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The Impact of Climate Change on Canadian Agriculture: A Parcel Level Ricardian Analysis

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The Impact of Climate Change on Canadian Agriculture: A Parcel Level Ricardian Analysis

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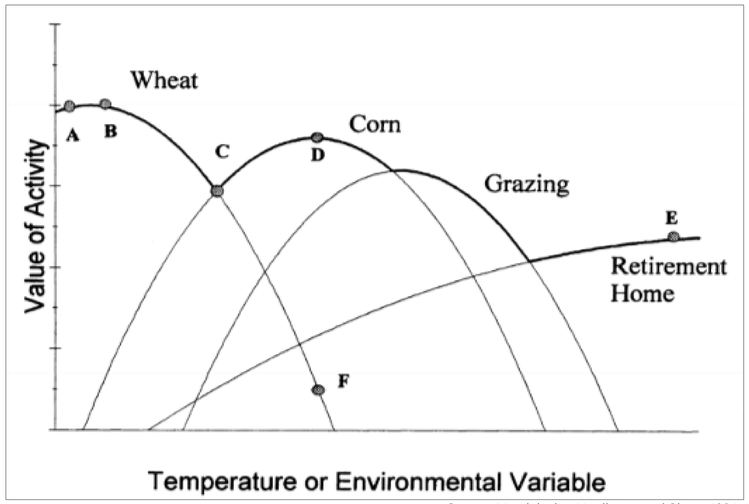
Introduction:

- This study uses a sample of Canadian parcel level farmland values to estimate Ricardian impacts of climate change on agriculture
- The Ricardian approach was first proposed by Mendelson, Nordhaus, and Shaw (1994) as an alternative to crop-specific approaches
- The Ricardian approach applies a hedonic property to farmland values and includes climate measures as key explanatory variables



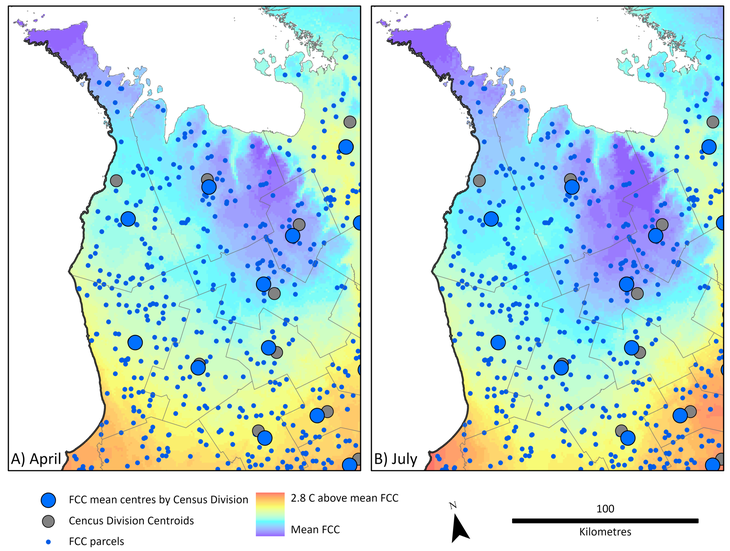
Source: Mendelsohn, Nordhaus, and Shaw, 1994

Research Contributions:

1. **Estimate the first Canadian Ricardian impact of climate change in over 15 years**
   - Impacts from climate change are location specific
   - Only three studies have applied the Ricardian approach to Canadian farmland values (Reinsborough, 2003; Weber and Hauer, 2003; Mendelsohn and Reinsborough, 2007)
2. **Use a novel farm level dataset to investigate the impact of spatial scale within the Ricardian approach**
   - Recent studies have focused on methodological or theoretical concerns such as omitted variables (Schlenker et al. 2005, Ortiz-Bobea. 2020) or alternative methods of estimation (Severen et al. 2018)
   - Only three studies have used granular spatial data on farmland value (Schlenker et al. 2006, Weber and Hauer 2003, Fezzi and Bateman 2015)

Data:

- Most studies have used county level averages for farmland values and all explanatory variables – including climate



- This study uses parcel level farmland values provided by Farm Credit Canada (FCC) - each datapoint is composed of real market transactions from the year 2020
- Historic and forecasted climate data were accessed from Adapt West and matched to the centroid location of each parcel
- Other control variables include soil quality, surrounding area population density and median total income

Empirical Approach

- The first stage estimates the marginal effect of climate on farmland values using a hedonic property model
- A spatial error model is used to allow for spatial correlation between observations

$$\ln(LV_{i,m,p}) = \boldsymbol{\beta}'\boldsymbol{C}_{i,m,p} + \boldsymbol{\theta}'\boldsymbol{F}_{i,m,p} + \boldsymbol{\tau}'\boldsymbol{N}_{m,p} + \boldsymbol{P}_{FE} + \boldsymbol{M}_{FE} + \boldsymbol{u}_{i,m,p}$$

- The second stage calculates the average predicted change in farmland values resulting from climate change and is multiplied the total amount of farmland in Canada (~160 million acres)

$$\Delta LV_i = \widehat{\boldsymbol{\beta}_j}\left(\boldsymbol{Future}_{i,j} - \boldsymbol{Historic}_{i,j}\right)$$

$$Ricardian\ Impact = \sum_{i=1}^{n} \Delta LV_i * 160M = \sum_{i=1}^{n} \widehat{\boldsymbol{\beta}} * \Delta\boldsymbol{Climate}_i * 160M$$

Marginal Effects of Climate on Farmland Values:

Variable	Base Model Coef.	Sig.	Provincial FE Model Coef.	Sig.	County FE Model Coef.	Sig.
April Rain	2.823***		2.191***		1.301***	
April Rain Sq	-0.033***		-0.027***		-0.037***	
July Rain	0.761***		0.778***		-0.565**	
July Rain Sq	-0.009***		-0.017***		-0.009	
April Temp	47.858***		28.106***		45.054***	
April Temp Sq	2.537***		1.949***		2.946***	
July Temp	-15.421***		2.435		-9.702	
July Temp Sq	0.590		-0.025		-0.067	
Pop. Density	0.246***		0.238***		0.177***	
Pop. Den. Sq	0.000***		0.000***		0.000***	
Obs.	9866		9866		9866	
R^2	0.4528		0.4625		0.5352	

p-values: * < 0.10, ** < 0.05, *** < 0.001

Estimated Impacts of Climate Change on Agriculture:

Model	Aggregate Impact	95% Confidence Interval
Base	44.83	(40.84 , 48.81)
Provincial FE	26.29	(23.80 , 28.77)
County FE	-15.65	(-23.37 , -5.93)

Impacts are presented in $ Millions CAD

Conclusions:

- The seasonal climate coefficients are sensitive to the inclusion of fixed effects
- All three models estimate small impacts from climate change on farmland values
- The estimated annualized impact from climate change ranges from $2.24M CAD in benefits to $700,000 CAD in damages, a small fraction of Canada's annual gross farm income of $72 Billion CAD

- Next steps:
  - Add parcel level measure of urban pressure – distance to nearest city
  - Validate results using additional yearly data