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DISASTERS AND ECONOMIC RESILIENCE: THE EFFECTS OF THE QUEENSLAND FLOODS 2010-11 ON INDIVIDUAL INCOME

A case study on the Brisbane River catchment area

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Cover: 2011 Brisbane floods. Source: Angus Veitch (CC BY-NC 2.0).

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ACKNOWLEDGEMENTS

As academic researchers, our primary focus is to produce high quality research and rigorously examine the effects that disasters have on our communities and economies.

To deliver socially meaningful and impactful research, we need to work closely with our government and research counterparts, so that our research is holistic, directly answers questions policy makers are grappling with, and makes our Australian communities safer and more resilient to natural disasters.

Our partnership with the Bushfire and Natural Hazards CRC (BNHCRC) has been a fantastic avenue for doing just that. We are grateful to the BNHCRC not only for generously funding this project, but also for their dedication and passionate support which has facilitated conversations and pushed for greater utilisation of our research among end-users and beyond. For this report, we particularly thank Dr Michael Rumsewicz, Dr John Bates, Dr Desiree Beekharry and Dr Matthew Haynes for their commitment to identifying utilisation opportunities and fostering collaborative relationships with end-users.

We thank Ed Pikusa, our lead end-user from the Department for Environment and Water (SA), who has steadfastly promoted the value of our research. We also warmly thank all end-users who have at various stages contributed their insights and expertise; collaborated on research design and informed the utilisation direction of the *Optimising Post-Disaster Recovery Interventions in Australia* research program. These organisations in alphabetical order are: Department of Fire and Emergency Services (WA), Department of Environment, Land, Water and Planning (VIC), Department for Environment and Water (SA), Emergency Management Australia, Emergency Management Victoria, IGEM South Australia, IGEM Victoria and Queensland Reconstruction Authority. For this report specifically, we thank Queensland Reconstruction Authority representative Mark Drew who has provided invaluable support, technical expertise and sound advice on all aspects of the case study, from research design to utilisation.

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END USER STATEMENT

Queensland Reconstruction Authority, *Queensland*

The Queensland Reconstruction Authority welcomes this Report which gives valuable insights into the economic impacts of the devastating 2010-11 flood event on communities in the Brisbane River Catchment Area. Its particular focus on income effects of disasters on certain segments of the workforce highlights the importance of building economic resilience to minimise the impact of disaster induced shocks on Queensland communities that are vulnerable to disasters.

This research aligns with the goals of the Queensland Strategy for Disaster Resilience and its implementation plan, Resilient Queensland by providing an evidence base to enable a better understanding of the disaster risks faced by communities in the Brisbane River Catchment Area. Findings of this Report highlight how economic impacts of disasters are borne differently by particular segments of the community depending on their demographic attributes, employment characteristics and areas of residence. This research highlights the importance of tailored approaches to build economic resilience as a key component of community resilience.

As the lead agency responsible for disaster recovery policy in Queensland, this research is relevant to QRA by demonstrating the important role for government assistance in the form of disaster relief and recovery programs that support the economic and psychosocial needs of vulnerable groups following disaster events.

Emergency Management Australia, ACT

Emergency Management Australia (EMA), as the national emergency management coordinating body, including national recovery policy, may have an opportunity to use findings from these reports at various national recovery fora, encouraging the recovery community to consider the findings in the design of future recovery policy and programs. EMA is often involved in reviewing national recovery handbooks, development of guidelines and frameworks and could use the report findings to guide the content of the resources being developed. Finally, in respect of sharing the results of this research, EMA will include these reports in its knowledge management repositories making it available to recovery communities across all jurisdictions.

PRODUCT USER TESTIMONIALS

Department of Communities, Disability Services and Seniors, *Queensland*

As lead agency for human and social recovery, DCDSS is acutely aware of the relationships between financial resilience and wellbeing. This report provides both insight and validation of DCDSS planning assumptions regarding people who are most likely to experience financial vulnerability, and highlights the important role that financial relief measures play in preventing greater economic inequality for those sectors most at risk. This type of information is useful in guiding how financial relief measures are targeted, but also prompts consideration of how resilience activities could be targeted at workers in particular service sectors that are likely to experience financial risk as a result of disruption in their sectors following a disaster, and/or how post disaster workforce recruitment activities could be targeted to address sectors that experience disruption.

The insights gleaned from this report can be used to:

- strengthen relief programs by testing disaster relief planning assumptions
- validate the important role that relief plays in preventing the widening of economic inequality
- validate the role that personal hardship relief provides as an immediate economic stimulus
- inform different approaches to Commonwealth income support and employer wage assistance measures (particularly part time workers) following a disaster
- inform disaster recovery workforce planning and recruitment strategies that deliberately target sectors that experience loss and disruption.

Inform resilience strategies that could be deliberately targeted to small business owners and workers in sectors highly vulnerable to disasters.

The information provided in this report validates the importance of targeting financial relief to low income earners, small business and primary producers, whilst also highlighting the importance on focusing on a few other particular sectors most susceptible to financial disruption, such as small business owners and people employed in part time/casual type arrangements in service sectors like hospitality and tourism. It also suggests that future policy needs to consider either how we prevent/mitigate from a resilience perspective the impact on individuals and sectors vulnerable to disruption/loss as a result of a disaster, and/or the sufficiency of relief measures combined with income support and/or targeted employer wage assistance measures in terms of addressing/mitigating the longer term personal economic loss versus short term band aid assistance.

It would be good to build upon this work to achieve a more holistic program logic for individual economic disaster resilience. There could be opportunity to collaborate with agencies in the Financial Resilience Sector to truly understand the barriers and opportunities around disaster financial resilience, including small business owners, self-employed contractors and individuals working in sectors which are susceptible to the impact of disasters. This could then be incorporated into a suite of measures (not just relief) that could be applied in the short, medium and longer term, and inform the policy approaches of all

levels of government and non-government (includes private sector) in terms of resilience as well as response and recovery. This will also ensure closer collaboration between the different recovery functions in Queensland.

As the disaster relief measures are already largely applied to low income earners, DCDSS will review its current data metrics in terms of what is captured in terms of specific demographic, employment cohorts, insurance status and financial capacities (ie rebuilds) etc. Deliberately capturing qualitative and contextual information that further informs DCDSS understanding of the personal financial impacts will better inform targeted recovery strategies between and across recovery pillars.

Department of Employment, Small Business and Training, *Queensland*

While the report did not find a statistically significant association between the Queensland Floods 2010–11 and the income trajectories of affected workers, the Department of Employment, Small Business and Training (DESBT) notes that income losses were found to be more likely among particular cohorts. Of relevance to DESBT, this includes business owners and workers in part-time employment or sectors sensitive to disasters (e.g. tourism).

DESBT is charged with the responsibility of making a recommendation to activate federal support and funding under the Natural Disaster Relief and Recovery Arrangements (NDRRA). DESBT also provides other support in terms of issuing a post-disaster survey to small businesses which informs the recommendation above. Also, the survey provides validation of Queensland Fire and Emergency Services' on the ground assessment of the level of damage, and can be used to support other policy decisions beyond those relating to NDRRA.

DESBT is developing a new Queensland Small Business Strategy. As part of its development, a discussion paper was released for public consultation. The discussion paper proposed five focus areas for action to help small business to grow and employ. The strategy recognises that small businesses are especially vulnerable to extreme weather events and natural disasters and *Focus area 3 – Creating sustainable jobs in regional Queensland,* within the discussion paper, considered ways to increase small business resilience so they can prepare, recover and adapt to disruptive events.

The report provides valuable information on the impacts of the Queensland Floods 2010–11 on the small business sector and employment, which helps to understand better the issues affecting small business resilience and recovery.

The report also reinforces the need to support small businesses through post-disaster recovery and may help inform responses to future disasters, including those in other regions throughout Queensland.

Interestingly, the report found an increase in demand for healthcare services following the floods, which was likely driven in part by the need for psychological support. DESBT's post-disaster survey could be widened to capture mental stress levels to enable targeted psychological support to be made available to small business owners.

Understanding more about the factors that impact loss/income recovery for small businesses and the impacts of psychological stress would be two areas of research that could be pursued.

This report could be used to inform post-disaster survey design to capture consequential financial losses and psychological stress.

KEY TERMS USED IN THIS REPORT

TABLE 1 ACRONYMS USED IN REPORT

Acronym	Explanation
ABS	Australian Bureau of Statistics
ACLD	Australian Census Longitudinal Dataset
ANZSIC	The Australian and New Zealand Standard Industrial Classification (ANZSIC) provides a basis for the standardised collection, analysis and dissemination of economic data on an industry basis for Australia and New Zealand
BRCA	Brisbane River Catchment Area, our case study area
GDP	Gross Domestic Product
GSP	Gross State Product
LGA	Local Government Area
SA2	Under the Australian Statistical Geography Standard framework used by the Australian Bureau of Statistics, Statistical Areas Level 2 (SA2) are medium-sized general-purpose areas built up from whole Statistical Areas Level 1. Their purpose is to represent a community that interacts together socially and economically.

TABLE 2 DEFINITIONS OF KEY TERMS USED IN REPORT

Term	Definition	Definition Source
Impact	The broadest term; includes both market-based (i.e. tangible) and non-market (i.e. intangible) effects. Individual impacts can be either negative or positive.	Stephenson, 2010
Difference in differences modelling	Difference-in-differences modelling is a quasi-experimental method that allows for evaluating the impact of a "treatment" on a group of interest. It is a natural experiment, in which one group has experienced the treatment, whereas another comparable group has not. The impact of the treatment is estimated by looking at the difference between the changes experienced by the two groups before and after the treatment.	Kennedy, 2003
Direct impact	Impacts that result from direct contact with the event	Stephenson, 2010
Disaster risk	The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity. Annotation: The definition of disaster risk reflects the concept of hazardous events and disasters as the outcome of continuously present conditions of risk. Disaster risk comprises different types of potential losses which are often difficult to quantify. Nevertheless, with knowledge of the prevailing hazards and the patterns of population and socioeconomic development, disaster risks can be assessed and mapped, in broad terms at least. It is important to consider the social and economic contexts in which disaster risks occur and that people do not necessarily share the same perceptions of risk and their underlying risk factors.	UNISDR, 2018
Economic resilience	At the macrolevel, static economic resilience refers to the ability or capacity of a system to maintain function (continue production) when shocked, while dynamic economic resilience is the ability and speed of a system to recover from a shock.	Xi et al., 2018

	At an individual level, this study considers an individual's income stream as effectively representing their economic resilience of to external shocks.	Author
Indirect impact	Impacts that arise as a consequence of the direct impacts of the event. For example, disruption to the flow of goods and services in and out of the affected area.	Stephenson, 2010
Natural disaster	Disasters caused by natural hazards. Natural hazards only lead to 'disaster' if they intersect with an exposed and vulnerable society (interrupting these systems) and when the consequences exceed people's capacity to cope.	Commonwealth of Australia, 2018a
Natural hazard	A natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation	UNISDR, 2018
Tangible impact	Impacts on items that are normally bought or sold and that are therefore easy to assess in monetary terms	Stephenson, 2010
Intangible impact	Impacts on items that are not normally bought or sold. Social and environmental impacts are considered to be intangible	Stephenson, 2010
Resilience	The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and function through risk management.	UNISDR, 2018
Vulnerability	The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.	UNISDR, 2018

1. EXECUTIVE SUMMARY

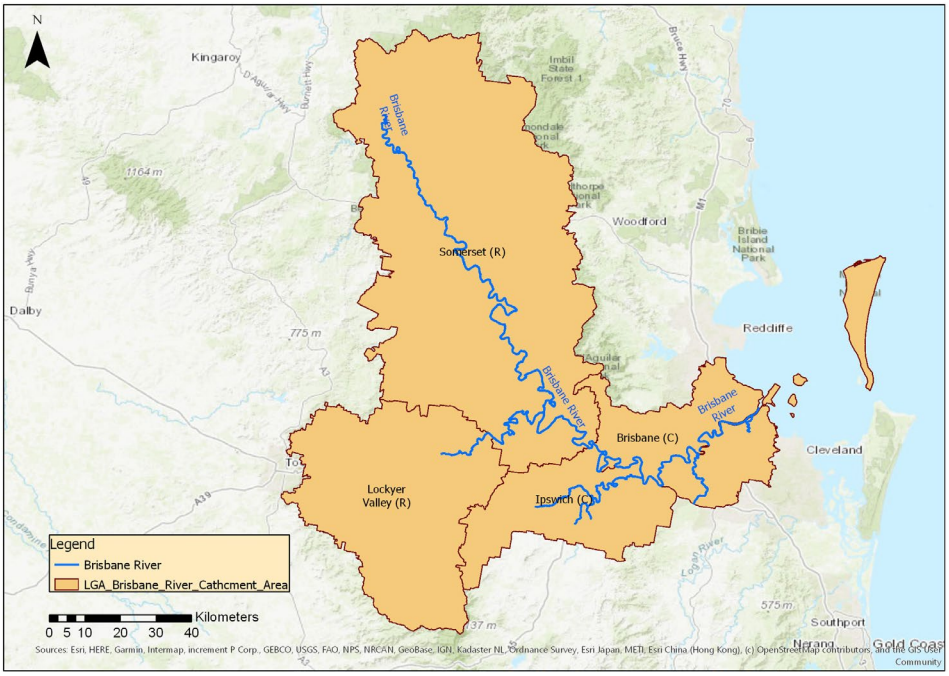
Australians are all too familiar with disasters arising from natural hazards like bushfires, cyclones, and floods. With climate change, we face the possibility of more frequent and intense natural hazards in new and unexpected places.

As we enter an uncertain decade, we find ourselves increasingly asking: What does a disaster-resilient Australia look like? How can we help our most vulnerable Australian communities endure the cumulative effects of frequent disasters? Amid tightening fiscal budgets, how can we create the right environment for our communities and economy to prosper in this new reality?

Answering these questions requires some deep thinking about the collective actions needed to support our communities, businesses, and the broader economy to become more disaster resilient; to not only adapt to a "new normal" but thrive in a changing climate. From a policy perspective, this becomes more pertinent when we consider that the average annual total economic costs of natural disasters of Australia are forecast to reach $39 billion per year by 2050 (Deloitte Access Economics, 2017),[1] and the fiscal constraints that will increasingly be imposed on government disaster expenditure by Australia's ageing population.

To that end, the *Disasters and Economic Resilience: The Effects of the Queensland Floods 2010-11 on Individual Income – A Case Study on the Brisbane River Catchment Area* report explores the impact of the Queensland Floods 2010-11 on the income trajectory of employed residents of the four Brisbane River Catchment Area (BRCA) local government areas (LGAs) depicted in FIGURE 1.

FIGURE 1 IN-SCOPE BRISBANE RIVER CATCHMENT AREA LGAS



[1] This figure is in 2017 prices and does not consider the impact of climate change.

The Queensland Floods 2010-11 remain one of Australia's costliest flooding events, causing an estimated $6.7 billion in tangible damages, with an overall cost of $14.1 billion (Deloitte Access Economics, 2016). To the best of our knowledge, this study is the first in the economics literature to examine the impact of a riverine-flooding in an Australian metropolitan economy on individual income, considering demographic and sectoral heterogeneities and post-disaster government assistance.

By focusing on individuals' economic resilience (measured through changes in their income stream), the report explores how disaster-induced economic shocks can be transmitted to individuals vis-à-vis income-earning channels, and offers a greater understanding of how indirect costs of disasters are borne by different segments of the workforce. Such costs are currently less known compared to direct damages reported in the immediate aftermath of disasters.

By examining the economic dimension of disaster resilience at the individual level, our research helps policymakers better understand the socioeconomics of natural disasters and formulate public policies in a sustainable way that better distributes scarce budgets and resources towards vulnerable socioeconomic groups and industries of employment that are more sensitive to disasters.

Recognising the profound and long-lasting psychosocial impacts of the floods, the report outlines the socioeconomic and disaster resilience profiles of the BRCA LGAs, and provides additional information to contextualise our assessment so that policymakers can holistically interpret our findings, within the broader social and economic conditions arising from the floods.

Isolating the effects of the floods from other shocks that hit the BRCA LGAs is challenging. The report attempts to pinpoint observed income effects to the Queensland Floods 2010-11 by using a difference-in-differences modelling approach. This approach compares income changes of individuals living in the BRCA LGAs (treatment group) with those living in comparable zones in Australia (control group). Because of their comparability, it is the control group which provides us with the income path that would have occurred for BRCA LGA employed residents had the floods *not* happened, and thus enable us to compute any income deviations (losses or gains) arisfrom the floods.

The report utilises the Australian Census Longitudinal Dataset (ACLD)[2], which provides a unique opportunity to robustly examine the flood's impacts across a longer timeframe (across 2006, 2011 and 2016) and across multiple dimensions (demographic and economic). All results we report are net results, post any disaster relief and recovery efforts; are relative to our baseline year (2006); and are compared to our control group. We define short-term results as changes over 2006-11, and medium-term results as changes over 2006-16.

While we develop the right modelling framework to capture income effects arising from the floods, data limitations have hampered our ability to *statistically* confirm that our control group is comparable to the BRCA LGA sample. The key implication is that our findings are not causal but correlational.[3]

[2] Available through the ABS DataLab.

[3] That is, we cannot say that the floods caused the statistically significant results we observe. Instead, for statistically significant results, we can only say that, compared to the control group, the floods were negatively/positively associated with the income changes for individuals in the BRCA that we observe since our baseline year (i.e. 2006).

Nevertheless, our report's findings offer new and compelling insights on how disasters like the Queensland Floods 2010-11 interact with existing economic conditions and workforce compositions to affect individuals within the community, and in turn their ability to economically cope with the ongoing effects of the disaster.

1.1 KEY INSIGHTS

1. We must look beyond overall impacts to understand our socioeconomic vulnerability to disasters

Overall, we do not find a statistically significant association between the Queensland Floods 2010-11 and the income trajectories of employed residents of the four BRCA LGAs.

However this masks the marked differences we observe between individuals with different demographic attributes, employment characteristics and even areas of residence.

To illustrate, the Queensland Floods 2010-11 were associated with short-term income losses among low-income earners (-10.1%; to the tune of $3,100 AUD) residing in BRCA LGAs. This contrasts with gains experienced by middle-income (8.5%; $3,780 AUD) and high-income earners (5.1%; or around $3,380 AUD). Apart from high-income earners,[4] these associations are not observed in the medium term. Some of these differences are explained by sectors of employment, which are discussed further below.

Out of all dimensions explored, the heaviest income losses associated with the Queensland Floods 2010-11 occurred for employed residents of the regional BRCA communities with the least capacity to cope and adapt to disasters. Unlike their metropolitan Brisbane counterparts, where no statistically significant income results were observed, employed residents of the regional Somerset and Lockyer Valley LGAs suffered average income losses of 27.3% (or around $9,780 AUD) in the first six months following the floods.

These acute individual-level losses highlight the scale of the flood's devastation in these regional councils and the extent of their economic exposure to the disaster-sensitive industries like agriculture.

Importantly, the losses underscore the long and difficult economic recovery period ahead for Somerset and Lockyer Valley residents who faced increased council rates and reduced levels of service following the floods.

2. There are several channels through which disaster-induced economic shocks can be transmitted to individuals

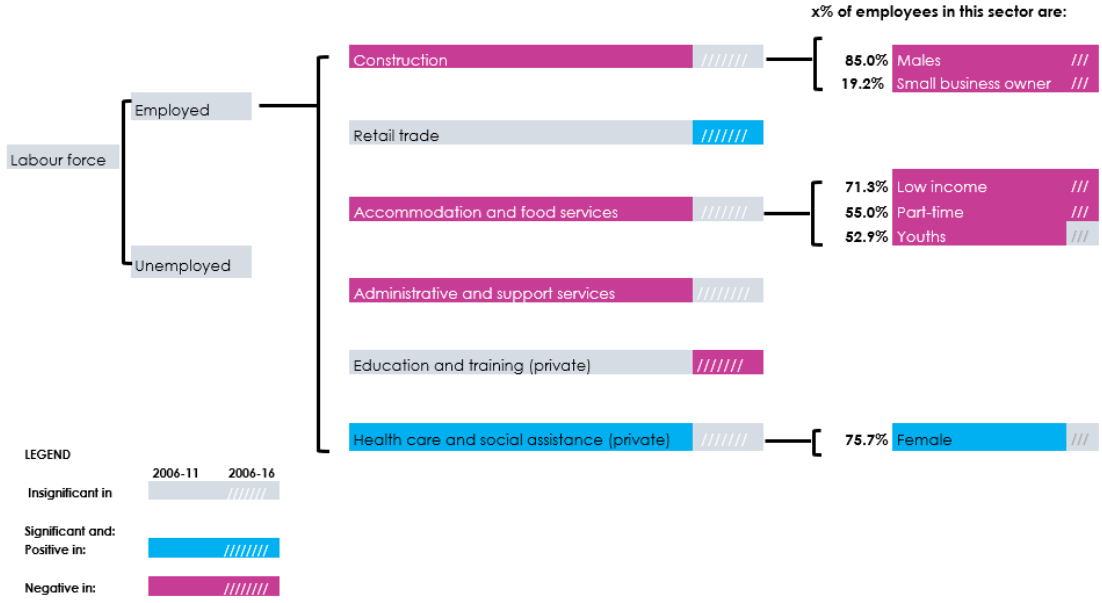
Our results show the likely channels through which disaster-induced economic shocks are transmitted to individuals in the labour force, vis-à-vis income.

Owning a business is one such channel. Regardless of their employment sector, BRCA LGA business owners who suffered significant income losses correlated with

[4] For this group, income losses in medium term were 6.6% ($4,590 AUD).

the Queensland Floods 2010-11(FIGURE 2). While average short-term losses were highest for owners of unincorporated businesses[5] (-11.9%; to the tune of $5,030 AUD), these findings were not observed in the medium term. In comparison, on average, small business owners experienced losses in both the short-term (-6.1%; around $3,130 AUD) and medium-term (-9.8%; $5,350 AUD). Likewise, incorporated business owners experienced income losses throughout the study period (-10.3%; or $6,030 over 2006-16).

FIGURE 2 SUMMARY OF STATISTICALLY SIGNIFICANT SECTORAL AND DEMOGRAPHIC RESULTS, BY SECTOR OF EMPLOYMENT



NOTE: PERCENTAGES REFLECT BASELINE YEAR (2006) SECTORAL DEMOGRAPHICS.

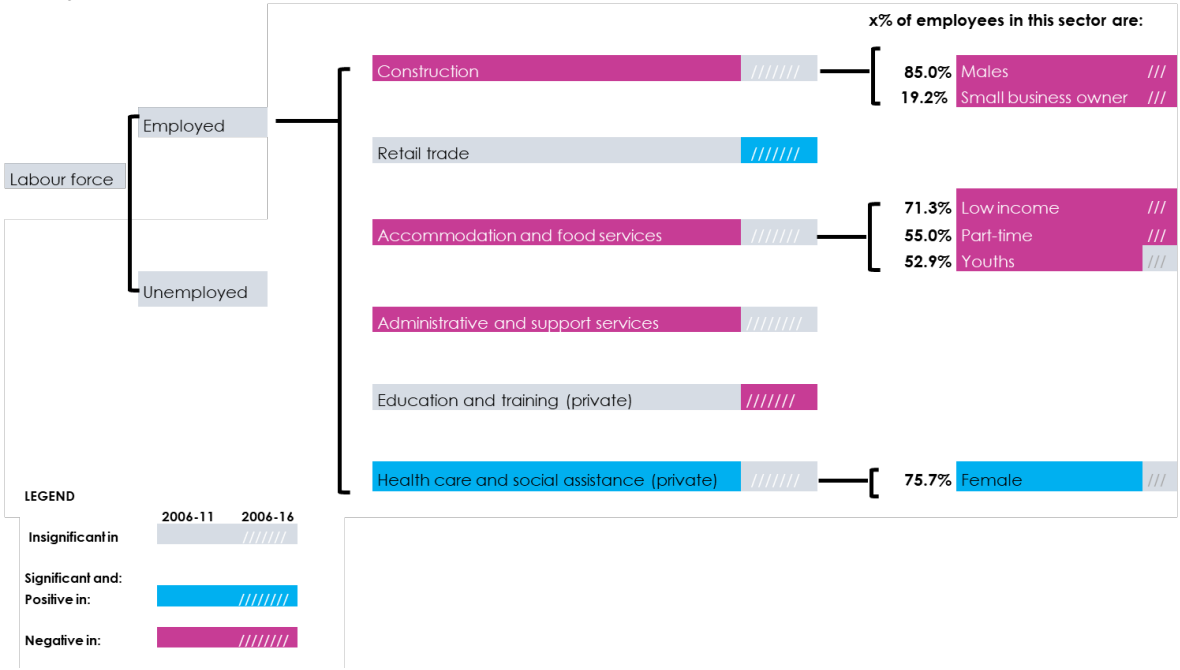
Another important channel is part-time employment. Unlike full-time counterparts, whose salaried positions appear to offer an important buffer to shocks, part-time workers include casual workers, and are more susceptible to sudden changes in economic activity, both positive and negative.

The Queensland Floods 2010-11 caused material volatility in labour markets, particularly part-time employment (Queensland Treasury, 2011), and this is reflected in our results. On average, part-time workers in the BRCA LGAs suffered income losses of 5.2% ($1,820 AUD) in the short-term, and 6% (around $2,440 AUD) in the medium-term (likely compounded by Cyclone Oswald).

Finally, the sector of employment itself can also play a role, whether through direct exposure to disaster damages (e.g. loss of agricultural production), or increased economic activity induced by the disaster (e.g. hospitals treating an influx of disaster victims). Here, we find that the Queensland Floods 2010-11 were associated with statistically significant income changes for individuals employed in six industry sectors (FIGURE 3), some of which are top employers in the region.

[5] These include sole proprietors and partnerships.

FIGURE 3 INCOME SHOCK PATHWAYS: SECTORS OF EMPLOYMENT WHERE STATISTICALLY SIGNIFICANT INCOME RESULTS WERE OBSERVED



NOTE: PERCENTAGES REFLECT BASELINE YEAR (2006) SECTOR COMPOSITIONS. SEE SECTION 5.4 FOR DISCUSSION ON CROSS-SECTOR TRANSITIONS DURING STUDY PERIOD.

These sectoral results are broadly in line with the widely reported disruptions to economic activity in the aftermath of the floods, and intuitive considering the economic composition of the BRCA LGAs.

To illustrate, it is well documented that following the floods, tourism suffered as tourists initially stayed away from flooded areas, while the retail trade sector economic activity spiked as households replaced flood-damaged household goods (Queensland Treasury, 2011) once businesses reopened.

Associated with this flood-induced economic activity, we observe short-term income losses for workers in the accommodation and food services sector (-8.2%, $2,740 AUD) and administration and support services sector[6] (-18.2%, $7,370 AUD), and income gains (13.1%, $5,500 AUD) for retail sector workers in the medium term.

While economic theory suggests construction may initially experience a boom as reconstruction efforts are undertaken, this will boost individual income where:

i) such individuals are employed in these efforts, and
ii) this offsets any income losses from disruptions to usual construction activities these individuals are employed in.

In Queensland and indeed the BRCA, much of the construction activity (and thus a construction worker's income stream) prior to the floods was tied to private dwelling construction which saw significant falls in housing approvals post-floods (Queensland Treasury, 2011). This helps explain the average short-term individual income losses (-9.7%, $4,950 AUD) for BRCA construction sector workers.

[6] Based on ABS ANZSIC classifications, this sector includes tourism-facing services like travel agency services and tour arrangement services. It also includes employment services which are likely impacted by subdued employment post floods (Queensland Treasury, 2011).

Apart from increased demand for health services following the floods (e.g. hospitalisation), economic activity in the health care and social assistance sector is likely to have been boosted in the short-term by a range of government-led community-focused programs, including ones that focused on alleviating the psychosocial stressors from the floods. This again helps explain the short-term income gains (-9%, $4,320 AUD) for BRCA health care and social workers.

Importantly, our sectoral results help explain why our gender-based income results run counter to prevailing literature, which suggests that women are more adversely affected by disasters compared to males. Instead, we find that the Queensland Floods 2010-11 were associated with income losses for males in the short (-8.3%, $4,380 AUD) and medium term (-7.4%, $4,330 AUD), while females experienced income gains (4.3%, $1,740 AUD) in the short-term.

The results relating to gender differences were initially surprising, as our female sample is largely comprised of low-income and part-time workers. However, by examining sectors of employment, income losses experienced in the male-dominated construction sector could be behind our overall male income results. Similarly, the income gains for females working in the female-dominated health and social assistance sector are likely behind the positive short-term gains reported for females overall.

All of this underscores the need to go beyond the overall results to understand how disaster-induced shocks interact with social and economic dimensions that influence an individual's economic resilience to disasters.

3. Socioeconomic vulnerabilities are concentrated in particular sectors of the economy

As FIGURE 3 highlights, our sectoral results are also useful in illustrating where some of the socioeconomic vulnerabilities to disasters lie.

For instance, we find that the floods were associated with short-term income losses among groups such as youths (-7.4%, $2,940 AUD), low-income earners (-10.1%, $3,100 AUD) and part-time workers (-5.2%, $1,820 AUD). Many of these individuals were employed in the accommodation and food services sector, which saw short-term average income losses of 8.2% (2,740 AUD). This employment sector is characterised by a high level of casualisation and lower earnings potential than other sectors. Much like regional BRCA LGA employed residents, such losses are disproportionate to the financial capacity of this sector's workforce to absorb them.

The key implication here is that while some sectors might be more economically important (e.g. in gross added value or for state revenue), or more prone to disaster-induced production disruptions (e.g. mining or agriculture), actual and/or acute socioeconomic vulnerabilities to disasters may lie elsewhere and this needs to be considered when developing any economic-focused disaster relief and recovery programs.

4. Government disaster relief and recovery programs have a role to play in supporting individual economic resilience to, and recovery from, disasters

While other market-based recovery means such as insurance payments are available, sovereign interventions are generally the first, and are essential for

alleviating the disasters' financial and cognitive burdens and expediting the economic recovery. To ensure a successful rebound, well-designed recovery and relief programs, targeted at both public domain and individual economic wellbeing, are the principal way forward.

Due to data limitations, we were unable to directly assess whether the substantial government relief and recovery programs played a role in mitigating or reducing the effects of the Queensland Floods 2010-11.

However, our research suggests that these programs are necessary to reduce any potential income inequalities that may arise from or be widened by these disasters. Here, we note that many of the programs under the Disaster Recovery Funding Arrangements[7] 2018 are already directed at groups that our research suggests are likely to be susceptible to income shocks (e.g. low-income earners, primary producers and small business owners).

With many government disaster relief and recovery programs focused on community outcomes, it is worthwhile examining how economic programs help communities recover in the longer term. Here, the extension of previously implemented wage assistance programs like the Cyclone Yasi program[8] to include part-time employees is likely to help such individuals better cope with disasters when they strike. Likewise, targeting disaster-sensitive sectors where socioeconomic vulnerabilities are concentrated may provide a helpful buffer to the most sensitive workforces, particularly those already living on the margin.

[7] Formerly National Disaster Relief and Recovery Arrangements.
[8] See appendix 11.2.2.

1.2 WHERE TO FROM HERE?

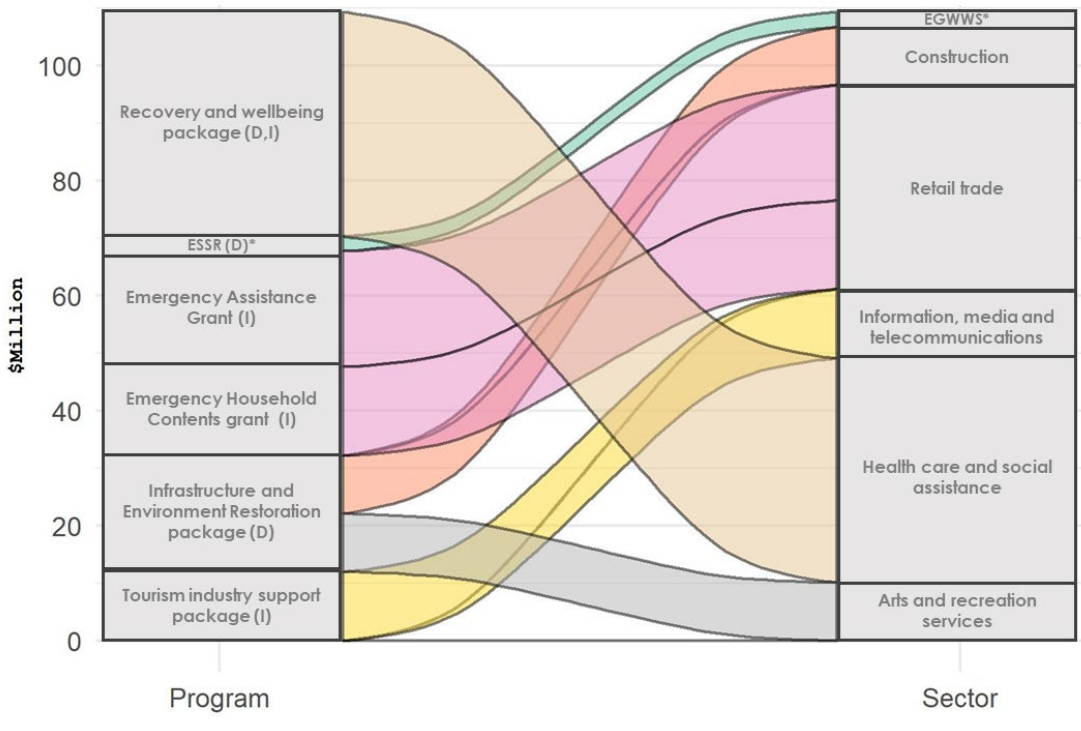
While not offering causal results due to data limitations, our report provides an appropriate framework to guide and inform future economic investigations of disasters arising from natural hazards.

Firstly, we have demonstrated the value of systematically examining the potential effects of disasters across and between multiple economic and social dimensions. Importantly, our report highlights the criticality of examining employment sectors and known social vulnerabilities concurrently, within the social and economic context of the disaster-hit regions, so that results are interpreted correctly, and programs formulated and targeted accordingly.

Such an approach aids in better understanding our vulnerabilities to disasters, as recommended by the National Disaster Risk Reduction Framework, and in informing evaluations of disaster recovery programs, as under A National Monitoring and Evaluation Framework for Disaster Recovery Programs.. Notwithstanding certain limitations, rich and publicly available datasets like the ACLD provide a path for doing so in a robust and rigorous way, before and after disasters.

We have also shown how government relief and recovery programs (were appropriate data to become available) can be overlayed with sector-specific results to establish causal links between government disaster efforts and subsequent economic activity in different sectors (FIGURE 4).

FIGURE 4 GOVERNMENT DISASTER RECOVERY PACKAGES THAT STIMULATE ECONOMIC ACTIVITY IN INDUSTRY SECTORS



Looking ahead, the completion of other case studies under the broader *Optimising Post-Disaster Recovery Intervention Program* will further consolidate our understanding of indirect costs of disasters arising from natural hazards and provide significant input in a policy brief note on post-disaster recovery interventions in Australia. This note will be an input into the development of a guideline for optimising budget allocation across economic sectors in both pre-disaster mitigation as well as post-disaster recovery phases.

Extensions to this research are warranted, particularly to further understand differences between income groups, and unpack the impacts of natural disasters on firm-level activity and on those who migrate out of disaster zones.

2011 BRIISBANE FLOODS,_NASH ST ROSALIE VILLAGE._CREDIT: ANGUS VEITCH (CC BY-NC 2.0)

2. INTRODUCTION

Disasters and Economic Resilience: The Effects of the Queensland Floods 2010-11 on Individual Income – A Case Study on the Brisbane River Catchment Area examines the impact of the Queensland Flood 2010-11 on the incomes of employed residents of the four BRCA LGAs.[9]

The Queensland flooding events that occurred in this region present a unique setting in which to examine the economic effects of riverine flooding on an Australian metropolitan city. Host to a population of two million, the city of Brisbane witnessed a succession of six excessive rainfall spells during December 2010–January 2011, only to see the flood waters reach 4.46 meters (14.63 ft) high on January 13, 2011, before spreading to surrounding regional areas over the following days. Over 30,000 residential and business properties in the region were partially or fully inundated, with the region accounting for 60% of total flood fatalities, most heavily felt in the Lockyer Valley Regional council.

This report sets out to contribute to a greater understanding of the indirect (market) effects that resulted from the Queensland Floods by analysing the income effects for employed individuals through data obtained from the ACLD of 2006-2011-2016. Such effects are currently less known compared to direct damages reported in the immediate aftermath of disasters.

Isolating the effects of the floods from other shocks that hit these LGAs is challenging. To that end, our difference-in-differences modelling[10] and use of end-user knowledge ensures we can, as much as possible, pinpoint and isolate the floods' effects from other shocks that hit our case study area during our study period. In this vein, the ACLD provides a unique opportunity to apply a longer-term examination of such impacts, and ensures we have representative, robust and large enough sample to undertake the empirical analysis.

Not all Australian communities have the same capacity for disaster resilience (Parsons et al., 2019). This is evident in the BRCA, where there are marked differences between the adaptive and coping capacities of the regional and metropolitan LGAs to disaster resilience.[11] Recognising this, the report disaggregates the overall income effects of the Queensland Floods 2010-11 by locational, social and economic dimensions. This is done to provide policymakers with a nuanced understanding of such effects to better target and evaluate the contributions that disaster recovery support initiatives can make to the longer-term economic recovery of disaster-hit communities.

The rest of the report is organised as follows. The project background defines our project scope and research rationale. We follow this with a socioeconomic and disaster resilience profiling of the BRCA LGAs and summarise the known social and economic impacts of the floods on this region. We then outline the research approach we have taken to estimating the floods' impacts, highlighting the implications of key assumptions and limitations, before turning to reporting and discussing the implications of our results.

[9] The four LGAs are: Brisbane City Council, Ipswich City Council, Lockyer Valley Regional Council and Somerset Regional Council. See Figure 1.
[10] See definition in TABLE 2.
[11] See discussion in section 4.2.

3. PROJECT BACKGROUND

The *Disasters and Economic Resilience: The Effects of the Queensland Floods 2010-11 on Individual Income – A Case Study on the Brisbane River Catchment Area* report is one of four natural disaster case studies explored as part of the Optimising Post-Disaster Recovery Interventions in Australia research program:

- The Victorian Black Saturday Bushfires 2009
- The Western Australian Toodyay Bushfires 2009
- The Queensland Floods 2010-11(this study)
- Cyclone Oswald 2013.

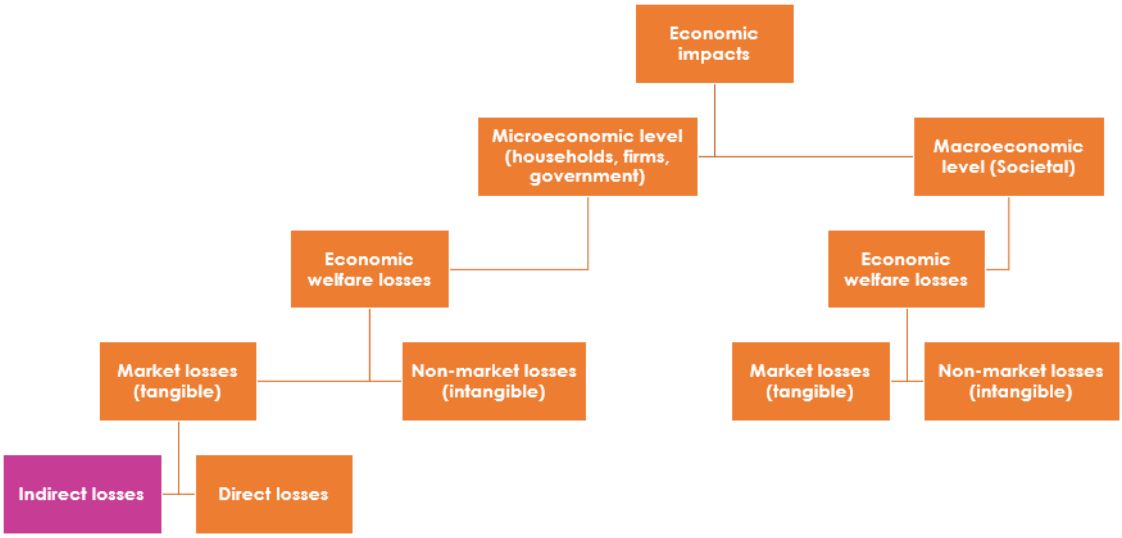
The case studies were chosen to unpack the economic effects that disasters of different types and scales can have on metropolitan and regional communities.

The research program is generously funded by the BNHCRC and informed by consultations with government emergency management agency end-users.

3.1 PROJECT SCOPE

Depending on the research motivation, economic impacts of natural disasters can be assessed at either a macro level (i.e. impacts across the whole economy), or micro level (i.e. impacts on households, firms/industry sectors or government). Within each categorisation, we can also explore market and non-market economic welfare losses (FIGURE 5).

FIGURE 5 WHERE OUR PROJECT SITS WITHIN THE BROADER ECONOMIC IMPACTS ASSESSMENT OF NATURAL DISASTERS



As we are looking at income changes (losses or gains) at an individual level, such changes (losses or gains) are microeconomic in nature. As income effects (where they arise) are not a direct effect but rather an indirect consequence of the floods, they fall within indirect market economic welfare changes.

3.1.1 In scope

This report measures the income changes for employed individuals who were living within the boundaries of the four Brisbane River Catchment area LGAs at the time of Queensland 2010-11 flood events. These LGAs are:

- Brisbane City Council (Brisbane)
- Ipswich City Council (Ipswich)
- Lockyer Valley Regional Council (an amalgamation of the Shire of Gatton and Shire of Laidley since 2008)
- Somerset Regional Council (an amalgamation of the Shire of Esk and Shire of Kilcoy since 2008).

We use difference-in-differences modelling[12] to assess:

- the effects the floods had on individuals' income streams in both the short term (August 2011) and medium term (August 2016), disaggregated by locational, demographic and sectoral attributes; and
- whether and how the government's relief and recovery expenditures assisted individuals to resume their normal economic course – to the extent that complementary publicly available government data are available.

The Australian Census Longitudinal Dataset (ACLD) is our primary dataset.

3.1.2 Out of scope

The project does not examine any other indirect costs[13] or any other economic effects described in FIGURE 5. We acknowledge that the Queensland Floods 2010-11 caused profound and long-lasting psychosocial impacts on the BRCA. Such intangible costs were estimated to have accounted for 52% of the total costs of the floods (Deloitte Access Economics, 2016; see FIGURE 9). Recognising this, we provide additional information to contextualise our assessment so policymakers can interpret our findings holistically, within the broader social and economic conditions arising from the floods.

We also do not compute the effect of income changes on individual expenditure. We acknowledge that this is likely to significantly influence the coping and adaptive capacity of individuals, and the scope by which individuals can respond to future shocks. We discuss this further in our analysis section and take this into account when formulating our key insights and conclusions.

The project does not assess the role insurance could have played in reducing or mitigating the effects of the floods, which we consider to play, at best, a stimulatory role in the medium-term (see 5.5.1.2.2). As noted in our limitations section (5.5.2), this is predominantly because of the dearth of insurance data at the LGA level.

[12] See TABLE 2 for definition.
[13] See FIGURE 6 for examples of such costs, and TABLE 2 for definitions of these terms.

3.2 RESEARCH RATIONALE

Disasters arising from natural hazards ("natural disasters") are very costly in Australia, and often have profound physical, psychological and economic consequences on impacted communities. Recent devastating examples include the Victorian Black Saturday Bushfires 2009, the Queensland Floods 2010-11 and Cyclone Debbie (2017), all of which caused loss of life, damage to countless homes and properties, and significant losses across multiple sectors.

With the severity and frequency of natural hazards in Australia expected to increase (Kitching et al., 2014), there is growing academic and policy effort towards better understanding the risks disasters arising from natural hazards pose on Australian communities; the impacts they have on different sections of the economy and community; and the role that disaster risk reduction can play in minimising such impacts and building disaster resilience.

1. **By estimating income effects, our research contributes to a greater understanding of the indirect market effects of natural disasters.**

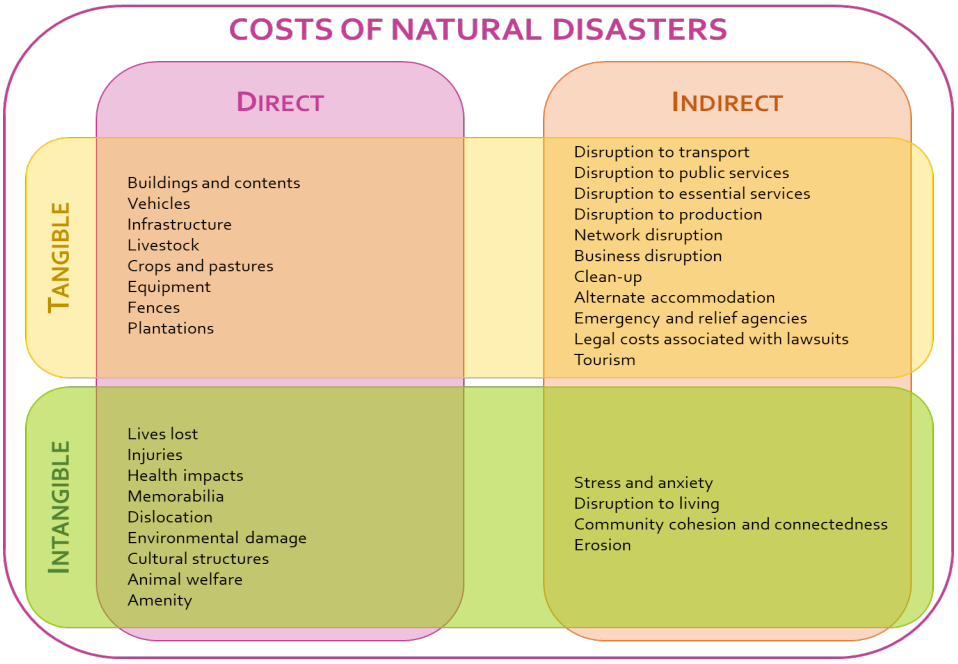
To date, empirical economic literature has focused on investigating the economic effects of natural disasters at a macro level, with typical instruments used in the analysis being GDP and aggregate consumption.

While such broader examinations are useful, aggregate indicators like GDP or GDP equivalents miss the impacts of disasters on government transfer payments (Deryugina, 2017). They can also mask very large distributive impacts, and thus, are misleading measures of actual welfare changes (Hallegatte, 2014). The poorest, Hallegatte argues (2014), would have little to lose in a disaster and so the impact on their welfare is "invisible". Rather, to measure welfare, recent OECD reports like the Commission on the Measurement of Economic Performance and Social Progress recommend focusing on income, as we do, and consumption instead of GDP (OECD, 2009).

Empirical analyses have also tended to focus on estimating direct market effects of natural disasters – a recent meta-analysis of the literature showed evidence of negative direct costs (Lazzaroni and van Bergeijk, 2014), with more severe disasters causing the highest damage and increasing the likelihood of long-term and/or negative consequences (Boustan et al., 2017; Kousky, 2014).

In contrast, the indirect and intangible effects (FIGURE 6) of disasters are rarely assessed (Ibarrarán et al., 2009), despite evidence suggesting such effects to be of a greater magnitude. Including these costs would likely yield much higher loss estimates than the more readily quantified direct market costs alone.

FIGURE 6 ECONOMIC COSTS OF NATURAL DISASTERS



SOURCE: SUPPLIED BY PENMAN ET AL. (2019)

2. Investigating income effects helps us understand the underlying vulnerability to disasters and likely flow-on effects on disaster resilience

Socio-economic inequality is widely recognised as one of the root causes of vulnerability to disasters (Wisner et al., 2004). A lower socio-economic status has been consistently associated with greater post-disaster hardship, with the poor suffering significant disaster effects due to lower financial capacity and limited access to public and private (e.g. insurance) recovery assets (Gladwin and Peacock, 2000; Fothergill and Peek, 2004).

While it is one of many potential measures of an individual's economic resilience, income is a significant socio-economic indicator that determines status in both absolute and relative terms (i.e. income inequality) and determines inter-generational transmission of skills (e.g. investment into children's education).

Income is also at the core of household finance, and determines the levels of indebtedness, borrowing and wealth accumulation. Unlike other possible measures, it is also the most readily assessable and accessible measure of economic resilience, particularly to correlate with other demographic and employment attributes we are interested in exploring. Moreover, income is a stream, something that can change in the short term and therefore offers a critical "pulse" through which we can measure the effects of disasters.[14]

Finally, recognising the broader intangible effects of disasters we noted earlier, there are also strong links between income disruptions during disasters and mental health outcomes. In the case of bushfires, the longevity of disruptions to income post-disaster has been shown to materially affect the mental health of those affected by bushfires. Following the Victorian Black Saturday Bushfire in 2009, people who experienced major life stressors after the fires (change in relationship, income, accommodation) were more likely to have poor mental health outcomes three to five years after the fires (Gibbs et al., 2016).

[14] In contrast, wealth is a stock and so doesn't change as easily, which makes it difficult to detect these effects.

3. Our analysis of the role of government intervention in post-disaster relief and recovery efforts fills a known gap in the economics literature

To the best of our knowledge, the present study is the first in the economics literature to examine the impact of a riverine-flooding on individual income, considering demographic and sectoral heterogeneities and the post-disaster government assistance in a case study of an Australian metropolitan economy.

The gap in the literature in evaluating the role of government intervention in individual economic recovery is partly there because the rich datasets that enable this type of analyses have been made available only recently. For example, the ACLD 2006 and 2011 linking was released by the ABS in 2013 and ACLD 2006-11-16 linked dataset was released in 2018.

International studies show the value of using individual-level panel datasets to investigate the income effects of disasters. At the forefront of this literature is the Deryugina, Kawano and Levitt (2018) study, which examines the tax return data from the USA to look at the long-term economic impacts of Hurricane Katrina on its victims. The authors find that "Hurricane Katrina had large and persistent impacts on where people live, but small and surprisingly transitory effects on their employment and income. Within just a few years, Katrina victims' incomes actually surpassed that of controls from similar unaffected cities. The strong economic performance of Hurricane Katrina victims is particularly remarkable given that the hurricane struck with essentially no warning." However, they do not study the role of government intervention in individual economic recovery.

Another study by Deryugina (2017) does look at the fiscal costs of disasters, but uses county-level data, rather than individual-level data, from the USA. Examining all hurricanes that landed on the USA during the period 1979-2002, Deryugina (2017) shows that "US hurricanes lead to substantial increases in non-disaster government transfers, such as unemployment insurance and public medical payments, in affected counties in the decade after a hurricane. The present value of this increase significantly exceeds that of direct disaster aid. This implies, among other things, that the fiscal costs of natural disasters have been significantly underestimated and that victims in developed countries are better insured against them than previously thought".

So, the studies by Deryugina and others focus on Hurricane Katrina and other hurricanes in the USA by examining their effects on income, unemployment insurance, and public medical payments. However, where they study income effects, they do not look at the government intervention, and where they study the fiscal costs, they do not use individual-level data.

In contrast, our study uses individual-level data from Australia to examine the income effects following a single disaster, the Queensland Floods 2010-11. While we are unable to formally assess whether government packages played a mitigating role (due to unavailability of related data), our approach nonetheless sheds light on the role of government intervention in disaster recovery. The Queensland Floods 2010-11 provides an exemplar case of post-disaster relief and recovery interventions across local, state and federal governments.

4. Focusing on the Brisbane river flooding events offers important lessons for other developed cities that are at increased risk of experiencing riverine flooding

To the best of our knowledge, this is one of the few studies[15] that has examined the economic impacts of such extensive riverine flooding on a sprawling urban area in the period following the disaster.

With the state capital Brisbane included in our study area, both the impact of the disaster and the efficacy of the government's recovery assistance can provide valuable lessons for many other developed cities around the world.

Globally, many major cities[16] are situated on riverbanks, and so riverine flooding poses considerable threats not only to human life and social order, but also to economic activity and public and private infrastructure. These complex urban systems have become increasingly exposed to urban flood risk owing to global warming, which is argued to have ushered in a new climatic regime of torrential rainfall with increased frequency and intensity (Boustan et al., 2017).

Locally, economic activity in Australia is concentrated in cities, many of which are located along riverbeds.[17] The Brisbane river flooding events thus offer an important case study for other Australian cities that are susceptible to flooding.

[15] The most relevant economic study is by Gallagher and Hartley (2017) who investigated the household economic well-being after Hurricane Katrina. While the study focused on disaster-driven riverine-flooding in a major metropolitan city, it examined the role of insurance rather than of government assistance in post-disaster household recovery, using credit card data from a commercial supplier to look at how households used their disaster insurance payments post disaster.

[16] Just some examples include: London, Paris, Berlin, Vienna, Budapest, Washington DC, Melbourne, Brisbane, Tokyo, Bangkok, Baghdad, Cairo, Delhi, Shanghai, Seoul, São Paulo and Buenos Aires.

[17] For instance, Kelly et al. (2014) found that the CBDs of Sydney and Melbourne – just 7.1 square kilometres in total – generated $118 billion in 2011-12, almost 10 per cent of all economic activity in Australia, and more than three times the contribution of the entire agriculture sector.

4. THE BRISBANE RIVER CATCHMENT AREA LGAS

At its core, our research aims to determine the effects a natural disaster has on an individual's income trajectory. From discussions with our end-users, we have agreed to limit the scope of our investigation to the flooding events that occurred in the four BRCA LGAs.

To set the context for our results, we first provide an overview of the in-scope BRCA's socioeconomic and disaster resilience profiles, then discuss the known social and economic impacts of the Queensland Floods 2010-11 on the region.

4.1 SOCIAL AND ECONOMIC PROFILE[18]

The BRCA is economically significant. On average, 31% of Queensland's employed workforce and 30% of its businesses are in the area.

This figure is largely driven by Brisbane. In 2006-07, it had 103 businesses per 1000 residents, with a significant share of these businesses (~39%) employing staff. Its population is relatively young (median age of around 34.6 across the decade) and highly skilled, with over 40% of its population holding a bachelor's degree or higher. The area's economic significance and service-oriented economy underscore its relatively low unemployment rate and comparably higher median personal and household income. Its population grew from 987,831 in 2006 to 1,184,752 in 2016.

In contrast, the historical provincial city of Ipswich presents a mixed profile. Over the study period, the region was one of the ten fastest growing LGAs in Queensland, growing from 141,986 in 2006 to 200,103 in 2016. Its median age dropped slightly from 33.2 to 32.5 years over the decade. While median income was generally in line with the state average, the region is characterised by relatively lower educational attainment levels and high rates of income support (, 2014). The unemployment rate has consistently exceeded the state average, rising from 5.1% in 2006 to 9% in 2016. The region is economically dependent on Brisbane, with almost half (49%) of Ipswich residents travelling outside the region for work, with the Brisbane LGA being the main destination (Queensland Department of Employment, 2014). Ipswich has the lowest business per capita count among LGAs in the BRCA, with population growth (3.4% annualised growth between 2006-07 and 2015-16) far exceeding growth in net business entries (0.9%) over the same period.

The regional Lockyer Valley and Somerset councils are relatively more socioeconomically disadvantaged. Their populations are smaller (31,305 and 19,608 in 2006, respectively), remaining below 40,000 throughout 2006-16. They are also relatively older, with median age rising to 39 years in Lockyer Valley and 43 years Somerset in 2016. Educational attainment levels are also low. Median personal income over the period was below the state average, equivalent to

[18] Unless otherwise stated, all data presented in this section has been sourced from the: Australian Bureau of Statistics 2024.0 - Census of Population and Housing (2017); Australian Bureau of Statistics (2017), 8165.0 - Counts of Australian Businesses, including Entries and Exits; Australian Bureau of Statistics (2017), 3218.0 Regional Population Growth, Australia.

~65-68% of what a typical neighbouring Brisbane resident earned in a given year. Unemployment rates were persistently above the state average.

The regional council areas are also characterised by a much larger share of non-employing businesses[19] (particularly Somerset), with a high concentration of these businesses in the agriculture industry.

Since 2001, the BRCA LGAs have seen marked changes to their economic composition. Their workforce has seen a shift away from historically significant industry sectors including agriculture and manufacturing. The strongest negative annualised change in employment share of manufacturing has been in Brisbane (-4.28%) and Ipswich (-3.79%), with the agricultural sector also ranking lowest in share of employment in these LGAs across the 2006-2016 period. Nevertheless, these industries remain important in the regional councils and Ipswich. The Lockyer Valley represents approximately 12-14% of the Queensland agricultural economy (Lockyer Valley Regional Council, 2014), while Ipswich holds approximately 40% of south-east Queensland's available industrial land (Ipswich City Council, 2011).

[19] The ABS defines non-employing businesses as businesses that are sole proprietorships or partnerships without employees.

TABLE 3 TOP INDUSTRIES OF EMPLOYMENT IN THE BRCA REGION (2001-2016)

Top 5 industries of employment, by LGA	2001	2006	2011	2016	2001-2016 Trendline	2001-2016 Annualised Δ
Brisbane						
Health care and social assistance	11.0%	11.7%	13.2%	14.2%		*1.73%*
Retail trade	10.6%	10.6%	9.2%	8.9%		*-1.12%*
Manufacturing	9.9%	9.0%	7.3%	5.2%		*-4.28%*
Education and training	9.7%	9.2%	9.3%	10.6%		*0.65%*
Professional, scientific and technical services	9.3%	9.7%	11.3%	10.9%		*1.07%*
Public administration and safety	7.0%	7.9%	8.1%	7.7%		*0.68%*
Ipswich						
Manufacturing	18.7%	18.2%	14.7%	10.5%		*-3.79%*
Retail trade	11.2%	11.5%	11.1%	11.0%		*-0.10%*
Health care and social assistance	11.1%	11.6%	12.5%	13.8%		*1.46%*
Public administration and safety	9.0%	8.6%	9.9%	9.5%		*0.36%*
Education and training	7.0%	6.9%	7.1%	8.5%		*1.30%*
Construction	6.1%	7.5%	7.8%	8.8%		*2.45%*
Lockyer Valley						
Agriculture, forestry and fishing	17.9%	15.1%	12.6%	14.5%		*-1.39%*
Manufacturing	13.0%	11.5%	9.9%	7.4%		*-3.67%*
Retail trade	10.1%	11.6%	11.2%	9.5%		*-0.39%*
Education and training	9.0%	8.4%	8.5%	9.6%		*0.41%*
Health care and social assistance	7.7%	8.9%	9.8%	10.2%		*1.91%*
Construction	5.7%	7.4%	7.8%	8.7%		*2.83%*
Somerset						
Agriculture, forestry and fishing	17.1%	12.2%	9.9%	9.6%		*-3.76%*
Manufacturing	15.1%	14.9%	13.9%	12.9%		*-1.01%*
Retail trade	9.0%	10.0%	10.3%	9.5%		*0.34%*
Health care and social assistance	8.2%	9.2%	10.3%	10.7%		*1.76%*
Education and training	7.9%	7.8%	7.6%	8.3%		*0.35%*
Construction	5.5%	7.8%	8.6%	9.7%		*3.79%*

SOURCE: ABS CENSUS OF POPULATION AND HOUSING, INDUSTRY OF EMPLOYMENT BY OCCUPATION (LGA) (2001, 2006, 2011, 2016). NOTE: EXCLUDES "NOT STATED" AND "NOT APPLICABLE" CATEGORIES.

4.2 DISASTER RESILIENCE PROFILE

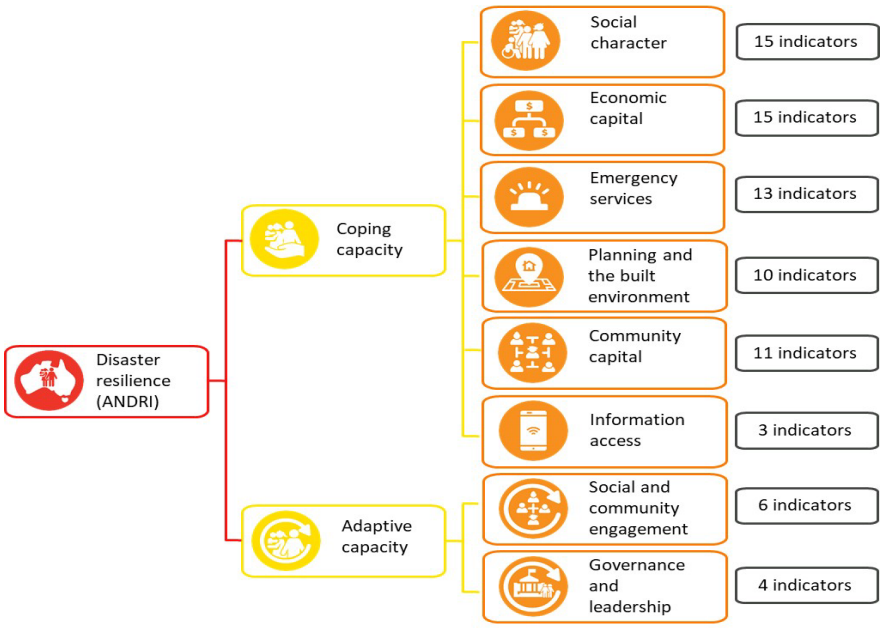
Not all Australian communities have the same capacity for disaster resilience (Parsons et al., 2019), with flow-on consequences on the speed by which they can socially and economically recover. This is especially true for regional communities, with some reported to take up to 25 years to recover (Regional Australia Institute, 2013).

The Australian Natural Disaster Resilience Index (ANDRI) is a national scale composite index that provides an evidence-based snapshot of the disaster resilience of SA2s across Australia. It defines resilience to disasters arising from natural hazards as: "the capacity of communities to prepare for, absorb and recover from natural hazard events and to learn, adapt and transform in ways that enhance these capacities in the face of future events." (Parsons et al., 2019).

Overall resilience to disasters arising from natural hazards (i.e. the ANDRI overall score) is viewed as a composite of coping and adaptive capacities (FIGURE 7). The coping and adaptive capacities for disaster resilience are captured using

eight themes that encompass various known dimensions of disaster resilience. The index ranges from 0 (lowest capacity for disaster resilience) to 1 (highest capacity for disaster resilience).[20]

FIGURE 7 ANDRI STRUCTURE



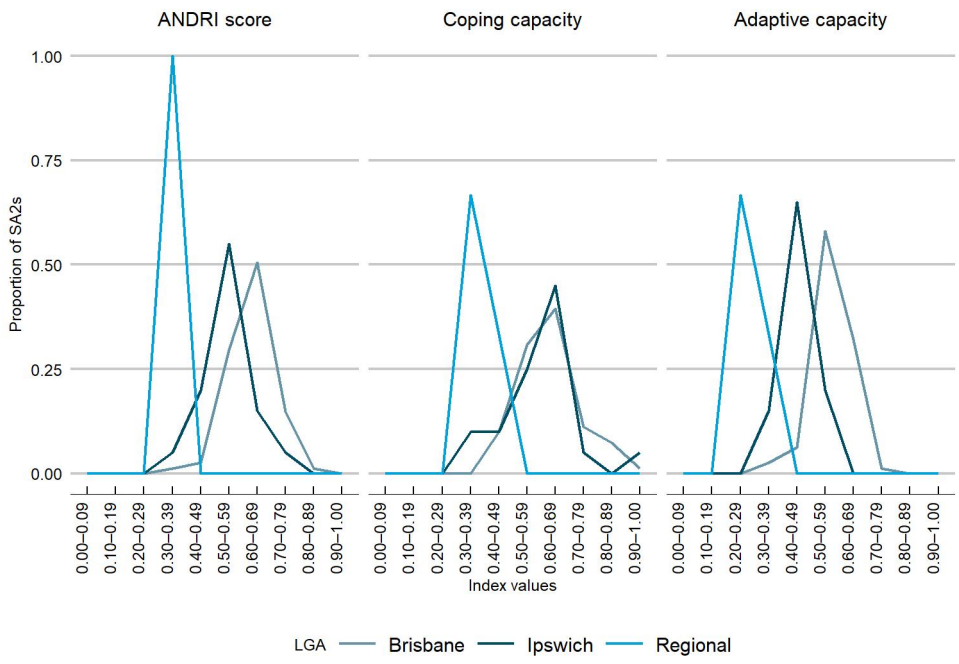
SOURCE: PARSONS ET AL, (2019)

ANDRI scores are available for SA2s corresponding with our in-scope BRCA LGAs.[21] For the BRCA as a whole (n=140), the majority of SA2s (69%, n=72) were assessed as having moderate capacity for disaster resilience. Typically, such SA2s have moderate levels of economic capital, moderate provision of an access to services, moderate community cohesion and variable encouragement for adaptive learning and problem solving. Typically, they scored better on coping capacity than adaptive capacity.

However, once SA2s are grouped by corresponding LGA, it is quickly apparent how the different underlying socioeconomic characteristics impact the capacity of these LGAs to cope and adapt to disasters, particularly the regional Somerset and Lockyer Valley councils (Figure 8).

[20] See Appendix 12.1 for further information on the ANDRI scoring.
[21] Approximate as SA2 and LGA boundaries do not completely overlap. Additionally, not all BRCA SA2s were assessed by the ANDRI: Brisbane = 84 SA2s, Ipswich = 20 SA2s, Somerset = 2 SA2s , Lockyer Valley = 1 SA2.

FIGURE 8 BRCA ANDRI SCORES, BY BRCA REGION



SOURCE: PARSONS ET AL. (2019)

Of the 23% of SA2s (n= 24) assessed as having high capacity for disaster resilience, all but one (Ipswich's Karalee - Barellan Point, ANDRI= 0.7228) were Brisbane SA2s. Factors contributing to their high disaster resilience typically included socioeconomic characteristics we outlined earlier (e.g. employment, education and income); good access to or provision of resources and services; strong community cohesion and ample opportunities for adaptive learning and problem solving.

Of the 7.7% of BRCA SA2s (n=8) assessed as having low capacity for disaster resilience, the lowest ANDRI scoring SA2s were in Somerset (Esk, ANDRI= 0.2904; Lowood, ANDRI= 0.3027), Ipswich (Riverview, ANDRI= 0.3519) and Lockyer Valley (Lockyer Valley – East: 0.3524). In reviewing the measures used to score each theme, it is evident that the relatively lower economic diversity, higher unemployment rates and lower educational attainment levels of the regional LGAs we discussed earlier detracted from the social engagement and economic capital that enable communities within these LGAs to cope and adapt to disasters. For this reason, undertaking a separate analysis of the income effects in the regional BRCA LGAs warrants further investigation.

4.3 IMPACTS OF THE QUEENSLAND FLOODS 2010-11

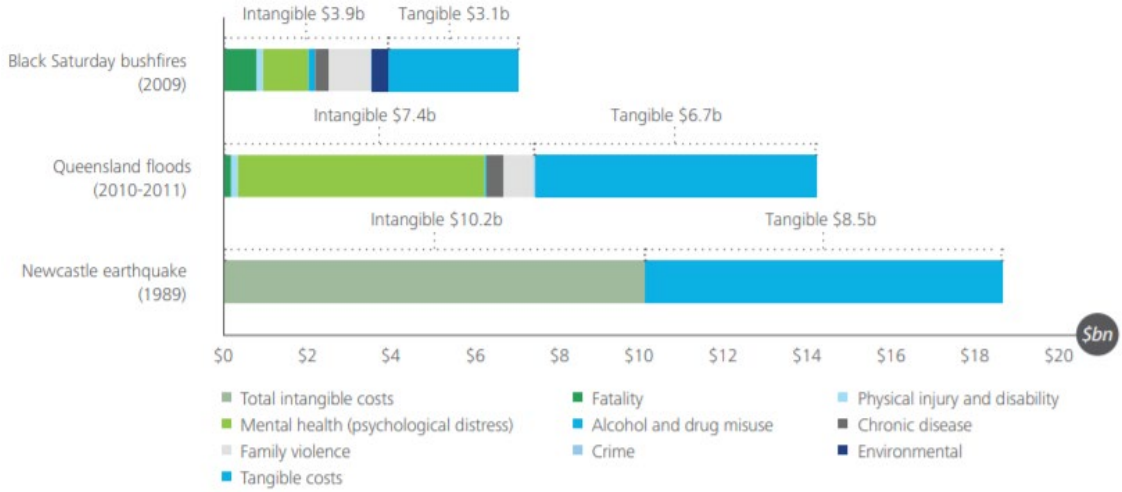
4.3.1 Overall Impacts

The 2010-2011 Queensland Floods are one of the most devastating complex of flood events in Australian history. Almost the entire state of Queensland was declared a natural disaster zone. Over 2.5 million people were affected by the floods; 5,900 people were evacuated from their homes (Emergency

Management Queensland, 2011), with 33 lives lost and 3 missing, presumed dead (Queensland Floods Commission of Inquiry, 2012).

The floods caused an estimated $6.7 billion in tangible damages, with an overall cost of $14.1 billion (Deloitte Access Economics, 2016). According to Beecroft et al (2017), approximately 20% (6,709 km) of the state-controlled road networks required full or partial reconstruction.

FIGURE 9 TOTAL ECONOMIC COST OF QUEENSLAND FLOODS, BLACK SATURDAY BUSHFIRES AND NEWCASTLE EARTHQUAKE



SOURCE: DELOITTE ACCESS ECONOMICS (2016)

The widescale devastation of the floods and subsequent impacts from Cyclone Yasi led to a national flood levy in 2011-12 income year (the Temporary Flood and Cyclone Reconstruction Levy) to help fund the rebuilding of essential infrastructure, including roads, bridges and schools that were damaged by these extreme weather events. Some 29,000 homes and businesses suffering inundation (Queensland Floods Commission of Inquiry, 2012). A total 56,200 flood-related insurance claims were made at a total reserved insured value of $2.55 billion (Queensland Government, 2011).

Coupled with Cyclone Yasi and wetter than usual weather conditions, the floods were estimated to have detracted around 2¼ percentage points from Queensland's GSP in 2010-11 (Queensland Treasury 2012), with significant losses in sectors that form key drivers of Queensland's economic growth (TABLE 4).

TABLE 4 ESTIMATED ECONOMIC SECTOR DAMAGE AND LOSSES FROM 2010-11 QUEENSLAND FLOOD & CYCLONE YASI

Sector	Estimated losses ($b)	Data source
Mining	**$2.5**	PriceWaterhouseCooper (a)
	$5.7	Queensland Treasury (b)
Agriculture	**$1.4**	Queensland Treasury (b)
	$1.6	IBIS World (a)
Tourism	**$0.4**	Queensland Treasury (b)
	$0.6	IBIS World (a)

SOURCES: (A) THE WORLD BANK AND QUEENSLAND RECONSTRUCTION AUTHORITY (2011), (B) QUEENSLAND TREASURY (2012).

Examining Queensland Economic reviews for the 2010-11 year, the floods also disrupted activity in the construction sector, exacerbating declines in private dwelling approvals, which fell by 16.6% in January 2011 alone (Queensland Treasury, 2011). Meanwhile, food retail spending initially spiked as consumers stocked up ahead of the floods (Queensland Treasury, 2011). In the immediate aftermath of the floods, cafes, restaurants and takeaway shops were also boosted as flood displaced individuals changed food spending patterns. There was also increased spending on clothing, footwear and household goods as flooded households replaced these goods (Queensland Treasury, 2011).

Apart from sector-specific effects, the floods caused widespread disruptions to business activity. In a survey of 211 Queensland businesses[22] conducted by the Chamber of Commerce and Industry Queensland (2011), 47.9% of respondents stated they were impacted by the floods. More than 53% of flood affected businesses experienced short-term closures throughout the initial floods and for indirectly impacted businesses, 48.6% had employees unable to attend work. While many of these businesses had recovered by August 2011, a significant proportion of those directly affected (40%) and indirectly affected (39.7%) were still experiencing negative business conditions six months later.

These disruptions had marked effects on Queensland's workforce, with noticeable volatility in labour force participation and subdued employment (particularly part-time employment) in the first few months following the disaster (Queensland Treasury, 2011). Importantly, a survey[23] by Clemens et al. (2013) of Queensland adults undertaken between March and June 2011 makes a connection between the floods and individual income:

- 62% of survey respondents (n=6104) reported being "affected in any way" by the 2010–2011flooding events
- 17% of survey respondents reported reduced income, with men and young to mid-aged adults most often reporting income loss. Residents of regional and remote areas were more likely to report income losses than city residents

[22] All regions of Queensland were represented in the survey. 35% of respondents were located in Brisbane; 62% had 20 employees or less, 26% had between 21 and 100 employees, and 12% had more than 100 employees.

[23] Data were collected as part of the Queensland Government's annual Self-Reported Health Status and was based on a cross-sectional telephone-based survey using a brief trauma exposure and impact screening instrument. The survey was conducted between 11 March and 6 June 2011 with 6,104 adults who answered natural disaster and mental health questions.

- 11.7% of respondents reported damage to their business or income-producing property.

Severe natural disasters exact a heavy and long-lasting social toll, and the Queensland Floods 2010-11 are no exception. In the Clemens et al. (2013) survey, many respondents (14%) reported feeling terrified, helpless or hopeless as a result of the floods. For some (7%), this distress continued five months after the floods. Mirroring international experience, the emotional burden was disproportionately and most acutely felt among the most vulnerable Queenslanders, particularly residents of disadvantaged areas and those living in rural and remote areas of Queensland (Clemens et al., 2013).

There is also some evidence that the flood events had lasting community impacts on mental health, alcohol misuse and family violence, exacerbating already existing chronic diseases (Deloitte Access Economics, 2016). While it's never easy to quantify these intangible impacts, a Deloitte Access Economics report (2016) estimated the lifetime cost of flood-related mental health issues alone at around $5.9 billion (net present value in 2015 dollars) (TABLE 5).

TABLE 5 ESTIMATES OF INTANGIBLE COSTS OF THE QUEENSLAND FLOODS 2010-11

Intangible cost	Net present value in 2015 dollars ($m)
Deaths and injuries	$320
Mental health issues	$5,900
Risky substance use (alcohol and smoking)	$20
Exacerbation of chronic and non-communicable diseases	$430
Family violence	$720

SOURCE: DELOITTE ACCESS ECONOMICS (2016)

4.3.2 Impacts on the BRCA

The Queensland Floods 2010-11 devastated the BRCA. Brisbane witnessed a succession of six excessive rainfall spells during December 2010–January 2011, only to see the flood waters reach 4.46 meters (14.63 ft) high on January 13, 2011, before spreading to surrounding regional areas over the following days.

Over 30,000 residential and business properties in the region were partially or fully inundated (TABLE 6). 33% of Ipswich properties were inundated, with approximately 1200 homes being significantly affected and 188 businesses directly impacted (Ipswich City Council, 2011).

TABLE 6 BRCA INUNDATED RESIDENTIAL AND BUSINESS PROPERTIES

Attribute	Inundated properties (a)			Insurance claims (b)	
	Total	Residential	Business	No.	Value($m)
BRCA LGAs	**33,847**	**25,706**	**7,859**	**31,698**	**$1,053**
Brisbane	29,768	22,097	7,671	19,779	$892
Ipswich	8,600	na	na	na	na
Lockyer Valley	2,409	2,409	na	11,919	$161
Somerset	282	na	na	na	na

Queensland	**136,000**	**na**	**na**	**49,400 (c)**	**$2,310 (c)**

SOURCES (A) BRISBANE: FLOOD RESPONSE REVIEW BOARD (2011) IPSWICH CITY COUNCIL (2011), LOCKYER VALLEY REGIONAL COUNCIL (2012), SOMERSET REGIONAL COUNCIL (2012) (B) QUEENSLAND GOVERNMENT (2011), (C) INSURANCE COUNCIL OF AUSTRALIA (2011)

The flash flooding resulting from intense rainfall was particularly traumatic for Lockyer Valley communities, who suffered the highest fatality count in the whole of South-east Queensland (TABLE 7).

TABLE 7 BRCA QUEENSLAND FLOODS 2010-11 FATALITIES

	2009-10		Queensland Floods 2010-11 fatalities (c)
	Estimated resident population (a)	Number of businesses (b)	
BRCA LGAs	**1,297,105**	**127,133**	**23**
Brisbane	1,073,144	113,688	1
Ipswich	167,134	8,395	1
Lockyer Valley	35,110	2,981	19*
Somerset	21,717	2,069	1
Queensland	**4,404,744**	**433,029**	**35**

NOTE: FIGURE INCLUDEES TWO RESIDENTS WHO ARE PRESUMED DEAD. SOURCES: (A) ABS, CAT 3218.0 REGIONAL POPULATION GROWTH; (B) ABS, CAT 8165.0 COUNTS OF AUSTRALIAN BUSINESSES, INCLUDING ENTRIES AND EXITS; (C) QUEENSLAND FLOODS COMMISSION OF INQUIRY (2012), QUEENSLAND OFFICE OF THE STATE CORONER (2012).

The BRCA councils were among 37% of Queensland LGAs to activate the Natural Disaster Resilience and Recovery Arrangements (NDRRA) Category D assistance, reserved for the most severe impact disasters. Damages to council assets were disproportionately borne by the BRCA councils with the least capacity to absorb these costs (TABLE 8).

TABLE 8 LOCAL GOVERNMENT ESTIMATES OF THE COSTS OF 2010-11 NATURAL DISASTER EVENTS TO COUNCIL ASSETS

	Population density (a) (per sq. km)	Net general rates (b) (2010-11) ($m)	Total damages to council assets (b)			
			2010-11			2009-10 to 2013-14
			($m)	per capita ($)	Damage as percent of rate revenue (%)	avg. annual damage as percent of rate revenue (%)
BRCA LGAs	**127**	**Na**	**$479.60**	**$376.23**	**Na**	**Na**
Brisbane	799.2	$592.68	$129.90	$121.05	22%	5.10%
Ipswich	154.0	$94.57	$99.70	$596.53	105%	20.10%
Lockyer Valley	15.5	$18.52	$154.70	$4,406.15	515%	204.10%
Somerset	4.0	$12.23	$95.30	$4,388.27	1,265%	204.50%
Queensland	**2.6**	**Na**	**$2,175.90**	**$542.89**	**Na**	**Na**

2010-11 COUNCIL FIGURES INCLUDE CYCLONE YASI COSTS.SOURCE: (A) ABS, CAT 3218.0 REGIONAL POPULATION GROWTH (2009-10), (B) LGAQ (2014).

Per-capita council flood costs for Lockyer Valley and Somerset councils were among the 20 highest recorded in the state, with 77% of Lockyer Valley's local road infrastructure destroyed. The floods resulted in an $11 million debt to finance recovery activities, resulting in increased rates borne by its residents and reduced levels of service (Lockyer Valley Regional Council, 2014). Meanwhile, Brisbane

City Council took two years to restore the city (Sultana et al., 2016), with an estimated overall recovery cost of $440 million (Brisbane City Council, 2011).

The Queensland Floods created many financial difficulties for BRCA residents. A Geoscience survey (2016) found two-thirds of Brisbane and Ipswich household respondents had one or more persons unable to work following the floods, with impacts on some small business owners. The main reasons given were flooded or damaged roads preventing access to the workplace (38%), the place of employment was closed (37%) and taking time off (with or without pay) to clean and repair the home (24%). The vast majority (87%) of these respondents also reported greater out-of-pocket expenses as a result of the floods, including relocation and accommodation costs, replacing of essential items, and increased utility and living expenses. Most respondents (78%) drew on their savings to pay for these expenses.

Consistent with the broader social impacts of the floods, multiple studies showed that the Brisbane flooding events had a significant impact on the physical and psychosocial health of residents. A survey of (n=960) conducted by Alderman et al. (2013) found that, compared to those unaffected by the Brisbane floods, people who reported direct flood impact were more likely to report:

- worse overall health,
- worse respiratory health,
- higher psychological distress,
- more problems with sleeping, and a
- higher probability of post-traumatic stress disorder.

Many Brisbane and Ipswich residents were forced to leave their homes for an average of 95 days (median = 21 days), often returning to incomplete, unrepaired homes (Geoscience Australia, 2016). Even when back home, the disruptions to every-day life made it difficult to recover. The stress of the floods caused some families to split, household members to become sick or unable to work; and some even contemplated suicide (Geoscience Australia, 2016).

> *The recovery period has taken a long time - we would never have imagined that nearly 18 months after the event we still wouldn't be back in our home. The daily frustrations have been enormous - we are just about to move for the 5th time since the floods due to rental properties being sold or owners having changed circumstances. This has resulted in a constant change of personal details with utility companies, phone companies, government organisations etc. Our energy levels and capacity to cope have been severely challenged over this time (Respondent from Fig Tree Pocket; Geoscience Australia, 2016).*

These effects persisted in the medium-term. In a survey of residents from flood-affected areas of Brisbane, Ipswich, Morton Bay, Lockyer Valley and Toowoomba, those with direct flood exposure had significant effects on perceived physical and psychosocial health outcomes, with 26% stating that they were still experience some adverse health effects from the floods six years later (Fitzgerald et al., 2019).

Thus, the long-term nature of these social and economic effects is important, given that these communities grappled with further and significant disasters in the immediate years following the floods.

These findings lend further support to:

- investigate the overall impact of the floods beyond the immediate few years
- isolate these effects to those who lived in the BRCA at the time of the floods and therefore were more likely to be directly impacted by the floods
- consider socioeconomic factors, including LGA residence at the time of the floods.

In the next section, we discuss our approach to undertaking this research.

5. RESEARCH APPROACH

5.1 MEASUREMENT

5.1.1 Model

As with other shocks, severe disasters can alter the income path for individuals residing or working in disaster-hit areas. In this report, we seek to find out how the Queensland Floods 2010-11 affected the incomes of individuals in the workforce who were residing in the BRCA at the time of the floods. We therefore need to know what the income path would have been had the floods *not* happened, and compare it to the observed income path post the floods.

To achieve this, we use a difference-in-differences model,[24] formally defined as:

$$\boldsymbol{Y_{ict} = cons + \alpha_i + L_c + \beta_1 Treat_{it} + \beta_2 PostDisaster_{ct} + \beta_3 Treat_{it} \times PostDisaster_{ct} + \varepsilon_{ict}}$$

where:

$\boldsymbol{Y_{ict}}$	= Income
$\boldsymbol{\alpha}$	= Individual fixed effect
$\boldsymbol{L}$	= LGA fixed effect
$\boldsymbol{\beta_3}$	= Coefficient of interest
$\boldsymbol{i}$	= Individuals
$\boldsymbol{c}$	= Cluster/LGA
$\boldsymbol{t}$	= 2006, 2011, 2016
$\boldsymbol{\varepsilon}$	= Disturbance Term

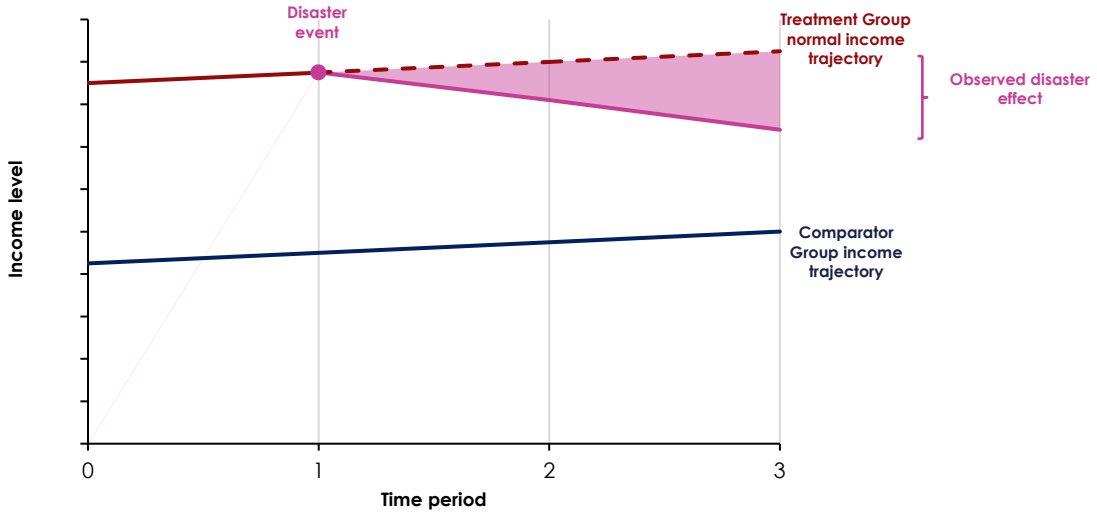
This model calculates the effect of a treatment (i.e. the floods) on an outcome (i.e. individual income) by comparing the differences in average changes over time between the treatment group (individuals living in the disaster hit area) and a control group (comparable individuals in a comparable area). The latter is chosen to closely resemble the treatment group.

FIGURE 10 illustrates a hypothetical case of negative disaster effect on income, whereby the pink solid line portrays the income trajectory in the treatment group and dashed pink line represents the counterfactual income in the treatment group had the disaster not occurred at point 1. This counterfactual income trajectory is provided by the control group. The fully realised income effect of the disaster in this hypothetical case is the difference between the pink dashed line and solid line at point 3 (with point 2 representing the effect in the shorter term).

Worthy of mention, we are not able to measure disaster recovery and relief assistance directly with data that would have enabled identifying its impact on individuals' income trajectory. Thus, the estimated income effect in our case is the *net* income effect of the disaster after the recovery and relief assistance has been provided.

[24] See TABLE 2 for definition.

FIGURE 10 ILLUSTRATIVE DIFFERENCE-IN-DIFFERENCES MODEL SHOWING A HYPOTHETICAL NEGATIVE DISASTER EFFECT



Our modelling examines both the average income effect on all individuals within our benchmark sample, and the disaggregated average effects by demographic and employment characteristics. We also conduct a separate analysis to investigate the income effects of the floods on the two regional BRCA LGAs, Somerset and Lockyer Valley.[25] This analysis is important considering variations in the ANDRI scores, flood severity and significantly different underlying socio-economic characteristics reported earlier.

5.1.2 Data

We utilise the rich, anonymised, individual-level ACLD. This dataset includes a nationally representative 5% sample from each of the 2006, 2011 and 2016 Censuses, and links the individual records in the 2006, 2011 and 2016 Censuses. In other words, an individual can be tracked over time, including the changes in their economic, demographic, and other characteristics.

The collection timing of the Censuses (August) provides 'baseline' (2006) and two 'end-line' (2011,2016) surveys for our difference-in-differences design. This allows us to measure the individual income effects of the floods by observing the treatment and control groups before (August 2006), six months after (August 2011), and five-and-a-half years after (August 2016) the floods. We refer to the 2006-11 results as "short-term" results, and 2006-16 as the "medium-term" results.

While there are several limitations of using this dataset (see section 5.5), compared to alternative sources, the ACLD has the largest sample size available for empirical research; enables decomposition of the population into different demographic and sectoral groups and collects information on the location of individuals, allowing us to isolate and track individuals who likely lived in the BRCA at the time of the floods.

The income variable is provided by the Census question: "What is the total of all wages/salaries, government benefits, pensions, allowances and other income the person usually receives?".

[25] A different control group was constructed for this analysis. See section 6.1.4 for details.

Because respondents tick a box that corresponds with an income range (e.g. $1-$7799), this provides interval-based annual income data.[26] We take the mid-point of the respective interval class as the actual income of individuals. We then adjust this income measure for inflation using the Consumer Price Index of Brisbane between 2006, 2011 and 2016. We confirm that changes in income are not driven by changes in prices over this period.

Other questions in the Census allow us to investigate social and economic dimensions. We choose attributes (TABLE 9) based on economic literature and end-user feedback. Our baseline is 2006 and so all demographic and sectoral results are based on the attributes in 2006.[27]

TABLE 9 INDIVIDUAL DATA COLLECTED, BY DIMENSION

Dimension	Attribute
Demographic	
Gender	Male, Female
Age	Less than 25, between 25 and 45, Older than 45
Home ownership status	Owner, Owner (outright), Owner (mortgage), Renting
Disability	Has disability
English language	Other language than English spoken at home
Economic	
Income level	Low (lower 33rd percentile), middle (middle 33rd percentile), high income (upper 33rd percentile)
Employment Status	Employed, Unemployed, Labour force
Hours worked	Full time, Part time
Business ownership	Does not own business, Owner of incorporated business, Owner of unincorporated business, Owner of small business, Owner of medium or large business
Employment Sector	19 sectors based on ANZSIC classification: A- Agriculture, B- Mining, C- Manufacturing, D- Electricity, gas, water and waste services, E- Construction, F- Wholesale trade, G- Retail trade, H- Accommodation and food services, I- Transport, postal and warehousing, J- Information media and telecommunications, K- Financial and insurance services, L- Rental, hiring and real estate services, M- Professional, scientific and technical services, N- Administrative and support services, O- Public administration and safety (private), P- Education and training (private), Q- Health care and social assistance (private), R- Arts and recreation services, S- Other services.

[26] $0, $1-$7799, $7800-$12999, $13000-$20799, $20800-$31199, $31200-$41599, $41600-$51999, $52000-$67599, $67600-$83199, $83200-$103999, and $104000 or more.

[27] For example: , if an individual was recorded to be in the agriculture sector in 2006 in the treatment group, we explore their income change in 2011 compared to the groups of individuals who were in the agriculture sector in the control group regardless of their sectoral movement or change in employment status in 2011. As a demographic example, for low (high) income group, we compare the individuals whose income belongs to bottom (upper) 33rd percentile both in the treatment and control groups in 2006. So we track these individuals' income changes within these groups and report the differential impact of the disaster on this group.

5.2 SAMPLE CONSTRUCTION

5.2.1 Sample refinement

As we are interested in individual income, we refine our sample to incorporate only individuals who were in the labour force. We construct our panel data by excluding the following individuals from our sample in the following order:

(i) individuals that are not within the working age,
(ii) individuals who were not in the labour force in 2006, and
(iii) individuals who reported to have negative income or chose not to report any sort of income.

The rationale behind this sample construction is as follows. It is a common practice in the literature on the economic effects of disasters caused by natural disasters to focus on individuals who are between 15 to 65 years of age. This means children and the retired people are not the focus of attention. From a policy perspective, we wish to know how to allocate scarce relief and recovery assistance for a sample of those who are part of market dynamics, and hence, those whose economic resilience may need to be supported by the government. For practical purposes, individuals who are not in the labour force are mostly those who are aged 15-20. These individuals could be subject to a separate analysis, and/or their relief and recovery assistance could be set on other grounds (i.e. youth allowance) than supporting their economic resilience.

We exclude those who are not in the labour force because ultimately, we aim to study the sectoral differences in income changes as a result of the disaster, and an individual's sector of employment is known only if they are in the labour force. In addition, it is important to understand how the pace of economic activity is affected by the disaster (i.e. decrease, no change, or increase) and this trend can be deduced only if someone is part of the labour force.

We exclude those who reported negative income as the ABS Census data report "-1" (i.e. minus 1) for these individuals' income. This information is practically unusable from the analysis perspective. This is a limitation of the ABS Census data. We note that these individuals constitute only a small portion of the sample, so we consider that their exclusion is unlikely to impact our results.

5.2.2 Treatment and control group construction

5.2.2.1 Full sample treatment group

The agreed treatment group area is the flooded areas around the Brisbane River at an LGA level. Our treatment group is formed by individuals who were residing in one of these LGAs in the baseline year, that is, individual's usual address in the 2006 Census. The length of the flooded part of the river was 84 km.

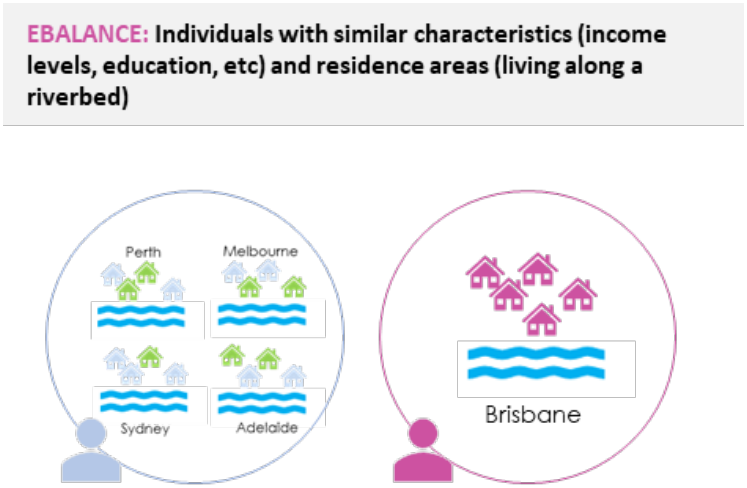
5.2.2.2 Full sample control (comparator) group

Finding an appropriate control group for the BRCA is challenging as almost the entire state of Queensland was declared a disaster zone following the floods.

From discussions with our end-user, the Swan River catchment area (incorporating Perth), the Yarra River catchment area (incorporating Melbourne), the Parramatta River catchment area (incorporating Sydney) and the Torrens River catchment area (incorporating Adelaide) were identified as appropriate control groups for the BRCA. We form the control groups by selecting the LGAs that are within 84km of the river mouth in each of the four catchment areas, which results in using 59 LGAs from New South Wales, Victoria, West and South Australia. This approach also diversifies the risk of relying on only one control group (e.g. Perth), and boosts the number of observations and thus the precision and reliability of point estimates.

We undertake an additional step, called entropy balancing, to identify the most appropriate individuals from the control group LGAs.[28] This technique helps us 'pick' the individuals who most closely resemble individuals in our treatment group. So we include individuals in our control group not just based on whether they have similar incomes as of 2006, but also for instance that they have similar education, marital status, age, and mover/non-mover status to individuals in our control group (Figure 11).

FIGURE 11 ILLUSTRATION OF USING DIFFERENCE-IN-DIFFERENCES MODELLING WITH ENTROPY BALANCING



5.3 FULL SAMPLE DESCRIPTIVE STATISTICS

Appendix 12.3 contains sample descriptive statistics for each Census year.

[28] Technically, entropy balancing matches individuals not just based on one attribute e.g. income levels but also their entire distribution, including the variance and skewedness of income levels. Specifically, we select more appropriate individuals from the control group by matching the individuals across treatment and control groups with similar levels of income, education, marital status, age, and mover-nonmover status.

TABLE 10 NUMBER OF OBSERVATIONS, BY YEAR AND SAMPLE GROUP

Year	Full sample	BRCA LGAs sample	Control Group sample
2006	137,562	30,680	106,882
2011	116,490	24,247	92,243
2016	88,366	17,826	70,540
Total observations	**342,418**	**72,753**	**269,665**

In this study, "observation" refers to individuals. As shown in TABLE 10, the treatment sample (BRCA LGAs) is overwhelmingly made of Brisbane LGA observations (about 85%-90%). The large number of observations comfortably provide the variations needed to detect statistically significant income effects (if they indeed exist). However, in certain sub-group analyses, such as disabled individuals, we run into a small sample size problem, which may result in an inability to detect any significant effects (even if they exist).

5.4 CHECKS AND CONTROLS

Our modelling aims to bring individuals in the treatment and control groups on 'equal footing'. In other words, the treatment and the control group individuals differ only in terms of the flood exposure of the treatment group. We adopt several approaches to help this happen, and perform the necessary robustness checks and sensitivity analyses.

While we control for most factors, we are unable to exclude income effects from other disasters that hit the BRCA LGAs post the Queensland Floods in the medium term. We report this as a limitation in our study, and include the necessary cautions in our results section.

5.4.1 Controlling for time-invariant and time variant factors

Our modelling eliminates all the time-invariant factors at the LGA-level, such as topography, climate, and institutional structure. Our modelling also nets out all the time-invariant[29] individual-specific characteristics. These characteristics include observable (i.e. measurable) factors and unobservable features such as an individuals' ability, risk-taking behaviour, and psychological resilience. These factors would influence an individual's coping mechanism to economic shocks, and if not eliminated, they would result in confounded flood effects on income.

Our modelling also isolates all time-varying individual factors that could affect individuals' responses to the floods, hence might drive the income effect to a certain direction. Isolating these characteristics allow us to account for potential self-selection into flood-prone areas or other potential moral hazard concerns, which might be related to better public schools, lifestyle choices or general

[29] These are characteristics that will remain the same no matter when you observe them. For instance, date of birth does not change, whether you collect this information in 2006 or 2011.

household well-being. These factors include education, age, marital status, and even gender.[30]

5.4.2 Measurement error checks

As the ACLD provides income for individuals in intervals,[31] we use the mid-point of the income interval for each individual. This could introduce measurement error (i.e. under-estimating or over-estimating effects of the floods). However, when we conducted the necessary checks (i.e. undertook 'interval estimation'), our results remained largely similar.

5.4.3 Checking that cross-sector transitions do not affect results

Over time, individuals might move between sectors, which could affect their income and, if many of them do this, the average income of these sectors. Investigating the data, most cross-sectoral transitions were below 0.1% and did not appear to be statistically detectable. This means that such transitions would not materially affect our results.

5.4.4 Controlling for migration

Some individuals who are severely hit by a disaster might decide to migrate out of the disaster hit-area. [32] It can also be that some individuals may migrate to the disaster zone for work in disaster-related economic activities.

To ensure that our results are not driven by migration, we construct an indicator of an individual's location in 2006 and 2011 and include the indicator in modelling to net out any effect of migration on changes in income levels.

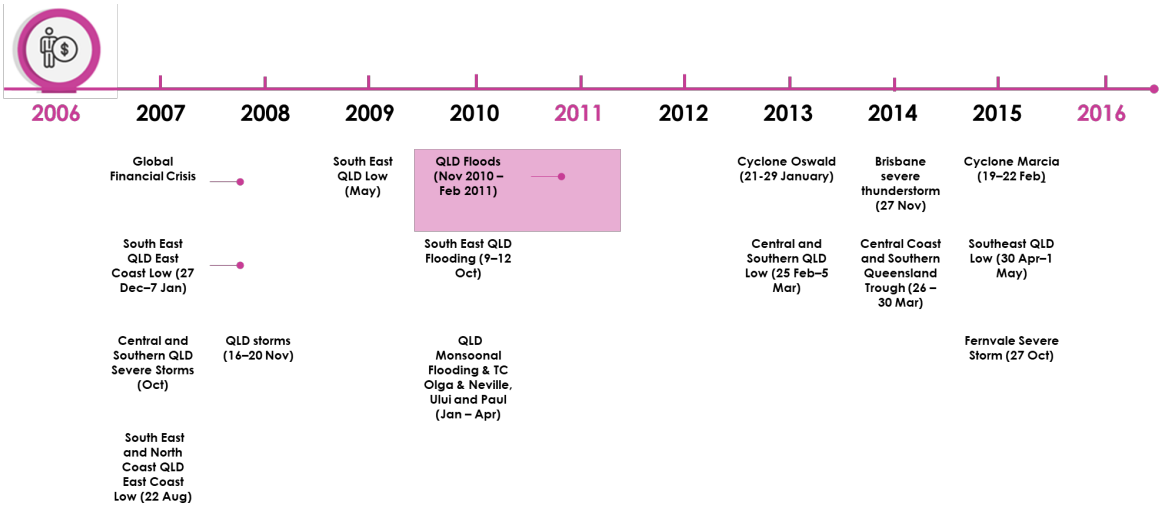
To further check the robustness of this modelling approach, in another exercise we utilise the sample of non-movers only (non-mover sample[33]). Here, we define an individual as a non-mover if they reported living in the same address in 2011 and one year ago (August 2010). Given that the floods occurred during Dec 10-Jan 11, this approach ensures that there is no disaster-driven migration in this sample. We find the results remain similar across both approaches.

5.4.5 Controlling for other shocks

Our results must also not be driven by any other shocks that occurred in between the Census periods. Between 2006 and 2016, the BRCA LGAs experienced 16 declared natural disaster events (FIGURE 12). This is in addition to the Global Financial Crisis (GFC) in 2008 and the millennium drought (1996 to mid-2010).

[30] Standard errors are clustered at the individual level, to account for correlations in individuals' outcomes over time.
[31] This is because Census respondents tick a box that corresponds with an income range (e.g. $1-$7799), which provides interval-based annual income data.
[32] Clemens et al. (2013) report that "only a small proportion (2.1%) of Queenslanders were displaced from their homes at least temporarily after the disasters, amounting to over 70 000 individuals among over 300 000 reporting damage. Prevalence did not vary by sex, age, employment or socioeconomic quintile, but did vary by remoteness. People in remote areas were 6.8 times more likely, and in outer regional areas 3.6 times more likely, to be displaced than people in major cities (8.8% and 4.6%, respectively, compared with 1.3%...)."
[33] The non-mover results are available upon request.

FIGURE 12 BRISBANE RIVER CATCHMENT AREA DISASTERS ACROSS STUDY PERIOD



SOURCE: AUTHOR COMPILATION FROM QUEENSLAND RECONSTRUCTION AUTHORITY NDRRA ACTIVATION AND DISASTER QUEENSLAND DISASTER RELIEF ACTIVATIONS RECORDS. SEE APPENDIX 11.1 FOR FULL DETAILS.

While we are confident our 2006-11 findings can be attributed to the Queensland Floods, we are not as confident this is the case for our 2006-2016 results.

Beginning with the 2006-11 period, the GFC is a universal shock in Australia and we believe is adequately controlled by our approach in constructing the comparison group, which pools individuals from river-banks in Australia. Our entropy balancing method matches similar individuals from the control group to those who faced the flooding in the treatment group, and so our control group would have a similar GFC exposure to treatment groups.

The millennium drought is another possible confounding shock in Australia in the sample period. If the drought affected an average individual differently across the treatment and control groups between 2006 and 2011, then our results may partly reflect the effect of this shock. One alleviating factor here is the overwhelming metropolitan focus of our analysis.[34] Another mitigating factor is that our samples are sufficiently diverse, and represent the Australian population such that the drought effect in the treatment and control groups may not be dramatically divergent. However, if the drought finds its way to the average individual in BRCA during out time period differentially than it does to the average person in our control group (or vice versa), we cannot entirely rule out the drought's confounding effect on our results. We interpret this to be of low possibility given the measures taken in our modelling.

We acknowledge that our modelling alone cannot account for and exclude all other disaster shocks from our estimations. This is a limitation of using ABS Census data, which only provides data at five-year intervals, and limited publicly available information on all LGA-level disaster damage and recovery data that could assist in completely isolating these effects from the floods.

Instead, by reviewing publicly available information, we are confident that our estimates in the 2006-11 period are substantively attributable to the Queensland

[34] See discussion in section 5.3.

Floods. The share of privately-incurred losses owing to the floods in the overall natural disaster-driven damage figures within the relevant 5-year interval is between 80% and 93%.[35] For public losses, the Local Government Association of Queensland (LGAQ) submission to the 2014 Productivity Commission natural disasters inquiry included natural disaster damages 2009-14 broken down by LGA. Based on this, the 2010-11 events form the majority (95%) of available damage costs over this period,[36] even for the hard-hit regional BRCA LGA areas which have been affected by other disasters.

Additionally, a review of Queensland Government Treasury Budget papers and Queensland Economic Reviews over the period 2006-2011 highlight the flood events 2010-11 and Cyclone Yasi, and provide much more analysis on economic impacts on these events than any other disaster during that period (apart from Cyclone Larry, which did not impact the BRCA). Other events mentioned appear to have had transitory effects, particularly on mining and agriculture, which were offset by other economic activity. Finally, in its submission to the Productivity Commission review, the Queensland Government (2014) emphasises the Queensland Floods 2010-11 over other events: "Despite the frequency and severity of the major rapid onset natural disasters experienced in Queensland over the last seven years, the devastating events of 2010-11 were unusual, and constituted a major disaster on an international scale...".

Turning to the 2011-16 period, our analysis of the Insurance Council damage data indicates that the Queensland Floods caused 31% to 48% of the total damages during the 2006-16 period. Meanwhile, LGA cost estimates are 71%, highlighting the role of other significant shocks that hit the flooded LGAs in the 2011-16 period. Of note, it is well documented that the Cyclone Oswald (January 2013) disrupted flood recovery activities, re-damaging repaired assets and thwarting progress on other repair activities in BRCA communities already devastated by the floods. For instance, Lockyer Valley Regional Council estimated the value of approved uncompleted flood repair work written off to be about $7 million, and the value of completed work re-damaged by the cyclone to be around $8 million (Lockyer Valley Regional Council, 2014). While there is evidence that Cyclone Oswald was not as severe on Brisbane and Ipswich households as the floods,[37] there is insufficient data at an LGA level to adequately isolate the 2013 flood's effects.

As such, we are less confident about the 2006-2016 results being *solely* attributable to the Queensland Floods. Thus, our 2006-16 estimates should be treated with care, particularly when interpreting the efficacy of intervention

[35] The ICA Catastrophe Database provides a record of insurance loss estimates for declared insurance catastrophe events. 33% of 2006-11 events have total loss figures available, while 44% of 2006-16 events are captured. All CAT D events (highest disaster severity) are included. Apart from the Queensland floods (where Lockyer Valley and Brisbane flooding losses were assessed separately), the loss figures encapsulate losses across all impacted areas. On average, 26 LGAs were impacted by each disaster. The lower bound(80%) makes no adjustment to these loss figures. The upper bound (93%) proportions a share of losses to the BRCA (assuming an equal share of losses across LGAs impacted).

[36] Damage costs for 56% of 2006-11 disaster events and 44% of 2006-16 disaster events are captured in this submission; all CAT D events are included.

[37] For instance, a Geoscience Australia (2016) survey of households in these LGAs found that compared to the 2011 floods, far fewer properties were affected by the 2013 flood events related to Cyclone Oswald; the average time away from home was 17 days (compared to 95 days), and households reported much lower out-of-pocket expenses and disruptions to work.

mechanisms in the medium-term. We note this as a limitation of our study (section 5.5.2), report the 2006-11 and 2006-16 estimates separately, and provide the necessary cautions in interpretation of 2006-16 results in our findings section.

5.5 ASSUMPTIONS AND LIMITATIONS

In this section, we outline the key assumptions and limitations of our report. While we have made every effort to address key assumptions and limitations, data restrictions have severely hampered our ability to make causal interpretation of the income effects of the Queensland Floods 2010-11.

The key implication is that we cannot say that the floods *caused* the statistically significant results we observe. Instead, for statistically significant results, we can only say that, compared to the control group, the floods were negatively/positively *correlated with* the income of individuals in the BRCA. For our 2006-16 results specifically, we have not been able to isolate the Queensland Floods from other, high severity disasters that hit the BRCA area.

5.5.1 Assumptions

5.5.1.1 Assumption 1: Parallel trends is satisfied

Our results are sensitive to the selection of control group, and so a key difference-in-differences model assumption we need to meet is that treatment and control group incomes were growing in parallel *before* the flooding (see FIGURE 10).

Put simply, if we know that the control and treatment groups were growing at similar trends prior to the disaster, and we have properly accounted for other potential reasons for variations in income, including socioeconomic characteristics and topography, this gives more confidence that the floods alone were responsible for any deviations of the treatment group from its expected trajectory post disaster.

We know from our use of entropy balancing, and from the descriptive statistics in our baseline year (2006) that the income levels of our treatment and control groups (TABLE 11) and industry sector share of employment (TABLE 12) were broadly comparable prior to the Queensland Floods.

However, a credible way of testing whether the parallel trends assumption holds is through statistical modelling. Our baseline period is 2006, and so to satisfy the parallel trends assumption, we need to establish within our model that there is no statistical difference between the treatment and control group income growth prior to 2006. For the ABS five-year interval dataset, we would need the 2001 Census data linked for all individuals in our sample.

Unfortunately, the ABS ACLD does not have the 2001 Census linked to the 2006 Census data. This means we are not able to formally confirm that the parallel trends assumption is met. Thus, we are not able to argue for having obtained causal estimates between the floods and individual income, however, we believe that the correlations that we establish are still important and informative.

5.5.1.2 Assumption 2: Intervention mechanisms played a role in mitigating the flood's effects on individual income

We assume that our results include the flood's effect plus disaster relief and recovery effect.[38] This assumption is critical for us to examine the role that government relief and recovery programs played in supporting the economic resilience of employed individuals in the BRCA.

The wording of the Census question is unlikely to prompt Census respondents to report government assistance received or insurance pay-outs as part of their annual income (see section 5.1.2). Rather, we know from the economics literature that when large and unexpected natural shocks hit the economic system, a negative wealth and income effect may appear. If the intervention mechanisms are strong enough (such as insurance markets and government programs), the negative income is smoothed, and potential losses are mitigated. In this case, the income effect is likely to be transient.

However, when the economy cannot resume its activities effectively and if the intervention mechanisms are not effective enough, the income trajectory remains lower than the pre-disasters levels, so that the effect is permanent.

So for instance, by speedily rebuilding roads, repairing critical assets, and reconnecting essential services, government recovery programs minimise disruptions to businesses and therefore reduce or fully mitigate any economic losses. Thus, well-designed interventions provide the supportive environment to enable the continuation of the income trajectory, which would be reflected in the results reported.

While we cannot directly test this due to data limitations, we are satisfied based on available evidence that the government post-disaster relief and recovery assistance are the primary intervention mechanism over the course of our study period, and so are the primary driver of the relief and recovery effect. We explain our reasoning below.

5.5.1.2.1 Queensland Floods 2010-11 government relief and recovery interventions

The Queensland Floods 2010-11 federal government assistance was unprecedented. Total state and Commonwealth relief and recovery expenditure amounted to AU$6 billion dollars during the 2010–11 fiscal year alone, of which 10% was direct income assistance.[39] This assistance amounts to 2.2% of Queensland's GDP in 2011.

Importantly, these relief and recovery programs:

- provided direct assistance to individuals and small businesses, thus are likely to have a bearing on the income of individuals with demographic and employment attributes that we investigate,

[38] This includes post-disaster income and recovery assistance by the government, and reconstruction efforts and infrastructure investments.
[39] See appendix 12.2.2 for QRA snapshot of flood (and Cyclone Yasi) relief and recovery activities and expenditure as at September 2011.

- impacted economic activity, both directly and indirectly, in multiple sectors, and thus are likely to have a bearing on the sectoral results we observe.

In terms of longevity, while recovery and relief activities commenced immediately following the floods, from Queensland Reconstruction Authority Board report documents,[40] flood-related recovery programs continued into the 2012-13 period, and thus would also be exerting influence on economic activity in our medium-term results.

For the BRCA region, we note that all LGAs were granted Category D assistance, the highest level of assistance that can be provided under the-then NDRRA arrangement.

Thus, the scale and period of assistance provide us with sufficient confidence to assume that the government relief and recovery efforts were large enough to exert influence on both our short- and medium-term results.

5.5.1.2.2 Insurance assistance

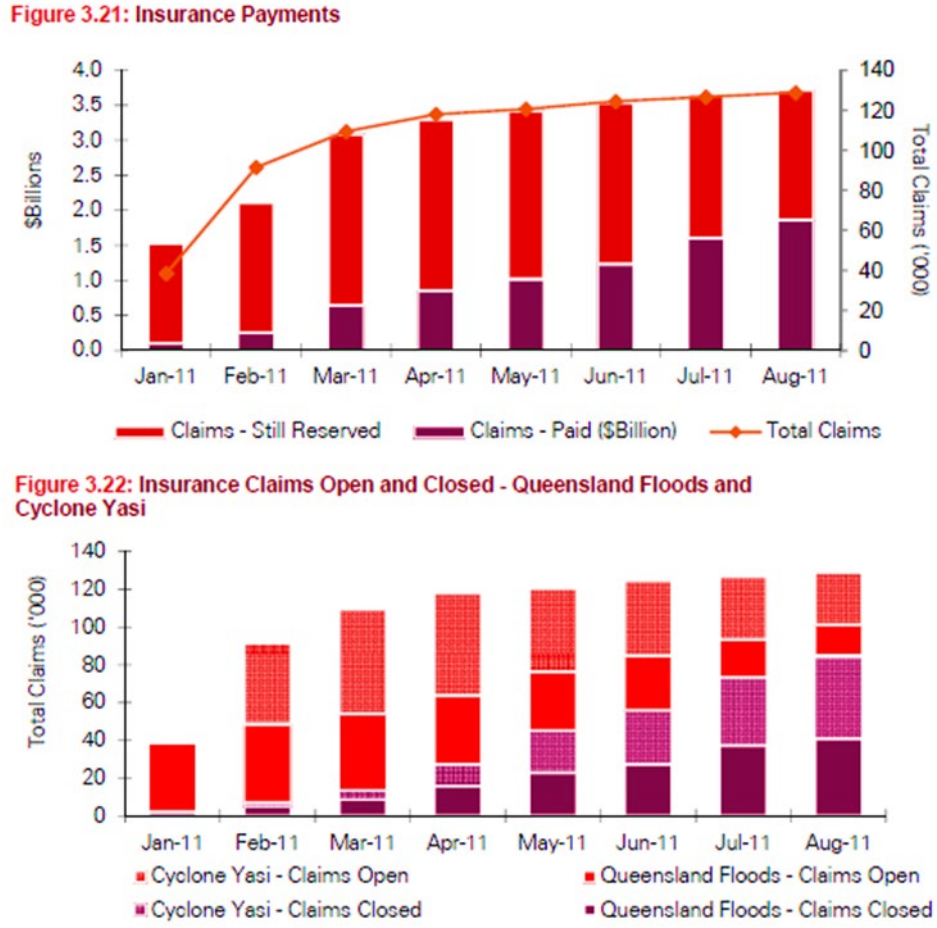
We do not have data on the spatial variation in insurance claims and payments, which we list as a limitation (section 5.5.2). While we do not fully rule out the possible contribution of disaster-related insurance claims to the income of individuals residing within the flooded regions of the BRCA, available evidence suggests that:

1. **It is unlikely that full insurance payments were received in the first six months following the floods:**

As at 25 August 2011, 50% (or $1.86 billion) of disaster related insurance claims had been paid (Queensland Reconstruction Authority, September 2011; FIGURE 13). According to the Queensland Floods Commission of Inquiry (2012), only 47% of total insurance claims were paid within the first six months of the floods by the largest insurance corporation, Suncorp.

[40] Available via: https://www.qra.qld.gov.au/board-reports.

FIGURE 13 INSURANCE DATA (QUEENSLAND FLOODS AND CYCLONE YASI)



SOURCE: QUEENSLAND RECONSTRUCTION AUTHORITY (2011)

2. There was a notable absence of flood insurance in the BRCA:

The role of insurance as a market mechanism in the BRCA region may be limited, with an absence of flood insurance for many policyholders, particularly in Brisbane and Ipswich (Commonwealth of Australia, 2011). Industry estimates indicate that around 400 properties managed by bodies corporate were directly affected by the recent Brisbane floods, with very few, if any, having flood insurance (Commonwealth of Australia, 2011).

3. There were well-publicised issues with insurance exclusions and denial of claims in Brisbane and Ipswich:

Despite significantly less insurance claims, as at 24 May 2011, insurance disputes related to the Queensland Floods were over eight times the number of Cyclone Yasi disputes (Commonwealth of Australia, 2011), with 15% of home and contents insurance claims in Brisbane relating to the Brisbane floods were denied, with most related to flood exclusions in home insurance policies (Commonwealth of Australia, 2011).

In a household survey by Geoscience Australia (2016) of Brisbane and Ipswich residents), 71% of respondents had thought they were full covered for flooding, but only 32% had their claim fully paid, and a further 13% had partial claims paid because some of the damage could be attributed to stormwater.

4. Even when paid, insurance payouts have typically not been enough to meet disaster claims

Historically, insurance payouts have been insufficient to meet natural disaster claims, exerting pressure on fiscal disaster relief expenditure (Commonwealth of Australia, 2018c). Flood insurance premiums are beyond the reach of average households, especially those in high-risk flood areas. In New South Wales, only 2% of these areas have full flood cover, while in Queensland, the figure is 5%. For an average house in these areas, the premium for flood insurance alone can be between $10,000 and $20,000, while other perils in Queensland combined attract an average premium of $1000 (Munich Re, 2015).

Consistent with this, a household survey by Geoscience Australia (2016) of Brisbane and Ipswich residents estimated the total damage to residential property (including contents) in Brisbane and Ipswich following the 2011 floods at $2.7 billion, with the total shortfall, post-insurance payments, to be $1.2 billion (TABLE 17).

TABLE 11 GEOSCIENCE AUSTRALIA BRISBANE FLOODS 2011 HOUSEHOLD SURVEY: COMBINED AVERAGE VALUE OF BUILDING AND CONTENTS DAMAGE, INSURANCE PAYMENT AND SHORFTALL BY DEPTH OF INUNDATION

Over-floor Inundation Depth (metres)	Combined average estimate of damage ($)	Combined average insurance payment ($)	Combined average shortfall (a) ($)	Insurance/Damage ratio (%)
0.15m or less	87,622	38,735	46,712	44
0.151m - 0.7m	135,321	84,554	50,876	62
0.71m - 1.2m	143,014	77,582	66,952	54
1.21m - 1.2m	164,103	88,941	79,638	54
More than 2.4m	204,687	106,750	97,390	52
Depth not stated	80,288	57,736	30,474	72
Overall average	**157,812**	**87,018**	**72,697**	**55**

SOURCE: GEOSCIENCE AUSTRALIA (2016).

Thus, we consider that insurance claim payments, at best, are more likely to induce income effects in the medium-term through creating multiplier opportunities in the economy than short-term income changes.

5.5.2 Limitations

As with any study, multiple limitations constrain the applicability of our findings.

5.5.2.1 Data limitations

Most critically, data limitations have hampered our ability to causally investigate the effect of the Queensland Floods on individual income in the BRCA LGAs.

5.5.2.1.1 General data limitations

As acknowledged in the 2018 National Disaster Risk Reduction Framework, "disaster risk data and information is not always available to those who need it and it does not adequately integrate climate science" (Commonwealth of Australia, 2018b, p. 12).

Related to this, information useful to:

- constructing measures such as disaster severity (including infrastructure and insurance data),
- estimating effects of government assistance on income, and
- estimating the effects of insurance pay-outs on income

is not readily available and/or requires significant consultation lead time before being made available. This has limited the scope of the project. These data limitations are general in nature and would affect other similar studies.

5.5.2.1.2 ACLD data limitations

The five-year interval collection period of the ACLD dataset is another major limitation. Coupled with the lack of LGA-level data discussed above, this makes it difficult to completely isolate the effects of the Queensland Floods from other shocks, particularly in the medium term (2006-16). This is why we make a distinction about the reliability of the 2006-11 and 2006-16 results.

While the timing of the August 2011 Census survey is useful, it will not pick up the full short-term impacts of the floods, particularly for different sub-groups. This is another motivation to explore inter-relationships between demographic groups and incorporate contextual information about the BRCA into our analysis.

5.5.2.2 Project scope limitations

Even if we could completely address these limitations, our choice of measure (individual income) and reporting of estimates (as point estimates) add further limitations in how our results can be interpreted.

5.5.2.2.1 Use of individual income as a measure of economic resilience

Disasters like the Queensland Floods cause immediate and profound distress for individuals or communities, with broad social impacts can still be felt many years later. These impacts are often significantly greater than tangible market costs, such as the income losses we examine in our study.

In the BRCA, the cumulative impacts of the floods and other subsequent disasters (e.g. Cyclone Oswald) are likely to have compounded these social issues, and are likely to affect the coping and adaptive capacities of local communities to disasters, and in turn their resilience in the face of future disasters. For this reason, as we have done in our analysis section, our results should be interpreted within this broader social context, including the broader coping and adaptive capacity (see 4.2) of each LGA within the region.

While income is an important measure of economic resilience, other financial dimensions are also likely to influence an individual's financial capacity to cope and recover from disasters. This includes access to credit cards, home loans, and ability to draw loans on existing assets.

Even when the income trajectory remains stable, the additional financial pressures created by disasters may be beyond the budget of an individual to cope with, even if government and or other assistance is provided. In certain

cases, disasters can push an already income-poor household further into poverty or drive a nonpoor household below the income poverty line (United Nations Office for Disaster Risk Reduction, 2019).

While our project does not consider such factors, we report the effects of the floods on each income group separately (i.e. low, middle, and high income).

5.5.2.2.2 The results reported are average point estimates, which do not give the complete distribution of effects of the floods.

This means there will always be certain individuals who are more (less) severely impacted than what we report. Again, this is why we break down our overall result, and consider the flood's effect on the income of different socioeconomic and demographic groups (e.g. by age, by gender, by sector of employment, by type of employment, and so on).

6. REPORT FINDINGS

In this section, we report on all key findings. Overall we find evidence that the Queensland Floods 2010-11 were associated with both income losses and gains for individuals with different demographic and work characteristics, particularly in the short term, which we analyse and explore further in section 6.2.1.

Guide to interpreting findings

1. **Given our research limitations, our results (and any quantifications) are correlational, not causal.**
2. **Unless otherwise indicated, our benchmark (full sample) results are largely reflective of the Brisbane LGA.**
3. **Our baseline period is 2006, and so all our results are relative to 2006.**
4. **The income losses/gains we report are changes in income levels compared to our control group, which determines what the normal income path would have been had the floods not happened in the short term (i.e. between 2006 and 2011) and medium term (i.e. between 2006 and 2016).**
5. **The income losses/gains we report include the disaster effect plus the relief and recovery effect.**

6.1 SUMMARY OF RESULTS

6.1.1 Overall

Overall, the Queensland Floods 2010-11 are not associated with a statistically significant change in the overall income levels of workforce residents within the BRCA across our study period (TABLE 18).

TABLE 12 OVERALL RESULTS: INDIVIDUAL INCOME CHANGES ASSOCIATED WITH THE 2010-11 QUEENSLAND FLOODS (RELATIVE TO 2006 AND CONTROL GROUP)

	BRCA Benchmark Full sample
post $\times D$	
2006-2011	-0.0211
	(0.0179)
2006-2016	-0.0240
	(0.0229)
Observations	336,423
R-squared	0.009

post ×D is the difference-in-differences estimate. Standard errors in parenthesis. For significant results, significance levels are denoted by: *p <0.10, ** p <0.05, *** p <0.01. Findings are correlational and based on use of ACLD Microdata.

6.1.2 Economic characteristics

As our report is focused on individual-level income, it shed lights only on indirect economic effects of the floods on businesses and industries. In this section, we delve into the income effects by disaggregating the average population effect based on individuals':

- employment type: employment hours (full-time, part-time); employment category (employed, unemployed),
- business size and type (if an employer); and
- employment sector.

Exploring these different attributes helps us better understand the mechanisms through which the income of individuals would be affected by disasters.

6.1.2.1 Labour force

Given our overall results were insignificant, it is unsurprising that examining the relationship between the floods and incomes of individuals in the labour force at a high level was also statistically insignificant (TABLE 19). We note that for unemployed individuals who were on government assistance payments, it is unlikely that such payments would have been disrupted during the floods.

TABLE 13 RESULTS BY LABOR FORCE STATUS: INDIVIDUAL INCOME CHANGES ASSOCIATED WITH THE 2010-11 QUEENSLAND FLOODS (RELATIVE TO 2006 AND CONTROL GROUP)

	Labour force status (in 2006)		
	In Labour force	**Employed**	**Unemployed**
post × *D*			
2006-2011	-0.02106	-0.00527	-0.17651
	(0.01792)	(0.01443)	(0.13548)
2006-2016	-0.02398	-0.00614	-0.14422
	(0.02290)	(0.02272)	(0.19492)
Observations	336423	321748	14675
R-squared	0.009	0.012	0.261

post ×D is the difference-in-differences estimate. Standard errors in parenthesis. For significant results, significance levels are denoted by: *p <0.10, ** p <0.05, *** p <0.01. Findings are correlational and based on use of ABS Microdata.

6.1.2.2 Business ownership

Overall, the floods were associated with income losses for business owners, regardless of business type (TABLE 20). This relationship was strongest in the short term for owners of unincorporated businesses (which include sole proprietors and partnerships) who experienced income losses of 11.9% (or $5,030 AUD).

TABLE 14 RESULTS BY BUSINESS OWNERSHIP STATUS: INDIVIDUAL INCOME CHANGES ASSOCIATED WITH THE 2010-11 QUEENSLAND FLOODS (RELATIVE TO 2006 AND CONTROL GROUP)

	Business ownership status			
	Does not own business	**Owns small business (1-19 employees)**	**Owns incorporated business**	**Owns unincorporated business**
post × *D*				
2006-2011	0.01157	-0.0608*	-0.08110**	-0.11942**
	(0.01473)	(0.0358)	(0.03688)	(0.05760)
2006-2016	0.00512	-0.0978***	-0.10318***	0.01822
	(0.02481)	(0.0376)	(0.03512)	(0.05207)
Observations	269388	21,739	22,243	24,809
R-squared	0.014	0.048	0.059	0.041

post ×D is the difference-in-differences estimate. Standard errors in parenthesis. For significant results, significance levels are denoted by: *p <0.10, ** p <0.05, *** p <0.01. Findings are correlational and based on use of ABS Microdata. Unincorporated enterprises include sole proprietors and partnerships.

In contrast, income losses for small business owners were higher in the medium term (-9.8%; $5,350 AUD) than the short term (-6.8%; $3,130 AUD), possibly affected by other disasters like Cyclone Oswald 2013. Likewise for incorporated business owners, who experienced 8.1% income losses in the short term ($4,340 AUD) and 10.3% ($6,030 AUD) medium term.

For those who were employed but did not own a business (thus, those who could be classified as wage-and-salary employees), we do not find a statistically significant relationship between income changes and the floods. These individuals make up nearly 84% of the employed sample.

6.1.2.3 Part-time versus full time status

We now consider whether the overall Employed result is masking any differences in outcomes for full time and part time workers (TABLE 21).

TABLE 15 RESULTS BY PART-TIME VS FULL-TIME: INDIVIDUAL INCOME CHANGES ASSOCIATED WITH THE 2010-11 QUEENSLAND FLOODS (RELATIVE TO 2006 AND CONTROL GROUP)

	Hours worked (as at 2006)	
	Part-time	**Full-time**
post × *D*		
2006-2011	-0.05154*	0.01984
	(0.02824)	(0.01374)
2006-2016	-0.06041*	0.02158
	(0.03491)	(0.02116)
Observations	92737	211291
R-squared	0.019	0.025

post ×D is the difference-in-differences estimate. Standard errors in parenthesis. For significant results, significance levels are denoted by: *p <0.10, ** p <0.05, *** p <0.01. Findings are correlational and based on use of ABS Microdata.

This turns out to be the case. Statistically significant income losses associated with the floods are concentrated in part-time employment, with part-time workers (whether employers or employees) experiencing 5.2% income losses ($1,820 AUD) in the short term, and 6% income losses ($2,440 AUD) in the medium term. This group makes up nearly 30% of the full sample.

On the other hand, the relationship is insignificant for full-time workers, who comprise about 70% of the full sample. Thus, full-time and salaried employment offers an important buffer for workers, particularly employees.

6.1.2.4 Employment sector

In examining employment sectors, we also find distinct differences in income outcomes. Of the 19 economic sectors, six had statistically significant income results, both positive and negative, in the short and medium term (TABLE 22).[41] Many of these sectors are top-employing sectors in the BRCA, thus provide an important source of income for employed residents in the BRCA.

TABLE 16 RESULTS BY SECTOR OF EMPLOYMENT: INDIVIDUAL INCOME CHANGES ASSOCIATED WITH THE 2010-11 QUEENSLAND FLOODS (RELATIVE TO 2006 AND CONTROL GROUP)

	Employment sector (as reported in 2006)					
	Construction	Retail trade	Accommodation and food services	Education and training (private)	Administrative and support services	Health care and social assistance (private)
post × *D*						
2006-2011	-0.09662***	0.03916	-0.08227*	0.02448	-0.18207***	0.09039***
	(0.03505)	(0.04194)	(0.04669)	(0.02619)	(0.04447)	(0.02978)
2006-2016	-0.01478	0.13084**	0.08114	-0.08864**	0.00953	0.02524
	(0.06078)	(0.06131)	(0.05455)	(0.03889)	(0.05887)	(0.06463)
Observations	20025	33889	19925	26550	10917	33524
R-squared	0.049	0.035	0.055	0.037	0.069	0.042

post ×D is the difference-in-differences estimate. Standard errors in parenthesis. For significant results, significance levels are denoted by: *p <0.10, ** p <0.05, *** p <0.01. Findings are correlational and based on use of ABS Microdata

In the short term, income losses associated with the floods by individuals employed in the construction (-9.7%, $4,950 AUD) and accommodation and food services (-8.2%, 2,740 AUD) sectors, with employees in administrative and support services sector also seemingly hard hit (-18.2%, $7,370 AUD). In contrast, employees in the health care and social assistance sector are associated with 9% ($4,320 AUD) income gains following the floods.

These results are broadly consistent with the known sectoral effects of the floods on industry sectors we discussed in section 4.3.1 and potential additional stressors from Cyclone Oswald (medium-term results only).

For instance, administrative and support services[42] and accommodation and food services sectors are tourism-oriented sectors, and thus would be adversely impacted by business closures and weakened demand from tourists for their services. Construction activity, particularly private dwelling construction, was

[41] Mining, while statistically significant and positive, has not been included in this table due to sample size and comparability concerns between the BRCA LGAs and the control group.
[42] Based on ABS ANZSIC classifications, this sector includes tourism-facing services like travel agency services and tour arrangement services. It also includes employment services which are likely impacted by subdued employment post floods (Queensland Treasury, 2011).

weakened post-floods. While reconstruction activity may create economic opportunities for the overall construction sector, unless construction workers in the BRCA region were employed in reconstruction activities, then they would not benefit from any offsetting income boosts related to these activities.

Demand for replacement household goods lost or damaged by the floods is likely to increase economic activity in the retail trade sector once businesses restock and reopen (e.g. increase in shifts for the workforce). Meanwhile demand for health and social services is also known to have increased following the floods, thus helping explain some of the income gains we observe for this sector's workers. We discuss the potential links with government flood-related recovery activities in section 6.2.2.

6.1.3 Social characteristics

So far, we have looked at some of the labour market and economic conditions that influence how individual income is likely to be affected by the floods. We now turn to how the floods correlate with changes in individual income of different demographic groups within our sample.

6.1.3.1 Income group

While our overall income results are insignificant, there are marked differences in outcomes for low, middle and high income earners (TABLE 23).

TABLE 17 RESULTS BY INCOME GROUP: INDIVIDUAL INCOME CHANGES ASSOCIATED WITH THE 2010-11 QUEENSLAND FLOODS (RELATIVE TO 2006 AND CONTROL GROUP)

	Income group (in 2006)		
	Low income	**Middle income**	**High income**
post × *D*			
2006-2011	-0.10135***	0.08498***	0.05142***
	(0.03218)	(0.01417)	(0.01245)
2006-2016	-0.05814	0.03477	0.06589**
	(0.05965)	(0.02599)	(0.02668)
Observations	127041	94769	114613
R-squared	0.032	0.037	0.052

post ×D is the difference-in-differences estimate. Standard errors in parenthesis. For significant results, significance levels are denoted by: *p <0.10, ** p <0.05, *** p <0.01. Findings are correlational and based on use of ABS Microdata

In the short term, the Queensland floods were associated with income losses among low-income earners (-10.1% or -$3,100 AUD), and income gains among middle (8.5%; $3,770 AUD) and high (5.1%; $3,380 AUD) income earners. Apart from high-income earners (6.6%; $4,590 AUD), these associations are not observed in the medium term.

These findings, particularly for low-income earners, provide some evidence to support existing literature. A lower socio-economic status has been consistently associated with greater post-disaster hardship, with the poor suffering significant disaster losses due to lower financial capacity and limited access to public and private (e.g. insurance) recovery assets (Gladwin and Peacock, 2000; Fothergill and Peek, 2004). For example, while storm damage from Hurricane Katrina was uniform across demographic groups, lower income individuals were less likely to have evacuated or had cover for flood insurance (Masozera et al., 2007).

6.1.3.2 Gender

Breaking down income changes by gender yields interesting results (TABLE 24).

TABLE 18 RESULTS BY GENDER: INDIVIDUAL INCOME CHANGES ASSOCIATED WITH THE 2010-11 QUEENSLAND FLOODS (RELATIVE TO 2006 AND CONTROL GROUP)

	Gender	
	Male	**Female**
post × *D*		
2006-2011	-0.08258***	0.04341*
	(0.01561)	(0.02506)
2006-2016	-0.07421***	0.03017
	(0.02284)	(0.02741)
Observations	175461	160962
R-squared	0.010	0.016

post ×D is the difference-in-differences estimate. Standard errors in parenthesis. For significant results, significance levels are denoted by: *p <0.10, ** p <0.05, *** p <0.01. Findings are correlational and based on use of ABS Microdata

We find that the Queensland Floods were associated with income losses for males in the short (-8.3%; $4,380 AUD) and medium term (-7.4%; $4,330 AUD). On the other hand, in the short term, females experienced income gains of (4.3%; $1,740 AUD) associated with the floods. This positive association is not statistically significant in the medium term.

These findings contrast with existing literature, which suggests women are likely to be more vulnerable to and adversely affected by disasters than men. Economic reasons for this include working in lower income or part-time jobs.

The female income result is also perplexing based on our sample - with females representing 61% of our low-income group cohort, we would have expected the female income to also be negatively associated with the floods. We explore this puzzling result further in our analysis section.

6.1.3.3 Age

Breaking down income changes by age group, we find that the Queensland floods were associated with income losses for youth in the short (-7.4%; $2,940 AUD) but not the medium term (TABLE 25).

TABLE 19 RESULTS BY AGE GROUP: INDIVIDUAL INCOME CHANGES ASSOCIATED WITH THE 2010-11 QUEENSLAND FLOODS (RELATIVE TO 2006 AND CONTROL GROUP)

	Age (as at 2006)		
	Under 26	**26 to 45**	**Over 45**
post × *D*			
2006-2011	-0.07379*	0.02506	0.03336*
	(0.04311)	(0.02562)	(0.01827)
2006-2016	0.03012	0.03791**	0.01817
	(0.06646)	(0.01580)	(0.02851)
Observations	73047	161110	102266
R-squared	0.079	0.012	0.049

post ×D is the difference-in-differences estimate. Standard errors in parenthesis. For significant results, significance levels are denoted by: *p <0.10, ** p <0.05, *** p <0.01. Findings are correlational and based on use of ABS Microdata

There is evidence that the floods were associated with statistically significant income gains for older age groups, however we note that there could be sectoral and age effects[43] at play. We investigate this further in section 6.2.1.

[43] For instance, older individuals have longer tenure and more advanced knowledge and skills, and therefore are more likely to have higher earnings than younger individuals who are entering the labour market.

6.1.3.4 Other

We do not find any significant relationship between the floods and individual income when we disaggregate results by home ownership type (TABLE 26).

TABLE 20 RESULTS BY HOME OWNERSHIP STATUS: INDIVIDUAL INCOME CHANGES ASSOCIATED WITH THE 2010-11 QUEENSLAND FLOODS (RELATIVE TO 2006 AND CONTROL GROUP)

	HOME OWNERSHIP STATUS (AS AT 2006)			
	Renter	Owner	Owner outright	Owner with mortgage
post × *D*				
2006-2011	-0.01903	-0.01749	-0.01244	-0.01739
	(0.02135)	(0.01898)	(0.02220)	(0.02225)
2006-2016	0.01135	-0.02403	-0.02593	-0.01860
	(0.02814)	(0.02386)	(0.04947)	(0.02163)
Observations	94228	231623	80046	151577
R-squared	0.013	0.013	0.020	0.016

post ×D is the difference-in-differences estimate. Standard errors in parenthesis. For significant results, significance levels are denoted by: *p <0.10, ** p <0.05, *** p <0.01. Findings are correlational and based on use of ABS Microdata

Importantly, we also do not detect any significant relationships when examining characteristics that might make individuals more vulnerable to disasters such as English being a second language or having a disability (TABLE 27).

TABLE 21 RESULTS BY SELECTED CHARACTERISTICS: INDIVIDUAL INCOME CHANGES ASSOCIATED WITH THE 2010-11 QUEENSLAND FLOODS (RELATIVE TO 2006 AND CONTROL GROUP)

	Disability	English not spoken at home
post × *D*		
2006-2011	0.11123	0.01119
	(0.14076)	(0.03782)
2006-2016	0.25028	0.04422
	(0.20816)	(0.05226)
Observations	1598	66648
R-squared	0.231	0.013

post ×D is the difference-in-differences estimate. Standard errors in parenthesis. For significant results, significance levels are denoted by: *p <0.10, ** p <0.05, *** p <0.01. Findings are correlational and based on use of ABS Microdata

For our disability result, this could possibly be due to the small proportion of residents with this attribute, which makes it difficult to detect statistically

significant results.[44] Noting the strong correlation that often exists between vulnerabilities (e.g. low income and disability), we explore and interpret the interrelationship between significant results and these attributes further in the analysis of results section.

6.1.4 Locational attributes

So far, we have considered the income outcomes for all individuals residing in the BRCA LGAs. With Brisbane observations making up about 90% of our sample, the overall statistically insignificant income results are mainly reflecting the income outcomes for individuals living in the Brisbane city council area, the most disaster resilient LGA in our case study area.

We know however, that the BRCA LGAs are socioeconomically diverse, with the regional councils of Somerset and Lockyer Valley having lower capacity for disaster resilience (see section 4) than the metropolitan areas of Brisbane and Ipswich. There is evidence to suggest that for more devastated, regional communities in Australia, economic recovery could take up to 25 years (Regional Australia Institute, 2013).

As such, we also analysed income effects for these regional councils, using the same difference-in-differences methodology but with a more appropriate comparator group (TABLE 28).[45]

TABLE 22 REGIONAL BRCA LGA RESULTS: INDIVIDUAL INCOME CHANGES ASSOCIATED WITH THE 2010-11 QUEENSLAND FLOODS (RELATIVE TO 2006 AND CONTROL GROUP)

	Lockyer Valley-Somerset Sample (2)
post × *D*	
2006-2011	-0.2729***
	(0.0884)
2006-2016	-0.1100
	(0.1613)
Observations	16171
R-squared	0.052

post ×D is the difference-in-differences estimate. Standard errors in parenthesis. For significant results, significance levels are denoted by: *p <0.10, ** p <0.05, *** p <0.01. Findings are correlational and based on use of ABS Microdata.

[44] For instance, while representative, there were only 170 disabled employed residents in our treatment group sample. This may impact on the ability to statistically pick up the relationship between the floods and income changes for these individuals.

[45] The group includes regional LGAs in outer Perth metropolitan areas: Bassendean, East Fremantle, Kalamunda, Mosman Park, Peppermint Grove, Victoria Park, Vincent, Wandering, and York.

Unlike our overall results, we found that the Queensland Floods 2010-11 were associated with significant short-term income losses in these areas (-27.3%; $9,780 AUD). Notably, these are the highest income losses across all dimensions and attributes explored, signalling the extent of devastation in these regions. These losses bring into sharp relief the difficult economic recovery journey ahead for community members discussed in section 4.3.2.

6.2 ANALYSIS OF RESULTS

In quantifying our statistically significant results, income losses have predominantly occurred in the short term and ranged between around $1,820 AUD and $9,780 AUD. Where income gains occurred, these gains ranged between around $1,470 AUD and $3,380 AUD. Income losses are primarily associated with smaller sub-populations, such as part-time workers or business owners, while income gains are associated with larger sub-populations, such as full–time employees or wage-and-salary workers.

While we have analysed and been able to explain some of these results through known disruptions (both positive and negative) in economic activity at the time of the floods, we are yet to explore the interlinkages between our demographic results, sectoral results and the government relief and recovery assistance programs. We do this here, before offering conclusions.

6.2.1 Interrelationship between results

The richness of the ACLD dataset allows us to explore the relationships between multiple attributes concurrently. Using a matrix (see appendix 12.3.2), we can establish some of the underlying relationships between our sectoral and demographic results. For instance, we can find out which sectors are over-represented by certain demographic groups, and from this, examine whether there is consistency between demographic and sectoral results.

For simplicity, we present in FIGURE 14 (next page) a visual representation of this matrix where we have found clear overlaps between our demographic groups and employment sectors in which they have the highest representation.

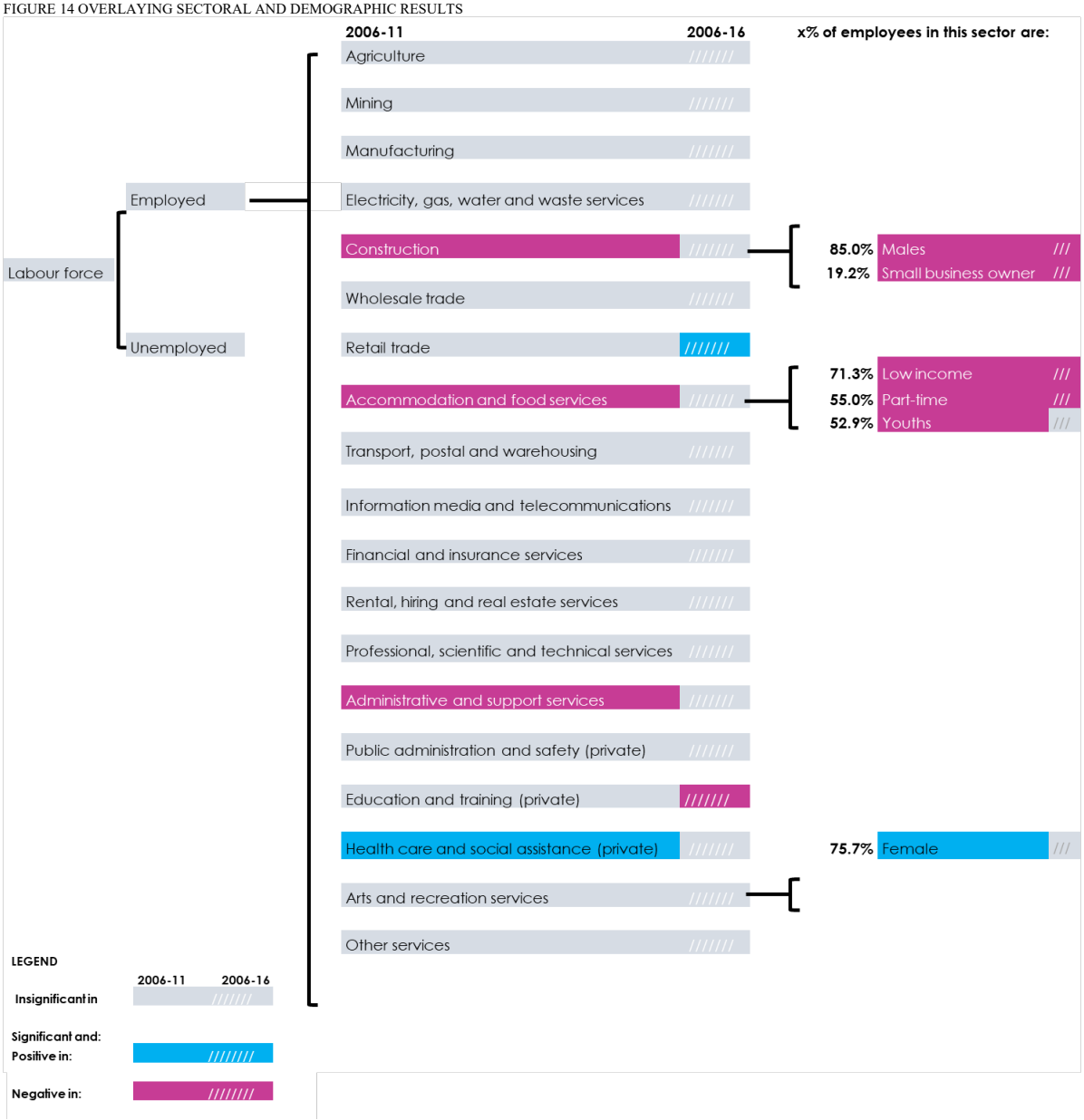
For instance, we can see that the income losses for part-time, low-income earners and youths are likely due to their high employment rates in the accommodation and food services sector, which is known to have been adversely impacted in the short term by the floods. In fact, many known other vulnerable groups (i.e. part-time employees, renters and non-English speaking employed individuals) are also highly represented in this sector. We also notice that many of these groups are similarly highly represented in other sectors (e.g. retail trade), thus suggesting a strong degree of overlap between them. That is, part-time, youths, and low- income workers are likely to be similar individuals.

The matrix also helps explain certain perplexing results. For instance, it becomes clear that the income gains of female workers in the health care and social assistance sector are likely behind the positive short-term relationship reported for females overall. For males, it also becomes clear that income losses experienced by male workers in the construction sector, an overwhelmingly

male employing sector (85%) in our baseline year, are contributing to the negative short-term income results reported earlier.

The relationships are less clear for other demographic groups and so are not included in FIGURE 14. However, from the matrix, medium and high-income earners are more heavily represented in industry sectors where we do not observe statistically significant income changes, likewise older age groups.

FIGURE 14 OVERLAYING SECTORAL AND DEMOGRAPHIC RESULTS



NOTE: PERCENTAGES REFLECT BASELINE YEAR (2006) SECTOR COMPOSITIONS. SEE SECTION 5.4.3 FOR DISCUSSION ON CROSS-SECTOR TRANSITIONS DURING STUDY PERIOD.

6.2.2 Role of government assistance

So far, we have not considered the role of intervention mechanisms in our analysis of results, which we have assumed to incorporate such government relief and recovery efforts (see section 5.5.1.2.1).

While we are unable to formally assess whether government packages played a mitigating role (due to unavailability of related data), we can shed light on the role of government assistance in income changes by mapping the relief and recovery programs to different groups and any related sectors.

We overlay our sectoral results with government relief and recovery assistance provided for the Queensland floods 2010-11 up until early September 2011 (thus coinciding with our 2006-11 results).[46] While not capturing all monetary assistance provided, it nevertheless provides a good representation of the likely *proportional* expenditure per program.

We use ABS ANZSIC classifications to guide sector categorisations and divide the assistance into:

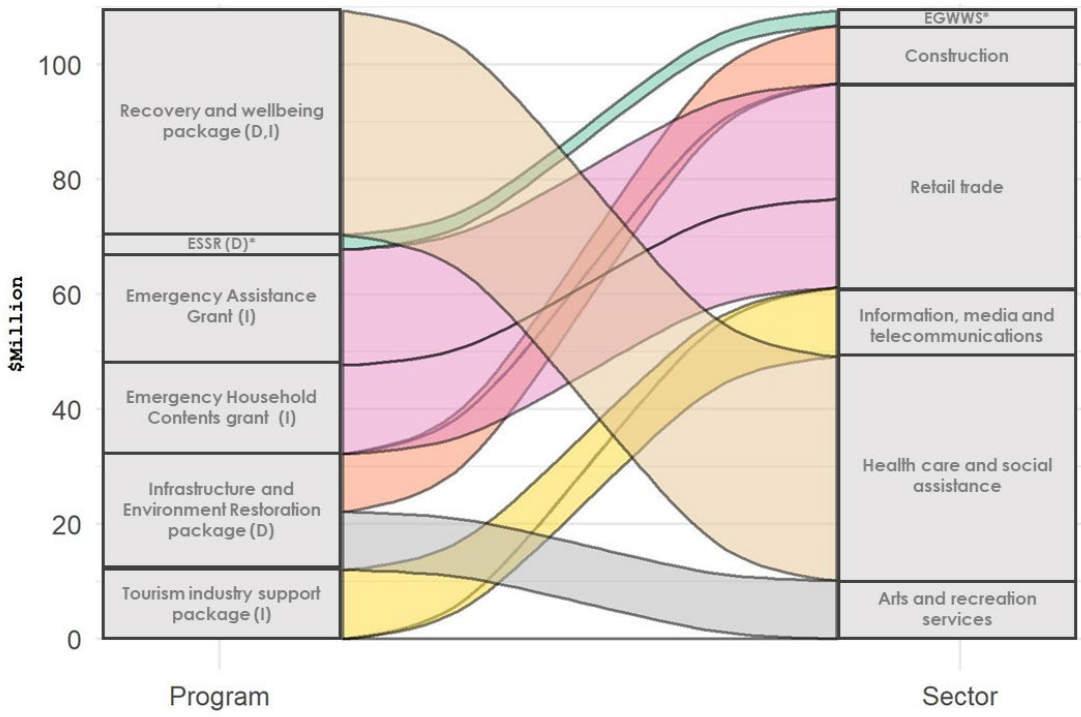
- Packages that create stimulatory economic activity (e.g. result in or encourage employment and/or income generation activities, whether directly or indirectly) in particular sectors.
- Packages that assist particular sectors in repair activities (e.g. primary producer assistance would go under agricultural sector).

As discussed earlier, we note that the breakdown of these packages at an LGA level is not available to us, which further constrains us to discussing the likely effects of these packages on economic activity in general terms.

[46] See appendix 12.2.2.

6.2.2.1.1 Government disaster recovery packages that stimulate sectoral economic activity

FIGURE 15 GOVERNMENT DISASTER RECOVERY PACKAGES THAT STIMULATE ECONOMIC ACTIVITY IN INDUSTRY SECTORS



NOTE: D = DIRECT, I = INDIRECT; ESSR = ESSENTIAL SERVICES SAFETY AND RECONNECTION; EGWWS = ELECTRICITY, GAS, WATER AND WASTE SERVICES. BASED ON DATA FROM QUEESNLAND RECONSRUCTION AUTHORITY (2011). SEE APPENDIX 11.2.2 FOR INFORMATION ON PACKAGES.

From the available data, government community recovery programs are likely to have increased money flows to particular sectors than otherwise would have occurred. For instance, the Mental Health Disaster Recovery Package provided $10 million to "bolster" mental health sector local organisations who were directly assisting disaster affected communities. This sector was associated with short-term, income gains and disproportionately employs part-time female workers.

For other sectors, such as the retail sector, the emergency assistance and household grants are likely to have resulted in a spike in demand for household goods once the businesses were reopened. We note that the retail sector was associated with income gains in the medium term (2006-16) which may be also correlated with economic activity associated with Cyclone Oswald 2013.

The accredited safety inspectors and repairer services needed to access the Essential services reconnection grants Is likely to have supported economic activity in the electricity, gas, water and waste services sector. The income results for this sector were not statistically significant; we note that this sector predominantly employs high income earners.

While the Tourism industry support package aimed to promote recovery in tourism-oriented sectors, it funded an advertising campaign and so is more likely to generate activity in the information, media and telecommunications sector. This sector predominantly employed middle-aged workers, high-income earners and full-time workers, and showed no statistically significant income results.

6.2.2.1.2 Government disaster recovery packages that assist in sector repair activities

FIGURE 16 shows the disaster recovery packages that we could most readily linked to specific sectors of the economy.

FIGURE 16 GOVERNMENT DISASTER RECOVERY PACKAGES THAT ASSIST IN RECONSTRUCTION AND REPAIR ACTIVITIES IN INDUSTRY SECTOR

Within these package groups, a significant proportion of joint Commonwealth-state government recovery expenditure under the NDRRA was grants and loans to primary producers (at least $100 million).

For our full benchmark sample, which had a small number of agricultural sector employees, the income results for the agricultural sector was statistically not significant. However, for our regional LGA sample analysis, where employment in the agricultural sector is much higher, we note that the income losses for employed residents in this region were 27.3% in the short term.

Government recovery programs also included packages to support the repair and reconstruction of Queensland sporting and recreational facilities. Such packages would assist repair activities in the arts and recreation services sector. The income results for this sector, which predominantly employs low-income, part-time workers, were statistically not significant.

7. CONCLUSIONS

While not causal, our findings provide an informative narrative on how disasters like the Queensland floods 2010-11 could interact with existing economic conditions and workforce composition to affect individuals within the community.

Although we do not find a statistically significant association between the Queensland Floods 2010-11 and income changes for the BRCA LGA's resident workforce as a whole, this overall result masks notable differences in outcomes for employed residents with different demographic characteristics, employment characteristics, and areas of residence. This, in turn, highlights the importance of looking beyond aggregates when reporting on economic effects of disasters.

In exploring reasons behind income changes, our research identifies three channels through which disaster-induced economic shocks can be transmitted to individuals, vis-à-vis income. These are: owning a business, working in sectors whose economic activity is susceptible to disaster shocks (both positive and negative), and working part-time. It also identifies particular vulnerabilities which require further policy attention.

Regardless of employment sector, owning a business is one channel through which shocks like natural disasters can influence individual income. Given the large number of inundated business properties, it is unsurprising that the Queensland Floods 2010-11 were associated with income losses for business owners in the BRCA region. While this result was consistent regardless of business type, these income losses were also observed in the medium term for small business owners and unincorporated businesses (which include sole traders and partnerships). On the other hand, incomes of those who do not own businesses (i.e. those who could be considered as wage-and-salary earners) do not significantly correlate with the floods. As the latter group makes up an important part of the full sample (nearly 84%), our results highlight the vulnerabilities experienced by business owners.

Disruptions, both positive and negative, to sectors of employment also matter and explain many of the statistically significant income changes we report. For instance, short-term income losses for construction workers and workers in tourism-oriented sectors are in line with the weakened economic conditions these sectors faced following the floods. Likewise, we find significant short-term losses for employed residents in areas with significant agricultural activity (i.e. Somerset and Lockyer Valley regional councils).

We find statistically significant income gains among employees in sectors like health and social assistance in the short term, and retail trade in the medium term. These sectors are known to have had increased economic activity following the floods, with increased demand for health services and from households replacing flood-damaged goods once businesses opened. In overlaying these sectoral results with government community recovery programs, we note that these programs are likely to have also increased money flows to these sectors than otherwise would have occurred, and potentially influenced our results.

These sector-level disruptions also had flow-on consequences on particular demographic groups. For instance, short-term income losses reported for males could be explained by losses in the male-dominated construction sector. Likewise, income gains reported for females are adequately explained by the gains experienced in the female-dominated health and social assistance sector. Importantly, we find that the floods were associated with income losses among groups such as youths, low-income earners and part-time employees, particularly in the short term. Many of these individuals were employed in the accommodation sector; a sector characterised by a high level of casualisation and lower earnings potential than other sectors, and thus their income stream is less likely to be resilient to economic shocks such as the floods.

Finally, part-time employment also appears to play a role. For instance, while we find no statistically significant effect for full-time workers (who comprise 70% of the sample), we find that part-time workers overall suffered income losses associated with the floods across our study period. With part-time employment including shift-work and casual jobs, our findings expose the vulnerability of such workers in sectors sensitive to disasters (e.g. tourism) to any potential disruptions to economic activity. This is a significant finding, considering the high level of under-employment among part-timer workers (Ai Group, 2019).

These mechanisms explain some, but not all income changes associated with the Queensland Floods 2010-11. Most noteworthy are the income gains we observe for medium-income earners and high-income earners. It is likely that some of these differences are due to increased economic activity within sub-sectors, or different skillsets these groups have (compared to low-income earners), however the aggregated nature of the ANZSIC sector classifications makes this impossible to assess. Considering that such individuals constitute a large percentage of the workforce, this is worth exploring further in future research.

While we cannot assess whether government assistance programs played a role in mitigating or reducing the effects of the disasters, we believe these programs are necessary to reduce any potential income inequalities that may arise or be widened by these disasters.

In examining the government recovery extended during the Queensland Floods 2010-11, many of the programs are already directed at groups that our research suggests are likely to be vulnerable to income shocks (e.g. low-income earners, small businesses). The extension of wage assistance programs like Cyclone Yasi program (see appendix 12.2.2) to include part-time employees is likely to help such individuals working in disaster-sensitive industries to better cope with disasters when they strike.

In ascertaining the appropriate level of assistance, our results indicate the importance of considering socioeconomic vulnerabilities and disadvantages. For instance, our average individual income losses associated with the Queensland Floods 2010-11 range between around $1,820 (part-time workers) and $5,030 (unincorporated business owners) within Brisbane, compared to $9,800 AUD for employed residents of the regional and more hard-hit BRCA councils.

While these income losses may initially seem relatively small and transitory, they need to be considered within the context of an individual's financial capacity to absorb them. For those already living on the margin, international evidence suggests such losses can push an already income-poor household further into poverty or drive a nonpoor household below the income poverty line (United Nations Office for Disaster Risk Reduction, 2019).

Indeed, many of the income losses we find are concentrated among groups already known to be disadvantaged (e.g. low-income and part-time workers) or residing in areas that have much higher economic exposure to disasters and have been assessed as having lower resilience to disasters (i.e. the Somerset and Lockyer Valley regional council areas).

We also know from surveys of households in Brisbane and Ipswich that the floods resulted in disruptions to work, and significant expenses that were not adequately covered by insurance, thus putting further stress on household budgets at a time of deep financial and psychological distress. Such income disruptions are known to exacerbate mental health conditions (Gibbs et al., 2016), and so need to be considered when formulating community recovery programs.

8. WHERE TO FROM HERE

While not offering causal results due to data limitations, our report provides an appropriate framework to guide and inform future economic investigations of disasters arising from natural hazards.

Firstly, we have demonstrated the value of systematically examining the potential effects of disasters across and between multiple economic and social dimensions. Importantly, our report highlights the criticality of examining employment sectors and known social vulnerabilities concurrently, within the social and economic context of the disaster-hit regions, so that results are interpreted correctly, and programs formulated and targeted accordingly.

Such an approach aids in better understanding our vulnerabilities to disasters, as recommended by the National Disaster Risk Reduction Framework, and in informing evaluations of disaster recovery programs, as under the National Monitoring and Evaluation Framework for Disaster Recovery Programs. Notwithstanding certain limitations, rich and publicly available datasets like the ACLD provide a path for doing so in a robust and rigorous way, before and after disasters.

We have also shown how government relief and recovery programs (were appropriate data to become available) can be overlayed with sector-specific results to establish causal links between government disaster efforts and subsequent economic activity in different sectors (FIGURE 4).

Looking ahead, the completion of other case studies under the broader *Optimising Post-Disaster Recovery Intervention Program* will further consolidate our understanding of indirect costs of disasters arising from natural hazards and provide significant input in a policy brief note on post-disaster recovery interventions in Australia. This note will be an input into the development of a guideline for optimising budget allocation across economic sectors in both pre-disaster mitigation as well as post-disaster recovery phases.

Extensions to this research are warranted, particularly to further understand differences between income groups, and unpack the impacts of natural disasters on firm-level activity and on those who migrate out of disaster zones.

9. KEY MILESTONES

TABLE 23 QUEENSLAND FLOODS 2010-11 CASE STUDY AND RELEVANT RESEARCH PROGRAM MILESTONES

Year	Milestone	Milestone date	Status
2018-19	Submit a demographic profile analysis of the Queensland Floods 2010-11 disaster-hit areas	31 December 2018	Completed
2018-19	Disseminate the preliminary findings of the Queensland Floods 2010-11 Case Study to beneficiaries	31 December 2018	Completed
2019-20	Disseminate final findings (including medium-term effects) of the Queensland Floods 2010-11 Case Study to beneficiaries	30 September 2019	Completed
2019-20	Submit the final report on the Queensland Floods 2010-11 Case Study	31 January 2020	Completed
2019-20	Submit Policy briefing for the Queensland Floods 2010-11 Case Study	31 March 2020	Upcoming
2019-20	A national seminar to sensitise the policymakers on the economic and social effects of disasters	30 May 2020	Upcoming
2019-20	Submit guidance note on the methodology of estimating economic and social impacts of natural disasters	30 June 2020	Upcoming
2019-20	Submit a research brief to facilitate the adoption of research findings at agency level	30 June 2020	Upcoming

10. UTILISATION OUTPUTS

10.1 ACHIEVEMENTS

10.1.1 Commercialisation/Utilisation

10.1.2 End user engagement

Since inception, the project has enjoyed the guidance, support and engagement of multiple government end-users. This engagement has strengthened the research design and utilisation potential. Apart from project deliverables, the project team has also produced multiple stakeholder updates which have provided end-user representatives with a more nuanced understanding of research methodology, and updates on relevant economic literature on disasters arising from natural hazards.

10.1.3 Opportunities

***Queensland Reconstruction Authority**, Queensland*

Findings of this research can support future approaches to the development and evaluation of recovery programs.

QRA will share the final report with State agencies who lead Queensland's economic and human and social functional recovery groups, given the relevance of the findings for several agencies involved in leading Queensland's response to recovery in these domains.

10.1.4 Impacts

10.1.5 Tracking

10.2 WHAT THIS PROJECT HAS REVEALED

The *Disasters and Economic Resilience: The Effects of the Queensland Floods 2010-11 on Individual Income – A Case Study on the Brisbane River Catchment Area* report has revealed the potential for disasters to widen socioeconomic disparities, and so emphasises the need for Australia's disaster relief and recovery arrangements to consider economic and social dimensions when implementing community recovery programs.

The project has revealed income streams within industries and sections of the workforce that are more susceptible to disaster-induced disruptions to economic activity. This information can help policy makers plan for and better target economic recovery programs so that long-term recovery is not only achieved more quickly, but also spread more evenly across the community.

Finally, the project has quantified indirect impacts (both income losses and gains) associated with a major disaster. In doing so, it has shown how these losses can be distributed unevenly across segments of the workforce, and exposed vulnerabilities that require policy attention. The research has helped demonstrate how such quantification exercises of intangible costs of disasters can be done, a current gap in disaster impact estimation, using national accounts records.

10.3 GAPS

As acknowledged in the 2018 National Disaster Risk Reduction Framework, "disaster risk data and information is not always available to those who need it and it does not adequately integrate climate science" (Commonwealth of Australia, 2018b, p. 12).

Over the course of this research program, multiple gaps particularly due to data limitations were revealed that require further investigation. These include the:

- lack of (access to) assistance, relief and recovery data at the LGA level
- impact on individuals who decide to migrate post disasters
- impact on firms following disasters
- role of insurance as a post-disaster intervention mechanism.

11. PUBLICATIONS LIST

11.1 PEER REVIEWED JOURNAL ARTICLES

1 Ulubasoglu M, Rahman MH, Önder Y, Chen Y, Rajabifard A, *Floods, bushfires and sectoral economic output in Australia, 1978-2014,* 2019: 1-23, Economic record, Chichester, Eng., C1.

2 Rahman MH. *Earthquakes don't kill, built environment does: Evidence from cross-country data*, Economic Modelling 2018; 70: 458–468.

3 Rahman MH, Anbarci N, Bhattacharya P, Ulubasoglu M, *Can Extreme Rainfall Trigger Democratic Change? The Role of Flood-Induced Corruption*, Public Choice, March 2017;171:331–358.

4 Rahman MH, Anbarci N, Bhattacharya P, Ulubasoglu M, *The Shocking Origins of Political Transitions? Evidence from Earthquakes*, Southern Economic Journal, January 2017;83: 796–823.

11.2 PAPERS

11.2.1 Refereed Conference papers

1 Rahman, M.H., M. Ulubasoglu, P. Bhattacharya, K. Potts, Y. Chen, M. Kalantari and A. Rajabifard (2015). "Natural Disasters and Economic Development: Evidence from Australia", Australian Conference of Economists, 7-10 July 2015, Brisbane.

11.2.2 Non-Refereed Conference Papers

2 Ulubasoglu, M. *Disasters and economic resilience: income effects of the Black Saturday bushfires on disaster-hit individuals*. AFAC18 (Bushfire and Natural Hazards CRC, 2018).Google Scholar BibTeX XML

3 Ulubasoglu M, Önder YK, Rahman MH, *Evaporative Heating: The Negative Income Effects of the Black Saturday Bushfires in Disaster-Hit Areas*, The 2018 Annual Conference of the Australasian Fire and Emergency Service Authorities Council, 5-8 September 2018, Perth.

4 Ulubasoglu M, Rahman MH, *Unpacking the Sectoral Income Effects of Natural Disasters: Evidence from the 2010-11 Queensland Floods*, The 2017 Annual Conference of the Australasian Fire and Emergency Service Authorities Council, , 3-5 September 2017, Sydney.

5 Rahman MH, Chen Y, Potts K, Bhattachary P, Rajabifard A, Ulubasoglu M, Kalantari M, *Bringing hazard and economic modellers together: A spatial platform for damage and losses visualisation*, 2015, Research proceedings from the Bushfire and Natural Hazards CRC and AFAC conference, Report No. 2015.084, Adelaide.

6 Rajabifard A, Ulubasoglu M, Potts K, Rahman MH, Kalantari M, Bhattacharya P. "*A pre-disaster multi-hazard damage and economic loss estimation model for Australia*", The 2014 Annual Conference of the Australasian Fire and Emergency Service Authorities Council, 2-5 Sep 2014 Wellington.

11.2.3 Working papers

In the coming year, we will also be progressing several working papers. These papers, while strictly outside the scope of our project, nevertheless have greatly benefited from and been informed by our BNHCRC research program methodology and learnings, underscoring the positive externalities that CRCs such as the BNHCRC effect on the quality and relevance of Australian research:

- Önder, Rahman, Ulubasoglu: *The Spillover Effects of Black Saturday Bushfires: A Network Approach*
- Önder, Rahman, Ulubasoglu: *Droughts and Crop Yield in Australia*
- Rahman, Anbarci, Ulubasoglu: *"Storm Autocracies": Islands as Natural Experiments*
- Rahman, Guven, Ulubasoglu: *Floods and Agricultural Productivity: Natural Field Experimental Evidence from Micro Plot-Level Data on Sri Lanka*.

11.2.4 Other

1 Ulubasoglu M, Beaini F, *Black Saturday bushfires: counting the cost*, Australian Journal of Emergency Management, 2019:5–6.

2 Beaini F, Ulubasoglu M, *Demographic profiling:* Toodyay Bushfire 2009 case study, Bushfire and Natural Hazards CRC, 2019.

3 Beaini F, Ulubasoglu M, *Demographic profiling: Victorian bushfires 2009 case study*, Bushfire and Natural Hazards CRC, 2018, https://www.bnhcrc.com.au/node/5214.

4 Beaini F, Ulubasoglu M, *Demographic profiling: Queensland Floods 2010-11 case study*, Bushfire and Natural Hazards CRC, 2019.

12. TEAM MEMBERS

Professor Mehmet Ulubasoglu – Project lead

Professor Mehmet Ulubasoglu is the Head of the Department of Economics and the Director of the Centre for Energy, the Environment and Natural Disasters at Deakin University. Professor Ulubasoglu is one of Australia's foremost experts on the economic impacts of natural disasters, with many years' experience working on these questions with governments in Australia, through his work with the Bushfire and Natural Hazards Cooperative Research Centre, and in South-East Asia with the Asia Disaster Preparedness Centre.

His current BNHCRC research project *Optimising Post-disaster Recovery Interventions in Australia* fills a major gap by estimating economic impacts of several Australian natural disasters on economic sectors and vulnerable groups.

He has published extensively in leading international journals, including the Review of Economics and Statistics, Journal of Development Economics, American Journal of Agricultural Economics, European Economic Review, and American Journal of Political Science.

Ms Farah Beaini – Research fellow

Farah Beaini is a Research Fellow in the Department of Economics at Deakin University, and the Industry Program and Research Coordinator at the Deakin Business School's Centre for Energy, the Environment and Natural Disasters.

Farah brings a wealth of stakeholder engagement and project management experience from her previous state and Commonwealth government roles in digital transformation, service delivery, administrative law and economic research. As part of the BNHCRC project, Farah oversees the stakeholder management and end-user engagement.

Other

In addition to the core research team, there are several casual members who contribute valuably to the project by working on the ArcGIS, statistical programming, and performing regressions as part of the Australian Bureau of Statistics visits.

13. APPENDIX

13.1 ANDRI SCORING INFORMATION

TABLE 24 ANDRI DESCRIPTION OF HIGH, MODERATE AND LOW ANDRI SCORE, COPING AND ADAPTIVE CAPACITY BANDS

Sector	Class	Percentile	Description
ANDRI Overall scoring	Low	<25th percentile 0 – 0.4461	Communities in areas of low disaster resilience may be limited in their capacity to use available resources to cope with adverse events and are limited in their capacity to adjust to change through learning, adaptation and transformation. Limitations to disaster resilience may be contributed by entrenched social and economic disadvantage, less access to or provision of resources and services, lower community cohesion and limited opportunities for adaptive learning and problem solving.
	Moderate	25-75 percentile 0.4462 – 0.6598	Communities in areas of moderate disaster resilience have some capacity to use available resources to cope with adverse events, and some capacity to adjust to change through learning, adaptation and transformation. Moderate disaster resilience is generally contributed by moderate levels of coping and adaptive capacity, which in turn are associated with moderate levels of economic capital, moderate provision of an access to services, moderate community cohesion and variable encouragement for adaptive learning and problem solving.
	High	>75th percentile 0.6598 –1	Communities in areas of high disaster resilience have enhanced capacity to use available resources to cope with adverse events, and enhanced capacity to adjust to change through learning, adaptation and transformation. Factors contributing to high disaster resilience may include employment, education, income, good access to or provision of resources and services, strong community cohesion and ample opportunities for adaptive learning and problem solving.
Coping capacity scoring	Low	<25th percentile 0 – 0.3945	Communities in areas of low coping capacity may be constrained in their capacity to use available resources to cope with adverse events and to prepare for, absorb and recover from a natural hazard event.
	Moderate	25-75 percentile 0.3946 – 0.6311	Communities in areas of moderate coping capacity have some capacity to use available resources to cope with adverse events and to prepare for, absorb and recover from a natural hazard event.
	High	>75th percentile 0.6312 - 1	Communities in areas of high disaster resilience have enhanced capacity to use available resources to cope with adverse events and to prepare for, absorb and recover from a natural hazard event.
Adaptive capacity scoring	Low	<25th percentile 0 – 0.4515	Communities in areas of low adaptive capacity may be constrained in their capacity to adjust to change through learning, adaptation and transformation.
	Moderate	25-75 percentile 0.4516 – 0.6656	Communities in areas of moderate adaptive capacity have some capacity to adjust to change through learning, adaptation and transformation.
	High	>75th percentile 0.6657 - 1	Communities in areas of high adaptive capacity have enhanced capacity to adjust to change through learning, adaptation and transformation.

13.2 BRCA AND QUEENSLAND FLOODS DISASTER INFORMATION

13.2.1 BRCA Natural disaster events (2006-2016)

To the author's best knowledge, the below table sets out all disaster events in which NDRRA was activated, and thus were severe enough to potentially create a shock to the income trajectory of BRCA residents. The Queensland Reconstruction Authority was formed in the aftermath of the Queensland Floods (2010-11). Events predating the QRA's formation were obtained from the Disaster Queensland Disaster Relief Activations archive page.

TABLE 25 DECLARED NATURAL DISASTER EVENTS IN THE BRISBANE RIVER CACHMENT LGAS THROUGHOUT STUDY PERIOD (2006-2016)

Date	Disaster event	NDRRA Category activated	NDRRA assistance activated for LGA?				Source
			Brisbane	Ipswich	Lockyer Valley	Somerset	
22 Aug 2007	South East and North Coast Queensland East Coast Low	A,B	Yes	Yes	Yes	Yes	Disaster Queensland
7–12 Oct 2007	Central & Southern Queensland Severe Storms	A,B	Yes	Yes	Yes	Yes	Disaster Queensland
28–30 Oct 2007	Central & Southern Queensland Severe Storms	A,B	Yes	Yes	Yes	Yes	Disaster Queensland
27 Dec 2007 – 7 Jan 2008	South East Queensland East Coast Low	A,B	Yes	No	No	No	Disaster Queensland
16 – 22 Nov 2008	Queensland storms	A,B	Yes	Yes	Yes	Yes	Disaster Queensland
May 2009	South East Queensland Low	A,B	Yes	Yes	Yes	Yes	Disaster Queensland
Jan – Apr 2010	Queensland Monsoonal Flooding & TC Olga & Neville, Ului and Paul, January to April 2010	A,B	No	No	Yes	No	Disaster Queensland
9–12 Oct 2010	South East Queensland Flooding	A,B	Yes	No	Yes	Yes	Queensland Reconstruction Authority
Nov 2010 – Feb 2011	Queensland Flooding and Tropical Cyclones Tasha and Anthony	A,B,C,D	Yes	Yes	Yes	Yes	Queensland Reconstruction Authority
25 Feb – 5 Mar 2013	Central and Southern Queensland Low	A,B	Yes	Yes	Yes	Yes	Queensland Reconstruction Authority
21–29 Jan 2013	Tropical Cyclone Oswald and Associated Rainfall and Flooding	A,B,C,D*	Yes	Yes	Yes	Yes	Queensland Reconstruction Authority
26 – 30 Mar 2014	Central Coast and Southern Queensland Trough	A,B	No	No	Yes	No	Queensland Reconstruction Authority
27 Nov 2014	Brisbane Severe Thunderstorm	A,B	Yes	No	No	No	Queensland Reconstruction Authority
19 – 22 Feb 2015	Severe Tropical Cyclone Marcia and South East Queensland trough	A*,B	Yes	Yes	No	Yes	Queensland Reconstruction Authority
30 Apr – 1 May 2015	South East Queensland Low	A	Yes	No	No	No	Queensland Reconstruction Authority

27 Oct 2015	Fernvale Severe Storm	A,B	No	No	No	Yes	Queensland Reconstruction Authority

13.2.2 Queensland Floods Government assistance programs

For consistency, all figures are taken from the 2011 Queensland Reconstruction Authority "Operation Queenslander Report" which provides a comprehensive report of:

- impacts of the Queensland Floods/Cyclone Yasi; and
- committed and distributed (marked with *) government recovery assistance.

All figures are up to September 2011.

TABLE 26 QUEENSLAND FLOODS 2010-11 GOVERNMENT ASSISTANCE PROGRAMS

Package	Total value ($m)	Objective
NDRRA		
Grants: Small Businesses, Primary Producers, and Charities and Non-Profit Groups	$117.2	Three types of grants of up to $25,000 are available to small businesses, primary producers and charities and non-profit groups. As at 1/9/11: Small business group ($49.1m distributed) - designed to cover the cost of clean-up and restoration to assist small businesses which have suffered direct damage as a result of the natural disasters. Grants may also be provided to assist with the costs of relocation to temporary premises in cases where immediate re-opening of damaged premises is not possible. Primary producers ($65.9) - provide short-term targeted assistance for clean-up, removal of debris, disposal of dead livestock and further restoration following a natural disaster event. The grants are provided in cases where the impact on the farming sector has been particularly severe and could result in production and viability being disrupted beyond the current season. Charities and not-for-profits ($2.2) - assist eligible organisations pay for costs arising out of direct damage caused by the Floods and Tropical Cyclone Yasi.
Personal Hardship and Assistance scheme	$42.9*	PHAS grants support homeowners and tenants experiencing immediate hardship. The Scheme includes Emergent Assistance Grants (EAG), Essential Household Contents Grants (EHCG) and Structural Assistance Grants (SAG). As at 7/9/11: Emergent Assistance Grant ($20.1m distributed) - provide assistance in the first few days following a natural disaster for immediate, unexpected needs such as temporary accommodation, food, essential clothing and medication. A grant of $170 per person, up to a maximum of $850 for a family of five or more, is available. Essential Households content grant ($15.4m distributed) - purpose of this grant is to provide assistance to replace household contents that have been lost or damaged as a result of the Queensland floods or Tropical Cyclone Yasi. Structural Assistance Grant ($7.4m distributed) assists eligible homeowners return their home to a habitable and secure condition
Essential Services Safety and Reconnection	$2.6	assists homeowners reconnect essential services, such as electricity, water, gas or sewerage/septic systems, damaged by the Queensland floods or Tropical Cyclone Yasi. ESSR grants provide up to $200 per service for safety inspections by accredited inspectors, and if deemed necessary, up to $4,200 to meet the cost of repairing or reinstalling services to Australian Standards by qualified tradespeople. Safety inspection payments will be refunded to the homeowner and reinstatement costs will be paid directly to the repairer by the DoC.
Community Recovery and wellbeing	$39*	Support the recovery and wellbeing of people in Queensland. The package includes: • $20 million for community development and recovery funds on the ground to provide intensive support to the State's most highly impacted local communities, including supporting not-for-profit community groups, events and memorials. • Up to $10 million for a Mental Health Disaster Recovery Package to support mental health services in disaster affected communities in Queensland on top of $1.2 million in funding announced earlier this year. Local organisations on the ground within the mental health sector will receive much needed funding to bolster their excellent work within severely affected communities. • Up to $5.8 million Financial Counselling to provide support to families and individuals affected by the disasters who are experiencing financial problems. • A $2m Disabilities Care Plan to help a number of nongovernment organisations across Queensland to deliver crisis accommodation and respite care for people with a disability.
Exceptional Concessional loans: Small Businesses, Primary Producers, and Charities and Non-Profit	$30.7	offered for businesses, primary producers and charities and non-profit groups, and are available to those suffering exceptional damage.

Groups		
Concessional loans: Small Businesses, Primary Producers, and Charities and Non-Profit Groups	$16.2	Two types of concessional loan facilities of up to $250,000 are available to eligible small businesses and primary producers. Both types of loans are designed to assist in meeting the needs of small businesses and primary producers in recovering from substantial natural disasters. As at 1 September, 87 loans, providing approximately $12.1 had been distributed
Rural Resilience Fund	$20	Assist the recovery of rural economies and communities impacted by Tropical Cyclone Yasi. The RRF will help fund business and community support activities by providing counselling, social, education, and clean-up services.
Freight Subsidies for Primary Producers	$0.177	Provides up to $5,000 in assistance, which can be tailored to address specific deficiencies that have occurred as a direct consequence of an eligible natural disaster. The subsidies can be used for restocking movement, fencing and fodder movements.
Additional Services	-	Provides additional community services, such as counselling, information and advice, accommodation and personal support to disaster affected residents. Eligible persons are able to claim during and after the disaster for up to 2 years.
Non-NDRRA		
Australian Government Disaster Recovery Payments	$775.4	Assist people who have been adversely affected by natural disasters, providing up to a maximum of $1,000 per adult and $400 per eligible child. This scheme is administered via Centrelink
Premier's Disaster Relief Appeal	$276.7*	Provides assistance to individuals and families affected by the natural disasters. $251.3 million distributed as at 5/9/11: Round 1 ($72.7m distributed) – payments provided $2,000 per eligible adult and $1,000 per dependent child. Round 2 ($31.4 m distributed) – means tested, available for eligible people whose homes have been destroyed or must be demolished as a result of the Queensland floods or Tropical Cyclone Yasi, providing an initial payment of $10,000 per home destroyed and additional assistance of up to $140,000 per property. Round 3 ($147.2m distributed) – means tested, available for eligible people whose homes have suffered structural damage as a result of the Queensland floods or Tropical Cyclone Yasi, providing $5,000 towards rehousing or recovery requirements and additional assistance of up to $75,000 depending on income and circumstances.
Queensland Natural Disaster Jobs and Skills Package	$83*	Assist Queensland industries, businesses, and apprentices and trainees affected by the floods or Cyclone Yasi, with a view to creating employment and training opportunities in affected locations.
Tourism Industry Support Package	$12	$12 million ($6 million from each of the State and Commonwealth) has been allocated to this package which is designed to assure all Australians that many of Queensland's iconic destinations are largely unaffected by the floods. The funding is allocated towards an advertising campaign that is being administrated by a combination of Tourism Queensland, DEEDI, Commonwealth Department of Resources, Energy and Tourism and Tourism Australia.
Disaster Income Recovery Subsidies	$69.5	Assist employees, small businesses and farmers who have incurred a loss as a direct result of a natural disaster
Cyclone Yasi wage assistance	$19.6	Available for employers (including businesses, primary producers and non-profit organisations) whose business has been affected by Cyclone Yasi, to help maintain their workforce. Payments of $469.70 per fortnight are available to each full time or full-time equivalent employee up to a maximum of 13 weeks.
Sport Flood fightback scheme	$13.6	up to $60,000 of available assistance for sport and recreation clubs to re-establish facilities, and up to $12,500 to repair or replace equipment that has been damaged in the floods
Racetrack recovery assistance	$2.35*	Provides $2.35 million for racecourses and country track clubs to repair disaster affected infrastructure in order to meet health and safety standards.
Flood recovery program	$2.35*	Assist primary producers in flood affected areas with clean-up initiatives, financial counselling, and biosecurity issues management
QLD Flood and Cyclone Legal Help	-	This program of assistance provides legal support to people affected by a disaster

NOTE: *MAXIMUM AVAILABLE FOR PROGRAM. SOURCE: QUEENSLAND RECONSTRUCTION AUTHORITY, 2011.

13.3 BRCA CASE STUDY ANALYSIS

13.3.1 2006 Descriptive statistics

TABLE 27 2006 SAMPLE DESCRIPTIVE STATISTICS: DEMOGRAPHIC AND EMPLOYMENT ATTRIBUTES

	Full sample (2006)			BRCA LGAs sample (2006)			Control Group sample (2006)		
	Mean	Std. dev.	Observations	Mean	Std. .dev.	Observations	Mean	Std. dev	Observations
Income (A$)	43867	28839	135316	42943	27339	30193	44133	29250	105123
Low income (%)	0.380	0.485	137562	0.379	0.485	30680	0.380	0.485	106882
Middle income (%)	0.276	0.447	137562	0.291	0.454	30680	0.271	0.445	106882
High income (%)	0.344	0.475	137562	0.329	0.470	30680	0.349	0.477	106882
Age	37.127	12.797	137562	37.300	12.822	30680	37.077	12.790	106882
Female (%)	0.473	0.499	137562	0.478	0.500	30680	0.472	0.499	106882
English not spoken at home (%)	0.201	0.401	137562	0.122	0.327	30680	0.224	0.417	106882
Disability (%)	0.005	0.070	137562	0.006	0.074	30680	0.005	0.069	106882
Home ownership status									
Owner (outright) (%)	0.230	0.421	137562	0.212	0.408	30680	0.236	0.424	106882
Owner (with mortgage) (%)	0.432	0.495	137562	0.433	0.496	30680	0.431	0.495	106882
Renter (%)	0.302	0.459	137562	0.321	0.467	30680	0.297	0.457	106882
Employment status									
Employed (%)	0.952	0.213	137562	0.959	0.198	30680	0.950	0.217	106882
Unemployed (%)	0.048	0.213	137562	0.041	0.198	30680	0.050	0.217	106882
Hours worked									
Part-time (%)	0.274	0.446	137562	0.274	0.446	30680	0.274	0.446	106882
Full-time (%)	0.622	0.485	137562	0.632	0.482	30680	0.620	0.485	106882
Business ownership									
Does not own business (%)	0.797	0.402	137562	0.812	0.391	30680	0.793	0.405	106882
Owns small business (%)	0.076	0.264	137562	0.073	0.260	30680	0.076	0.265	106882
Owns incorporated business (%)	0.065	0.247	137562	0.061	0.239	30680	0.066	0.249	106882
Owns unincorporated business (%)	0.073	0.260	137562	0.071	0.257	30680	0.074	0.262	106882

NOTE: % REFERS TO THE SHARE OF THE GROUP IN THE RELATED SAMPLE.

TABLE 28 2006 SAMPLE DESCRIPTIVE STATISTICS: SHARE OF TOTAL EMPLOYMENT, BY SECTOR

	Full sample (2006)			BRCA LGA sample (2006)			Control group sample (2006)		
	Mean	Standard deviation	Observations	Mean	Standard deviation	Observations	Mean	Standard deviation	Observations
Agriculture (%)	0.006	0.080	127951	0.008	0.08792	28754	0.006	0.077	99197
Mining (%)	0.008	0.091	127951	0.006	0.07576	28754	0.009	0.095	99197
Manufacturing (%)	0.090	0.286	127951	0.092	0.28896	28754	0.089	0.285	99197
Electricity, gas, water and waste services (%)	0.008	0.090	127951	0.010	0.10009	28754	0.008	0.087	99197
Construction (%)	0.065	0.246	127951	0.066	0.24812	28754	0.065	0.246	99197
Wholesale trade (%)	0.044	0.204	127951	0.041	0.19733	28754	0.045	0.206	99197
Retail trade (%)	0.109	0.311	127951	0.106	0.30745	28754	0.110	0.312	99197
Accommodation and food services (%)	0.068	0.251	127951	0.063	0.24312	28754	0.069	0.253	99197
Transport, postal and warehousing (%)	0.045	0.206	127951	0.052	0.22103	28754	0.043	0.202	99197
Information media and telecommunications (%)	0.026	0.159	127951	0.018	0.13364	28754	0.028	0.165	99197
Financial and insurance services (%)	0.051	0.220	127951	0.042	0.20030	28754	0.054	0.225	99197
Rental, hiring and real estate services (%)	0.019	0.136	127951	0.021	0.14282	28754	0.018	0.134	99197
Professional, scientific and technical services (%)	0.094	0.292	127951	0.088	0.28262	28754	0.096	0.295	99197
Administrative and support services (%)	0.035	0.185	127951	0.033	0.17820	28754	0.036	0.187	99197
Public administration and safety (private) (%)	0.065	0.246	127951	0.079	0.26950	28754	0.060	0.238	99197
Education and training (private) (%)	0.080	0.272	127951	0.088	0.28283	28754	0.078	0.268	99197
Health care and social assistance (private) (%)	0.104	0.305	127951	0.110	0.31337	28754	0.102	0.302	99197
Arts and recreation services (%)	0.016	0.127	127951	0.013	0.11405	28754	0.017	0.130	99197
Other services (%)	0.036	0.186	127951	0.036	0.18689	28754	0.036	0.186	99197

NOTE: % REFERS TO THE SHARE OF THE GROUP IN THE RELATED SAMPLE.

13.3.2 2011 Descriptive statistics

TABLE 29 SAMPLE DESCRIPTIVE STATISTICS: DEMOGRAPHIC AND EMPLOYMENT ATTRIBUTES

	Full sample (2011)			BRCA LGA sample (2011)			Control Group sample (2011)		
	Mean	Std. dev.	Observations	Mean	Std. .dev.	Observations	Mean	Std. dev	Observations
Income	48951	26454	115043	48054	25514	23968	49187	26691	91075
Low income (%)	0.337	0.473	116490	0.359	0.480	24247	0.331	0.471	92243
Middle income (%)	0.333	0.471	116490	0.367	0.482	24247	0.324	0.468	92243

High income (%)	0.330	0.470	116490	0.274	0.446	24247	0.345	0.475	92243
Age	40.740	12.692	116490	41.084	12.705	24247	40.649	12.687	92243
Female (%)	0.479	0.500	116490	0.487	0.500	24247	0.477	0.499	92243
English not spoken at home (%)	0.208	0.406	116490	0.131	0.337	24247	0.229	0.420	92243
Disability (%)	0.006	0.075	116490	0.006	0.077	24247	0.006	0.075	92243
Home ownership status									
Owner (outright) (%)	0.228	0.420	116490	0.219	0.414	24247	0.230	0.421	92243
Owner (with mortgage) (%)	0.470	0.499	116490	0.470	0.499	24247	0.469	0.499	92243
Renter (%)	0.271	0.444	116490	0.282	0.450	24247	0.268	0.443	92243
Employment status									
Employed (%)	0.960	0.196	116490	0.963	0.189	24247	0.959	0.197	92243
Unemployed (%)	0.040	0.196	116490	0.037	0.189	24247	0.041	0.197	92243
Hours worked									
Part-time (%)	0.260	0.439	116490	0.261	0.439	24247	0.259	0.438	92243
Full-time (%)	0.650	0.477	116490	0.653	0.476	24247	0.649	0.477	92243
Business ownership									
Does not own business (%)	0.795	0.404	116490	0.811	0.391	24247	0.791	0.407	92243
Owns small business (%)	0.084	0.277	116490	0.080	0.271	24247	0.085	0.279	92243
Owns incorporated business (%)	0.074	0.261	116490	0.069	0.253	24247	0.075	0.263	92243
Owns unincorporated business (%)	0.075	0.264	116490	0.069	0.253	24247	0.077	0.266	92243

NOTE: % REFERS TO THE SHARE OF THE GROUP IN THE RELATED SAMPLE.

TABLE 30 2011 SAMPLE DESCRIPTIVE STATISTICS: SHARE OF TOTAL EMPLOYMENT, BY SECTOR

	Full sample (2011)			BRCA LGA sample (2011)			Control group sample (2011)		
	Mean	Standard deviation	Observations	Mean	Standard deviation	Observations	Mean	Standard deviation	Observations
Agriculture (%)	0.005	0.073	109980	0.006	0.080	22970	0.005	0.071	87010
Mining (%)	0.013	0.113	109980	0.012	0.110	22970	0.013	0.114	87010
Manufacturing (%)	0.077	0.267	109980	0.075	0.263	22970	0.078	0.268	87010
Electricity, gas, water and waste services (%)	0.011	0.103	109980	0.013	0.112	22970	0.010	0.100	87010
Construction (%)	0.070	0.255	109980	0.070	0.254	22970	0.070	0.255	87010
Wholesale trade (%)	0.041	0.198	109980	0.038	0.192	22970	0.042	0.200	87010
Retail trade (%)	0.085	0.279	109980	0.082	0.275	22970	0.085	0.279	87010
Accommodation and food services (%)	0.044	0.205	109980	0.041	0.198	22970	0.045	0.207	87010
Transport, postal and warehousing (%)	0.048	0.214	109980	0.054	0.226	22970	0.047	0.211	87010
Information media and telecommunications (%)	0.024	0.153	109980	0.017	0.128	22970	0.026	0.159	87010
Financial and insurance services (%)	0.053	0.224	109980	0.041	0.199	22970	0.056	0.231	87010
Rental, hiring and real estate services (%)	0.018	0.131	109980	0.017	0.130	22970	0.018	0.132	87010
Professional, scientific and technical services (%)	0.110	0.313	109980	0.109	0.311	22970	0.110	0.313	87010
Administrative and support services (%)	0.033	0.178	109980	0.029	0.168	22970	0.034	0.181	87010
Public administration and safety (private) (%)	0.076	0.264	109980	0.092	0.290	22970	0.071	0.257	87010
Education and training (private) (%)	0.093	0.290	109980	0.099	0.298	22970	0.092	0.288	87010
Health care and social assistance (private) (%)	0.120	0.325	109980	0.130	0.336	22970	0.117	0.322	87010
Arts and recreation services (%)	0.017	0.128	109980	0.013	0.115	22970	0.018	0.131	87010
Other services (%)	0.036	0.186	109980	0.035	0.184	22970	0.036	0.187	87010

NOTE: % REFERS TO THE SHARE OF THE GROUP IN THE RELATED SAMPLE.

13.3.3 2016 Descriptive statistics

TABLE 31 2016 SAMPLE DESCRIPTIVE STATISTICS: DEMOGRAPHIC AND EMPLOYMENT ATTRIBUTES

	Full sample (2016)			BRCA LGA sample (2016)			Control Group sample (2016)		
	Mean	Std. dev.	Observations	Mean	Std. .dev.	Observations	Mean	Std. dev	Observations
Income	57105	33492	87352	55937	32068	17631	57400	33836	69721
Low income (%)	0.357	0.479	88366	0.366	0.482	17826	0.355	0.478	70540
Middle income (%)	0.313	0.464	88366	0.353	0.478	17826	0.303	0.459	70540
High income (%)	0.330	0.470	88366	0.281	0.449	17826	0.343	0.475	70540
Age	44.947	11.845	88366	45.470	11.661	17826	44.815	11.888	70540
Female (%)	0.487	0.500	88366	0.493	0.500	17826	0.486	0.500	70540
English not spoken at home (%)	0.210	0.408	88366	0.135	0.342	17826	0.229	0.420	70540
Disability (%)	0.008	0.088	88366	0.007	0.085	17826	0.008	0.089	70540
Home ownership status									
Owner (outright) (%)	0.232	0.422	88366	0.238	0.426	17826	0.231	0.421	70540
Owner (with mortgage) (%)	0.501	0.500	88366	0.495	0.500	17826	0.503	0.500	70540
Renter (%)	0.236	0.424	88366	0.238	0.426	17826	0.235	0.424	70540
Employment status									
Employed (%)	0.959	0.199	88366	0.961	0.193	17826	0.958	0.200	70540
Unemployed (%)	0.041	0.199	88366	0.039	0.193	17826	0.042	0.200	70540
Hours worked									
Part-time (%)	0.268	0.443	88366	0.259	0.438	17826	0.271	0.444	70540
Full-time (%)	0.647	0.478	88366	0.662	0.473	17826	0.644	0.479	70540
Business ownership									
Does not own business (%)	0.778	0.415	88366	0.791	0.407	17826	0.775	0.417	70540
Owns small business (%)	0.061	0.240	88366	0.060	0.237	17826	0.062	0.240	70540
Owns incorporated business (%)	0.083	0.276	88366	0.079	0.270	17826	0.084	0.277	70540
Owns unincorporated business (%)	0.079	0.270	88366	0.074	0.261	17826	0.081	0.272	70540

NOTE: % REFERS TO THE SHARE OF THE GROUP IN THE RELATED SAMPLE.

TABLE 32 2016 SAMPLE DESCRIPTIVE STATISTICS: SHARE OF TOTAL EMPLOYMENT, BY SECTOR

	Full sample (2016)			BRCA LGA sample (2016)			Control group sample (2016)		
	Mean	Standard deviation	Observations	Mean	Standard deviation	Observations	Mean	Standard deviation	Observations
Agriculture (%)	0.007	0.086	81863	0.008	0.091	16584	0.007	0.084	65279
Mining (%)	0.013	0.113	81863	0.011	0.104	16584	0.013	0.115	65279
Manufacturing (%)	0.061	0.240	81863	0.059	0.235	16584	0.062	0.241	65279
Electricity, gas, water and waste services (%)	0.011	0.106	81863	0.013	0.115	16584	0.011	0.104	65279
Construction (%)	0.072	0.258	81863	0.067	0.250	16584	0.073	0.260	65279
Wholesale trade (%)	0.032	0.176	81863	0.027	0.163	16584	0.033	0.179	65279
Retail trade (%)	0.072	0.258	81863	0.070	0.255	16584	0.072	0.259	65279
Accommodation and food services (%)	0.033	0.179	81863	0.029	0.168	16584	0.034	0.182	65279
Transport, postal and warehousing (%)	0.049	0.216	81863	0.055	0.228	16584	0.047	0.213	65279
Information media and telecommunications (%)	0.022	0.148	81863	0.016	0.124	16584	0.024	0.153	65279
Financial and insurance services (%)	0.054	0.225	81863	0.044	0.206	16584	0.056	0.230	65279
Rental, hiring and real estate services (%)	0.021	0.143	81863	0.023	0.149	16584	0.020	0.141	65279
Professional, scientific and technical services (%)	0.110	0.312	81863	0.108	0.310	16584	0.110	0.313	65279
Administrative and support services (%)	0.034	0.180	81863	0.030	0.171	16584	0.034	0.182	65279
Public administration and safety (private) (%)	0.083	0.275	81863	0.099	0.299	16584	0.078	0.269	65279
Education and training (private) (%)	0.112	0.315	81863	0.127	0.333	16584	0.108	0.310	65279
Health care and social assistance (private) (%)	0.140	0.347	81863	0.146	0.353	16584	0.138	0.345	65279
Arts and recreation services (%)	0.018	0.132	81863	0.013	0.115	16584	0.019	0.136	65279
Other services (%)	0.036	0.186	81863	0.035	0.184	16584	0.036	0.187	65279

NOTE: % REFERS TO THE SHARE OF THE GROUP IN THE RELATED SAMPLE.

13.3.4 Full Sample Results

TABLE 33 FULL SAMPLE RESULTS, DISSAGGREGATED BY SECTOR OF EMPLOYMENT

Panel A										
	(1) Agriculture	(2) Mining	(3) Manufacturing	(4) Electricity, gas, water and waste services	(5) Construction	(6) Wholesale trade	(7) Retail trade	(8) Accommodation and food services	(9) Transport, postal and warehousing	(10) Information media and telecommunications

t_2011	0.15019 (0.19284)	0.25202** (0.10771)	0.02563 (0.03425)	-0.00629 (0.08189)	-0.09662*** (0.03505)	-0.01815 (0.04672)	0.03916 (0.04194)	-0.08227* (0.04669)	-0.04062 (0.03738)	0.01820 (0.08437)
t_2016	-0.00673 (0.19979)	-0.28041*** (0.09763)	0.08038 (0.05834)	0.05313 (0.12671)	-0.01478 (0.06078)	0.01869 (0.05128)	0.13084** (0.06131)	0.08114 (0.05455)	-0.00329 (0.10851)	-0.10768 (0.08127)
Observations	2000	2559	28528	2654	20025	13771	33889	19925	13835	8168
R-squared	0.189	0.192	0.048	0.233	0.049	0.048	0.035	0.055	0.063	0.070

Panel B

	(11) Financial and insurance services	(12) Rental, hiring and real estate services	(13) Professional, scientific and technical services	(14) Administrative and support services	(15) Public administration and safety (private)	(16) Education and training (private)	(17) Health care and social assistance (private)	(18) Arts and recreation services	(19) Other services	
t_2011	-0.01648 (0.04852)	0.02692 (0.09466)	0.00005 (0.02370)	-0.18207*** (0.04447)	0.01851 (0.03800)	0.02448 (0.02619)	0.09039*** (0.02978)	-0.01227 (0.08583)	0.02396 (0.05853)	
t_2016	-0.05062 (0.05439)	0.03361 (0.10839)	-0.02243 (0.03674)	0.00953 (0.05887)	0.02041 (0.04761)	-0.08864** (0.03889)	0.02524 (0.06463)	0.01544 (0.11369)	0.09286 (0.07552)	
Observations	16168	5930	29873	10917	20998	26550	33524	5058	11302	
R-squared	0.063	0.111	0.033	0.069	0.053	0.037	0.042	0.111	0.060	

post ×D is the difference-in-differences estimate. Standard errors in parenthesis. For significant results, significance levels are denoted by: *p <0.10, ** p <0.05, *** p <0.01. Findings based on use of Australian Bureau of Statistics Microdata

13.3.5 Matrix

TABLE 34 PERCENTAGE OF TOTAL SECTOR EMPLOYEES, BY ATTRIBUTE (TREATMENT GROUP, AS REPORTED IN BASELINE YEAR)

	Gender		Income group			Part-time vs Full-time		Business owner	Age group			Other characteristics	
	Male	Female	Low	Middle	High	Part-time	Full-time	Small Business	Under 26	26-45	Over 45	Other language than English spoken at home	Disability
Agriculture	67.9	32	50.4	24.9	24.7	27.4	72.6	16.1	22.23	39.8	38.0	16.85	1.08
Mining	75.0	25	4.5	9.6	85.8	6.8	93.2	4.0	14.83	54.9	30.1	10.21	0.12
Manufacturing	71.0	29	28.8	34.4	36.7	14.3	85.7	6.4	15.74	51.1	33.1	27.99	0.37
Electricity, gas, water and waste services	71.1	29	12.4	28.7	58.9	11.8	88.2	3.2	14.65	50.0	35.5	16.90	0.14
Construction	85.0	15	27.8	33.0	39.2	18.1	81.9	19.2	21.69	49.9	28.5	19.87	0.27
Wholesale trade	63.8	36	27.1	33.1	39.7	16.5	83.5	9.5	15.54	54.7	29.8	22.97	0.39
Retail trade	43.5	57	64.0	21.9	14.1	48.6	51.4	7.5	44.32	35.4	20.2	21.95	0.37
Accommodation and food services	46.8	53	71.3	19.3	9.4	55.0	45.0	6.4	52.89	32.1	15.0	31.40	0.31
Transport, postal and warehousing	74.0	26	27.2	36.9	36.0	19.4	80.6	7.3	12.37	50.8	36.8	23.19	0.40
Information media and telecommunications	55.3	45	22.1	29.3	48.6	20.6	79.4	5.3	21.17	57.7	21.1	19.06	0.31
Financial and insurance services	49.5	50	14.2	29.6	56.2	15.5	84.5	6.5	15.91	61.8	22.3	21.81	0.26
Rental, hiring and real estate services	50.4	50	31.2	28.1	40.6	26.6	73.4	13.7	22.67	45.0	32.2	15.37	0.24
Professional, scientific and technical services	56.0	44	19.6	25.0	55.4	20.3	79.7	14.1	17.79	55.2	27.0	19.07	0.26
Administrative and support services	47.1	53	43.1	30.2	26.7	35.3	64.7	7.9	20.55	50.5	28.9	26.09	0.98
Public administration and safety (private)	54.7	45	14.4	33.4	52.2	15.7	84.3	0.7	13.18	53.0	33.8	13.87	0.52
Education and training	31.5	68	29.0	27.4	43.6	35.6	64.4	1.6	11.89	44.4	43.7	15.59	0.30
Health care and social assistance	24.3	76	37.0	29.2	33.8	39.9	60.1	6.1	13.40	47.7	38.9	21.12	0.90
Arts and recreation services	51.1	49	47.7	26.9	25.3	41.3	58.7	5.0	30.56	47.5	22.0	12.45	0.50
Other services	54.4	46	48.0	30.4	21.7	27.5	72.5	12.3	23.51	46.4	30.1	21.02	0.57
Avg. across sectors	56.4	44	**32.6**	**28.0**	**39.4**	**26.1**	**73.9**	**8.1**	**21.3**	**48.8**	**29.8**	**19.83**	**0.44**

SOURCE: OBTAINED USING ACLD MICRODATA.

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