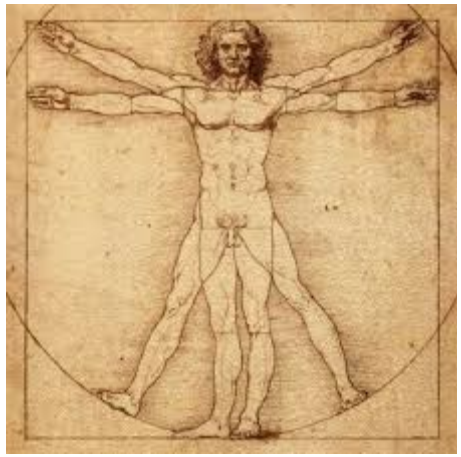
# Survival of the Weakest: Why the West Rules

with Salvatore Modica



## *Introduction*

model of institutions that evolve through conflict.

one of three configurations can emerge

- extractive hegemony
- balance of power between extractive societies
- balance of power between inclusive societies (where innovation is presumed to take place)

extractive societies assumed to have an advantage in head to head confrontations so the latter is “survival of the weakest”

# *Why the West "Rules"*

we contend industrial revolution in the West was due to two events in the far East around 1200 CE

- the invention of the cannon
- the depopulation of Mongolia

the theory also account for the low historical rate of innovation in India


## *The Model*

two societies contend over land/resources

two units of land one for each society

two configurations:

- *balance of power*: each society on its own land
- *hegemony*: one society controls both units of land

in a hegemony one society is *occupier* and one *occupied*

two groups in each society: *masses* and *elites*

two types of institutions: *inclusive* (w) and *extractive* (s)

inclusive institutions: masses have the upper hand

extractive institutions: elites have the upper hand

## States and Time

five possible states: $z \in Z = \{w, s, ww, sw, ss\}$

first two are hegemonies, remaining three are balance of power

conflict takes place over time $t = 1, 2, \ldots$.

beginning of period $t$ there is a status quo from the previous period $z_{t-1}$

game between the two groups in the two societies is played

outcome determines the state $z_t$ in the current period.

game depends on the status quo $z_{t-1}$ random events

## *Outline of the Game*

two stages

first stage: only one of the four groups active

active group may decide to initiate a conflict with a particular goal

(*attack* or *rebellion* depending on circumstances)

second stage takes place only if conflict initiated in the first stage

(otherwise $z_t = z_{t-1}$)

second stage: simultaneous move conflict game between the active group (*aggressor*) and one group from the other society (*defender*)

aggressor and defender choose effort levels and conflict resolution function determines the new state

all groups are myopic

all random shocks are iid

## *Outsiders*

four decision making groups plus $n > 0$ *outsiders*

outsiders do not make decisions but determine the environment in which conflict takes place

outsiders are societies and people outside of the model

protected by geographical and other barriers from the insiders

but never-the-less interfere

England versus the continent

hypothesis: outsiders are disruptive of hegemony and supportive of a balance of power (see Levine and Modica 2018)

in broad accordance with historical facts

## *Stage One: The Initiation of Conflict*

balance of power each society has equal chance of being active

- inclusive society it is the masses; extractive society it is the elites
- the goal is to occupy the land of the other society

hegemony only the occupied is active

- in an inclusive hegemony it is the masses; in an extractive hegemony it is the elites
- notice that the occupied society “inherits” institutions from the occupier
- again this seems in broad accordance with historical fact
- there are two possible goals: install an inclusive or extractive society
- both have positive probability regardless of who is in charge

## *Random Discrete Choice Model*

iid random utility shock $\tilde{u}$

based on this the active group then decides whether or not to initiate conflict - to attack or revolt

if conflict is initiated the utility of the active group is increased by $\tilde{u}$ and the utility of all groups is determined by the current state minus the costs of conflict

utility shock (wars to the death are uncommon): only the upper tail matters.

exponential form with three parameters $U(z,n) > 1$, $0 < P < 1$ and $0 < \epsilon < 1$

for $v \geq -U(z,n)$ then $\Pr(\tilde{u} \geq v) = P\epsilon^{U(z,n)+v}$

with probability $1 - P$ shock is smaller than $-U(z,n)$ and no conflict is initiate

## *The Parameters*

parameter $\epsilon$ scale parameter for the utility shock distribution.

If small probability of a shock much bigger than $U(z,n)$is very small: this is the case of interest

cutoff $U(z,n)$ depends on state and number of outsiders.

if $z$ is a hegemony then $U(z,n) = h(n)$

$h(n)$ is decreasing in $n$ with $\lim_{n\to 0} h(n) > 2$ and $\lim_{n\to\infty} h(n) = 1$

more outsiders reduces utility from hegemony

if $z$ is a balance of power then $U(z,n) = b(n)$

$b(n)$ is increasing with $n$ with $\lim_{n\to 0} b(n) = 1$ and $\lim_{n\to\infty} b(n) > 2$

more outsiders increases utility from balance of power

both continuous so a unique value $n^*$ such that \$$h(n^*) = b(n^*)$

## *Stage Two: Conflict Resolution*

aggressor determines the level of effort $1 \geq x_a \geq 0$ to devote to the conflict

defender is the masses if the society under attack has inclusive institutions and the elite if the society under attack has extractive institutions

defender determines a level of effort $1 \geq x_d \geq 0$ to devote to the conflict

contestants $i \in a, d$ face a quadratic cost of effort provision $C(x_i) = (1/2)x_i^2$

probability the aggression succeeds depends on effort

$$\pi(x_a, x_d) = \gamma + \alpha\left(x_a - [(1-\varphi)x_d + \varphi]\right)$$

$0 \leq \varphi \leq 1$ and $\gamma, \alpha \geq 0$ satisfy $\gamma + \alpha < 1$ and $\gamma - \alpha > 0$ (outcome uncertain)

## *The Parameters*

$\alpha$ measures the sensitivity of the outcome to the differential effort of the two combatants (basically weights the costs)

$\gamma$ small represents an intrinsic advantage of being a defender

$\varphi$ measures the sensitivity of the outcome to defensive effort

coefficient on $x_d$ is $(1\text{-}\varphi)x_d + \varphi$ a weighted average of the defensive effort and 1

- 1 measures the value of fixed fortifications.
- strong the effort of defenders should not matter much so $\varphi$ should be large.
- siege technology is effective - for example cannons can knock down defensive walls - then $\varphi$ should be small
- we interpret $\varphi$ as the effectiveness of fortifications

## *Transfers and Utility*

two possible tax levels representing a transfer from the masses to the elite on each unit of land

- high taxes are normalized to 1 and low taxes are $\tau > 0$
- hegemony occupier elite receive taxes from both units of land
- balance of power the elite receive the taxes from their own land only
- taxes are low in an inclusive state either in a balance of power or for the occupier of a hegemony
- taxes are high if institutions are extractive or for the occupied regardless of institutions

# *Equilibrium*

equilibrium is the stochastic process in which a Nash equilibrium occurs within each period.

will show that this equilibrium is unique, so depends only on the state $z \in Z = \{w, s, ww, sw, ss\}$

probability of current state conditional on the within period equilibrium depends only on the previous state

hence an equilibrium is a Markov process on the state space $Z$

positive probability of remaining in place and a positive probability of each of the eight feasible transitions.

process is aperiodic and ergodic so there is a unique ergodic probability distribution $\mu_\epsilon$

## *The Limit Distribution*

from Young: as $\epsilon \to 0$ the ergodic distributions $\mu_\epsilon$ have a unique limit $\mu_0$

states that have positive probability in the limit distribution $\mu_0$ are called stochastically stable

we will characterize the stochastically stable states

## *Stochastic Stability*

**Main Theorem:** *For generic values of the parameters there is a unique stochastically stable state. Only* $s, ss, ww$ *can be stochastically stable. There exists a* $0 < \tau^* < 1$ *and a strictly decreasing function* $0 < \varphi_\tau < 1$ *such that*

*1. if* $\tau > \tau^*$ *or* $\varphi > \varphi_\tau$ *then* $ww$ *is not stochastically stable with* $s$ *stochastically stable for* $n < n^*$ *and* $ss$ *stochastically stable for* $n > n^*$

*2. if* $\tau < \tau^*$ *and* $\varphi < \varphi_\tau$ *then* $ss$ *is not stochastically stable and there is a positive continuous strictly decreasing function* $n(\varphi) \geq n^*$ *with* $s$ *stochastically stable for* $n < n(\varphi)$ *and* $ww$ *stochastically stable for* $n > n(\varphi)$.

moderately extractive institutions: Olson's deteriorating institutions + Hayek's road to serfdom?

Rest of paper: $\tau < \tau^*$

## *The Conflict Subgame*

**Theorem:** *The conflict subgame has a unique Nash equilibrium. The utility gain to the aggressor* $u(y_a, y_d, \varphi)$ *is strictly increasing in* $\varphi$ *and* $y_a$*, decreasing in* $y_d$*, satisfies* $u(y_a, y_d, \varphi) < 1$ *and* $u(0, y_d, \varphi) = 0$*. There is a* $0 < \tau^* < 1$ *and a strictly decreasing function* $0 < \varphi_\tau < 1$ *such that the function* $v(\varphi) \equiv u(1, 1-\tau, \varphi) - u(\tau, 1, \varphi) - u(1-\tau, 0, \varphi)$ *satisfies* $v(\varphi) < 0$ for $\tau < \tau^*$ *and* $\varphi < \varphi_\tau$ *and* $v(\varphi) > 0$ *otherwise.*

## *Idea of the Main Theorem*

resistance: derivative of the logarithm of a probability with respect to the logarithm of $\epsilon$

resistance of a transition $r(z_{t-1} \to z_t)$

ex ante probability of a successful implementation of the particular goal has the form $Q \cdot \Pr(u(y_a, y_d, \varphi) + \tilde{u} \geq 0) = Q\epsilon^{U(z,n)-u(y_a,y_d,\varphi)}$ where $Q$ is independent of $\epsilon$

hence resistance given by $U(z, n) - u(y_a, y_d, \varphi)$

## *Modified Radius*

attribute of a state that determines the relative time the process spends in it is the modified radius $R(z)$

the stochastically stable states are exactly those with the greatest modified radius

modified radius computed by adding incremental costs of passing through states according to the circuit structure

a *circuit* is a collection of states with a least resistance path between any pair

here the circuit structure is $[(ss \leftrightarrow s) \leftrightarrow sw] \leftrightarrow (w \leftrightarrow ww)$

the rest is a computation where we find that the difference between modified radii of $ss$ and $ww$ is given by $v$

## *Survival of the Weakest*

a head to head contest between an extractive and an inclusive society: that is, the state $sw$

$$r(sw \to w) - r(sw \to s) = u(1, 1-\tau, \varphi) - u(0, 1, \varphi) > 0$$

high resistance = low probability that the inclusive society prevails

the extractive society is strong the inclusive society is weak

## *Home Field Advantage*

$r(ww \to w) - r(ss \to s) = u(1, 1, \varphi) > 0.$

the strong perform well on foreign ground, the weak do not: the fact that the strong do well both at home and away while the weak only do well at home is well known to sports fans

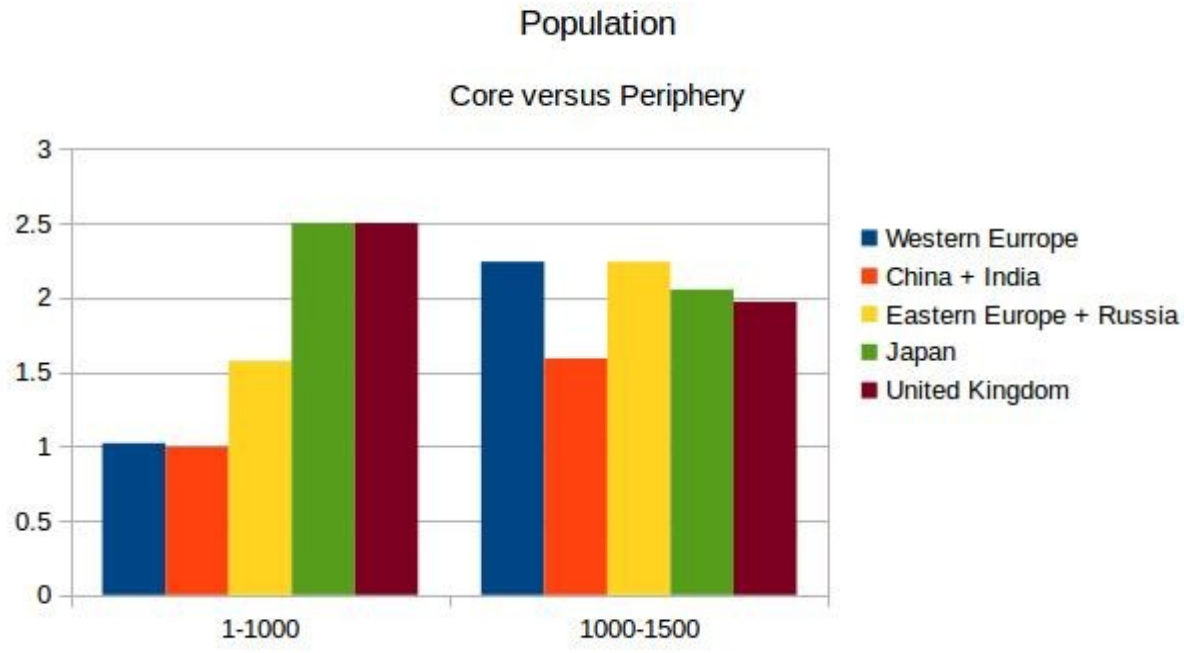
the idea the there is an advantage in defending home ground differentiates this model from our earlier work

# *History*

Europe, China and India (where everyone lived) in the Common Era

- population
- Mongolian diaspora (1200 CE)
- warfare

# *Population: Early Globalization*




Western Europe
Eastern Europe
Mongolia
Middle East
Central Asia
China
India

## *A Brief History of Siege Warfare*

brick city walls as early as 2500 BCE

remained dominant until the invention of gunpowder

impact of cannon on fortification well documented

arrives in Europe around 1200 CE

arrives in India around 1500 CE

but use of gunpowder bombs in China beginning around 800 CE gradually eroded the effectiveness of fortifications culminating with the invention of the cannon

# *Europe*

extractive hegemony (Rome through 330 CE)

extractive balance of power (early Medieval to about 1300 CE)

inclusive balance of power (Renaissance) [only period with substantial innovation]

## *China*

to about 900 CE: both extractive hegemonies and extractive balance of power

900 CE – 1300 CE: Song era – inclusive balance of power

1300 CE to 1911 CE – extractive hegemony

Song era China looks much like Renaissance Europe both in terms of competing states, political institutions, arts, commerce and innovation

canal locks, paddle boats, windmills, various measurement devices, improvements in the use of power, improvements in ships and navigation - and in addition to crossbows, most notably the invention of gunpowder together with land mines, bombs, flamethrowers and of course cannons

## *India*

too soon and too late

- outsiders arrived too soon for extractive hegemony
- cannons arrived too late for inclusive balance of power

India had an extractive balance of power through most of its history

remarkably little innovation: it is famous for advances in art, architecture, mathematics and astronomy - but not in the more practical arts

always strong outsiders

- population of Central Asia very large compared to Mongolian
- nobody ever invaded central asia successfully from India
- the other way around was common