

# Climate Change Fosters International Cooperation: Evidence from Water Treaties

by  
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Find the paper [here](#).

## Motivation

- Climate change effect on water resources: an important issue
  - Agricultural production depends directly of this resource
  - Countries use to share a basin or a river
  - The over-exploitation of the common resource may be exacerbated by climate change.
  
- Thus
  - A growing body of works analyses the hydrological, political and economical reasons behind water basins management policies (Ex: Egypt vs Ethiopia)
  - The climate shocks have been neglected.
  
- However
  - Many findings are based on cross-sectional analysis which is problematic since many determinants of WTs are unobserved or hard to measure.
  - The lack of a time dimension impedes to analyze the behavior of agents over time since individuals and governments can adopt adaptation strategies.

## What I do, what I find

- By using panel FE regression and long run difference we analyze:
  - Whether climatic shocks drive WTs.
  - How this effect evolves over time.
  
- Thus:
  - We use panel data.
  - We focus on weather fluctuations (temp , prec..).
  - We also revisit the economic and political determinants of WTs.
  
- We find that WTs are mainly climate policies.
  - Fluctuations in weather definitely drive WTs: more interestingly WTs appear to be an adaptation policies.
  - In contrast to the literature, only economic interdependence matters within economic and political variables.

## Presentation plan

- Brief literature
- Empirical strategies
- Data
- Climate change and WTs
  - Short-run effect
  - Long-differences
- Heterogeneous analyses by type of WTs
- Economic and political determinants of WTs
- Conclusion

- Dinar et al. (2010) pursue this analysis: the water supply variability (both annual runoff variability and precipitation variability) in international bilateral basins fosters international cooperation.
  
- Tir and Ackerman (2009):
  - How political institutions, development and water scarcity increase the likelihood of international river cooperation between contiguous riparian states?
  - WTs is drive by asymmetrical power distribution, economic interdependence, democratic governance, and water scarcity.
  
- Zawahri et al. (2016):
  - They study factors influencing treaty design (according to their content).
  
- Concerning the methodology, it is derived from:
  - Climate change and conflicts literature
  - See Dell et al. 2014 for a survey.
  - See Schlenker and Roberts (2009), Burke and Emerick (2015) for the “long differences” approach ).

- The most common empirical strategy to analyze WTs has been the cross-sectional approaches.

$$\Gamma_{ij} = \alpha X_{ij} + \beta Z_{ij} + \varepsilon_{ij}$$

- We propose to analyze WTs by using the following this gravity based specification:

$$WT_{ijt} = \alpha Clim_{ijt} + \beta Clim_{it} + \mu Clim_{jt} + Z_{itj} + f_{ij} + f_i + f_j + f_t + \varepsilon_{ij}$$

- We thus:
  - we directly analyze climate change effect ( $Clim_{ijt}$ ,  $Clim_{it}$ ,  $Clim_{jt}$ ).
  - the problem of reverse causality is not a concern here: climatic variables are exogenously determined.
  - We account for country-fixed effects and Country-pair fixed effects control for bilateral relationship, and time effects
  - The term  $Z_{itj}$  refers to a vector of bilateral variables that varies over time (economic, political and institutional variables).
- Although:
  - By using yearly fluctuations, we are capturing the short-run effect of climate change.

- Dependent variable:
  - Water treaties :  $WT_{ijt}$  is a dummy built from the International Freshwater Treaty Database.
  
- Climate variables:
  - Climate variables (temperature and precipitations) with geomatics tools.
  - Constructed by combining historical monthly weather rasters provided by WorldClim and river basin's shapefiles from McCracken and Wolf (2019).
  - Non linear effect of climate change:
    - An agriculture measure: Growing degree unit (GDU) and Killing degree units (KDU).
    - An urban point of view: Cooling Degree Units (CDU) and Heating Degree Units (HDU)
    - Precipitation above the mean: difference between monthly and the mean precipitation (over a decade) when the former is greater than the latter; and the mean precipitations minus the monthly precipitation otherwise.

Literature  
 Empirical strategies  
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 Climate change and WTs  
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 Second nature of WTs

	(1)	(2)	(3)	(4)	(5)	(6)
	LPM	LPM	LPM	LPM	LPM	LPM
VARIABLES	Dep var: Water treaties					
Avg Temp in i and j	0.0160*** (0.0035)					
Avg Trecip in i and j	0.0304*** (0.0101)					
Temp i * Temp j		0.0010*** (0.0001)				
Precip i * Precip j		0.0054*** (0.0014)				
Temp: member with the highest CV			0.0106*** (0.0029)			
Precip: member with the highest CV			0.0109 (0.0079)			
Avg number of warmer months in i and j				0.1384*** (0.0193)		
Avg number of rainier months in i and j				-0.0035 (0.0148)		
Avg Growing Degree Unit in i and j					0.0324*** (0.0052)	
Avg Killing Degree Unit in i and j					0.0233*** (0.0072)	
Avg Heating Degree Unit in i and j						0.0012 (0.0037)
Avg Cooling Degree Unit in i and j						0.0628*** (0.0064)
Avg Precipitation gap in i and j					0.0006*** (0.0002)	0.0007*** (0.0002)
Avg additional Precipitation in i and j					0.0004 (0.0003)	0.0005 (0.0003)
Constant	-0.3491*** (0.0869)	-0.3896*** (0.0572)	-0.1599** (0.0669)	-0.0143 (0.0127)	-0.3216*** (0.0586)	-0.2168*** (0.0304)
Observations	24,252	24,252	24,252	24,252	24,252	24,252
R-squared	0.318	0.319	0.317	0.318	0.318	0.320
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
country i and j FE	Yes	Yes	Yes	Yes	Yes	Yes
Country pair FE	Yes	Yes	Yes	Yes	Yes	Yes

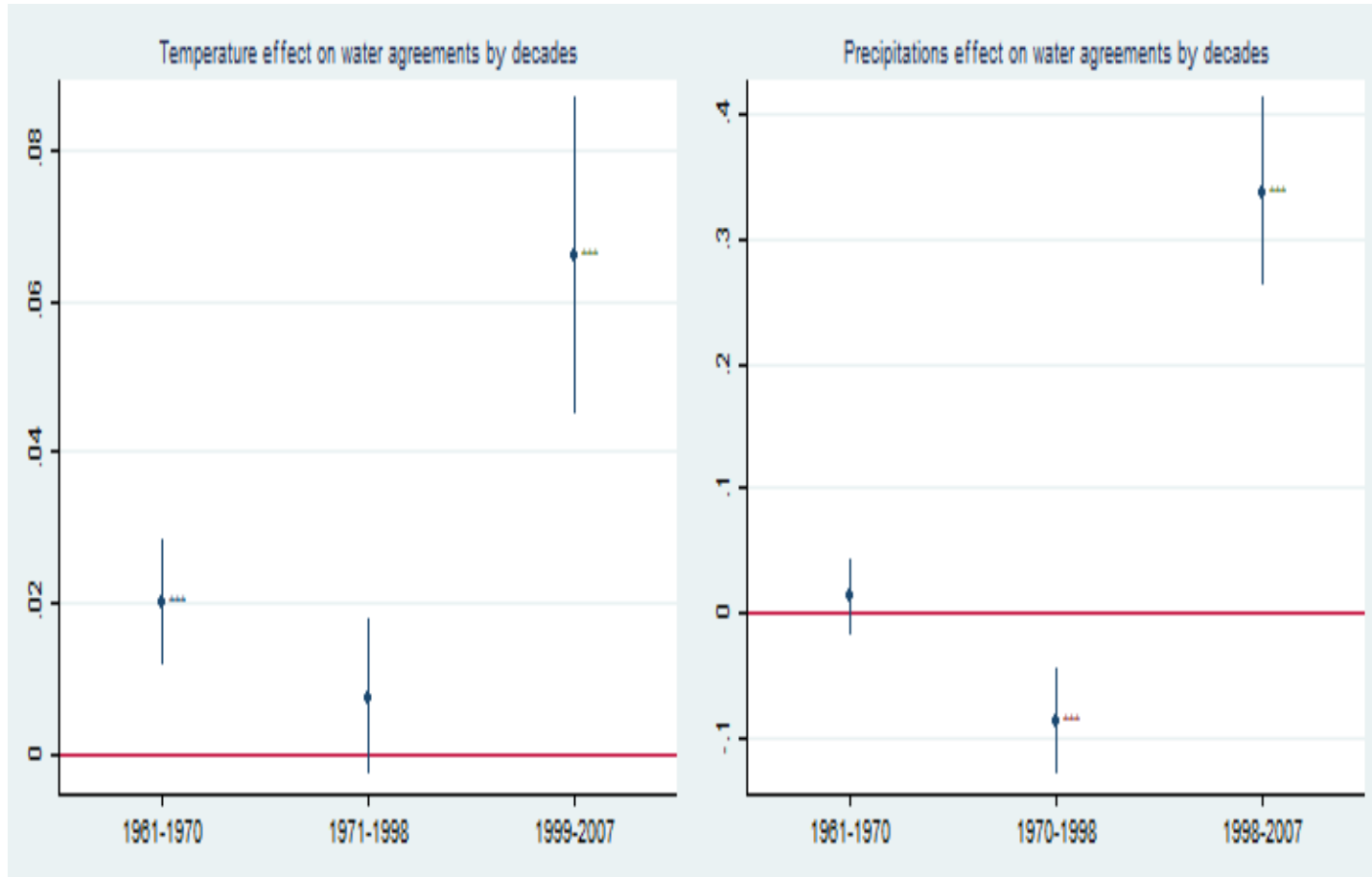
About the “first nature” of treaties:  
 Short run effects



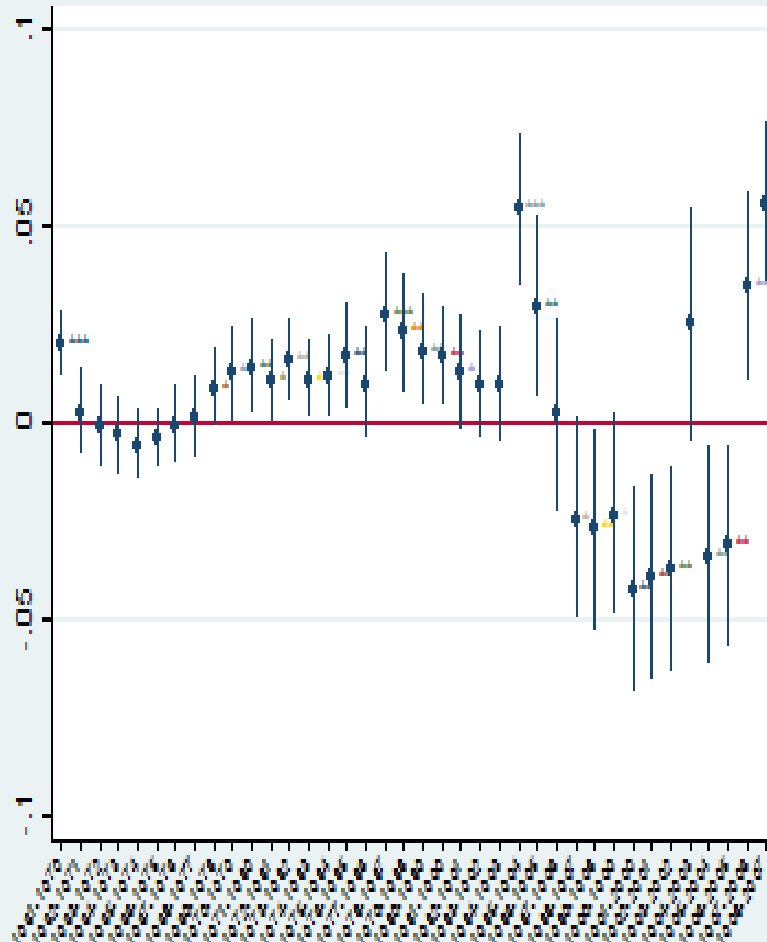
- Previous results are short run effects:
- But governments can't always adjust their policy in the short run: thus the panel-FE analyses may underestimate the long-run effect of climate change.
- WTS may take time to be enforced.
- The long run effect specification (Burke and Emerick, 2015).

$$\overline{WT}_{ijt2} - \overline{WT}_{ijt1} = \alpha(\overline{Clim}_{ijt2} - \overline{Clim}_{ijt1}) + \beta(\overline{Clim}_{ijt2} - \overline{Clim}_{ijt1}) + \Delta\varepsilon_{ij}$$

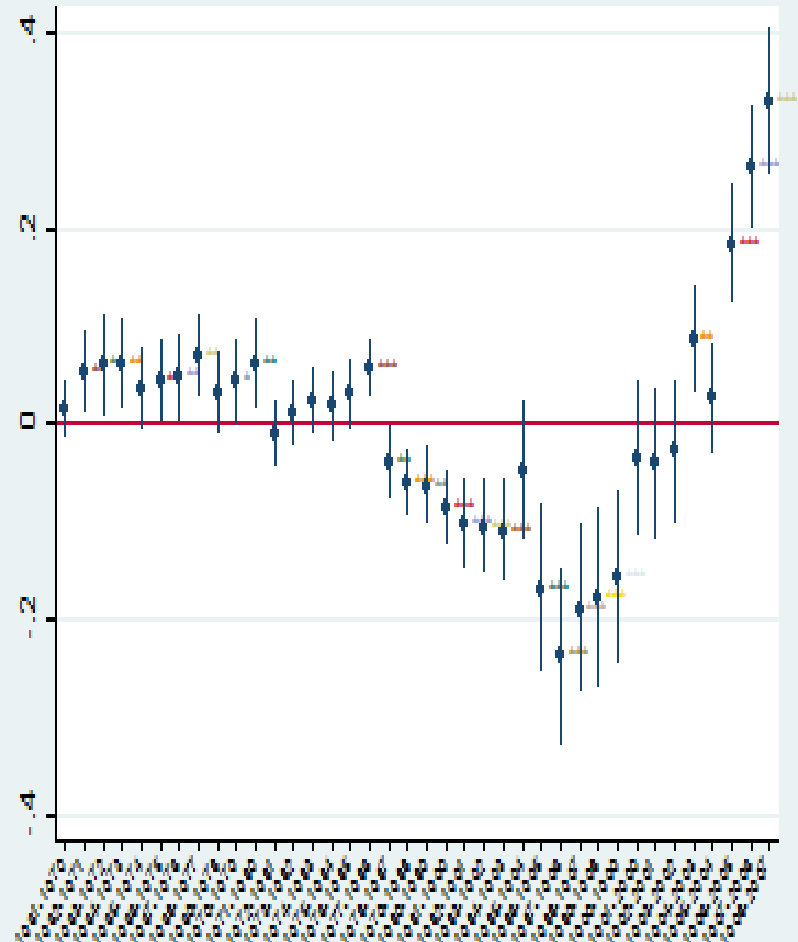
- For instance:  $\overline{WT}_{ijt2}$  and  $\overline{WT}_{ijt1}$  represent the average number of water treaties in the respective  $t_1 = 1961 - 1970$  and  $t_2 = 1998 - 2007$  periods.
- $\overline{Clim}_{ijt2}$  and  $\overline{Clim}_{ijt1}$  represent the average each climate variable on these two periods.
- Here we estimate the long difference change: allow to appreciate the adaptation of government.



Temperature effect on water agreements by decades



Precipitations effect on water agreements by decades

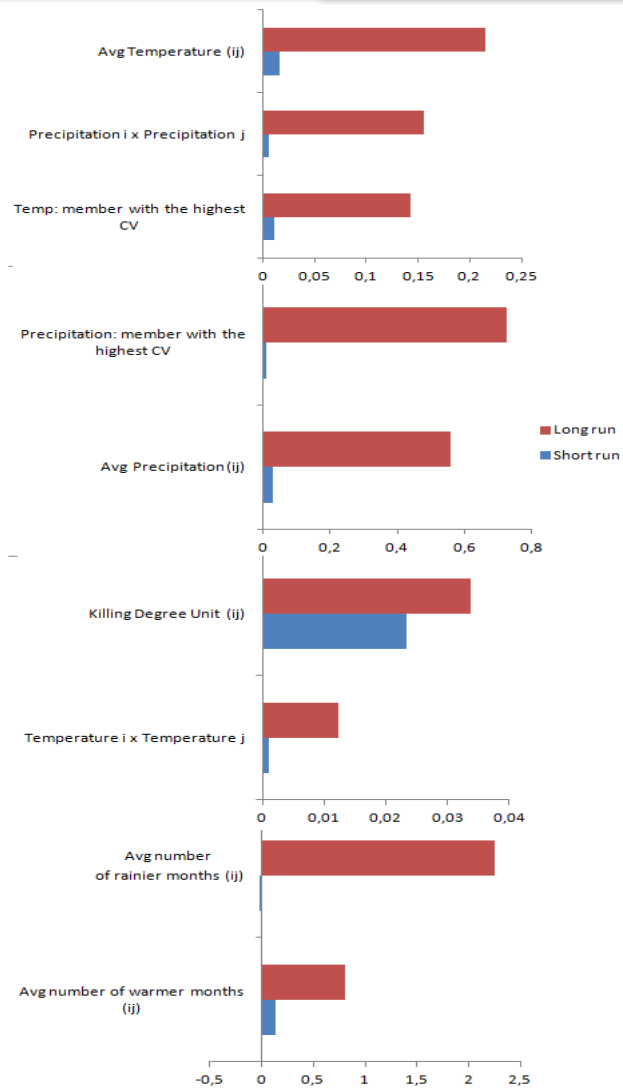


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**Long differences**  
**results**

Climate reasons of  
 water agreements

	(1)	(2)	(3)	(4)	(6)	(6)
	MCO	MCO	MCO	MCO	MCO	MCO
VARIABLES						
Avg Temp in i and j	0.0390*** (0.0103)					
Avg Trecip in i and j	0.0964* (0.0560)					
Interaction: Temp i and j		0.0024*** (0.0004)				
Interaction: Precip i and j		0.0299*** (0.0079)				
Temp: member with the highest CV			0.0247*** (0.0093)			
Precip: member with the highest CV			0.1207*** (0.0463)			
Avg number of warmer months in i and j				0.1800** (0.0723)		
Avg number of rainier months in i and j				0.5778*** (0.1963)		
Avg GDM in i and j (below the threshold)					0.1959*** (0.0217)	
Avg KDM in i and j (Above the threshold)					0.1615*** (0.0226)	
Avg HDM in i and j (Below the threshold)						-0.0483*** (0.0112)
Avg CDM in i and j (Above the threshold)						0.1531*** (0.0204)
Avg Precip in i and j (Below the threshold)					0.0082*** (0.0027)	0.0086*** (0.0029)
Avg Precip in i and j (Above the threshold)					-0.0047 (0.0029)	-0.0023 (0.0032)
Constant	0.0082 (0.0093)	-0.0175* (0.0090)	0.0191** (0.0088)	0.0268*** (0.0045)	-0.0721*** (0.0136)	-0.0476*** (0.0119)
Observations	516	516	516	516	516	516
R-squared	0.022	0.091	0.023	0.021	0.201	0.099



	(1)	(2)	(3)	(1')	(2')	(3')
	Likelihood of water agreements					
	Short run results			Long run results		
	Water quality & an Water quantity	Economic development	Environ-ment protection	Water quantity & an Water quantity	Economic development	Environment protection
	LPM	LPM	LPM	LPM	LPM	LPM
Avg Temp in i and j	0.0035* (0.0020)	0.0155*** (0.0021)	0.0104*** (0.0027)	0.0874*** (0.0298)	0.0901* (0.0536)	0.0363*** (0.0087)
Avg Trecip in i and j	0.0322*** (0.0084)	0.0580*** (0.0061)	0.0055 (0.0092)	-0.6762*** (0.1625)	-0.0298 (0.3734)	-0.0323 (0.0419)
Constant	-0.1524*** (0.0511)	-0.4927*** (0.0518)	-0.1883*** (0.0714)	0.0784*** (0.0236)	0.2215*** (0.0492)	-0.0192** (0.0075)
Observations	24,252	24,252	24,252	516	516	516
R-squared	0.404	0.247	0.086	0.044	0.003	0.043
Year FE	Yes	Yes	Yes	No	No	No
country i and j FE	Yes	Yes	Yes	No	No	No
Country pair FE	Yes	Yes	Yes	No	No	No

- The scarcity of the resource can be balanced with efficient markets and well functioning institutions.
- But political and socioeconomic variables analyses exhibits some caveats.
- Thought, it is important to take a look to these factors for two reasons:
  - Compare the results to that from the literature.
  - Even if climates matter, it is good to know in which socio-economic conditions WTs emerge.
- Political and socioeconomic factors .
  - *Joint democracy*: (polity-2 from PolityIV value is above 6, Brochmann, 2012).
  - *Peace history*: (Dinar et al., 2011; Brochmann, 2012). Build from COW, *International Water Events Database*
  - *Alliance ties*: formal alliances among states (including mutual defense pacts, non-aggression treaties and ententes; data from COW).
  - *Power distribution*
    - (i) Composite Index of National Capability of “strongest state” as a proportion of the dyad-year total capabilities (Hensel et al., 2008; COW); (ii) Highest GDP on lowest GDP by dyad; (3) Highest GDP per-capita on the lowest GDP per-capita by dyad.
  - *Economic interdependency*:  $(M+X)/GDP$  (Dinar, 2010; Sigman, 2004; FMI-DOTS and WDI).
  - Dyad shared river: dummy from Peace Research Institute Oslo (PRIO).

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	(1)	(2)	(3)	(4)
	LPM	LPM	LPM	LPM
VARIABLES	Dep Var : Water treaties			
<i>Joint democracies</i>	-0.0004 (0.0114)	0.0005 (0.0114)	0.0007 (0.0112)	-0.0000 (0.0114)
<i>Economic interdepdance (Trade)</i>	0.0024*** (0.0009)	0.0023*** (0.0009)	0.0025*** (0.0009)	0.0023*** (0.0009)
<i>Economic power (Highest GDP on lowest GDP by dyad)</i>	0.0100 (0.0078)		0.0096 (0.0078)	0.0102 (0.0078)
<i>Welfare power (Highest GDP per capita on lowest GDP per capita by dyad)</i>		0.0098 (0.0073)		
<i>Power distribution</i>	-0.0019 (0.0197)	-0.0027 (0.0193)	-0.0023 (0.0196)	-0.0027 (0.0198)
<i>Alliance ties</i>	-0.0034 (0.0179)	-0.0051 (0.0177)	-0.0064 (0.0174)	-0.0054 (0.0174)
<i>Number of peacefull years (regarding Bilateral Militarised interstate disputes)</i>	-0.0006*** (0.0002)	-0.0006*** (0.0002)		
<i>Number of peacefull years (regarding Bilateral Water disputes)</i>			-0.0024** (0.0011)	
<i>Number of peacefull years (regarding Bilateral negative Water events)</i>				-0.0006 (0.0008)
Constant	0.0996*** (0.0369)	0.1100*** (0.0346)	0.0999*** (0.0353)	0.0951*** (0.0359)
Observations	8,259	8,259	8,259	8,259
R2	0.288	0.288	0.288	0.288
Year FE	Yes	Yes	Yes	Yes
country i and j FE	Yes	Yes	Yes	Yes
Country pair FE	Yes	Yes	Yes	Yes
*** p<0.01, ** p<0.05, * p<0.1				
Source: Author's calculations. Standard errors adjusted for clustering at the country pair level.				

**Results**  
 About the “second nature” of treaties: economic and political determinants of WTs



## Conclusion

- ❑ Climates change drives cooperation over water resources.
- ❑ WTs are adaptation policies.
- ❑ But only economics interdependence matter in explaining WTs .
- ❑ Obviously the effectiveness of these international agreements remain unknown.
- ❑ But, it is comforting to observe that governments look for these solutions by cooperating more between them regarding the forthcoming stress of common water resources due to climate change.

Thanks