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**THE ECONOMIC IMPACTS OF CLIMATE
CHANGE ON THE CHILEAN AGRICULTURAL
SECTOR. A NON-LINEAR AGRICULTURAL
SUPPLY MODEL**

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Presentation Outline

- Motivation
- Model
- Study Area
- Data / Results
- Final Remarks

Motivation

- **Water and Climate Change** (Bates, *et al.* 2008, Field, *et al.* 2014)
 - Documented changes
 - Change in precipitation patterns
 - Extreme weather events
 - Reduction of snow cover
 - Changes in soil moisture

Motivation

- **Water and Climate Change** (Bates, *et al.* 2008, Field, *et al.* 2014)
 - Expected changes
 - Increase in precipitation in high latitude areas, decrease in low latitude areas. For other areas high *uncertainty*.
 - Increase of precipitation intensity and high variability
 - Glaciers surface is likely to decline (long term water supply)

- Water and Climate Change

(Bates, *et al.* 2008; Field, *et al.* 2013)

The new climate conditions will likely have serious impacts on agriculture and food supply.

Impacts on human welfare

Model: Non-Linear Ag. Supply Model

- Agricultural Supply Model
 - Uses the last available information for Chile
 - Sensitivity analysis
 - Climate shock: changes on agricultural yields

Model: Non-Linear Ag. Supply Model

- Model Structure

Model Calibrated
Using PMP

$$Z = \sum_r \sum_a \sum_s (Pa * Y_{r,a,s} - AC_{r,a,s}) * X_{r,a,s} \quad [1]$$

$$AC_{r,a,s} = vcost_{r,a,s} \quad [2]$$

$$\sum_a \sum_s r_{i,r,a,s} * X_{r,a,s} \leq b_{i,r} \quad [3]$$

$$X_{r,a,s} = X_{r,a,s}^0 + e_{r,a,s} \quad [4]$$

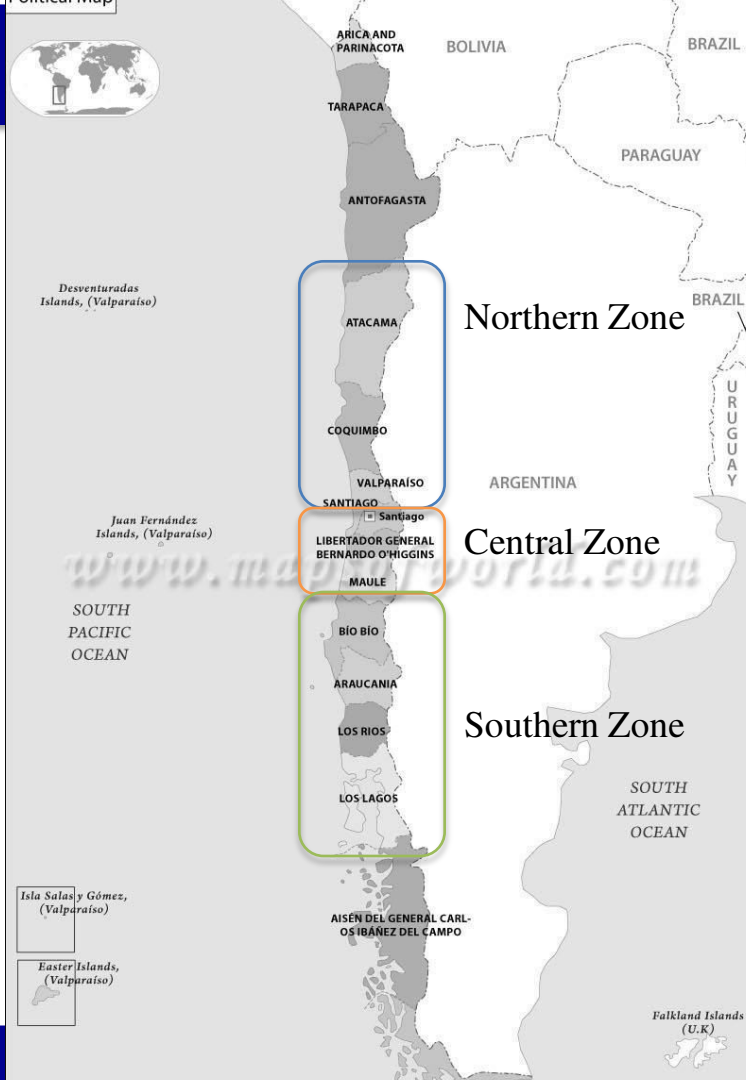
$$X_{r,a,s} \geq 0 \quad [5]$$

$$AC_{r,a,s} = \alpha_{r,a,s} * (X_{r,a,s})^{\beta_{r,a,s}} \quad [6]$$

Model: Non-Linear Ag. Supply Model

- Model Specification
 - 256 municipalities (36 provinces, 10 regions).
 - 22 agricultural activities
 - Annual crops (10)
 - Fruits (10)
 - Forest (2)
 - Total agricultural land: 3,3 million ha.

Study Area

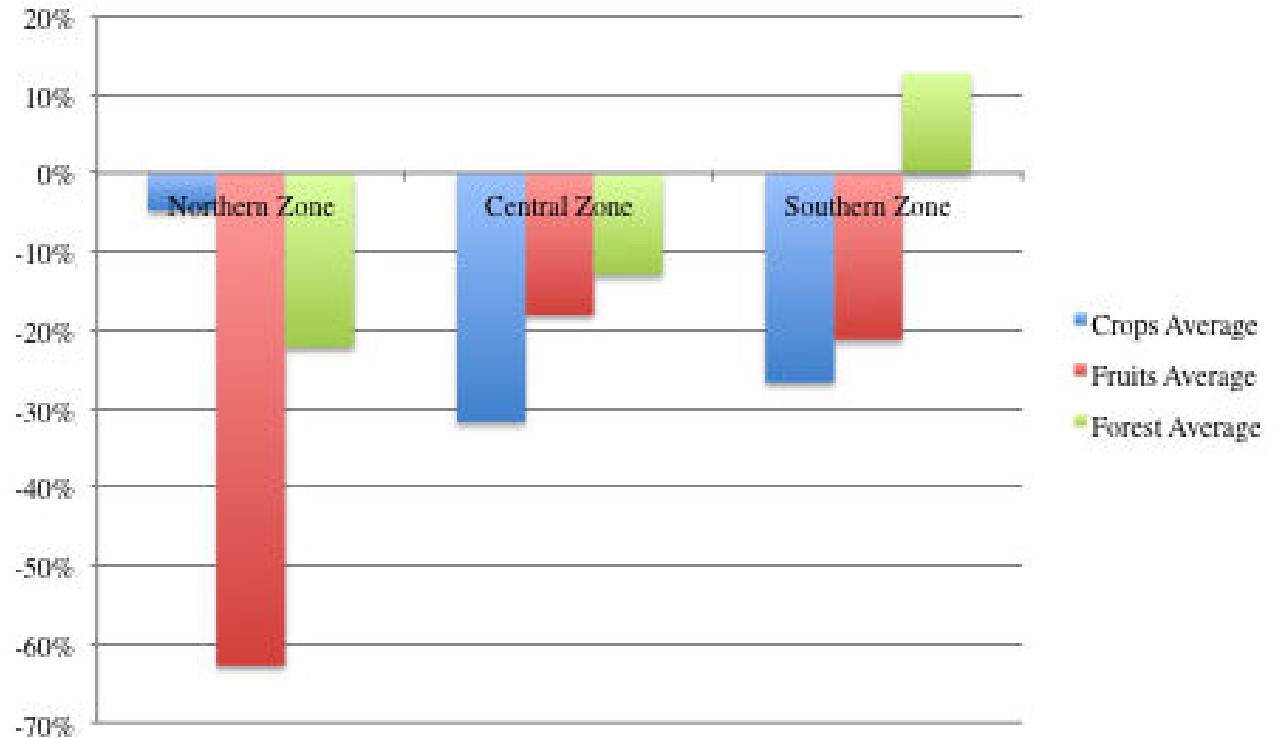


- Information Sources

- Agricultural Census (2007): Area, yield, production
- ODEPA (2010): costs, production systems, labor intensity
- ODEPA (2010): prices
- Various sources (1995,2008 2011): elasticities
- Santibáñez *et al.* (2008): climate shock

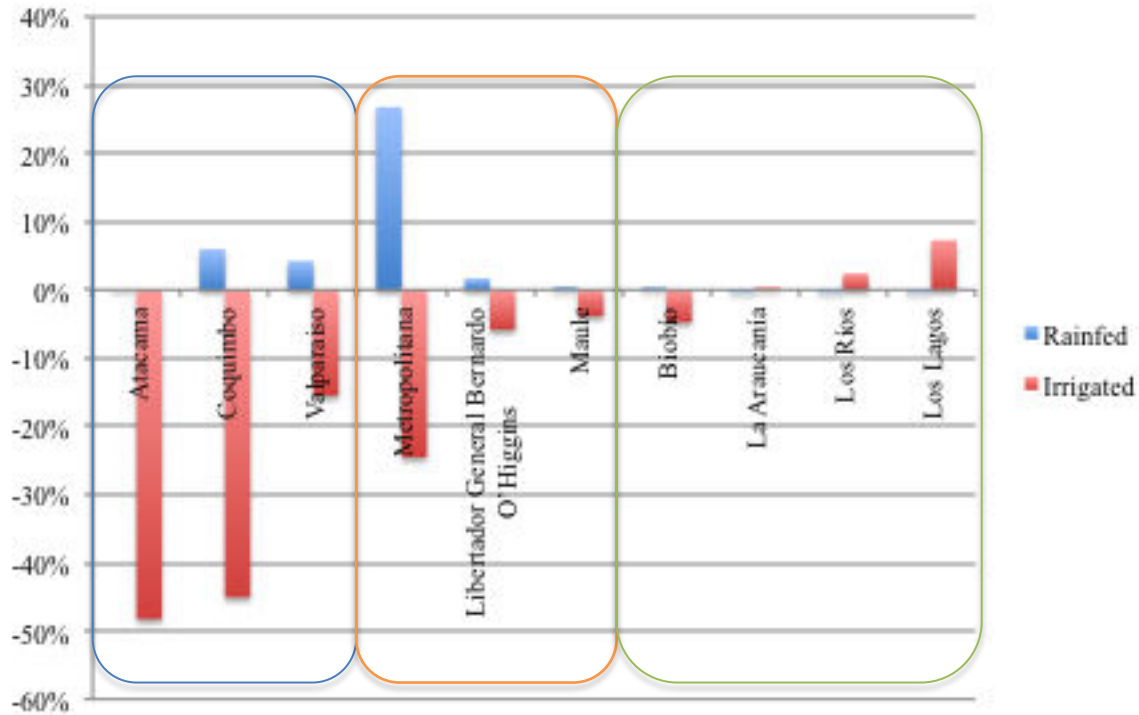
Data and Results

Average yield changes

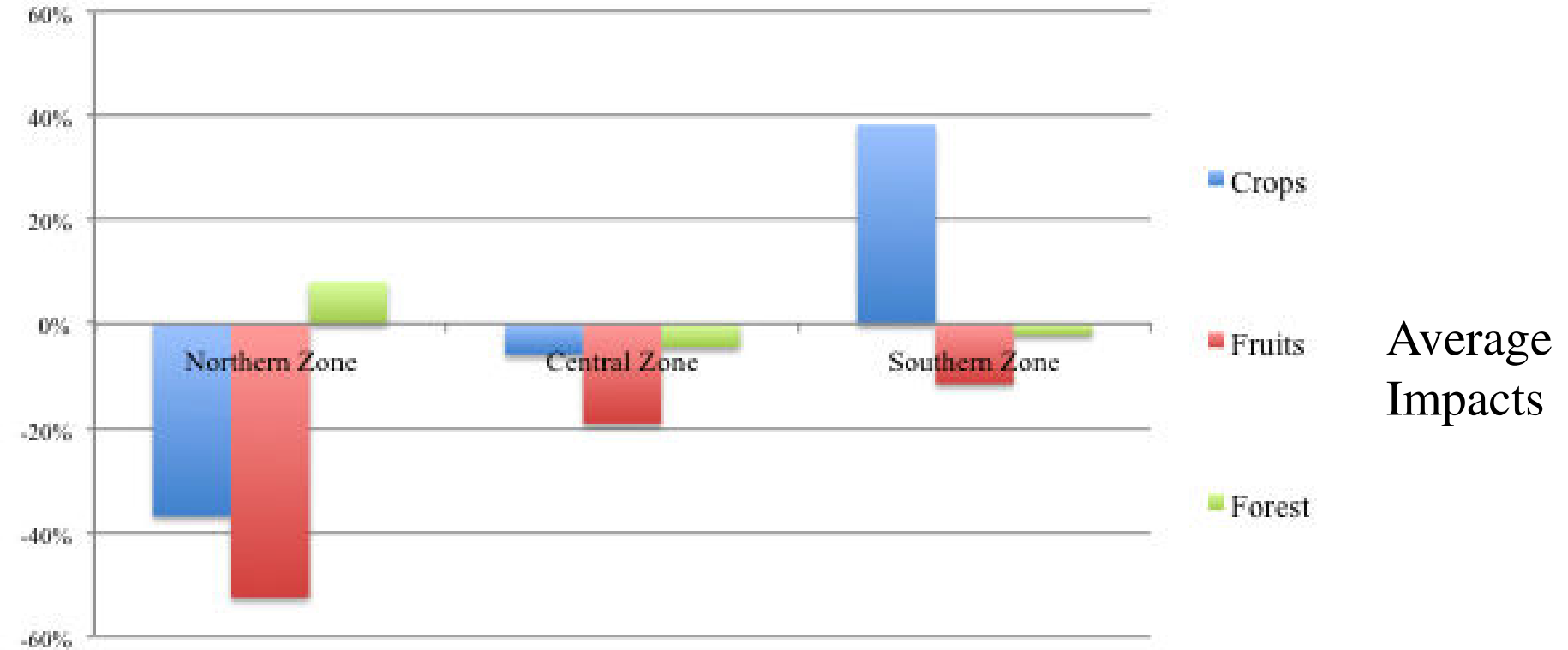


Data and Results

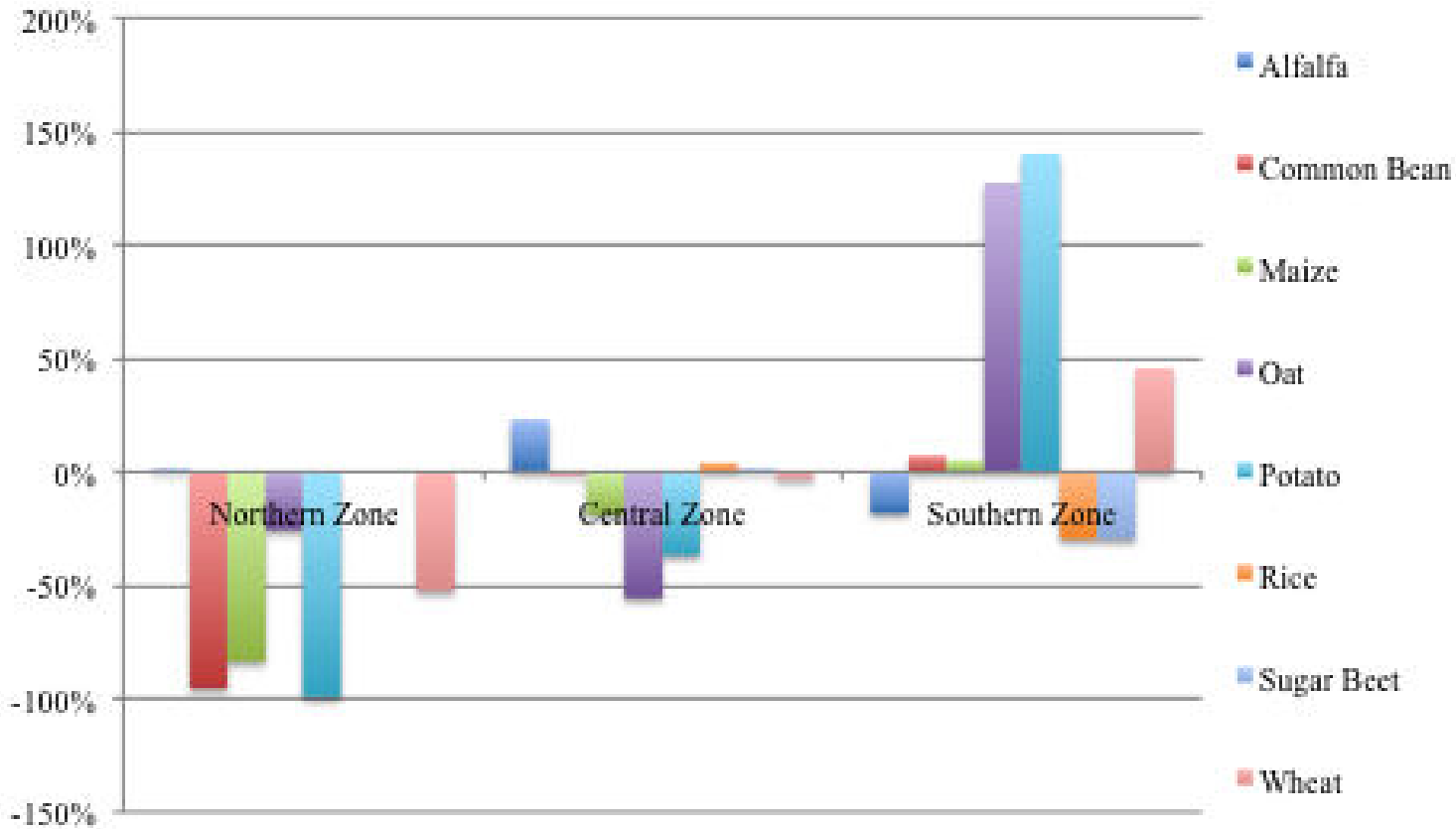
- Main Results: Land Allocation Change



Data and Results

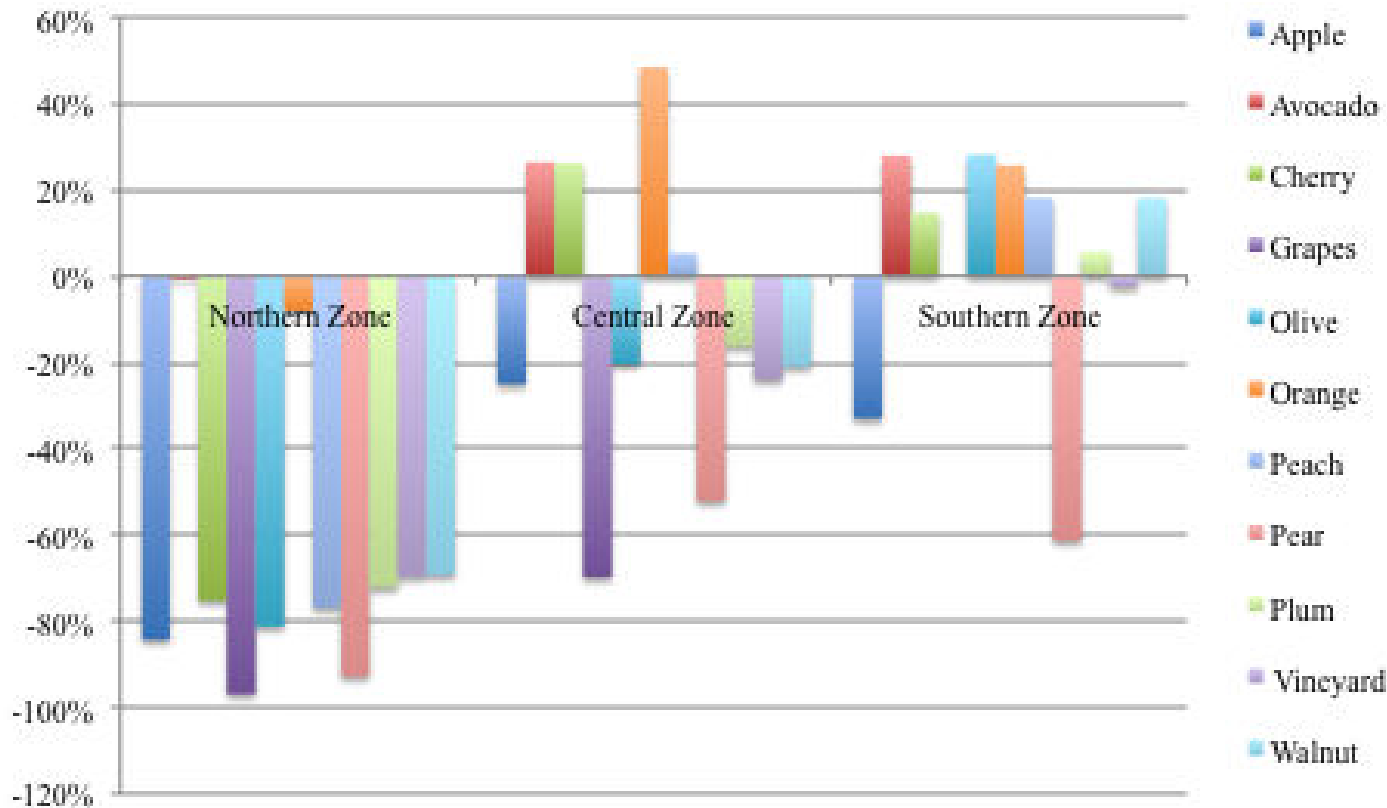


Data and Results



Annual Crops

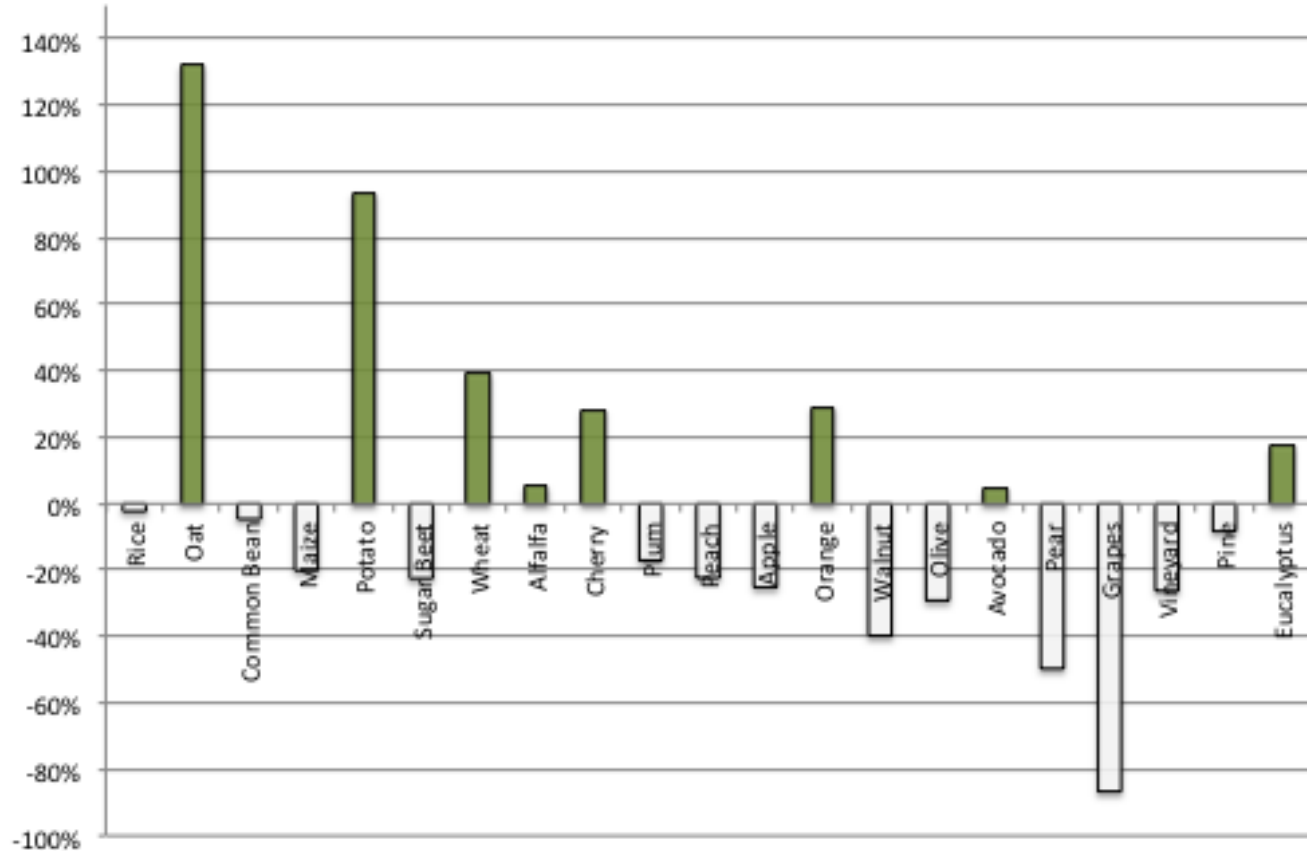
Data and Results



Fruits

Data and Results

- Agricultural Net Income Change (activity)



Data and Results

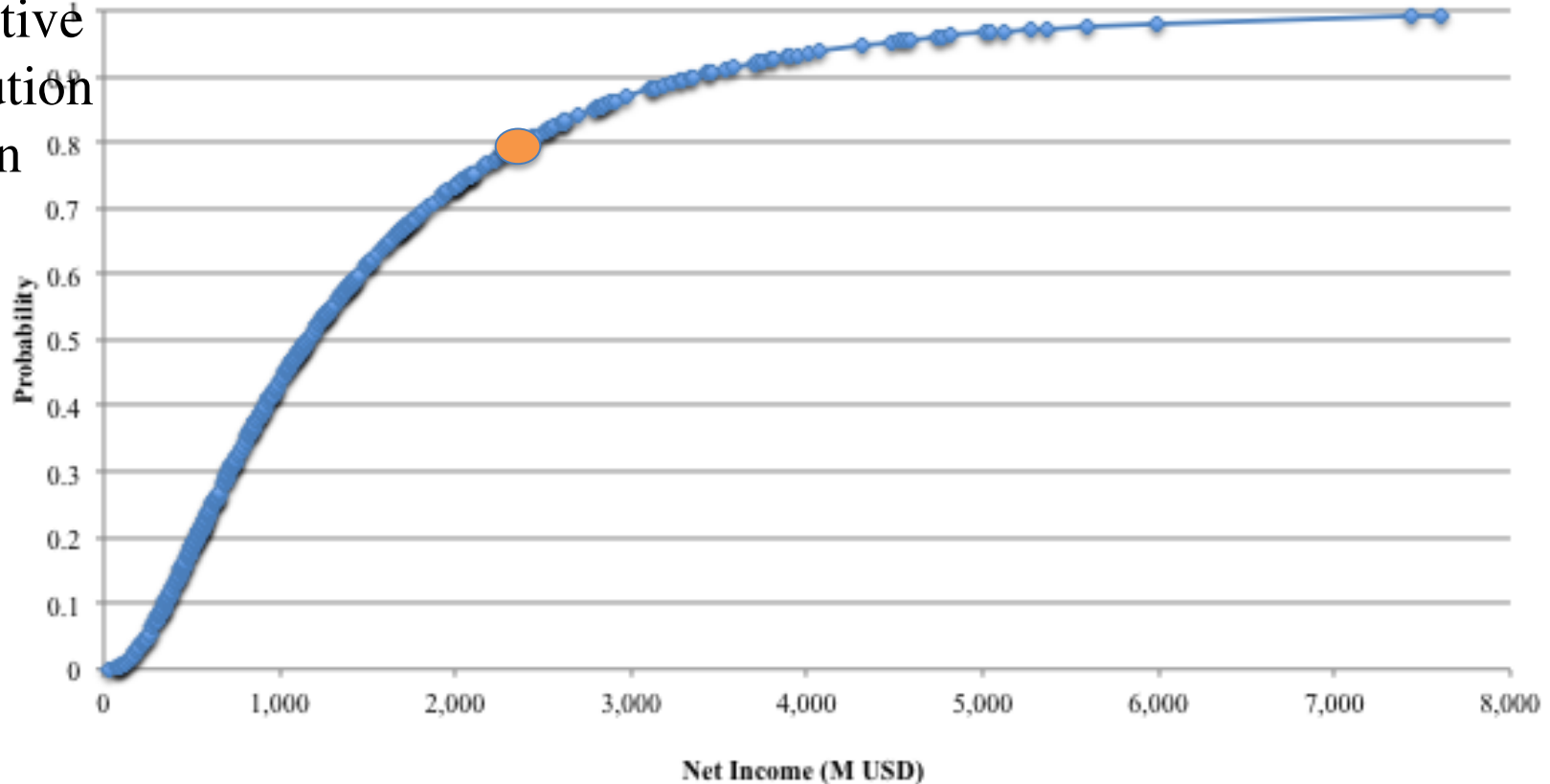
- Agricultural Net Income

Region	Baseline (million USD)	Climate change (million USD)	
Atacama	13	4	-37%
Coquimbo	112	46	
Valparaíso	202	156	
Metropolitana	186	111	-12%
Libertador General Bernardo O'Higgins	388	373	
Maule	430	398	
Biobío	453	494	20%
La Araucanía	297	363	
Los Ríos	105	130	
Los Lagos	50	101	
Total	2235	2176	

- Sensitivity Analysis
 - Using Monte Carlo Simulations for changes on agricultural yields (400 scenarios).
 - Probability Distribution Function assumed: GAMMA

Data and Results

- Cumulative Distribution Function



Final Remarks

- Results are consistent with previous studies for Chile
 - Chilean agricultural sector is vulnerable to climate change
- Small aggregated impacts on total production and total income
- Large distributional effects across regions and activities
 - Fruits producers will be worse-off than crop producers

Final Remarks

- This paper only considers autonomous adaptation, planned adaptation should be considered in further studies.
- More agronomic studies are needed in order to improve the water-yield representation.
- Water markets are a strong adaptation option, its inclusion requires more information about prices, transactions, and geographic allocation



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Thanks!

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