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# Natural disasters and financial stress in agricultural areas

Robert Breunig\*, Ben Edwards\*\*, Syed Hasan\* and Boyd Hunter\*

\* Australian National University, Canberra

\*\* Australian Institute of Family Studies (AIFS), Melbourne

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# Outline

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# BACKGROUND

## Natural disasters

- ▶ we look specifically at extreme weather events
- ▶ regularly occur in OECD and other countries
- ▶ some evidence that the number of extreme weather events has risen recently around the globe
- ▶ likely to increase further with increasing concentration of greenhouse gases

## Natural disasters: consequence

- ▶ substantial negative economic impacts
  - ▶ e.g., drought in 2012 in US costs \$75 – 150 billion
  - ▶ may negatively affect economic status of agricultural households
  - ▶ may also affect income of other households in affected areas (Edwards et al. 2009, Alston and Kent 2004)
- eventually lead to financial stress to related households

## Financial stress

- ▶ represents the strain in a household associated with either
    - ▶ a lack of financial resources or
    - ▶ an inability to manage the resources available
  - ▶ can be a precursor of poverty
  - ▶ but does not necessarily reflect all welfare considerations
  - ▶ initial concept developed in Townsend (1979)
- ← different concept than income poverty

# DATA

## 2007 Rural and Regional Families Survey (RRFS)

- ▶ conducted by AIFS – Australian Institute of Family Studies
  - ▶ to investigate the impact of drought and other weather patterns on families living outside Australia's major cities
  - ▶ fieldwork conducted between Sep. and Dec. 2007
- during which there were localities experiencing some type of drought in all states and the Northern Territory
- ▶ frame for the survey was the 2001 Australian census

## 2007 RRFS (contd.)

- ▶ based upon rainfall deficiency in 3 years prior to April 2007
- SLAs were stratified into four categories (severe drought; moderate drought; average rainfall; above-average rainfall)
- households were selected at random within each of the four strata
- ▶ used computer-assisted telephone interviewing (CATI)
- ▶ employed random digit dialling into eligible postcodes
- ▶ cooperation rate – 27%

## Sample restrictions

- ▶ total sample size of 2007 RRFS – 8,000 households
- spread across Australia except the ACT
- ▶ this analysis dropped
  - ▶ 1,676 observations with missing household income data
  - ▶ 109 households – sole representative of their postcode
  - ▶ 13 households with missing data on financial difficulty

## Types of households

- ▶ farming household
  - if at least one household member is engaged in farming
- ▶ non-farming agricultural household
  - if not a farming household but any member was employed in agriculture (farm manager/worker) or a service industry related to agriculture
- ▶ non-agricultural households
  - if no household member is engaged in farming or employed in agriculture or a related service industry

Table 1: Composition of the analysis sample

Household type	Severe drought	Moderate drought	Below avg. rainfall	Above avg. rainfall	Total
<b>Agricultural</b>					
Farming	188 12%	200 13%	196 13%	150 9%	734 12%
Non-farming	219 14%	242 16%	246 16%	308 19%	1015 16%
<b>Non-agricultural</b>	1131 74%	1114 72%	1056 70%	1152 72%	4453 72%
Total	1538	1556	1498	1610	6202

*Note:* Percentages in table are proportion of column totals.

## Types of financial stress

Respondents were asked if in the last 12 months, because of a shortage of money, they suffer from

1. difficulty paying bills
2. failed to pay mortgage or rent on time
3. asked friends/family for help
4. going without meals,
5. pawning something
6. asking for help from welfare organisations

## **Types of financial stress (contd.)**

- ▶ positive responses for any of 1-3 – cashflow difficulty
- ▶ positive responses for any of 4-6 – hardship
- ▶ positive response for at least one – any financial stress
- ▶ Also asks respondents whether the household would be able to raise \$2,000 within one week for an emergency

Table 2: Proportion of financial difficulty by type of survey households

	Household type			
	Farm	Non-farm agri.	Non-agri.	All
Suffering from cashflow problem	0.26 (0.44)	0.28 (0.45)	0.21 (0.41)	0.23 (0.42)
Suffering from hardship	0.26 (0.44)	0.15 (0.35)	0.11 (0.32)	0.14 (0.34)
Suffering from any financial stress	0.37 (0.48)	0.32 (0.47)	0.24 (0.43)	0.27 (0.44)
Could not raise \$2000 for an emergency	0.13 (0.34)	0.19 (0.39)	0.21 (0.40)	0.19 (0.40)

Table 2a: Proportion of survey respondents by type of cashflow problem

	Household type			
	Farm	Non-farm agri.	Non-agri.	All
Felt difficulty paying bills	0.19 (0.39)	0.21 (0.41)	0.15 (0.36)	0.16 (0.37)
Could not pay mortgage or rent on time	0.09 (0.28)	0.08 (0.28)	0.06 (0.23)	0.06 (0.25)
Asked for financial help from friends/family	0.11 (0.31)	0.16 (0.36)	0.12 (0.32)	0.12 (0.33)
Suffering from cashflow problem	0.26 (0.44)	0.28 (0.45)	0.21 (0.41)	0.23 (0.42)

Table 2b: Proportion of survey respondents by type of hardship

	Household type			
	Farm	Non-farm agri.	Non-agri.	All
Pawned or sold something	0.18 (0.38)	0.09 (0.29)	0.06 (0.24)	0.08 (0.27)
Went without meals	0.03 (0.17)	0.03 (0.17)	0.04 (0.19)	0.04 (0.19)
Asked for help from welfare/comm. org.	0.11 (0.31)	0.05 (0.22)	0.05 (0.21)	0.06 (0.23)
Suffering from hardship	0.26 (0.44)	0.15 (0.35)	0.11 (0.32)	0.14 (0.34)

## Natural disaster type

- ▶ This analysis considered three different types of natural disasters which are regular phenomena in Australia
  1. droughts
  2. bushfire and
  3. floods/cyclones
- ▶ we construct a measure of incidence based upon subjective responses from the survey
- ▶ additionally used an objective measure for drought using information from the Bureau of Meteorology (BOM)

Table 3: Disaster prevalence (frequency) with different definitions

	Individual responses	Community level measure	BOM definition
Drought	4,803 (0.77)	4,812 (0.78)	2,747 (0.44)
Bushfire	1,248 (0.20)	682 (0.11)	
Flood & cyclone	826 (0.13)	580 (0.09)	
N	6,202	6,202	6,202

## Independent variables

- ▶ summary statistics for the independent variables in Table 4
- ▶ farm households are more likely to suffer from drought

Table 4: Summary statistics- independent variables

	Household type			
	Farm	Non-farm agri.	Non-agri.	All
Annual household income	80,653 (76,119)	75,010 (49,035)	59,042 (47,726)	64,213 (52,761)
Household size	3.26 (1.46)	3.34 (1.53)	2.53 (1.35)	2.75 (1.44)
No. of adults	2.32 (0.82)	2.32 (0.93)	1.97 (0.78)	2.07 (0.83)
Parenting household	0.44 (0.50)	0.50 (0.50)	0.29 (0.45)	0.34 (0.47)
Married/defacto	0.84 (0.36)	0.80 (0.40)	0.66 (0.47)	0.71 (0.45)
Remote areas household	0.24 (0.42)	0.21 (0.40)	0.19 (0.39)	0.20 (0.40)
Inner regions household	0.18 (0.39)	0.25 (0.43)	0.28 (0.45)	0.26 (0.44)
Drought believed by 50%+	0.84 (0.37)	0.80 (0.40)	0.76 (0.43)	0.78 (0.42)
Bushfire believed by 50%+	0.10 (0.30)	0.08 (0.28)	0.12 (0.32)	0.11 (0.31)
Flood or cyclone believed by 50%+	0.06 (0.24)	0.09 (0.29)	0.10 (0.30)	0.09 (0.29)
N	734	1,015	4,453	6,202

# ESTIMATION AND METHODOLOGY

## Modeling issues

- ▶ financial stress (FS) is negatively associated with household income (Table 5)
  - ▶ FS is positively associated with household size (Table 6)
  - ▶ both are crucial in modeling the welfare of a household
- employed interaction of household income and household size with other independent variables

Table 5: Financial stress at different quintiles of household income

Stress type	Quintile					All
	1	2	3	4	5	
Suffering from cashflow problem	0.28 (0.45)	0.28 (0.45)	0.25 (0.43)	0.21 (0.41)	0.11 (0.32)	0.23 (0.42)
Suffering from hardship	0.22 (0.41)	0.18 (0.39)	0.14 (0.34)	0.10 (0.29)	0.06 (0.24)	0.14 (0.34)
Suffering from any financial stress	0.35 (0.48)	0.34 (0.47)	0.29 (0.46)	0.25 (0.43)	0.14 (0.35)	0.27 (0.44)
N	1,172	1,178	1,258	1,322	1,272	6,202

Table 6: Financial stress at different household size

Stress type	Household size					All
	1	2	3	4	4+	
Suffering from cashflow problem	0.21 (0.41)	0.16 (0.37)	0.29 (0.45)	0.28 (0.45)	0.31 (0.46)	0.23 (0.42)
Suffering from hardship	0.14 (0.35)	0.11 (0.31)	0.15 (0.36)	0.16 (0.37)	0.18 (0.39)	0.14 (0.34)
Suffering from any financial stress	0.25 (0.43)	0.20 (0.40)	0.32 (0.47)	0.34 (0.47)	0.35 (0.48)	0.27 (0.44)
N	1,066	2,406	900	1,058	772	6,202

## Empirical Model

- ▶ follows Breunig and Cobb-Clark (2006) and Cobb-Clark and Ribar (2012) to model the propensity to report difficulty

$$\begin{aligned} & Prob(difficulty = 1 | \ln(y), \ln(hhsize), \mathbf{Z}) \\ & = F(\beta_1 + \beta_2 \ln(y) + \beta_3 \ln(hhsize) + \mathbf{Z}'\hat{\alpha}_1 + \\ & \quad \ln(y) * \mathbf{Z}'\hat{\alpha}_2 + \ln(hhsize) * \mathbf{Z}'\hat{\alpha}_3) \end{aligned} \quad (1)$$

- ▶ where  $y$  — annual household income
- ▶  $hhsize$  – household size and

$$\mathbf{Z} \left\{ \begin{array}{l} =1 \text{ if farming household} \\ =1 \text{ if non-farming, agricultural household} \\ =1 \text{ if kids present in household} \\ =1 \text{ if couple-headed household} \\ =1 \text{ if household lives in drought-affected area} \\ =1 \text{ if remote household} \end{array} \right.$$

## Empirical Model (contd.)

- ▶ We are interested to estimate an equivalence scale,

$$e_s = \hat{y}_s / y_{ref} \quad (2)$$

- ▶ where, ref and s indicates reference type and size s household, respectively
- ▶ We can solve for  $\hat{e}_s$  by solving for  $\hat{y}_s$  from:

$$\begin{aligned} & \frac{1}{n} \sum_{i=1}^n F(\hat{\beta}_1 + \hat{\beta}_2 \ln(y_{ref}) + \hat{\beta}_3 \ln(hhsize_{ref}) + \mathbf{Z}'_{ref,i} \hat{\alpha}_1 + \\ & \quad \ln(y_{ref}) * \mathbf{Z}'_{ref,i} \hat{\alpha}_2 + \ln(hhsize_{ref}) * \mathbf{Z}'_{ref,i} \hat{\alpha}_3) \\ & = \frac{1}{n} \sum_{i=1}^n F(\hat{\beta}_1 + \hat{\beta}_2 \ln(\hat{y}_s) + \hat{\beta}_3 \ln(s) + \mathbf{Z}'_{s,i} \hat{\alpha}_1 + \\ & \quad \ln(\hat{y}_s) * \mathbf{Z}'_{s,i} \hat{\alpha}_2 + \ln(s) * \mathbf{Z}'_{s,i} \hat{\alpha}_3) \quad (3) \end{aligned}$$

**Solving for the equivalence scale** Our solution will depend upon:

- ▶ Reference income
- ▶ Reference characteristics

## Special cases



$$\mathbf{Z}_{s,i} = \mathbf{Z}_{ref,i} = \mathbf{0} \quad (4)$$

$$e_s = \left( \frac{s}{hsize_{ref}} \right)^{\frac{-\hat{\beta}_3}{\hat{\beta}_2}} \quad (5)$$



$$\mathbf{Z}_{s,i} = \mathbf{Z}_{ref,i} = \bar{\mathbf{Z}} \quad (6)$$

$$e_s = \left( \frac{s}{hsize_{ref}} \right)^{\frac{-(\hat{\beta}_3 + \bar{\mathbf{Z}}' \hat{\alpha}_3)}{(\hat{\beta}_2 + \bar{\mathbf{Z}}' \hat{\alpha}_2)}} \quad (7)$$

# RESULTS

Table 7: Determinants of financial stress-summary measures  
(marginal effects)

	Suffering from		
	cashflow problem	hardship	any financial stress
Log (household income)	-0.115*** (0.008)	-0.096*** (0.006)	-0.138*** (0.008)
Log (household size)	0.126*** (0.018)	0.098*** (0.015)	0.117*** (0.019)
Farm household	0.050*** (0.019)	0.151*** (0.019)	0.131*** (0.021)
Non-farm agri. household	0.085*** (0.017)	0.053*** (0.014)	0.099*** (0.018)
Kids	0.115*** (0.022)	0.003 (0.014)	0.112*** (0.022)
Couple	-0.082*** (0.014)	-0.046*** (0.012)	-0.076*** (0.015)
Drought	0.035*** (0.012)	0.026*** (0.010)	0.045*** (0.014)
Remote	0.031** (0.013)	0.047*** (0.012)	0.041*** (0.013)

Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 1

*Equivalence scales with reference household size 1*

$$\bar{z}_s = z_{ref} = 0 \quad \bar{z}_s = z_{ref} = \bar{z} \quad \bar{z}_s = z_{ref} = \tilde{z}$$

Household size (s)	(5) <sup>a</sup>	Equation: (7) <sup>b</sup>	(7) <sup>c</sup>
2	2.7976	2.4558	1
3	5.1068	4.1538	3.4523
4	7.8268	6.0310	8.3156
5	10.8998	8.0539	16.445
6	14.2869	10.2009	28.7076
Prob (difficulty)	0.0993	0.1158	0.0499

The last row shows the probability of financial difficulty at median income for the particular set of characteristics for the reference household size.

<sup>c</sup> Couple-headed, non-farm, non-ag, no kids, non-remote drought area

Table 1

*Equivalence scales with reference household size 1*

$$\bar{\mathbf{z}}_s = \mathbf{z}_{ref} = \frac{\bar{\mathbf{z}}_s}{\tilde{\mathbf{z}}} = \frac{\bar{\mathbf{z}}_s}{\tilde{\mathbf{z}}} = \frac{\bar{\mathbf{z}}_s}{\mathbf{z}_i} = \frac{\bar{\mathbf{z}}_s}{\mathbf{z}_{ref}}$$

Household size (s)	(5) <sup>d</sup>	Equation: (7) <sup>e</sup>	(7) <sup>f</sup>
2	1.7843	0.8861	1.9544
3	2.5037	0.8255	3.1318
4	3.1837	0.7851	4.5743
5	3.8362	0.7551	6.3114
6	4.4673	0.7315	8.3687
Prob (difficulty)	0.1433	0.5688	0.1396

<sup>d</sup> Couple-headed w/kids, non-farm, non-ag, non-remote drought area

<sup>e</sup> Ag., non-farm, non-couple-headed with kids, remote drought area

## **Other equivalence scales**

What is the equivalence scale between farming and non-farming families

- ▶ Cashflow: 1.03
- ▶ Any stress: 1.10
- ▶ Hardship: 1.21

What is the equivalence scale between farming with drought and non-farming families in a non-drought area

- ▶ Cashflow: 1.31
- ▶ Any stress: 1.41
- ▶ Hardship: 1.53

## What is right comparison group?

Should we average over all characteristics in the data and switch farming/drought on and off for each observation?

Or, should we average over the set of households who are farming in a drought area and compare them to households that are not farming in a non-drought area?

Produces very different results

For hardship,

- ▶ Farming: 6.19  
26% to 12%
- ▶ Farming and in drought: 8.55  
28% to 11%

# CONCLUSIONS

- ▶ farm households suffer from a higher FS
- ▶ FS of non-farm agricultural households are lower than farm household but higher than that of reference household
- ▶ households living in drought affected areas suffer from additional FS, although the difference is small
- ▶ the story is similar with the hardship and cashflow measures of FS
- ▶ FS measures produce reasonable equivalence scales
- ▶ Equivalence scales dependent upon comparison groups and baselines