Community, state and market:

understanding historical water governance evolution in Central Asia

Iroda Amirova, Martin Petrick, Nodir Djanibekov

irodaamirova@gmail.com

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

Leibniz Institute of Agricultural Development in Transition Economies

VolkswagenStiftung

Historical Central Asian water governance

Pre-colonial – Tsarist – Soviet periods

Source: “HASAHAR”. Irrigation of Uzbekistan cited in Abdullaev & Rakhmatullaev, 2015

Pre-colonial:
Election- sanctioning mechanism

Elections:

Tier 1: Community reps → Mirab-bashi of central authority

Tier 2: Several sublocalities→ 1 Ketman → max 4 Aksakal (ketman repr)→ Mirab & Assistant

Remuneration:

- Kipsen (kapsan) - it depended on the satisfaction level of farmers concerning the irrigation service quality they received

Tsarist time: transformations in water governance

✕ Election – sanctioning (de jure)

- Appointment & fixed wage (de facto) - Kaufman's initiative
- Initial large infrastructure (cotton goal)

Correlated with:

- Physical deterioration of irrigation system
- Increased corruption

Soviet time : transformations in water governance

- Full abolishment of self-governance
  - replacement with a water bureaucracy
- Kolkhozes, sovkhozes
- Diffusion of- large scale irrigation infrastructure
- Omnipresent low water use efficiency
- Aral Sea’s irreversible transformation into Aralkum Desert started

Today: depleted land and water endowment

- Inherited from previous regime

- Fundamental water problem of Central Asia:
  - mismanagement and bad governance associated with pseudo self-governance

Photo is taken from Creative Time, Inc., 2018

Photo by Iroda Amirova

(Lioubimtseva & Henebry, 2009; Zinzani, 2015)

Research questions

- Our study goes beyond the established historical insights
- We use game theory
- Model the evolution path of water governance

1. How likely it is that current water management could return to ancient principles of election-sanctioning?

2. Could private property in water management improve irrigation management efficiency today?

Evolutionary game theory as an analytic narrative

- Tool - through which we reiterate the historical events
  - mechanisms at play
  - game changers
  - drifts from one equilibrium into another
- Model water users' interaction in an evolutionary **Hawk-Dove** game
  - three alternative strategies to share a common good
- Evolutionary game theory
  - a priori programmed players, some strategies earn more than others
  - Successful strategies with higher payoffs are replicated more than unsuccessful ones, hence successful strategies proliferate in the population

(Dixit et al., 2015; Weibull, 1995; Petrick, 2013)

Guide to modelling steps

- The **hawk-dove game** (grab or share) as an analytical narrative of resource conflict. Equilibria involve ongoing wasteful fighting.
- **Multiplayer game**: equilibrium of both grabbers & sharers
- Introducing a third strategy: punishment by community members
- **Evolutionary game**: many players, many rounds, updating based on replicator dynamics, identifies Evolutionary Stable Strategies (ESS) that allow to trace governance dynamics over time.
- Historical undermining of punishment leads to evolutionary **return to fighting** ("Kaufmann drift").
- Introducing a fourth strategy: property rights ("Krivoshein game"), move to punishment or burgeois/share.

Hawk-Dove-Game: Payoff table in words

	Hawk (Grabber)	Dove (Sharer)
Hawk (Grabber)	Both: fight, incur cost, 50/50 chance to win	Hawk gets all resource
Dove (Sharer)	Hawk gets all resource	Share equally

Solutions

When fighting is not so costly:

- [Hawk-Hawk] : dominant strategy
- Everyone always fights

When fighting is costly

- [Dove-Hawk]: Nash equilibrium
- [Hawk-Dove]: Nash equilibrium

Hawk-Dove-Game: Payoff table

Player 2

Player 1		Hawk (Grabber)	Dove (Sharer)
	Hawk (Grabber)	(v-c)/2; (v-c)/2	v; 0
	Dove (Sharer)	0; v	v/2; v/2

- Two sides are **competing** over **common water** resource of value =**v**
- Each chooses to be a “hawk” or “dove” simultaneously
- Fighting cost = c

Waste & institutions to overcome

- The “waste” arises due to the fighting of the Hawks
  - In water use interaction: waste arises from problems as water stealing, and free riding during maintenance of the infrastructure
- Institutions which may overcome this waste and lead to sharing - is what we are interested in

1. Punishing (civic) behavior
2. Private property - Krivoshein game

(Bowles, 2004)

Return

Grab-Share-Punish-Game: Payoff Table in words

	Grab	**Share**	**Punish**
Grab	Both: fight, incur cost, 50/50 chance to win		
Share	Nothing; All resource	Share equally	
Punisher	Collective punishing; *wins: punishing water users share the water among themselves ; *lose: the punisher bears the cost of fight with the hawk	Share equally	Share equally

(Bowles, 2004, 382)

Return

Grab-Share-Punish-Game: Payoff Table

	Grab	**Share**	**Punisher**
Grab	(v-c)/2; (v-c)/2	v; 0	$(1-\beta)$v− βc; v/n−$(1-\beta)$c
Share	0; v	v/2; v/2	v/2; v/2
Punisher	v/n−$(1-\beta)$c; $(1-\beta)$v− βc	v/2; v/2	v/2; v/2

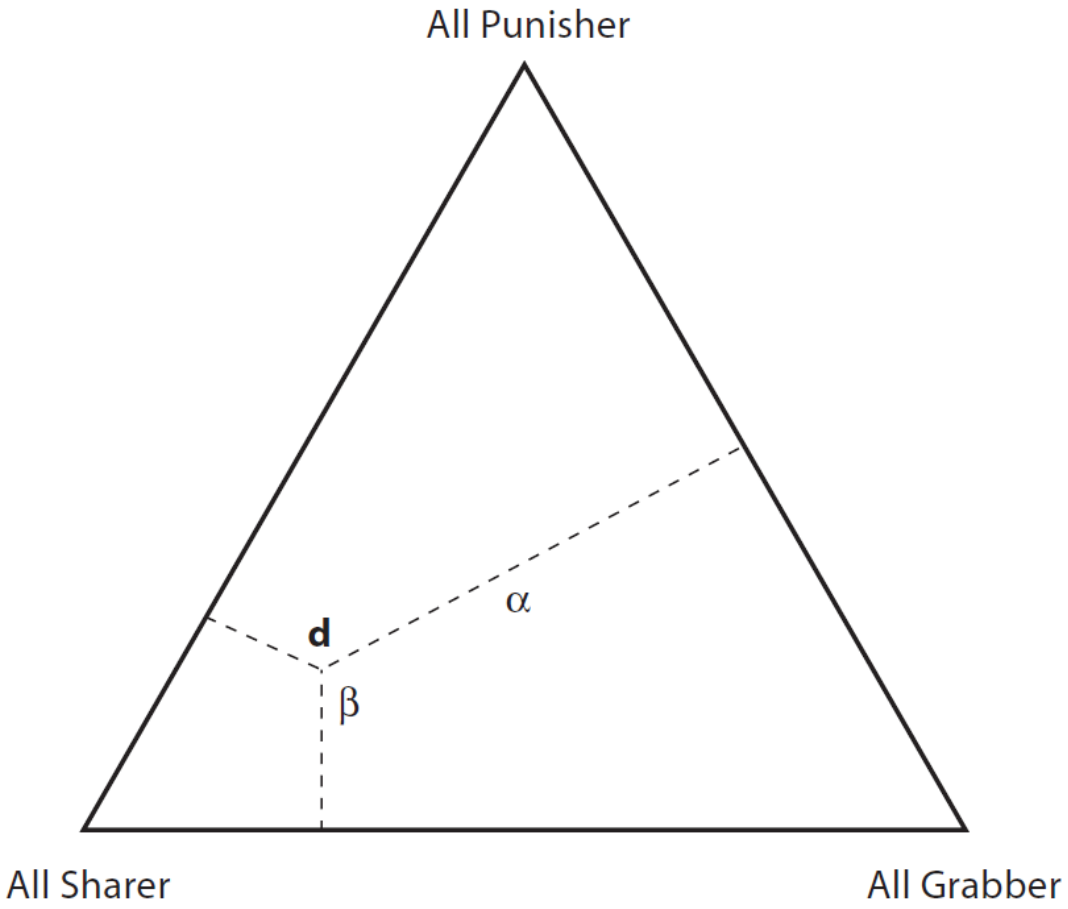
β Share of punishers in population.

Grab-Share-Punisher-Game

- There are two equilibria: Grab-Grab; Punish-Punish
- **Pre-Tsarist water governance resembled: Punish-Punish equilibrium**
  - Election – sanctioning mechanism: which we consider as a punishing strategy in the game
  - Mahalla & waqf further nurtured the punishing & sharing behavior

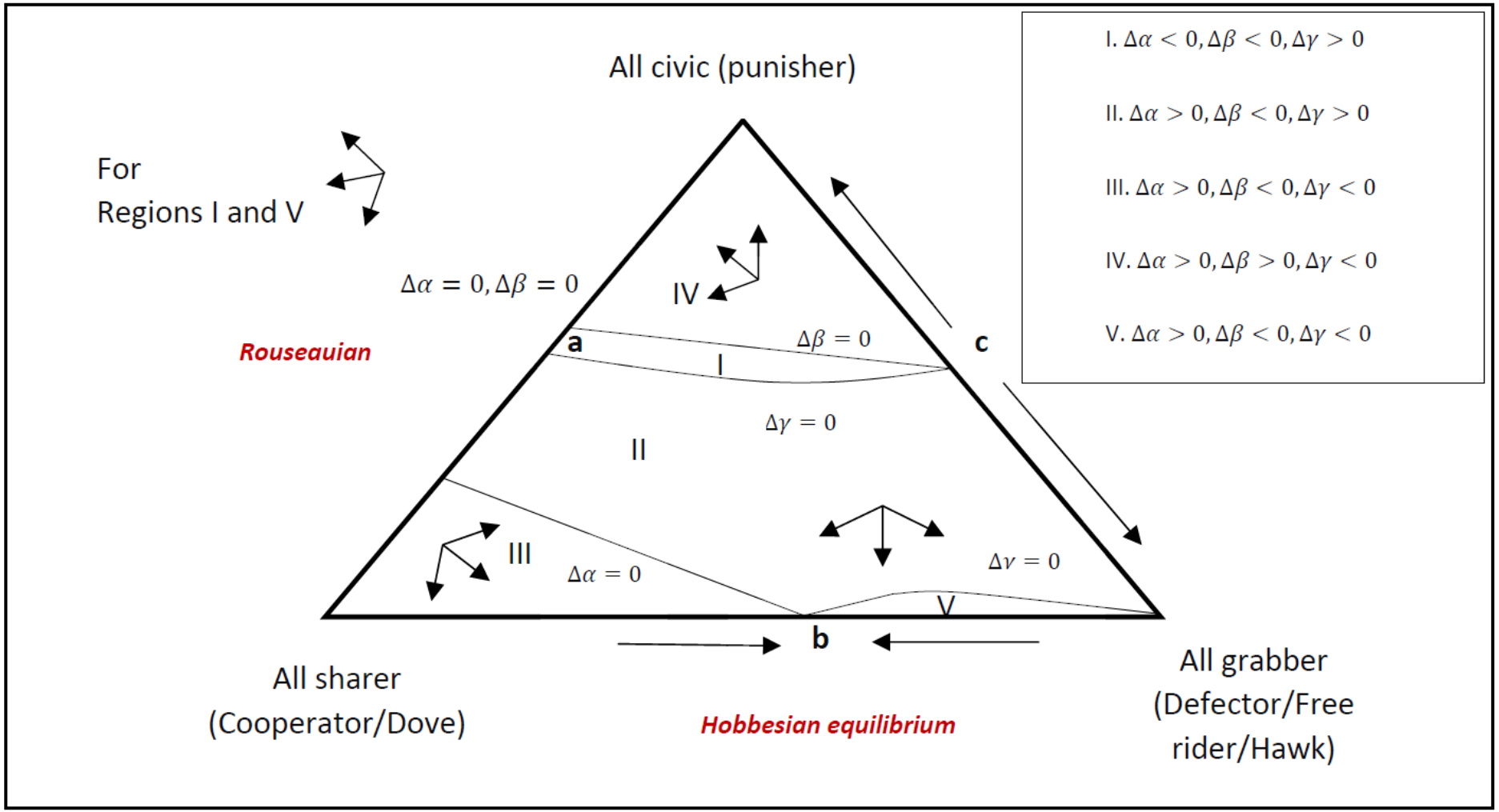
(Bowles, 2004)

Distribution of strategies in a multi-player game



Bowles 2004

Within groups dynamics multi-player



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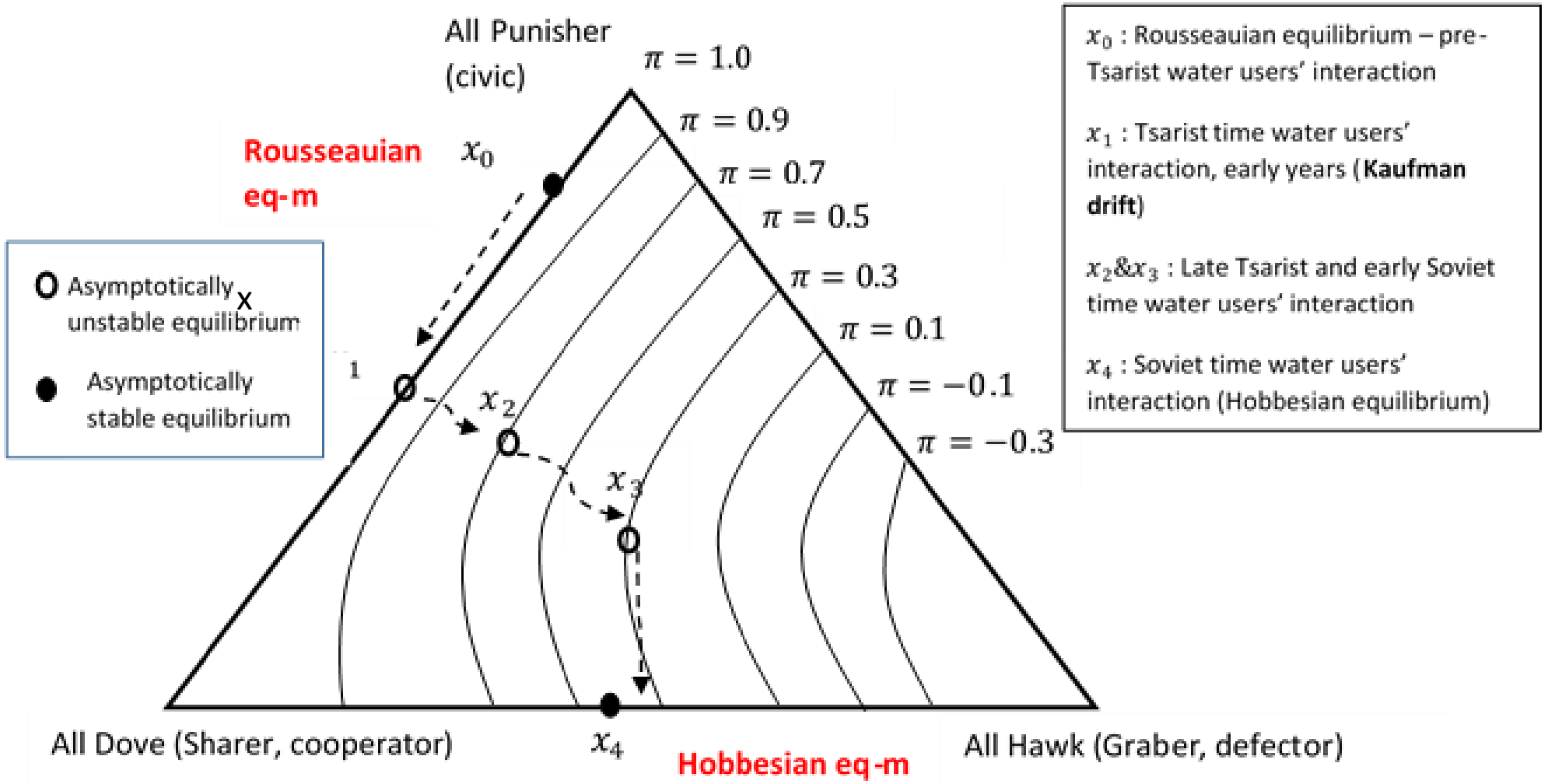
Effects of undermining the punishment mechanism



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Krivoshein's privatization goal

- Privatization law as a solution to corrupted traditional Central Asian water governance
- It would legalize the water trade that was already taking place in Fergana valley
- But Tsarist Russia dismantled shortly after this law proposal was submitted to the Duma
- Hard to guess the possible consequence
- **But we can imagine one possible consequence with stylized games**

Krivoshein Game

- Adopt a new strategy: “Bourgeois” strategy to Grab-Share-Punish game
- Bourgeois peasant:
  - if he owns the (water) resource, then he will behave like a Hawk
  - If he is not the owner of the resource, he would share the water resource with the interacting party (behave like Dove)
- We assume:
- ½ time the Bourgeois player is the resource possessor
  - hence claims for it
- ½ of the time he is a non-possessing Bourgeois
  - hence does not claim the water

Krivoshein Game: Payoff Table

	Bourgeois	Share	Punish (Civic)
Bourgeois	$v/2; v/2$	$3v/4;\ v/4$	$\frac{1}{2}[(1-\beta)v - \beta c];$ $\frac{1}{2}[v/n - (1-\beta)c]$
Share	$v/4\ ;\ 3v/4$	$v/2; v/2$	$v/2; v/2$
Punish (Civic)	$\frac{1}{2}[v/n - (1-\beta)c];$ $\frac{1}{2}[(1-\beta)v - \beta c]$	$v/2; v/2$	$v/2; v/2$

- **The stationary and stable states (solutions) are**:

1. All-Civic (Punisher) group of water users (Max Aggregate payoff &egalitarian)
2. Combinations of Bourgeois with Doves (Max Aggregate payoff & non-egalitarian)

(adopted and adjusted from Bowles& Choi 2013)

Relevance for today

- Hobbesian equilibrium with non-civic players is still prevailing in Central Asia
- Reformers do not displace it easily, due to its positive feedback mechanism
- There are two ways out:

1. Private property regime in irrigation water
   - All merits of the private property
   - Unobservable incomplete information, a weak institutional setting, prone to corruption, complicate private property regime enforcement over water
2. Restoring the election-sanctioning element to the WUAs
   - Nourish civic-mindedness
   - Handle the market failures associated with incomplete contracting and high transaction costs

Thank you

Research highlights

- Ancient water governance was more efficient than Tsarist and Soviet periods
- The traditional arrangement linked irrigation duties with benefits
- The de-facto appointing irrigation staff corrupted the traditional water governance
- Community & Privatization are still viable solution for the issues in irrigation governance today

Iroda Amirova. Email: irodaamirova@gmail.com