of home damage on individuals at different points of the LoC distribution. It is important to note that, for demonstration purposes, we have intentionally used raw summary scores of LoC in this figure.

Columns 3 and 5, are positive and highly statistically significant at the 1% level. This suggests that individuals affected by any cyclone within 100 km of its eye are more likely to report weather-related home damage. For instance, consistent with the findings by Nguyen and Mitrou (2024c), the estimate from the first stage of the FE-IV regression indicates that individuals affected by such a cyclone are about 10 percentage points more likely to report home damage (Column 5). Importantly, the first-stage F-statistic, reported at the bottom of Columns 3 and 5 in Table 2, surpasses 160 in both IV regressions, robustly rejecting the null hypothesis of a weak instrument (Stock & Yogo 2005). Second, the IV estimates of home damage are statistically insignificant, regardless of whether individual fixed effects are accounted for. Therefore, the estimate derived from our preferred FE-IV model indicates a statistically insignificant treatment effect of weather-induced home damage on LoC at the mean of the LoC contribution.

As with the regressions at the mean presented in Table 2, Figure 2 similarly reports graphical estimates of the home damage variable across nine deciles from four quantile regression models: a pooled model without controlling for individual fixed effects (Panel A), an individual FE model (also in Panel A), an IV model without controlling for individual fixed effects (Panel B), and an individual FE-IV model (Panel B).[3]

The pooled quantile regression estimates (Panel A) are negative and statistically significant at least at the 5% level for quantiles at or below the 60th quantile. Moreover, these estimates are more pronounced at the lower end of the distribution. These results suggest that weather-related home damage is negatively associated with the locus of control for individuals having a weaker sense of control, with the negative relationship being more pronounced for those at the lower

[3] In our analysis, we employ the qregpd command developed by Powell (2022) in STATA MP Version 18 to conduct estimations using a quantile instrumental variable model, regardless of whether individual fixed effects are accounted for. The qregpd command utilizes a GMM estimator, as described by Wooldridge (2010) and Powell (2022), for estimating these equations. It is important to note that while qregpd incorporates the instrument, it does not provide any test statistic for evaluating the strength of the instrument.

end of the distribution. However, the quantile FE estimates, also reported in Panel A, show no statistically significant association between home damage and LoC, as all estimates are statistically insignificant across the entire distribution of LoC.

Panel B presents the quantile IV regression results. The IV estimates are consistently negative and statistically significant at the 1% level across all nine deciles of the LoC distribution. However, the magnitude of the effect varies. The estimates are relatively small at the upper end of the distribution (80th and 90th quantiles) but begin to increase in absolute value from the 70th quantile, reaching a maximum negative impact at the 30th quantile before decreasing again.

In contrast, the quantile FE-IV estimates show a more nuanced pattern (also reported in Panel B). While similar to the IV estimates at the 70th and 80th quantiles, the FE-IV estimates differ significantly at other points. Notably, the FE-IV estimate is not statistically significant at the 90th quantile, suggesting no significant effect for individuals with the highest LoC. Furthermore, the absolute magnitude and statistical significance of the FE-IV estimates are generally lower than those of the IV estimates at quantiles 20, 30, 50, and 60. However, the FE-IV estimates are more negative and statistically significant at the 10th and 40th quantiles. Interestingly, the difference between the two estimates is statistically significant at the 5% level at the 40th quantile, as indicated by non-overlapping 95% confidence intervals at this quantile. Panel B also reveals that the FE-IV estimate reaches its maximum negative effect (in absolute value) at the 10th and 30th quantiles. This suggests that weather-related home damage reduces LoC for individuals at these points in the distribution by up to 0.23 standard deviations.

In summary, our preferred FE-IV regression results provide compelling evidence that cyclone-induced home damage significantly reduces individuals' LoC. However, this impact is particularly pronounced for those near or below the median of the LoC distribution. Moreover, individuals at the lower end of the LoC distribution experience the greatest erosion in their LoC following weather-related home damage.

5. Robustness checks and additional results

5.1. Robustness checks

We assess the robustness of our findings through a series of sampling and specification tests. The first sampling test involves excluding from the regression those states/territories that were not affected by any cyclone during the study period. This test addresses concerns regarding whether the baseline sample contained sufficient variation in cyclone exposure. Similarly, the second sampling test includes only Local Government Areas (LGA) that were impacted by at least one cyclone within 100 km of its eye during the study period. The results from these two experiments are presented in Panel B1 and Panel B2 of Appendix Table A3, respectively. Reassuringly, these results closely align with those from the baseline regressions (re-reported in Panel A), both at the mean and across different quintiles.

We next investigate the sensitivity of our findings using different instruments. Specifically, we separately employ two alternative instruments, each constructed from a different cyclone exposure measure derived from the baseline instrument. The two cyclone exposure-based instruments are: exposure to any cyclone within 40 km of its eye, and exposure to a category 5 cyclone within 100 km of its eye.[4] The results from these sensitivity tests are presented in Panels C1 and C2, respectively, and reveal two notable findings.

Firstly, utilizing exposure to more severe cyclones, as measured by closer proximity to the home or higher category, enhances the strength of the instrument, as indicated by a higher reported F statistic compared to the baseline. This finding is consistent with the previous

[4] We refrain from utilizing other cyclone exposures as instruments due to their limited capacity to induce home damage or the relatively small number of individuals affected by such cyclones during the study period, thus rendering them weak instruments.

Australian study by Nguyen and Mitrou (2024c), which observes that the impact of cyclone exposure on home damage increases with the cyclone category and decreases with the distance from the cyclone eye.

Second, using exposure to more severe cyclones as an instrument substantially alters the estimates of home damage impacts, with the change varying across the points of the LoC distribution. On the one hand, it makes the estimates of cyclone-induced home damage more pronounced in terms of statistical significance or magnitude at the median or above of the LoC distribution. The heightened devastating impacts observed from using exposure to more severe cyclones as an instrument align with the view that these more severe cyclones are expected to cause more home damage (BOM 2024), resulting in a more notable impact on LoC, especially for individuals at the higher end of the LoC distribution. Conversely, this approach slightly reduces the magnitude of the estimates of home damage at the 10th, 30th, and 40th quantiles. However, the main finding of a more pronounced impact of cyclone-induced home damage on LoC for individuals at the lower end of the distribution remains robust.

We next exclude certain time-variant variables, such as education, marital status, household size, and whether the individual lived in a major city, which may be concurrently affected by the cyclone exposure-based instrument, from the regression. The results, presented in Panel D1 of Appendix Table A3, indicate that cyclone-induced home damage now has a significantly stronger impact on LoC, particularly for individuals at the lowest three quantiles of the distribution, than previously observed in the baseline regressions. For example, for individuals at the 10th quantile, cyclone-induced home damage now reduces their LoC by 0.62 standard deviations, which is 2.7 times greater than the baseline estimate of 0.23 standard deviations. However, consistent with the baseline results, this robustness check confirms that individuals at the lowest quantiles of the LoC distribution exhibit the most significant reduction in their LoC.

Conversely, we separately and additionally control for each of two time-variant variables that may be concurrently correlated with natural disaster-related home damage in the regression (Baryshnikova & Pham 2019; Johar *et al.* 2022). Specifically, we control for non-wage income and health, as measured by the Short Form (SF)-36 general health summary score. The results from these two experiments are presented in Panels D2 and D3 of Appendix Table A3, respectively. Panel D2 indicates that additionally controlling for non-wage income does not alter the estimates, consistent with the finding of a statistically insignificant relationship between home damage and this source of income (Johar *et al.* 2022).

However, including general health in the regression reduces the magnitude of the estimates (i.e., the estimates become less negative, as can be seen from Panel D3), particularly for individuals at the lower end of the LoC distribution. This result aligns with the statistically significant positive association between health shocks and an external locus of control found by Elkins *et al.* (2017). It also corresponds with prior evidence from Baryshnikova and Pham (2019), which shows that home damage negatively affects the mental health of individuals, especially those at the lower end of the mental health distribution. Despite this reduction in magnitude, the estimate for individuals in the top quintile remains the smallest, reaffirming the key finding of more pronounced impacts on individuals at the lower end of the LoC distribution.

Overall, the above comprehensive sensitivity analysis demonstrates that our findings are resilient to various sampling and specification tests, bolstering the internal and external validity of the study.

5.2. Additional results

This subsection provides additional results on the impacts of cyclone exposure on individuals' LoC. Following the methodology outlined by Nguyen and Mitrou (2024c, 2024a), we investigate the effects of cyclone exposure by incorporating a variable describing the individual’s exposure to local cyclones as an additional explanatory variable in an individual fixed effects model similar to Equation (1). Specifically, we use this cyclone exposure variable in place of the weather-related home damage variable in Equation (1), while other explanatory variables remain the same as previously described in Section 3. For brevity and demonstration purposes, we separately employ one of four cyclone exposure measures, each identified by (i) the distance from the individual’s residing postcode centroid to the cyclone eye (i.e., 40 km or 100 km) and (ii) the cyclone category (i.e., any category and category 5 only). Similar to the analysis of weather-related home damage, we employ an individual fixed effects regression model to explore the effects of cyclone exposure on LoC both at the mean and along the distribution of LoC. This section utilizes a larger sample than previously used, as we only need to restrict the sample to HILDA survey waves with valid LoC measures (recall that previously we restricted the sample to survey waves with both home damage and LoC measures available).

The results from this experiment, presented in Appendix Table A4, show limited evidence that exposure to cyclones substantially influences individuals’ LoC. This is the case for both regressions at the mean and along the distribution of LoC. However, there are a few exceptions. First, exposure to any cyclone within 40 km of its eye statistically significantly (at the 5% and 10% levels, respectively, as shown in Panel A – Columns 8 and 9) reduces LoC for individuals at the 70th and 80th quantiles of the LoC distribution. Similarly, exposure to a category 5 cyclone within the same distance marginally statistically significantly (at the 10% level, as shown in Panel B – Column 3) diminishes LoC for individuals at the 20th quantile of the LoC distribution. Conversely, exposure to any category 5 cyclone within 100 km of its eye marginally statistically significantly (at the 10% level, as shown in Panel D – Column 10) improves LoC for individuals at the top quantile of the LoC distribution.

The finding that the negative impact on LoC is observed only for individuals exposed to cyclones of greater severity (i.e., closer proximity to home or higher category) corroborates our earlier evidence of a heightened impact of home damage on LoC when using exposure to more severe cyclones as an instrument. However, the widespread statistically insignificant impact of cyclone exposure, compared with the widespread statistically significant impact of cyclone-induced home damage, suggests that while LoC is resilient to cyclone exposure, only cyclones that damage or destroy homes diminish individuals' perception of control over their life outcomes. This result aligns with Nguyen and Mitrou (2024a), who also found that cyclone-induced home damage, particularly from the most severe cyclones, significantly reduces life satisfaction compared to cyclone exposure alone.

6. Heterogeneity

To explore potential channels through which home damage affects LoC and to identify vulnerable sub-populations, we employ a quantile FE-IV regression model[5] to estimate the effects of home damage separately for two distinct groups defined by eight individual, household, or regional characteristics. These characteristics include gender (male vs. female), age group (young vs. old, categorized relative to the median population age), homeownership status (renters vs. homeowners), income group (lower income vs. higher income households, defined relative to the median), residential insurance status (insured vs. uninsured)[6], urban/rural residence (major city vs. rural area), distance to the coast (coastal areas vs. inland areas, defined relative to the median distance to the coast), and whether the individual resides in a "cyclone-

[5] We have conducted a similar heterogeneous analysis of the impacts of home damage on the mean of locus of control by applying the FE-IV model to various subgroups as described below. Consistent with the population estimates derived from the FE-IV regression at the mean, all subgroup estimates of home damage are statistically insignificant. The results of this analysis are presented in Appendix Table A5 demonstrates that the instrument is empirically robust, as the F statistic from the first-stage regression exceeds 45 in nearly all instances. However, there are two notable exceptions: the regression results for residents in urban areas and historically cyclone-free areas, where the F statistic falls below the conventional threshold of 10. This is likely due to the small number of individuals affected by any cyclone within 100 km or the cyclone not being sufficiently strong to cause substantial home damage in such areas. Consequently, the interpretation of the results for these subgroups should be approached with caution due to the presence of a weak instrument.

[6] Following Nguyen and Mitrou (2024c, 2024b), this study categorizes individuals as "insured" if their reported annual household expenditure on combined home, contents, and motor vehicle insurance exceeds $1,250 (adjusted to 2010 prices). Those reporting lower expenditures are categorized as "uninsured." Data on home and contents insurance is derived from Wave 6 onwards, utilizing responses to the "other insurance (home/contents/motor vehicle)" expenditure question.

prone area" (postcode experiencing a cyclone within 100 km in the past 30 years) or a "cyclone-free area".

To mitigate concerns regarding the influence of weather-related home damage on sub-population classification, individuals are categorized based on the values of time-variant variables (excluding age) observed at their first appearance in the sample. Figure 3 presents the heterogeneous results across eight panels, with each panel displaying subgroup estimates based on one of the characteristics described above.

Panel A of Figure 3 reports subgroup estimates by gender, indicating that females are disproportionately affected, particularly those at the lower end of the LoC distribution. This is evident from the more pronounced estimates for females in terms of both magnitude and statistical significance across the four lowest quantiles. Specifically, the estimates are more negative and statistically significant for females at these quantiles, with the gender difference being statistically significant at the 5% level for the 20th, 30th, and 40th quantiles, as indicated by non-overlapping 95% confidence intervals. Moreover, the estimate is negative and statistically significant at the 1% level exclusively for females at the 10th quantile.

In contrast, for males, the estimates are more negative and statistically significant at the 50th, 60th, and 70th quantiles, with the gender difference being statistically significant (at 5% level) only at the 60th quantile. Panel A also reveals that the greatest reduction in LoC due to home damage occurs for females at the 30th quantile, while for males, the most substantial reduction is observed at either the 20th or 30th quantile.

Subgroup estimates by age, reported in Panel B, indicate that cyclone-induced home damage disproportionately reduces LoC of older individuals compared to younger ones. Specifically, the estimates of home damage are more negative and statistically significant for older individuals positioned within all deciles except the highest quantile where estimates are statistically insignificant for both age groups. The difference between the two age groups is statistically significant, at least at the 5% level, across the 30th, 50th, 60th, 70th, and 80th quantiles. Moreover, consistent with the results for the entire population, subgroup estimates also reveal that home damage has a more pronounced impact on individuals positioned at the lower end of the spectrum, particularly among older individuals. The most negative impact on LoC is observed for older individuals at the 10th quantile, while for younger individuals, the most substantial reduction is at the 20th quantile.

Panel C of Figure 3 illustrates a noticeable disparity in the impact of home damage on LoC between homeowners and renters, with this difference varying across different points along the LoC distribution. Home damage reduces LoC more for renters positioned at the lower end of the distribution, with this difference being statistically significant at the 5% level at the 30th quantile. Additionally, cyclone-induced home damage significantly diminishes LoC of renters, but this effect is statistically significant only at the 40th quantile. Conversely, home damage has a more pronounced impact on LoC of homeowners at the three highest quantiles (70th, 80th, and 90th), with the impacts being negative and statistically significant at the 1% level exclusively for them.

Notably, even homeowners positioned at the upper end of the LoC distribution demonstrate a diminished sense of control when cyclones damage their homes. The heightened negative impact of home damage for homeowners at the top of the LoC distribution can be attributed to their greater personal investment in, and perhaps attachment to, their homes, along with the financial responsibility which comes with ownership. Renters may lack such a bond. For example, from a renter's perspective, the expensive repairs and any preventive fortification of the damaged house would be considered a problem for the landlord and their insurance company. This finding underscores the substantial psychological toll of cyclone-induced home damage, especially for homeowners. For both renters and homeowners, the most negative impact on LoC is observed at the 30th quantile.

Subgroup estimates by household income, as reported in Panel D, suggest that cyclone-induced home damage disproportionately reduces LoC of individuals from wealthier households. Specifically, the estimates of home damage are more negative and statistically significant for this group across all nine quantiles of the LoC distribution. The difference between income groups is statistically significant at the 5% level for the 30th and 70th quantiles, as evidenced by non-overlapping 95% confidence intervals. Additionally, estimates are negative and statistically significant at the 1% level for individuals from higher income households only, at the 10th and 80th quantiles.

Panel E displays subgroup estimates by residential insurance status, indicating that individuals without prior home insurance experience a more pronounced reduction in LoC at the 40th quantile, with the difference being statistically significant at the 1% level. Moreover, the estimate is negative and statistically significant at the 1% level exclusively for uninsured individuals at the top quintile of the distribution. This finding underscores the disproportionate diminishment of LoC among individuals without prior residential insurance. When considered alongside evidence presented by Nguyen and Mitrou (2024c) indicating that acquiring residential insurance serves as an effective coping mechanism, the importance of residential insurance becomes evident. Together, our findings suggest that residential insurance not only mitigates future home-related repair costs but also helps maintain LoC when individuals are exposed to future natural disasters.

Panel F illustrates that cyclone-induced home damage disproportionately diminishes LoC of urban residents compared to rural residents. This is demonstrated by the more negative and statistically significant estimates for urban residents, particularly those positioned in the first seven deciles of the distribution. Additionally, the rural/urban disparity in the impact of home damage on LoC is statistically significant at least at the 5% level for individuals at the 20th, 40th, and 60th quantiles. An exception is observed at the top quintile of the LoC distribution, where cyclone-induced home damage statistically significantly (at the 5% level) reduces LoC of rural residents exclusively. The heightened negative impact of cyclone-induced home damage on LoC of urban residents, coupled with the fact that urban residents are nearly twice as less likely to report weather-related home damage as rural residents, suggests a critical role for natural disaster readiness in protecting individuals in less-affected regions from future adverse events.

Subgroup estimates of the impact of home damage by distance to the coast reveal a noticeable difference in the impact of home damage on LoC between residents in coastal and inland regions, with this disparity varying across different points along the LoC distribution (Panel G). The impact of cyclone-induced home damage is more pronounced for residents in coastal regions at the 10th and 20th quantiles, as demonstrated by more negative and statistically significant estimates for these groups, with the difference being statistically significant at the 5% level at the 20th quantile. However, compared to the estimates for residents in coastal areas, the estimates for those in inland areas are more negative and statistically significant at the top seven deciles of the LoC distribution, with the difference being statistically significant at least at the 5% level at almost all of these seven deciles, except for the median.

Notably, even residents in inland regions positioned at the upper end of the LoC distribution demonstrate a diminished sense of control when cyclones damage their homes. The finding that cyclone-induced home damage substantially and disproportionately reduces LoC of residents in inland areas—who are 11% less likely to be affected by any cyclone within 100 km of its eye but 33% more likely to report weather-related home damage—underscores the critical importance of natural disaster preparedness in safeguarding individuals in less-affected regions such as inland areas from future natural disasters.

Panel H in Figure 3 reports subgroup estimates of home damage impacts by locality cyclone exposure history, unveiling a disproportionate reduction in LoC for residents in historically cyclone-free areas. Specifically, compared to the estimates for residents in historically cyclone-prone regions, the estimates for those in historically cyclone-free regions are more negative and statistically significant at all nine deciles of the LoC distribution, except for the third decile where the estimates for both groups are largely similar. Moreover, the difference is statistically significant at least at the 5% level at the 20th, 40th, 80th, and 90th quantiles. Notably, cyclone-induced home damage statistically significantly (at the 1% level) and substantially reduces LoC of residents in historically cyclone-free regions positioned at the top decile of the LoC distribution by 0.10 standard deviations.

The pronounced disparity in the impact of cyclone-induced home damage on LoC between individuals from historically cyclone-free and cyclone-prone regions, particularly at both extremes of the LoC distribution, underscores the significance of historical context in shaping responses to extreme events. The finding of a more severe negative impact on LoC for residents in historically cyclone-free regions aligns with the broader concept of acclimatization documented in climate change literature, where populations routinely exposed to environmental threats exhibit less pronounced behavioural responses to new pressures (Dell *et al.* 2014). Our analysis indicates that individuals lacking prior experience with extreme events may be particularly vulnerable to diminished LoC when encountering such events for the first time. This finding further emphasizes the role of natural disaster readiness in protecting individuals in historically natural disaster-free regions from future disasters.

Overall, the aforementioned heterogeneous analysis highlights substantial differential impacts of cyclone-induced home damage on LoC among various socio-demographic and regional groups. The extent of this heterogeneity varies along the LoC distribution. However, a general finding is that individuals with specific characteristics—women, older individuals, those from wealthier households or households without prior residential insurance, residents in urban or inland areas, and those in historically cyclone-free regions—are more negatively affected. This underscores the necessity for targeted support policies aimed at building resilience and assisting vulnerable populations.

7. Conclusion

This study represents the first investigation into the causal impacts of natural disaster-driven home damage on individuals' locus of control. Utilizing longitudinal data from the Household, Income and Labour Dynamics in Australia (HILDA) survey, we implemented an individual fixed effects instrumental variables (FE-IV) approach. This method leverages time-varying, exogenous exposure to local cyclones to effectively address the endogeneity of self-reported weather-related home damage. This study unveils new and robust evidence that cyclone-induced home damage substantially reduces individuals' sense of control over their life outcomes. However, this significant impact is only observed in the quantile FE-IV regressions, where individuals near or below the median of the locus of control distribution are negatively and substantially affected by weather-related home damage. Notably, individuals at the lower end of the LoC distribution exhibit the greatest erosion in their locus of control, with weather-related home damage reducing their locus of control by 0.23 standard deviations.

Our extensive heterogeneous analysis further reveals substantial differential impacts of cyclone-induced home damage on locus of control across various socio-demographic and regional groups. The extent of this heterogeneity varies along the locus of control distribution, with a general trend indicating more pronounced impacts for women, older individuals, those from wealthier households or households without prior residential insurance, residents in urban or inland areas, and those in historically cyclone-free regions.

The results presented in this study have significant methodological and policy implications. Methodologically, our findings highlight the importance of adequately addressing the endogeneity of self-reported natural disaster-related home damage when quantifying its impacts on locus of control. Specifically, we address this endogeneity by leveraging time-varying, exogenous exposure to local cyclones in our FE-IV approach. This study also demonstrates the benefits of examining the effects of natural disaster exposure beyond the mean of the locus of control distribution. Specifically, our results show that focusing solely on the mean impact would inadvertently fail to detect the severe consequences of natural disaster exposure on individuals' locus of control and miss crucial insights into the differential impacts across different points of the distribution.

Our novel finding of the negative and substantial impacts of weather-related home damage on internal locus of control indicates that locus of control can be altered under specific conditions. From a policy perspective, this insight offers valuable guidance for developing effective policies and interventions to support affected populations, especially those disproportionately impacted by natural disasters.

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Table 1: Sample means of key variables by weather-related home damage status

	With home damage	Without home damage	With - Without (1) - (2)
	(1)	(2)	(3)
Age (years)	45.183	46.810	-1.628**
Male	0.488	0.464	0.024
ESB immigrant	0.078	0.098	-0.02*
NESB immigrant	0.086	0.114	-0.028**
Married/De facto [(a)]	0.679	0.661	0.018
Separated/divorced/widowed [(a)]	0.129	0.132	-0.003
Year 12 [(a)]	0.142	0.150	-0.008
Vocational or Training qualification [(a)]	0.426	0.387	0.039**
Bachelor or higher [(a)]	0.157	0.212	-0.055***
Household size	2.836	2.815	0.021
Major city [(a)]	5.338	5.308	0.030
Local area unemployment rate (%)	5.003	5.591	-0.588***
Local area SEIFA index	0.469	0.628	-0.159***
Exposure to any cyclone within 100 km [(a)]	0.116	0.017	0.100***
Locus of control (standardized)	-0.083	0.072	-0.155***
Observations	782	38,585	

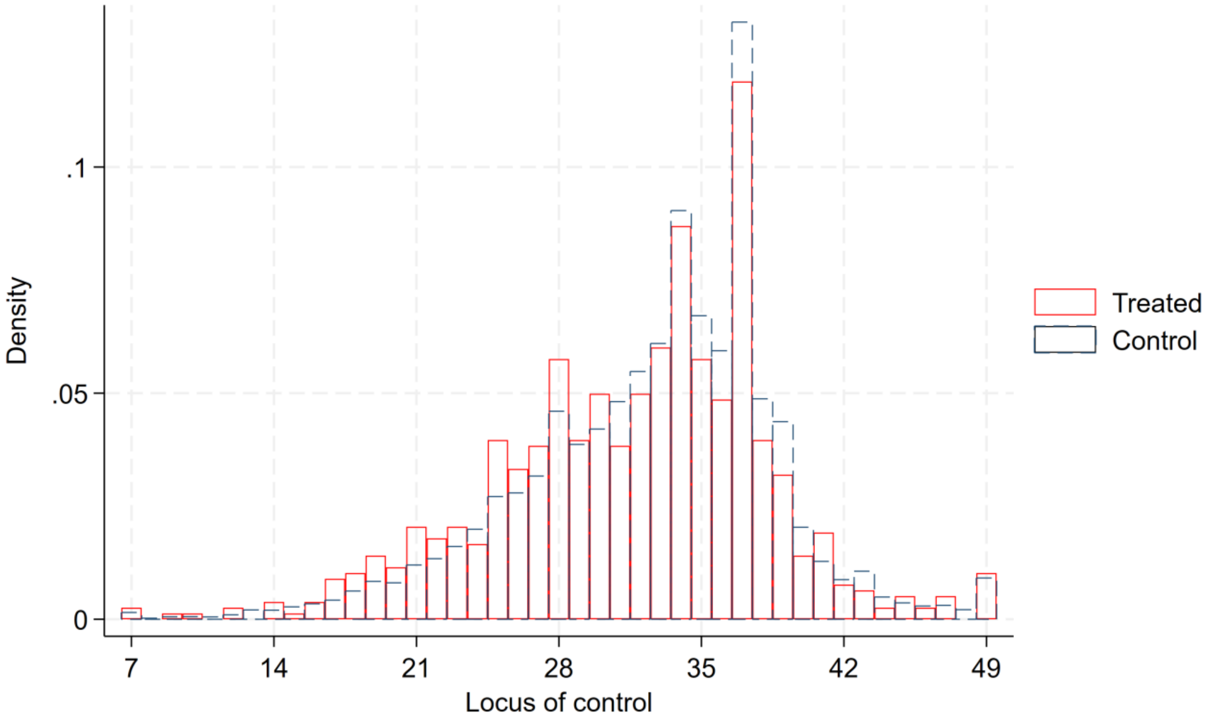
Notes: Figures are sample means. The 'treated group' consists of individuals with self-reported weather-related home damage in the past year, while the 'control group' includes those with no reported damage. [(a)] indicates a binary variable. Tests are performed on the significance of the difference between the sample mean for treated and control groups. The symbol *denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2: Estimates of weather-related home damage on locus of control at the mean

Specification:	Pooled	FE	IV		FE-IV	
			First stage	Second stage	First stage	Second stage
	(1)	(2)	(3)	(4)	(5)	(6)
Home damage	-0.13***	0.01		-0.25		0.31
	[0.04]	[0.04]		[0.41]		[0.46]
Age	-0.01***	0.00	-0.03	-0.01***	-0.73***	0.00
	[0.00]	[0.01]	[0.02]	[0.00]	[0.10]	[0.01]
Age squared	0.00***	0.00	0.00	0.00***	0.00***	0.00
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Male	0.03**		0.19	0.03**		
	[0.01]		[0.14]	[0.01]		
Born overseas in ESB country [(a)]	0.04*		-0.36	0.04*		
	[0.02]		[0.23]	[0.02]		
Born overseas in NESB country [(a)]	-0.15***		-0.08	-0.15***		
	[0.02]		[0.22]	[0.02]		
Married [(b)]	0.20***	0.09***	0.45**	0.20***	0.94*	0.09***
	[0.02]	[0.03]	[0.23]	[0.02]	[0.50]	[0.03]
Separated [(b)]	-0.03	0.03	0.40	-0.03	0.32	0.03
	[0.03]	[0.04]	[0.30]	[0.03]	[0.79]	[0.04]
Year 12 [(c)]	0.08***	0.04	-0.23	0.08***	-0.10	0.04
	[0.02]	[0.03]	[0.26]	[0.02]	[0.59]	[0.03]
Vocational or training qualification [(c)]	0.10***	0.07*	0.15	0.10***	0.17	0.07*
	[0.02]	[0.04]	[0.20]	[0.02]	[0.84]	[0.04]
Bachelor degree or higher [(c)]	0.17***	0.08*	-0.23	0.17***	-0.24	0.08*
	[0.02]	[0.04]	[0.23]	[0.02]	[0.85]	[0.04]
Household size	-0.01	-0.01**	-0.04	-0.01	0.01	-0.01**
	[0.00]	[0.01]	[0.06]	[0.00]	[0.11]	[0.01]
Local area unemployment rate	0.01	0.00	0.25**	0.01	0.16	0.00
	[0.01]	[0.01]	[0.12]	[0.01]	[0.14]	[0.01]
Local area SEIFA index	0.03***	0.00	-0.03	0.03***	-0.05	0.01
	[0.00]	[0.00]	[0.03]	[0.00]	[0.07]	[0.00]
Major city	-0.05***	0.00	-0.70***	-0.05***	-1.87***	0.01
	[0.02]	[0.03]	[0.18]	[0.02]	[0.54]	[0.03]
Exposure to any cyclone within 100 km			10.71***		9.72***	
			[1.37]		[1.43]	
Observations			39,367			
Number of unique individuals			14,744			
Mean of dependent variable			0.07			
F test statistic			334.39		161.97	

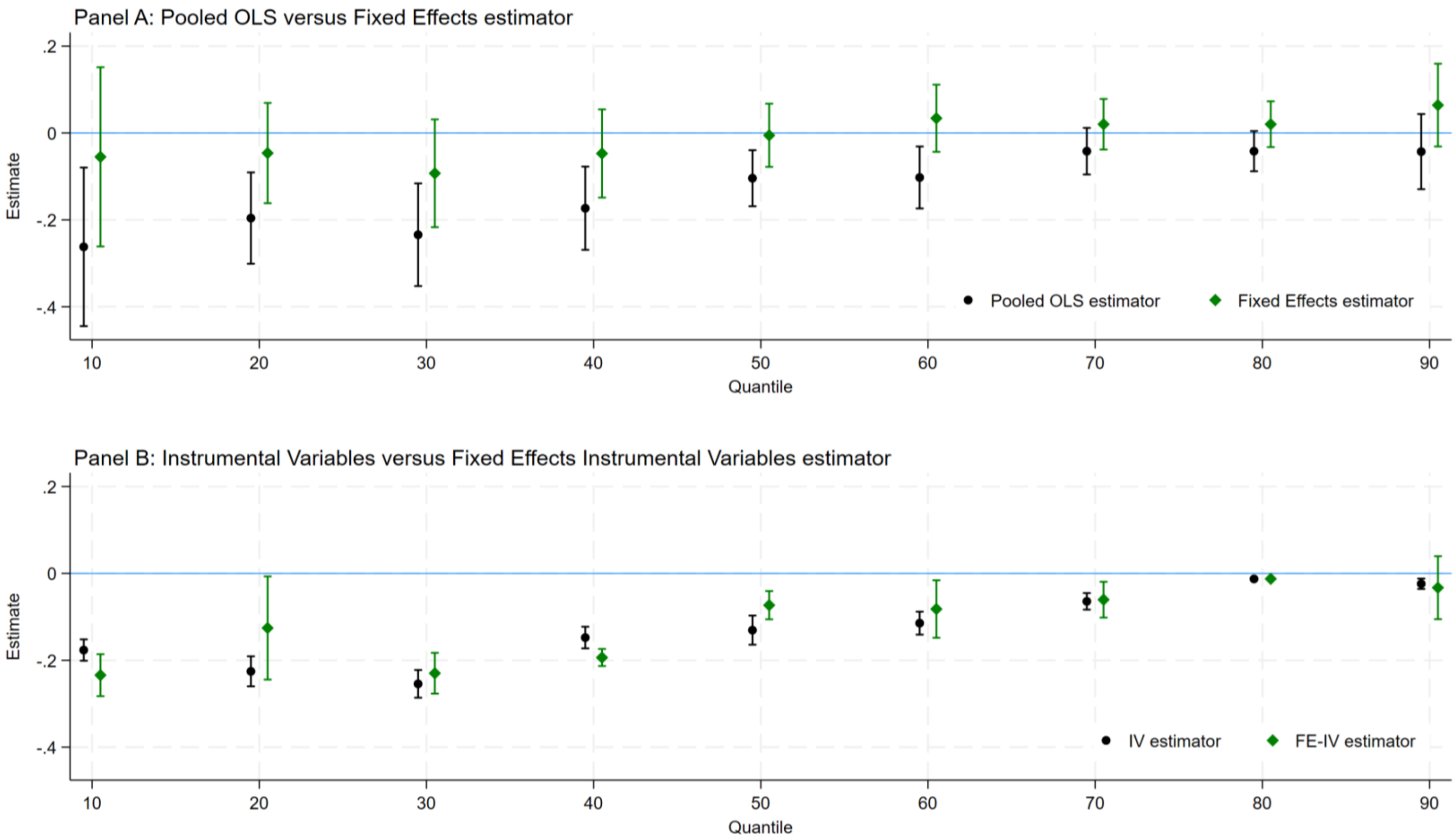
Notes: "Pooled" ("FE") results are from the regression (1) without (with) controlling for individual FEs. "IV" ("FE-IV") results from instrumental variable regressions (i.e., equations (1) and (2)) without (with) controlling for individual FEs. "F test statistic" denotes the F statistic for the strength of the excluded instrument in the first stage regression. [(a)], [(b)] and [(c)] indicates "Australia born", "Single" and "Under year 12 qualification" as the comparison group, respectively. Other explanatory variables include local area socio-economic variables, state/territory dummies, wave dummies, and survey quarter dummies. Robust standard errors clustered at the individual level in parentheses. Results from the first stage regressions are multiplied by 100 for aesthetic purposes. The symbol * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Figure 1: Histogram of locus of control by weather-related home damage status



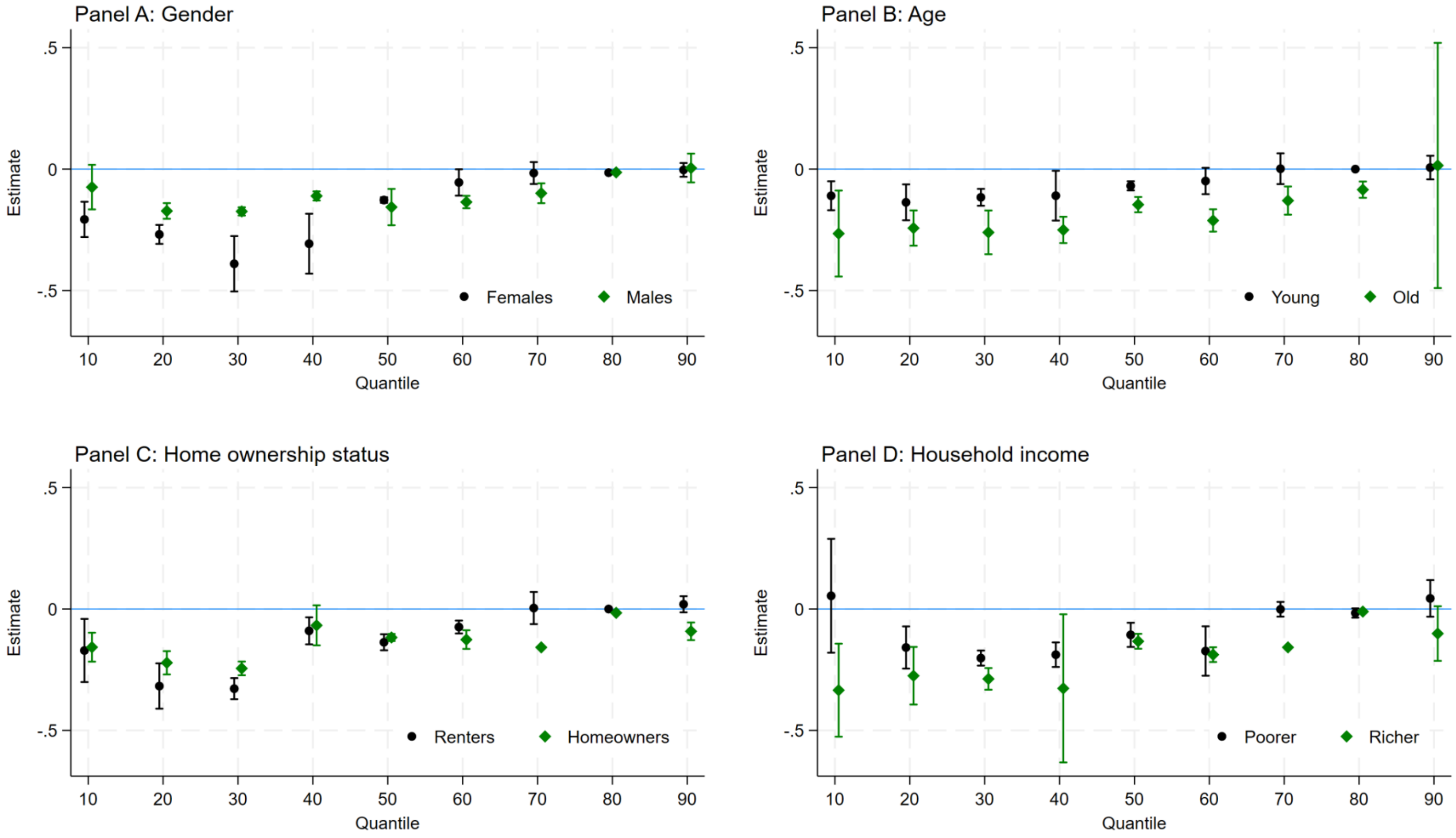
Notes: The treated" group consists of individuals with self-reported weather-related home damage in the past year, while the "control" group includes those without home damage. Sample size: 39,367 observations.

Figure 2: Estimates of weather-related home damage on locus of control along the distribution - Results from various estimators



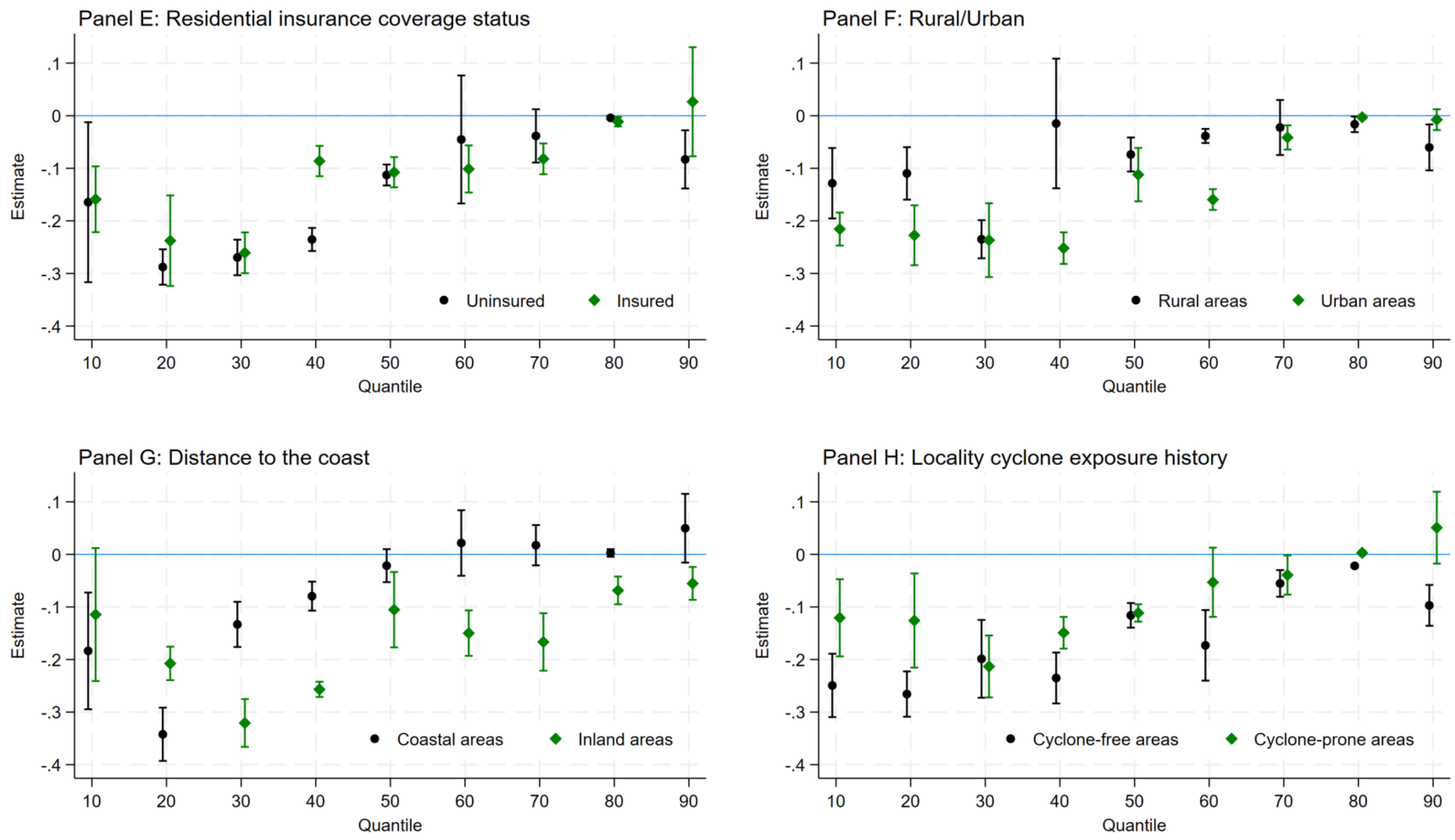
Notes: Results (estimates and their corresponding 95% confidence intervals) reported in each quantile and panel are from a separate regression. "Pooled OLS" and "Fixed Effect" estimators refer to the quintile regression Equation (1) without and with controlling for individual fixed effects, respectively. "Instrumental Variables" and "Fixed Effect Instrumental Variables" estimators refer to the quantile regression of Equations (1) and (2) without and with controlling for individual fixed effects, respectively. Instrument: Exposure to any cyclone within 100 km. Other explanatory variables include age (and its square), marital status, education, household size, urban, local area socio-economic variables, state/territory dummies, wave dummies, and survey quarter dummies. Gender and migration status variables are also included in pooled OLS and IV regressions. Standard errors in parentheses are obtained from bootstrapping (200 iterations) for Panel A and adjusted for clustering at individual level in Panel B. Results are reported in Appendix Table A2.

Figure 3: Heterogenous impacts of weather-related home damage on locus of control along the distribution



Notes: Results (estimates and their corresponding 95% confidence intervals) reported in each subgroup and quantile are from a separate quantile FE-IV regression. Instrument: Exposure to any cyclone within 100 km. Other explanatory variables include age (and its square), marital status, education, household size, state/territory dummies, year dummies, and survey quarter dummies. Detailed regression results are reported in Appendix Table A6.

Figure 3: Heterogenous impacts of weather-related home damage on locus of control along the distribution (continued)



Notes: Results (estimates and their corresponding 95% confidence intervals) reported in each subgroup and quantile are from a separate quantile FE-IV regression. Instrument: Exposure to any cyclone within 100 km. Other explanatory variables include age (and its square), marital status, education, household size, state/territory dummies, year dummies, and survey quarter dummies. Detailed regression results are reported in Appendix Table A6.

Online Appendix

for refereeing purposes and to be published online

Appendix Table A1: Variable description and summary statistics

Variable	Description	Mean	Min	Max	Standard deviations		
					Overall	Between	Within
Age	The respondent's age at the survey time (years)	46.78	15.00	100.00	18.25	18.29	3.08
Male	Dummy variable: = 1 if the individual is male and zero otherwise	0.46	0.00	1.00	0.50	0.50	0.00
Born overseas in ESB country	Dummy variable: = 1 if the individual was born overseas in an English-Speaking Background (ESB) country and zero otherwise	0.10	0.00	1.00	0.30	0.30	0.00
Born overseas in NESB country	Dummy variable: = 1 if the individual was born overseas in a Non-English-Speaking Background (NESB) country and zero otherwise	0.11	0.00	1.00	0.32	0.32	0.00
Married/De facto	Dummy variable: = 1 if the individual is married or in de factor relationship at the survey time and zero otherwise	0.66	0.00	1.00	0.47	0.44	0.20
Separated/divorced/widowed	Dummy variable: = 1 if the individual is separated/divorced/widowed at the survey time and zero otherwise	0.13	0.00	1.00	0.34	0.31	0.13
Year 12	Dummy: = 1 if the individual completes Year 12 and zero otherwise	0.15	0.00	1.00	0.36	0.33	0.15
Vocational or training qualification	Dummy: = 1 if the individual has a vocational or training qualification and zero otherwise	0.39	0.00	1.00	0.49	0.47	0.13
Bachelor degree or higher	Dummy: = 1 if the individual has a bachelor degree or higher and zero otherwise	0.21	0.00	1.00	0.41	0.39	0.12
Household size	Number of household members	2.82	1.00	13.00	1.42	1.27	0.67
Local area unemployment rate	Yearly unemployment rate at the individual's residing local government area (%)	5.31	2.90	7.90	0.84	0.58	0.62
Local area SEIFA decile	Socio-Economic Indexes for Areas (SEIFA) decile at the individual's residing local government area	5.58	1.00	10.00	2.87	2.68	1.04
Major city	Dummy variable: = 1 if the individual lives in a major city and zero otherwise	0.63	0.00	1.00	0.48	0.46	0.15
Exposure to any cyclone within 100 km	Dummy variable: = 1 if an individual's residential postcode was within 100 km of any cyclone eye last year and zero otherwise	0.02	0.00	1.00	0.14	0.10	0.09
Locus of control	Summary scores from responses to seven questions asking about the individual's locus of control, standardized, with a higher score indicating a greater sense of control over life outcomes	0.07	-3.98	2.65	0.99	0.80	0.59
Home damage	Dummy variable: = 1 if home destroyed or damaged due to a weather-related disaster last year and zero otherwise	0.02	0.00	1.00	0.14	0.09	0.11

Notes: Statistics are calculated from the baseline sample of 39,367 individual-wave observations from 14,744 unique individuals.

Appendix Table A2: Estimates of weather-related home damage on locus of control along the distribution - Results from various estimators

	Q10th	Q20th	Q30th	Q40th	Q50th	Q60th	Q70th	Q80th	Q90th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Pooled OLS regression model (Observations: 39,367, Individuals: 14,744)									
Home damage	-0.26***	-0.20***	-0.23***	-0.17***	-0.10***	-0.10***	-0.04	-0.04*	-0.04
	[0.09]	[0.05]	[0.06]	[0.05]	[0.03]	[0.04]	[0.03]	[0.02]	[0.04]
Panel B: Fixed effects regression model (Observations: 39,367, Individuals: 14,744)									
Home damage	-0.05	-0.05	-0.09	-0.05	-0.01	0.03	0.02	0.02	0.06
	[0.11]	[0.06]	[0.06]	[0.05]	[0.04]	[0.04]	[0.03]	[0.03]	[0.05]
Panel C: Instrumental variable regression model (Observations: 39,367, Individuals: 14,744)									
Home damage	-0.18***	-0.23***	-0.25***	-0.15***	-0.13***	-0.11***	-0.06***	-0.01***	-0.02***
	[0.01]	[0.02]	[0.02]	[0.01]	[0.02]	[0.01]	[0.01]	[0.00]	[0.01]
Panel D: Fixed effects Instrumental variable regression model (Observations: 39,367, Individuals: 14,744)									
Home damage	-0.23***	-0.13**	-0.23***	-0.19***	-0.07***	-0.08**	-0.06***	-0.01***	-0.03
	[0.02]	[0.06]	[0.02]	[0.01]	[0.02]	[0.03]	[0.02]	[0.00]	[0.04]

Notes: Results reported in each column and panel are from a separate regression. "Pooled OLS" and "Fixed Effect" estimators refer to the quintile regression Equation (1) without and with controlling for individual fixed effects, respectively. "Instrumental Variables" and "Fixed Effect Instrumental Variables" estimators refer to the quantile regression of Equations (1) and (2) without and with controlling for individual fixed effects, respectively. Instrument: Exposure to any cyclone within 100 km. "Observations" and "Individuals" refer to "Number of observations" and "Number of unique individuals", respectively. Other explanatory variables include age (and its square), marital status, education, household size, urban, local area socio-economic variables, state/territory dummies, wave dummies, and survey quarter dummies. Gender and migration status variables are also included in pooled OLS and IV regressions. Standard errors in parentheses are obtained from bootstrapping (200 iterations) for Panel A and B and adjusted for clustering at individual level in Panel C and D. The symbol * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix Table A3: Robustness checks

FE-IV regression at:	Mean	Q10th	Q20th	Q30th	Q40th	Q50th	Q60th	Q70th	Q80th	Q90th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Baseline (Observations: 39,367; Individuals: 14,744; Mean: 0.05; F statistic: 161.97)										
Home damage	0.31	-0.23***	-0.13**	-0.23***	-0.19***	-0.07***	-0.08**	-0.06***	-0.01***	-0.03
	[0.46]	[0.02]	[0.06]	[0.02]	[0.01]	[0.02]	[0.03]	[0.02]	[0.00]	[0.04]
Panel B1: Different sample: Excluding cyclone-free states/territories (Observations: 23,592; Individuals: 8,877; Mean: 0.04; F statistic: 114.83)										
Home damage	0.45	-0.09***	-0.26***	-0.29***	-0.36***	-0.13***	-0.07	-0.01	0.00	-0.01
	[0.48]	[0.03]	[0.02]	[0.11]	[0.09]	[0.02]	[0.05]	[0.02]	[0.01]	[0.03]
Panel B2: Different sample: Including individuals in LGAs experiencing at least one cyclone within 100 km (Observations: 8,286; Individuals: 3,152; Mean: 0.02; F statistic: 104.24)										
Home damage	0.33	-0.15***	-0.14***	-0.16**	-0.02	-0.10***	-0.04***	-0.06	-0.00**	-0.03
	[0.41]	[0.03]	[0.04]	[0.07]	[0.04]	[0.03]	[0.01]	[0.05]	[0.00]	[0.04]
Panel C1: Different instrument: any cyclone within 40 km (Observations: 39,367; Individuals: 14,744; Mean: 0.07; F statistic: 233.73)										
Home damage	-0.55	-0.18***	-0.20***	-0.18***	-0.18***	-0.11***	-0.12***	-0.09***	-0.01***	-0.02**
	[0.39]	[0.05]	[0.06]	[0.02]	[0.01]	[0.00]	[0.01]	[0.01]	[0.00]	[0.01]
Panel C2: Different instrument: any category 5 cyclone within 100 km (Observations: 39,367; Individuals: 14,744; Mean: 0.07; F statistic: 264.62)										
Home damage	0.15	-0.20***	-0.18***	-0.18***	-0.19***	-0.10***	-0.04	-0.08***	-0.01***	-0.03**
	[0.38]	[0.02]	[0.01]	[0.05]	[0.01]	[0.01]	[0.04]	[0.01]	[0.00]	[0.02]
Panel D1: Excluding some time-variant variables (Observations: 39,367; Individuals: 14,744; Mean: 0.07; F statistic: 165.29)										
Home damage	0.32	-0.62***	-0.64***	-0.31***	-0.14**	-0.10*	-0.02	-0.14***	-0.02**	-0.07
	[0.46]	[0.12]	[0.08]	[0.02]	[0.07]	[0.06]	[0.05]	[0.02]	[0.01]	[0.11]
Panel D2: Including non-wage income (Observations: 39,274; Individuals: 14,720; Mean: 0.07; F statistic: 162.91)										
Home damage	0.30	-0.21***	-0.20***	-0.21***	-0.22***	-0.13***	-0.11***	-0.08***	-0.02***	-0.05***
	[0.46]	[0.02]	[0.01]	[0.01]	[0.02]	[0.01]	[0.01]	[0.01]	[0.00]	[0.01]
Panel D3: Including general health summary (Observations: 38,927; Individuals: 14,633; Mean: 0.07; F statistic: 165.31)										
Home damage	0.23	-0.09***	-0.19***	-0.11***	-0.09***	-0.07***	-0.07***	-0.07***	-0.07***	-0.05***
	[0.45]	[0.03]	[0.03]	[0.00]	[0.01]	[0.01]	[0.01]	[0.01]	[0.02]	[0.01]

Notes: Estimates for each column and panel is from a separate FE-IV regression. Unless stated otherwise, the instrument is exposure to any cyclone within 100 km. “F statistic” denotes the F statistic for the strength of the excluded instrument in the first stage regression from a two-stage least squares (2SLS) regression at the mean. Unless indicated otherwise, other variables include age (and its square), marital status, education, household size, state/territory dummies, year dummies, and survey quarter dummies. Robust standard errors clustered at the individual level in parentheses. The symbol * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix Table A4: Impact of cyclone exposures on locus of control at the mean and along the distribution

FE regression at:	Mean	Q10th	Q20th	Q30th	Q40th	Q50th	Q60th	Q70th	Q80th	Q90th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Exposure to any cyclone within 40 km										
Cyclone exposure	-0.05	-0.07	-0.16	-0.05	-0.05	-0.06	0.00	-0.16**	-0.08*	-0.04
	[0.06]	[0.14]	[0.12]	[0.10]	[0.08]	[0.07]	[0.06]	[0.06]	[0.04]	[0.09]
Panel B: Exposure to any category 5 cyclone within 40 km										
Cyclone exposure	-0.06	-0.28	-0.42*	-0.15	0.01	0.03	0.11	-0.04	0.01	0.04
	[0.10]	[0.22]	[0.21]	[0.16]	[0.14]	[0.11]	[0.08]	[0.09]	[0.07]	[0.15]
Panel C: Exposure to any cyclone within 100 km										
Cyclone exposure	0.03	0.10	-0.02	-0.05	-0.01	0.01	0.02	0.00	-0.01	0.05
	[0.03]	[0.08]	[0.07]	[0.06]	[0.04]	[0.04]	[0.04]	[0.04]	[0.03]	[0.06]
Panel D: Exposure to any category 5 cyclone within 100 km										
Cyclone exposure	0.05	-0.02	-0.07	-0.08	0.04	0.06	0.07	0.04	0.03	0.18*
	[0.06]	[0.14]	[0.12]	[0.08]	[0.07]	[0.07]	[0.06]	[0.06]	[0.04]	[0.10]

Notes: Estimates for each column and panel is from a separate individual FE regression. Sample: 79,796 observations from 25,683 unique persons. Other variables include age (and its square), marital status, education, household size, state/territory dummies, year dummies, and survey quarter dummies. Robust standard errors clustered at the individual level in parentheses. The symbol * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix Table A5: Heterogenous impact of weather-related home damage on locus of control at the mean

Separate regression by:	Gender		Age		Home ownership status		Household income	
	Females	Males	Young	Old	Renters	Homeowner s	Poorer	Richer
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Home damage	0.62	0.02	0.03	0.64	0.81	-0.01	0.04	0.58
	[0.68]	[0.64]	[0.72]	[0.63]	[0.84]	[0.56]	[0.63]	[0.68]
Observations	21,063	18,304	18,677	18,604	11,821	27,546	19,868	19,499
Number of unique individuals	7,841	6,903	7,473	6,953	4,545	10,199	7,499	7,245
Mean of dependent variable	0.03	0.08	0.07	0.07	-0.07	0.13	-0.04	0.18
F test statistic	79.98	82.40	59.41	101.52	46.47	116.49	85.16	77.06
Separate regression by:	Residential insurance status		Rural/Urban		Distance to the coast		Locality cyclone exposure history	
	Uninsured	Insured	Rural	Urban	Coastal areas	Inland areas	Cyclone-free areas	Cyclone-prone areas
Home damage	0.68	0.23	0.34	-5.76	-0.4	0.71	2.41	0.24
	[0.75]	[0.65]	[0.44]	[5.74]	[0.76]	[0.57]	[5.16]	[0.40]
Observations	19,402	18,116	14,487	24,880	19,389	19,978	27,687	11,680
Number of unique individuals	7,245	6,672	5,430	9,314	7,274	7,470	10,392	4,352
Mean of dependent variable	0.00	0.15	0.06	0.08	0.09	0.05	0.08	0.05
F test statistic	70.98	71.29	134.46	2.56	67.43	97.44	1.40	145.80

Notes: Estimates for each subgroup is from a separate FE-IV regression. Instrument: Exposure to any cyclone within 100 km. "F test statistic" denotes the F statistic for the strength of the excluded instrument in the first stage regression. Other explanatory variables include local area socio-economic variables, state/territory dummies, wave dummies, and survey quarter dummies. Robust standard errors clustered at the individual level in parentheses. The symbol * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix Table A6: Heterogenous impact of weather-related home damage on locus of control along the distribution

	Q10th	Q20th	Q30th	Q40th	Q50th	Q60th	Q70th	Q80th	Q90th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A1: Females (Observations: 21,063; Individuals: 7,841; Mean: 0.03)									
Home damage	-0.21***	-0.27***	-0.39***	-0.31***	-0.13***	-0.06**	-0.02	-0.01***	0.00
	[0.04]	[0.02]	[0.06]	[0.06]	[0.01]	[0.03]	[0.02]	[0.00]	[0.01]
Panel A2: Males (Observations: 18,304; Individuals: 6,903; Mean: 0.08)									
Home damage	-0.07	-0.17***	-0.17***	-0.11***	-0.16***	-0.14***	-0.10***	-0.01***	0.00
	[0.05]	[0.02]	[0.01]	[0.01]	[0.04]	[0.01]	[0.02]	[0.00]	[0.03]
Panel B1: Young (Observations: 18,677; Individuals: 7,473; Mean: 0.07)									
Home damage	-0.11***	-0.14***	-0.12***	-0.11**	-0.07***	-0.05*	0.00	0.00**	0.01
	[0.03]	[0.04]	[0.02]	[0.05]	[0.01]	[0.03]	[0.03]	[0.00]	[0.02]
Panel B2: Old (Observations: 18,604; Individuals: 6,953; Mean: 0.07)									
Home damage	-0.27***	-0.24***	-0.26***	-0.25***	-0.15***	-0.21***	-0.13***	-0.08***	0.02
	[0.09]	[0.04]	[0.05]	[0.03]	[0.02]	[0.02]	[0.03]	[0.02]	[0.26]
Panel C1: Renters (Observations: 11,821; Individuals: 4,545; Mean: -0.07)									
Home damage	-0.17**	-0.32***	-0.33***	-0.09***	-0.14***	-0.07***	0.00	0.00	0.02
	[0.07]	[0.05]	[0.02]	[0.03]	[0.02]	[0.01]	[0.03]	[0.00]	[0.02]
Panel C2: Homeowners (Observations: 27,546; Individuals: 10,199; Mean: 0.13)									
Home damage	-0.16***	-0.22***	-0.24***	-0.07	-0.12***	-0.13***	-0.16***	-0.02***	-0.09***
	[0.03]	[0.02]	[0.01]	[0.04]	[0.01]	[0.02]	[0.00]	[0.00]	[0.02]
Panel D1: Poorer household (Observations: 19,868; Individuals: 7,499; Mean: -0.04)									
Home damage	0.05	-0.16***	-0.20***	-0.19***	-0.11***	-0.17***	0.00	-0.02*	0.04
	[0.12]	[0.04]	[0.02]	[0.03]	[0.03]	[0.05]	[0.02]	[0.01]	[0.04]
Panel D2: Richer household (Observations: 19,499; Individuals: 7,245; Mean: 0.18)									
Home damage	-0.33***	-0.27***	-0.29***	-0.33**	-0.13***	-0.19***	-0.16***	-0.01***	-0.10*
	[0.10]	[0.06]	[0.02]	[0.16]	[0.02]	[0.02]	[0.00]	[0.00]	[0.06]

Notes: Estimates for each subgroup and quantile is from a separate quintile FE-IV regression. Instrument: Exposure to any cyclone within 100 km. Other explanatory variables include age (and its square), marital status, education, household size, urban, local area socio-economic variables, state/territory dummies, wave dummies, and survey quarter dummies. "Observations", "Individuals", and "Mean" refer to "Number of observations", "Number of unique individuals" and "Mean of locus of control for individuals in the subgroup", respectively. Robust standard errors clustered at the individual level in parentheses. The symbol * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix Table A6: Heterogenous impact of weather-related home damage on locus of control along the distribution (continued)

	Q10th	Q20th	Q30th	Q40th	Q50th	Q60th	Q70th	Q80th	Q90th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel E1: Uninsured (Observations: 19,402; Individuals: 7,245; Mean: 0.00)									
Home damage	-0.16**	-0.29***	-0.27***	-0.24***	-0.11***	-0.05	-0.04	-0.00***	-0.08***
	[0.08]	[0.02]	[0.02]	[0.01]	[0.01]	[0.06]	[0.03]	[0.00]	[0.03]
Panel E2: Insured (Observations: 18,116; Individuals: 6,672; Mean: 0.15)									
Home damage	-0.16***	-0.24***	-0.26***	-0.09***	-0.11***	-0.10***	-0.08***	-0.01**	0.03
	[0.03]	[0.04]	[0.02]	[0.01]	[0.01]	[0.02]	[0.01]	[0.00]	[0.05]
Panel F1: Rural areas (Observations: 14,487; Individuals: 5,430; Mean: 0.06)									
Home damage	-0.13***	-0.11***	-0.23***	-0.01	-0.07***	-0.04***	-0.02	-0.02**	-0.06***
	[0.03]	[0.03]	[0.02]	[0.06]	[0.02]	[0.01]	[0.03]	[0.01]	[0.02]
Panel F2: Urban areas (Observations: 24,880; Individuals: 9,314; Mean: 0.08)									
Home damage	-0.22***	-0.23***	-0.24***	-0.25***	-0.11***	-0.16***	-0.04***	0.00	-0.01
	[0.02]	[0.03]	[0.04]	[0.02]	[0.03]	[0.01]	[0.01]	[0.00]	[0.01]
Panel G1: Coastal areas (Observations: 19,389; Individuals: 7,274; Mean: 0.09)									
Home damage	-0.18***	-0.34***	-0.13***	-0.08***	-0.02	0.02	0.02	0.00	0.05
	[0.06]	[0.03]	[0.02]	[0.01]	[0.02]	[0.03]	[0.02]	[0.00]	[0.03]
Panel G2: Inland areas (Observations: 19,978; Individuals: 7,470; Mean: 0.05)									
Home damage	-0.11*	-0.21***	-0.32***	-0.26***	-0.11***	-0.15***	-0.17***	-0.07***	-0.06***
	[0.06]	[0.02]	[0.02]	[0.01]	[0.04]	[0.02]	[0.03]	[0.01]	[0.02]
Panel H1: Cyclone-free areas (Observations: 27,687; Individuals: 10,392; Mean: 0.08)									
Home damage	-0.25***	-0.27***	-0.20***	-0.24***	-0.12***	-0.17***	-0.06***	-0.02***	-0.10***
	[0.03]	[0.02]	[0.04]	[0.02]	[0.01]	[0.03]	[0.01]	[0.00]	[0.02]
Panel H2: Cyclone-prone areas (Observations: 11,680; Individuals: 4,352; Mean: 0.05)									
Home damage	-0.12***	-0.13***	-0.21***	-0.15***	-0.11***	-0.05	-0.04**	0.00	0.05
	[0.04]	[0.05]	[0.03]	[0.02]	[0.01]	[0.03]	[0.02]	[0.00]	[0.03]

Notes: Estimates for each subgroup and quantile is from a separate quintile FE-IV regression. Instrument: Exposure to any cyclone within 100 km. Other explanatory variables include age (and its square), marital status, education, household size, urban, local area socio-economic variables, state/territory dummies, wave dummies, and survey quarter dummies. “Observations”, “Individuals”, and “Mean” refer to “Number of observations”, “Number of unique individuals” and “Mean of locus of control for individuals in the subgroup”, respectively. Robust standard errors clustered at the individual level in parentheses. The symbol * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level.