Do Stronger Institutions Mitigate the Impacts of Climate Change? Evidence from Water Governance in Chile

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1. Introduction

Climate change is increasing the frequency, severity, and duration of droughts in many parts of the world, with particularly acute impacts on agriculture and water resources.These changes pose major challenges for managing common-pool resources like groundwater and surface water, which are essential for irrigation and especially vulnerable to overuse under stress. In this paper, I ask whether stronger institutions can mitigate the impacts of climate shocks on agriculture. Chile presents a unique institutional laboratory, in which some agricultural basins are governed by self-organized Water Boards while others remain unregulated. I use this variation, together with the onset of a 14-year long drought–marked by a 20–30% reduction in rainfall and persistent deficits in river flows since 2008–to examine how local governance influences both short-run responses and long-run adaptation to water scarcity.

2. Conceptual Framework

I develop a dynamic model of groundwater extraction under stochastic droughts, with heterogeneous farmers and planner-imposed extraction caps. Unregulated farmers respond to shocks based on private incentives, while a central planner maximizes collective welfare.

The model predicts: (i) unregulated areas will over-extract groundwater during droughts, preserving yields but depleting aquifers; (ii) governance induces long-run sustainability but imposes short- and medium-run constraints—especially on less productive farmers; and (iii) the gap between decentralized and optimal behavior grows with drought persistence.

3. Data and Empirical Strategy

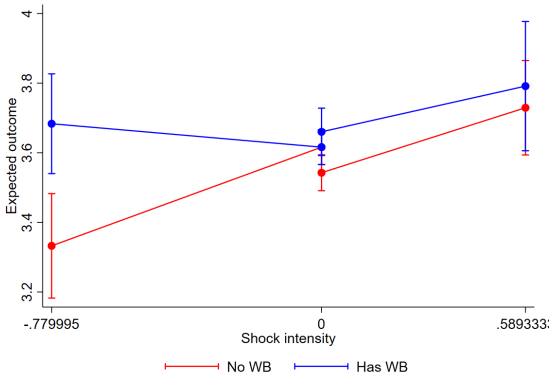
I construct a panel dataset for over 200,000 farms from 2000 to 2020, combining satellite-based estimates of evapotranspiration (ETa) and greenness (EVI), groundwater monitoring data, two rounds of agricultural census (2007 and 2021), and high-resolution climate and hydrology data. Drought shocks are estimated using Elastic Net models that predict baseline ETa and EVI per farm and year, allowing me to isolate deviations under drought conditions.

4. Results

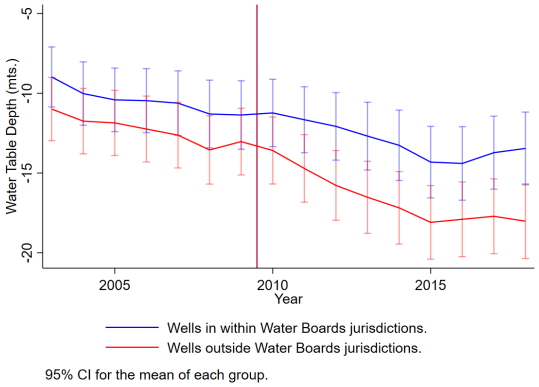
Short-run: Farms under Water Boards experience 25–40% smaller reductions in ETa and yield per unit drought shock, suggesting that governance helps buffer short-term impacts.

Medium-run: Governed areas show larger reductions in irrigated surface between 2007 and 2021, especially in traditional systems. Micro- and macro-irrigation are less affected. This suggests governance constrains adaptation by limiting extractive flexibility.

Long-run: Water tables declined 4 meters more in ungoverned areas, despite no difference in the issuance of legal groundwater permits—implying unregulated or informal extraction in areas without institutional oversight.



(a) Estimated sensitivity of water use (measured as farm-level evapotranspiration (ETa))to drought shocks, by governance status. Drought shocks are computed as deviations from farm-specific predicted ETa under baseline (pre-drought) conditions. The flatter slope for governed farms indicates lower sensitivity to drought, suggesting that local water governance buffers short-run impacts.



(b) Water table depth at monitoring stations in agricultural areas, by governance status. Following the onset of the drought, areas without governance experience greater groundwater extraction—reflected in a sharper decline in water table depth—compared to areas under Water Board governance.

5. Discussion

Institutions reshape the trade-offs of climate adaptation. Governance enables long-term sustainability and reduces short-run vulnerability but may restrict medium-term flexibility, especially for less productive or resource-poor farmers. These trade-offs matter for both policy design and evaluations of adaptive capacity. Importantly, focusing only on short-term outcomes may overlook hidden costs such as aquifer depletion or distributional inequities.

6. Conclusion

Stronger institutions play a critical role in managing climate-related risks. This paper combines dynamic modeling and rich empirical evidence to show that Water Boards reduce exposure to climate shocks and promote long-run groundwater sustainability. However, these gains come with trade-offs in flexibility and equity. Designing effective adaptation policy requires a careful accounting of both environmental and institutional dimensions.