

ABSTRACT

We explore the effects of a small bushfire on the income trajectory of employed residents of Toodyay, a regional town in Western Australia. Our study reveals how detailed profiling, using public data, can overcome statistical limitations in disaster risk reduction exercises and better direct post-recovery interventions to minimise disruptions to important income streams in small regional towns.

Disasters and economic resilience in small regional communities: the case of Toodyay

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Introduction

Natural disasters in Australia are very costly, and often have devastating socio-economic effects on impacted communities. Recent devastating examples include the Victorian Black Saturday Bushfires 2009 and the Queensland Floods 2010-11, which caused significant loss of life, losses across multiple sectors (including mining and agriculture), and damage to countless homes and properties. With the severity and frequency of natural disasters expected to increase (Kitching et al., 2014), there is growing academic and policy effort towards better understanding: the risks such disasters pose on Australian communities; the impacts they have on different industry sectors and community groups; and the role that disaster risk reduction can play in minimising such impacts and building disaster resilience.

Estimating the total economic costs of natural disasters can be difficult, owing to the lack of complete and systematic data, conceptual difficulties (Kousky 2014) and divergent predictions from growth theory about the effects of natural disasters on economic growth (Loayza et al. 2012). While the literature is inconclusive, with some studies reporting negative effects and others positive or insignificant effects (Loayza et al., 2012), a recent meta-analysis of the literature showed evidence of negative impacts in terms of 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).

There is also evidence of distributional effects. Economic and human losses shown to be more pronounced in poorer countries (Schumacher & Strobl 2011), and institutional factors and educational attainment levels found to be important determinants that influence resilience and recovery (Kousky 2014; Felbermayr & Gröschl, 2014). Economic diversity also matters. Relying on a single economic sector for income heightens community vulnerability and elongates disaster recovery time compared to diversified economies (Cutter et al. 2008). The type and interlinkages of economic sectors also play a significant role. Due to its land-intensive nature, the agricultural sector is often adversely affected (FAO 2015). Locally, a study of major Victorian bushfires found that industries most susceptible to direct or indirect impacts are the Agriculture, forestry and fishing sector and retail trade (Stephenson 2010). Conversely, the construction sector may experience a boom in the immediate aftermath of the disaster as households redirect expenditure towards rebuilding that they otherwise would've deferred, only to experience a lull in the next few years once that expenditure subsides (Kousky 2014). Even with a diversified economy structure, the interdependence of sectors can have knock-on effects (Yu et al. 2014).

Thus, industries more heavily reliant on inputs from the agricultural sector are likely to experience adverse effects to their production. While these broader examinations are useful, aggregated numbers can mask very large distributive impacts, as the typical instruments used (GDP and aggregated consumption) can be misleading measures of actual welfare losses (Hallegatte 2014). What's missing is a systematic understanding of how these broader economic impacts of natural disasters translate to the individual level vis-à-vis income effects; how long these effects persist; and which individuals within the community bear the brunt of these costs. Indeed, regardless of a country's economic development, a lower socio-economic status has been consistently associated with greater post-disaster hardship (Norris et al. 2002), with the poor suffering significant disaster losses due to lower financial capacity and limited access to public and private (e.g. insurance) recovery assets (Blaikie et al. 1994; Gladwin & Peacock 1997). For example, while storm damage from Hurricane Katrina was uniform across demographic groups, it was lower income individuals who were less likely to have evacuated or cover for flood insurance (Masozera et al. 2007). Many other known vulnerabilities to disasters, such as being female, old age, or with lower educational attainment (McKenzie & Canterford 2016), are highly correlated or interdependent with income.

The link between income and disasters also extends to 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 (Gibbs et al. 2016). Thus quantifying the effects of disasters based on these social and economic dimensions can help policymakers better target and evaluate disaster mitigation recovery programs.

To that end, our research program explores the impact of a number of Australian natural disasters, of various types (fires,

flood and cyclone), scales (small, large), and locational settings (regional, metropolitan) on the disaster-hit individuals' economic resilience (measured through their income stream). It disaggregates these impacts on individuals based on who they are (their demographic attributes), if they work (unemployed, employed), how much they work (part-time, full-time) and the industries they work for.

This paper investigates the income effects of the 2009 Toodyay bushfire on the income trajectory of residents of Toodyay – a small regional town in Western Australia with a population of 4,450 around the time of the bushfire. The fire conditions were some of the worst seen in Western Australia at the time, and burnt around 2,900 hectares, the equivalent of 2% of the Shire of Toodyay's total area. While no casualties were reported, the total cost of damages was estimated at \$100 million (FESA 2010b).

From a policy perspective, this paper contributes to a greater understanding of the potential economic effects of natural disasters on individuals and communities living in regional towns within Australia (Figure 1). Toodyay is fairly typical of such small, regional Australian towns, having an ageing population within the 1,000–4,999 population range, and an economy historically linked to agriculture, mining and manufacturing; industries which are known to be sensitive to natural disasters (Ulubasoglu et al. 2019). Such towns (~1,700 in 2016) form 9.7% of Australia's population and are mostly concentrated around Australia's eastern seaboard (ABS, 2018).

For Western Australia in particular, it is expected that agricultural businesses in currently marginal areas, such as the Wheatbelt region (in which Toodyay is located) are most at risk from climate change (Sudmeyer et al. 2016), and so deserve particular attention when considering disaster resilience in the state.

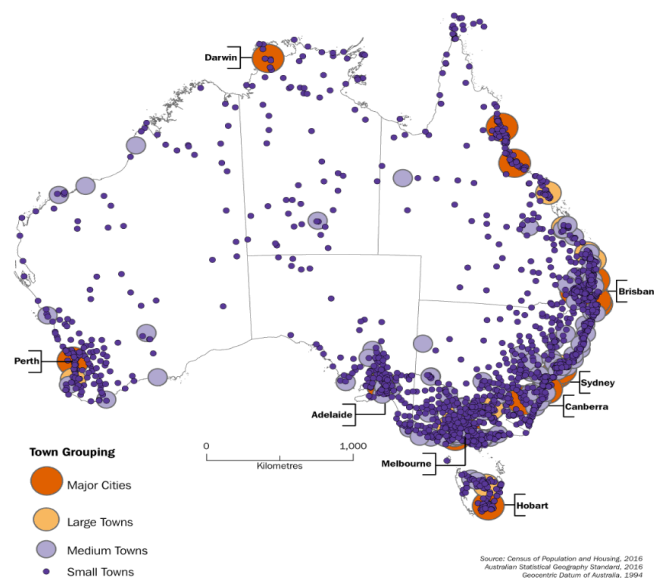


Figure 1: Australian towns, by population size groupings 2016. Source: Australian Bureau of Statistics 2018.

The rest of this paper is organised as follows. We set the scene by providing an overall socioeconomic profile of Toodyay and contextual information on the Toodyay fires 2009. We then outline our methodology, incorporating our sample construction and descriptive statistics. Following our results, we offer conclusions on how this study can be utilised to inform disaster mitigation and recovery activities.

Toodyay profile

Socioeconomic profile

Toodyay is a regional town located in the northern Wheatbelt region of Western Australia, approximately 80km North/East of the state capital Perth. It is characterised by agricultural activities and low population density, with 2.7 persons per square kilometre.

Toodyay has a small population, which grew from 4,330 in 2006 to 4,707 in 2013, before declining to 4,500 in 2016,

placing it within the ~1,700 small towns scattered across Australia. The population is relatively older and ageing – Toodyay’s median age reached 51 years in 2016, with the share of residents aged 65 or older increasing from 12.8 per cent to 23.3 per cent over the decade.

Since 2006-07, there have around 400 businesses on average located in the Shire of Toodyay (Figure 2). A significant share of these businesses are non-employing (i.e. either sole-proprietorships or partnerships with no employees; Figure 3), and are mostly concentrated in the agricultural and construction sectors (Figure 4). Owing to this, over 60% of Toodyay’s employed residents typically work outside the Toodyay Shire (Figure 5), mostly in Perth (~28%) and neighbouring Northam (~16%).

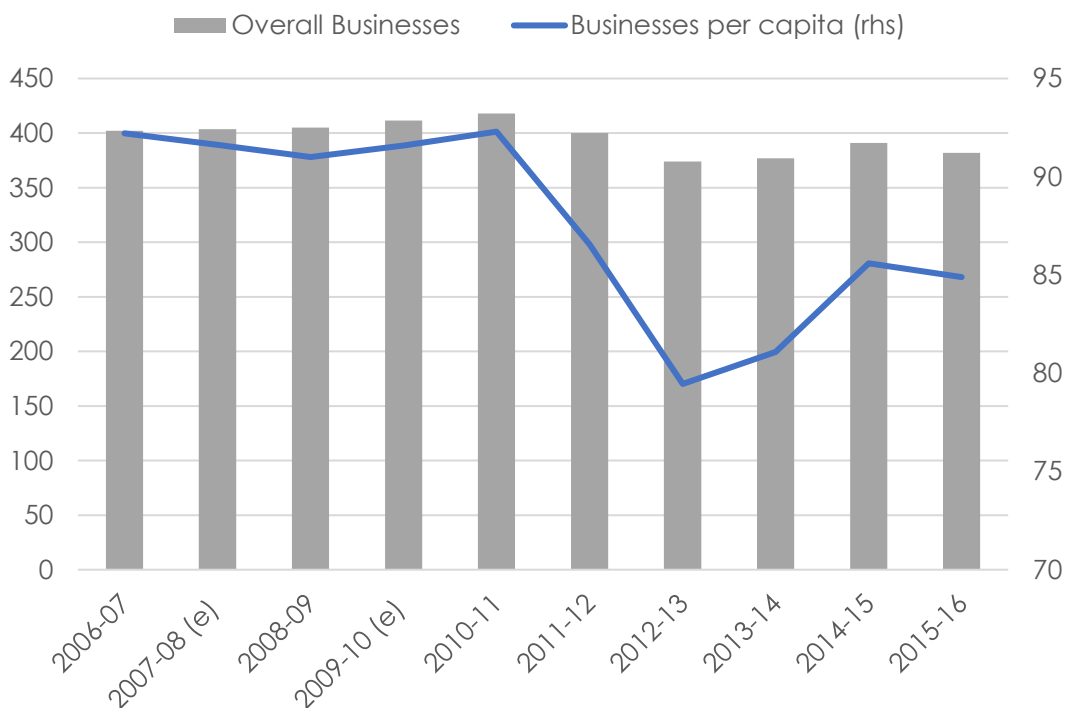


Figure 2: Toodyay Shire businesses, overall and per 1000 persons. Source: ABS, CAT 3218.0 Regional Population Growth; ABS, CAT 8165.0 Counts of Australian Businesses, including Entries and Exits.

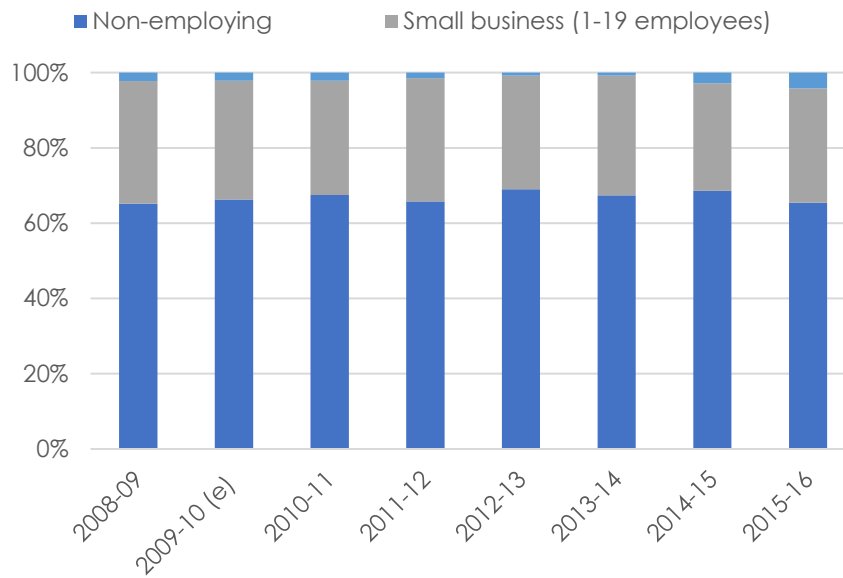


Figure 3: Toodyay Shire businesses, overall and per 1000 persons. Source: ABS, CAT 8165.0 Counts of Australian Businesses, including Entries and Exits.

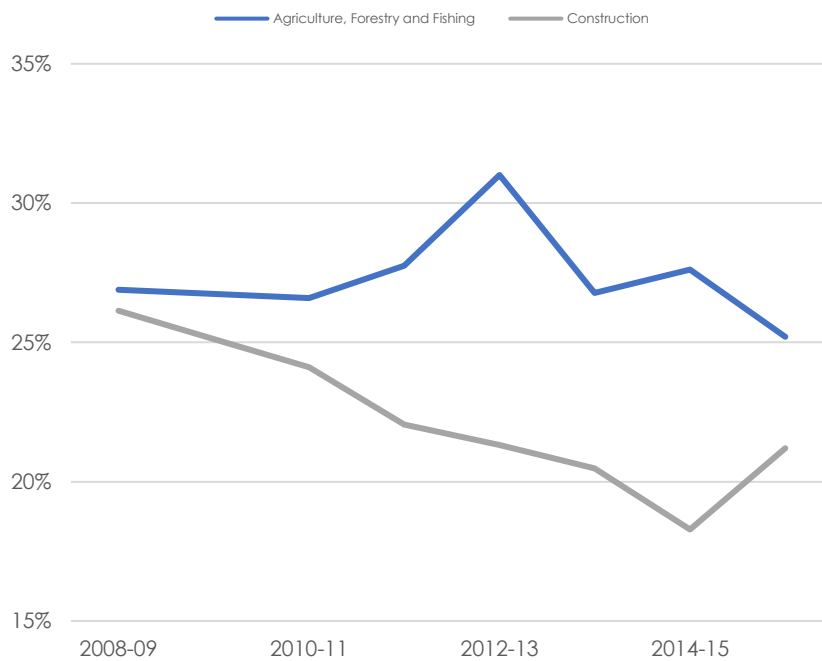


Figure 4: Toodyay Shire non-employed agricultural and construction businesses (% of total non-employed). Source: ABS, CAT 8165.0 Counts of Australian Businesses, including Entries and Exits.

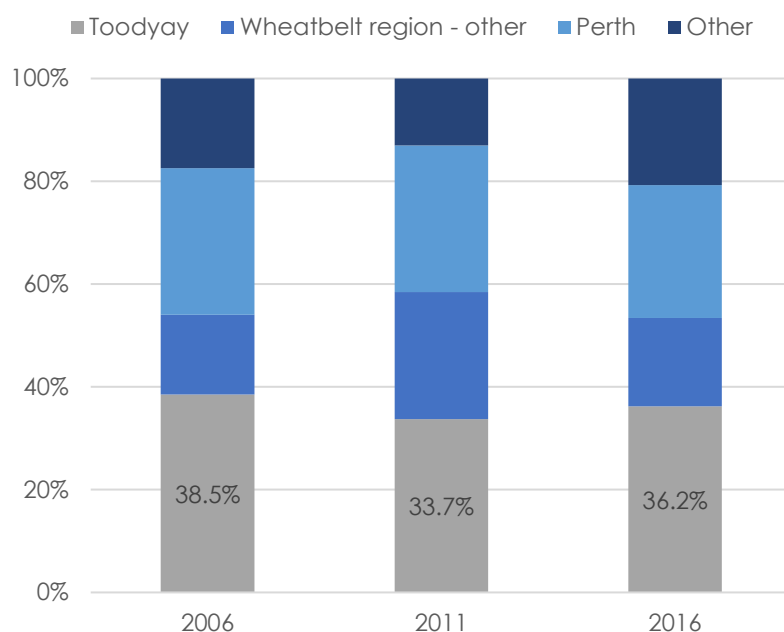


Figure 5: Toodyay Shire residents place of work (%). Source: ABS Census of Population and Housing (2006, 2011, 2016) (Usual Residence Data) retrieved via Table builder. Figure 5 excludes Place of Work “Not Stated” Or “Not Applicable”.

Top 5 Industries of Employment	2001	2006	2011	2016	2001-2016	
					Trendline	Annualised Δ
Toodyay						
Agriculture, forestry and fishing	12.56%	11.10%	7.73%	7.69%		-3.22%
Construction	10.22%	10.97%	10.81%	9.84%		-0.25%
Manufacturing	9.16%	8.17%	6.28%	5.88%		-2.91%
Health care and social assistance	9.01%	9.48%	11.40%	10.06%		0.74%
Public administration and safety	8.52%	8.04%	8.60%	9.89%		1.00%
Retail trade	8.02%	9.10%	9.53%	7.86%		-0.14%
Education and training	7.45%	8.35%	8.02%	8.42%		0.82%
Mining	1.99%	3.62%	6.22%	8.59%		10.25%
Wheatbelt region						
Agriculture, forestry and fishing	29.19%	25.70%	20.28%	20.78%		-2.24%
Retail trade	9.25%	10.01%	9.54%	8.82%		-0.31%
Education and training	7.78%	8.00%	8.54%	8.97%		0.96%
Health care and social assistance	7.19%	8.36%	9.21%	10.02%		2.24%
Construction	6.33%	7.03%	8.28%	7.72%		1.34%

Figure 6: Top 5 industries of employment 2001-2016. Source: ABS Census of Population and Housing (2006, 2011, 2016) (Usual Residence Data). Generated 17 December 2018 using Australian Bureau of Statistics Table Builder.

More broadly, and compared to the Wheatbelt region, Toodyay's overall employed workforce has seen a greater shift away from manufacturing and the agricultural sector, which dropped from the largest employer in 2001 and 2006, to become the sixth largest employing industry in 2016 (Figure 6). Health care and social assistance became the top employer in 2011, while mining also exhibited the strongest gain, most notably over the 2011-2016 period. Based on ABS Census data (at the SA2 level), the top 5 employing industries have typically accounted for 49 per cent of employment. While the overall rankings are different, the common top industries of employment between 2001 and 2016 were Health care and social assistance and Construction.

Toodyay fires 2009

The 29 December 2009 Toodyay Bushfires burnt around 2,900 hectares, the equivalent of 2% of the Shire of Toodyay's total area. According to 2008-09 ABS estimates, 4,450 residents and 405 businesses would have been residing/located within the Shire at the time of the fires.

The fire conditions were some of the worst seen in Western Australia at the time. The total cost of damages was estimated at \$100 million (FESA 2010b), though no breakdown is

provided. The fire's ignition point was close to the urban interface, destroying 38 houses and damaging over 170 properties (FESA 2010a; FESA 2010c). Some of the properties lost were holiday or second homes (Barnett 2010). One-thirds of affected residents did not have adequate insurance (Parliament of Western Australia 2010). The fires caused material damage to the agricultural sector. 18 cows (Lampathakis 2011) and 100 sheep were killed (FESA 2010b), with damage to 20 sheds, fencing, farming machinery, crops, orchards, vineyards, dairies and olive groves (Moylan, 2010). There was also considerable damage to electricity distribution lines, with repair and restoration of public assets totalling around \$443,000. While costly, the Toodyay fire was relatively small (FESA, 2010a), with no fatalities and only 4 injuries recorded (FESA 2010b).

The Toodyay fire was declared a natural disaster, with Category A and B assistance provided by the Federal Government totalling \$1.7 million. Over half of this assistance was provided within six months of the disaster (Table 1).

Apart from the federal assistance, the State Government, in conjunction with Western Energy, announced a \$10 million financial assistance package for affected individuals on 11 October 2010 (Table 2).

Table 1: Federal Government Assistance (NDRRA).

NDRRA Measure	2009-10	2010-11	2011-12	Total
Category A assistance	\$ 299,285	\$ 139,065	\$ 208,414	\$ 646,764
Emergency Food, Clothing or Temporary accommodation	\$ 2,343	\$ 37,431	\$ 3,065	\$ 42,839
Removal of debris from residential properties	\$ 170,699	\$ 3,880	\$ 29,228	\$ 203,807
Counter Disaster Operations assistance to individuals	\$ 87,593	\$ 32,478	\$ 11,477	\$ 131,548
Personal and financial counselling	\$ -	\$ 616	\$ 3,247	\$ 3,863
Extraordinary costs of delivering Category A assistance	\$ 38,650	\$ 64,660	\$ 161,397	\$ 264,707
Category B assistance	\$ 646,205	\$ 370,878	\$ 46,370	\$1,063,453
Restoration or repair of essential public asset	\$ 131,452	\$ 311,392	\$ —	\$ 442,844
Counter Disaster Operations assistance to the general public	\$ 514,753	\$ 59,486	\$ 46,370	\$ 620,609
Annual totals	\$ 945,490	\$ 509,943	\$ 254,784	\$1,710,217

Source: DFES, supplied.

Table 2: Toodyay Financial assistance package. Source: Barnett (2010).

Category	Description	Maximum payment	
Residential buildings	Established homes which were damaged or destroyed	\$ 150,000	
External Structures	Sheds, fences and other external structures	\$ 15,000	
Site Clean-up	Cost of site clean-up and rubbish removal	\$ 5,000	
Home Contents	Home contents	\$ 30,000	
Tools of Trade	items used for employment purposes (tools and equipment)	\$ 5,000	
Private Motor Vehicles	private motor vehicles including cars, motor homes and motorbikes.	\$ 10,000	\$190,000 total payment for each property

Table 3: Toodyay bushfire disaster assistance.

Assistance	Total allocated	Total distributed			As at October 2012
		2009/10	2010/11	2011/12	
NDRRA (a)	\$ 1,710,217	\$945,490	\$509,943	\$254,784	\$1,710,217
Toodyay Financial Assistance Package (b, c)	\$10,000,000	—	\$4,084,280	—	\$4,084,280
Lord Mayor Disaster Relief Fund - Toodyay Bushfires (d)	\$193,000	\$193,000	—	—	\$193,000
Salvation Army Toodyay Bushfire Appeal (e)	\$1,626,000	\$1,100,000	\$526,000	—	\$1,626,000
Western Power settlements (f)	\$3,000,000	—	—	—	< \$ 3,000,000
Total	\$16,529,217	\$2,238,490	\$5,120,223	\$254,784	~\$10,612,497

Source: (a) DFES, supplied; (b) Barnett, 2010; (c) Parliament of Western Australia 2011; (d) Lord Mayor Disaster Relief Fund, 2010; (e) Salvation Army, 2010; (f) Parliament of Western Australia 2012.

It is noted that the payments were provided regardless of insurance cover (Parliament of Western Australia, 2010) and were directed at assisting with residential rather than commercial losses. The first payments were reported in December 2010 (Farm Weekly, 2010), with less than half of the funds paid as at 24 October 2012 (Parliament of Western Australia, 2012). Combined with public bushfire appeals and Western Power settlements, monetary assistance for the Toodyay bushfires totaled \$16.5 million, with up to \$10.6 million distributed as at October 2012 (Table 3).

Methodology

At its core, the research aims to determine the disruptive effects a natural disaster has on an individual's income trajectory. We use a statistical technique called difference-in-differences (DID) model to analyse the Toodyay fire's effect on

the income of individuals in the workforce who would have been residing in Toodyay at the time of the fires. The model mimics experimental research design by comparing the differential effect of a treatment (i.e. natural disaster) on a 'treatment group' versus a 'control group'. It calculates the effect of this treatment on an outcome (individual income) by comparing the differences in average changes over time between the treatment and control groups (hence difference-in-differences).

We exploit the rich individual-level Australian Census Longitudinal Dataset (ACL) available through ABS Datalab which allows us to explore the heterogenous effect of the disaster and provides a convenient 'baseline' (2006) and 'end-line' (2011) surveys for our DID design. As we're interested in impacts on income, we refine our sample to incorporate only Toodyay residents who were in the labour force and reported non-negative income (n=889).

We further restrict our sample to those who did not move between the census years (non-movers; n=447). This is because, in the absence of a full analysis of the migration decisions (which is difficult with the ABS Census being conducted only once every five years), we cannot understand what motivated this movement and what happened to movers.

We compare the difference in incomes of the Toodyay residents (treatment group) and two of its immediate neighbours (Northam and Chittering) as our control group, as their socio-economic characteristics closely resemble those of Toodyay, thus meeting a necessary condition of this model, and enabling us to pinpoint any bushfire-driven effects. Added to the overall income effects, we further explore four key dimensions across which one might expect to observe differences in impact of the fire on individuals:

- gender
- income level
- education
- age.

While our model usually disaggregates sectoral and demographic effects, Toodyay's small population constrained the sample size, making it difficult to achieve statistical power and limiting what we could report on for ABS confidentiality reasons. The small, regional nature of Toodyay is challenging for statistical computations as the non-mover sample size is less than 1000, meaning that achieving statistical power will be difficult. The small sample size also meant that not all variables could be reported due to ABS confidentiality constraints. For these reasons, analysis was limited to demographic attributes that had a sample size of 200 or greater (represented by the horizontal blue line in Figure 7) and met ABS confidentiality constraints. Unfortunately, these restrictions meant that we could not disaggregate at a sectoral level (i.e. by an individual's industry of employment), which we have done for other case studies in our research program.

We present the descriptive statistics for our non-mover sample in Tables 4 and 5.

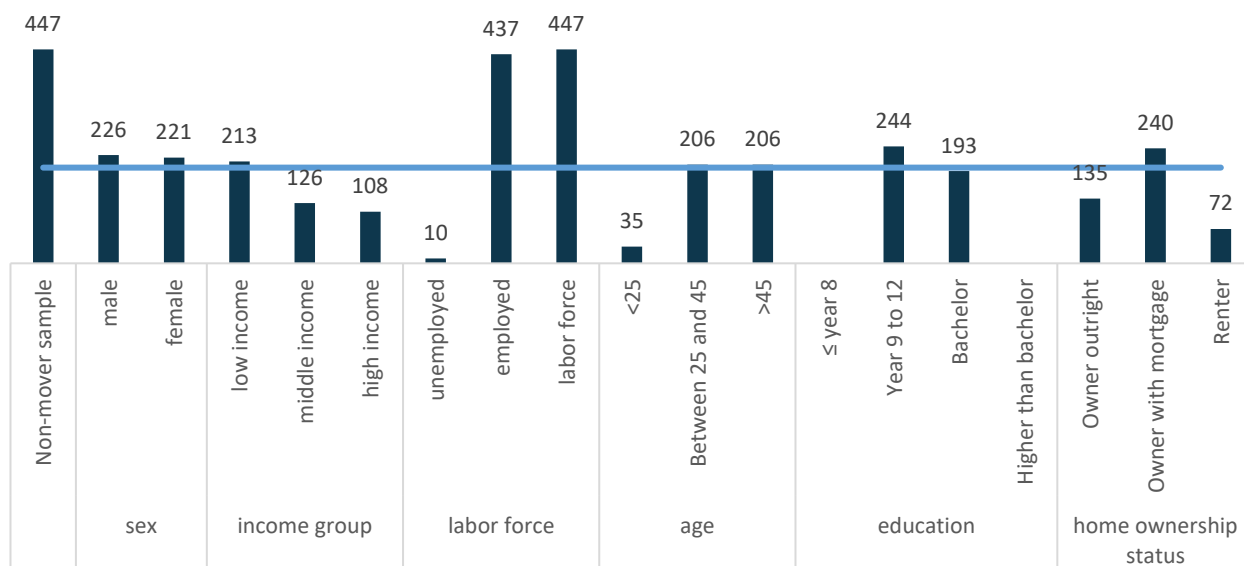


Figure 7: Toodyay non-mover sample sizes (no.), by demographic attributes.

Table 4: Non-mover sample summary statistics (2006).

	(1) Toodyay			(2) Control			(3) Non-mover sample		
	mean	median	std. dev.	mean	median	std. dev.	mean	median	std. dev.
Income	\$38,070	\$36,400	\$25,056	\$38,298	\$36,400	\$24,733	\$38,204	\$36,400	\$24,840
Age	39.4	41.0	11.7	38.7	41.0	12.2	39.0	41.0	12.0
education level									
year 8 or lower	0.000	0.000	0.000	0.010	0.000	0.101	0.006	0.000	0.078
year 9 to 12	0.460	0.000	0.500	0.555	1.000	0.498	0.516	1.000	0.500
bachelor degree	0.470	0.000	0.500	0.377	0.000	0.485	0.414	0.000	0.493
higher than bachelor degree	0.141	0.000	0.349	0.099	0.000	0.300	0.116	0.000	0.321
employment status									
unemployed	0.046	0.000	0.209	0.034	0.000	0.182	0.039	0.000	0.193
employed	0.955	1.000	0.209	0.966	1.000	0.182	0.961	1.000	0.193
home ownership status									
owned outright	0.232	0.000	0.423	0.243	0.000	0.430	0.239	0.000	0.427
owned with mortgage	0.429	0.000	0.496	0.548	1.000	0.499	0.500	0.500	0.501
rented	0.293	0.000	0.456	0.158	0.000	0.365	0.212	0.000	0.409

Results

Overall results

We find that the Toodyay disaster did not adversely affect the overall income trajectory of workforce residents within Toodyay; i.e. the difference in incomes of the bushfire-hit residents and our control groups is not significant (Table 6).

While this is likely due to our small sample size (n=447), we note that the fire was relatively small and quickly contained (2% share of burnt area). This is in contrast to another regional bushfire study of the Victorian BSB which occurred over a longer period (7 February – 14 March 2009), with the share of burnt area ranged from 0.1 to 72.2 percent, and for which we found significant and persistent negative effects on the overall income trajectories of individuals residing within the bushfire-hit areas (Ulubasoglu 2019).

From our profiling of the fire and demographic profiling of the Toodyay region, we note that the degree of economic exposure and speed of recovery activities are likely to have also influenced economic resilience to the fire:

- Recovery assistance: Combined with public bushfire appeals and Western Power settlements, available monetary assistance for the Toodyay Bushfires

totaled \$16.5 million, with up to \$10.6 million distributed as at October 2012

- Degree of economic exposure: With a significant number of non-employing local businesses, employed residents mostly work outside Toodyay. This fact, and the historical shift away from disaster-sensitive industries like agriculture naturally limits the fire’s effect on the overall income trajectory
- Speed of recovery activities: Compared to bushfires with significant effects (e.g. VIC Black Saturday bushfires), the Toodyay fire was relatively small and quickly contained (14 hours), with 29% of public assistance distributed within first three months.

Thus while individuals, particularly sole traders, within this community may have suffered significant income losses, this does not appear to have translated into any persistent changes to the income trajectory of the broader Toodyay community (in comparison to our control groups).

Arguably, Toodyay residents’ continued access to neighbouring unaffected areas they were economically dependent on is likely to have significantly contributed to reducing or eliminating any persistent income losses they could have experienced. This also has an added and material benefit: 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 (Gibbs et al. 2016).

Table 5: Non-mover sample summary statistics (2011).

	(1) Toodyay			(2) Control			(3) Non-mover sample		
	mean	median	std. dev.	mean	median	std. dev.	mean	median	std. dev.
income	\$41,458	\$40,610	\$25,722	\$41,603	\$40,610	\$25,704	\$41,553	\$40,610	\$25,679
age	361.6	53.0	451.9	45.0	47.0	11.3	184.6	49.0	338.5
education level									
year 8 or lower	0.005	0.000	0.068	0.015	0.000	0.120	0.010	0.000	0.101
year 9 to 12	0.569	1.000	0.496	0.562	1.000	0.497	0.565	1.000	0.496
bachelor degree	0.495	0.000	0.501	0.518	1.000	0.501	0.508	1.000	0.500
higher than bachelor degree	0.120	0.000	0.326	0.113	0.000	0.317	0.116	0.000	0.321
employment status									
unemployed	0.046	0.000	0.211	0.033	0.000	0.179	0.039	0.000	0.193
employed	0.954	1.000	0.211	0.967	1.000	0.179	0.961	1.000	0.193
home ownership status									
owned outright	0.245	0.000	0.431	0.234	0.000	0.424	0.239	0.000	0.427
owned with mortgage	0.482	0.000	0.501	0.515	1.000	0.501	0.500	0.500	0.501
rented	0.208	0.000	0.407	0.215	0.000	0.412	0.212	0.000	0.409

Figures based on use of Australian Bureau of Statistics Microdata.

Table 6: Impact of Toodyay Bushfires on individual income trajectory.

	(1) Non-mover sample
post × D	0.1281 (0.2077)
Observations	447
R-squared	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 based on use of Australian Bureau of Statistics Microdata.

Demographic results

Turning to our demographic modelling, while our point estimates suggest that we have some heterogeneities, their standard errors are high due to the small sample size (n=447). As such, we do not report these point estimates.

Nevertheless, the signs of the point estimates are likely to inform us about the potential impacts of the bushfire on different groups within the Toodyay community had the sample size been larger. Here, we do find some differences between these demographic groups, which largely coincide

with our observations in other case studies within our research program:

- Gender: Males experienced some income increase, while women’s income changes were close to zero. This is a similar pattern to our Victorian BSB case study, where we found females lost on average (-7%), whereas the income trajectory of males was not affected (Ulubasoglu 2019).
- Income group: Low-income individuals also experienced some income decrease, consistent with results obtained in the Victorian BSB case study (Ulubasoglu 2019).

- Education: Another group that seems to have lost is those with high school education only, whereas those with a university degree seem to have experienced some positive income change.

These groups largely coincide with those noted in the literature as being more vulnerable to natural disasters (McKenzie & Canterford 2016) and are likely to be more sensitive to disruptions in income-generating activities, particularly if they are working in part-time or seasonal occupations in the agricultural sector. Unfortunately, due to the small sample size and confidentiality constraints, we are unable to explore sectors of employment to determine this.

Conclusions

Overall, we find that the Toodyay fires did not have a significant effect on the income trajectory of individuals residing in Toodyay who were in the labour force in 2006 and did not move between the census years, largely due to sample size limitations, noting that there was also significant public assistance provided.

While the large standard errors mean we cannot report point estimates, the signs of the point estimates inform us that there are likely to be heterogeneous impacts on different demographic groups, with females, low-income individuals, and those with lower education levels (high school only) relatively more disadvantaged than others within their demographic groupings. These patterns not only coincide with our other regional bushfire case study (Victorian Black Saturday Bushfires 2009), but also with groups noted in the literature as being more vulnerable to natural disasters (Masozera et al. 2007; McKenzie & Canterford 2016). These results are therefore informative for policymakers interested in better understanding the distributive effects of disasters.

From the literature we know that limiting the longevity of income disruptions post-disasters is incredibly important for the mental health of individuals within disaster-affected communities (Gibbs et al. 2016). From our demographic profiling, we observed that a significant number of Toodyay residents commuted to Perth and neighbouring areas for work, which likely helped mitigate overall income losses. Ensuring that these areas remain/are quickly made accessible to community members if such disasters were to strike is critical not only for survival, but also for their longer-term health and economic prosperity.

For regional communities in particular, where there are challenges in obtaining sufficient sample size for statistical computations, our study reveals that detailed demographic profiling, using publicly available data, could be undertaken as part of disaster risk reduction exercises to help policy makers build disaster resilience and better direct post-recovery interventions to minimise disruptions to important income streams.

Acknowledgements

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