Model of a principle and an agent. The agent represents the farmers in an early state of antiquity, and the principle is the government who wants to maximise taxation revenue.

The problem is that of moral hazard - the actions of the agent and the state of nature are not observable. Output could be high or low. It is high if and only if effort is high and the state of nature is good.

There is a signal on the state of nature, and the signal is valuable - it does provide information on the real state of nature, but the accuracy of the signal is not perfect (q) - the Nilometer is not perfect.

There is a cost for agent to exert high effort. The cost is y (calories). This is a constraint on the principle (the state must allow the agent to retain this amount of food to survive.) U = I - y

The moral hazard problem is that the agent could avoid working and still receive w payment.

In equilibrium, the contract takes this into account. The agent gets some rents from being the agent. The principle cannot reduce the payments such that the agent barely survives, because the agent could just shirk and receive y.

Two period model. Need multiple period because we're interested in the contract: the incentive scheme which has a carrot (bonus) and a stick. The stick is dismissal: for dismissal to be meaningful we need additional periods.

V = value of employment
delta = time discount factor
0 = value of unemployment

At the end of the first period the agent could be punished and obtain 0, or stay and retain the job and obtain a level of welfare of V.
The carrot is that the principle offers a bonus (b) if output is high - with the restriction that w (omega) must be paid (which = y).

There are two types of contracts: using dismissal, or not using dismissal (only relevant in the first period).
- d=0 - don't use dismissal
- d=1 - use dismissal
  - used when output is low but the signal on the state of nature is good: (chance 1-q that this is wrong).
  - punishment incentives the agent on account of the bonus payment.
- Replacement cost = x
  - cost on both sides means that it is an inefficient mechanism

So in first period, there are two types of contract: *pure carrot* and *carrot & stick*
The second period optimisation implies this-
In second period, stick is not an option at all, because it is not credible - so it is only the bonus:
- Bonus payment needs to be sufficiently high to compensate for the cost of effort (**b2=y**)
- This dictates the value of being employed in the 2nd period.

If b2=y the value of employment in the second period for the agent = the cost of effort (**V=y**)
- The principle pays the agent full compensation for the cost of effort (y) + a bonus (b) which is equal to y.

The intuition:
The agent always has the option to shirk and still receive the payment for compensating for the effort (because the principle doesn't observe the effort)
- so min. agent obtains is income above subsistence of the cost of effort
- principle must compensate agent for effort with additional bonus payment of size of compensation

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(9:40)
Now we go the first period optimisation, and the objective function of the principle is to minimise the cost of incentivising the agent, subject to the incentive constraint compatibilities holding

This is expected utility of agent if they exert **high effort**: (LHS)

$$b_1 + \omega - \gamma + \delta V$$

This is expected utility of agent if they exert **low effort**: (RHS)

$$\omega + (1-d)\delta V + d(1-q)\delta V$$

LHS > RHS otherwise agent will not exert effort

$$b_1 + \omega - \gamma + \delta V \geq \omega + (1-d)\delta V + d(1-q)\delta V$$

Agent know states of nature, so this is only relevant when the state of nature is good. If the state of nature is bad, the agent doesn't work, because it's useless.
- But if the state of nature is good, the agent knows that if he works he receives
- the bonus + (minimum wage - cost of effort) + value next period being employed * discount factor

If d=0, pure carrot contract means that the agent retains the job, for sure -> just receives **w**
- But the agent knows he could avoid working: benefit from shirking is receiving
- the minimum wage (without paying the cost of effort) + income next period if not dismissed (d<1) + income next period if signal on state of nature is misleading
- § Agent takes into account the probability that the state of nature is misleading: q= accuracy of the signal.

If q is low (Mesopotamia) then expected payoff from shirking is higher
- **gets minimum wage, exerts no effort (so no cost) and there is chance they will retain the position.**

If q is close to 1, and agent is shirking, very high chance they will be dismissed.

Which simplifies to this:

$$b_1 \geq (1 - dq\delta)\gamma$$

If d=0 (no dismissal - pure carrot) then b>y
But if d>0 (stick is a threat) then multiplier on y is smaller -> so b is smaller.
- The threat of dismissal by the principal (if output is low, when signal on state of nature is good) reduces the bonus as the agent doesn't want to be dismissed.

Trade-0ff between using the stick and the carrot: more stick, less carrot
- Reason why stick would be included in the contract

First period optimization

The principal's objective function OF_1:

$$\min_{b \geq 0} pb_1 + \gamma + (1-p)(1-q)dx$$

subject to the agent's incentive compatibility constraint, IC_1, for $\theta = G$:

$$b_1 + \omega - \gamma + \delta V \geq \omega + (1-d)\delta V + d(1-q)\delta V$$

→

$$b_1 \geq (1 - dq\delta)\gamma$$

-

Solution

The IC is binding:

$$b_1 = (1 - dq\delta)\gamma$$

(Note that both the OF_1 and the IC_1 are linear in b_1 and d and thus the optimization implies a corner solution)

The stick and carrot contract:
b under the stick is smaller than b under the carrot -
which is the reason why the principle would include the stick in the contract

Stick & Carrot: $(d = 1)$

$$b_S = (1 - q\delta)\gamma$$

Pure Carrot: $(d = 0)$

$$b_C = \gamma$$

Why might principle **not** include the stick?
- There is a cost to using the stick: it is a threat, but has to be enforced when appropriate to remain **credible**
- Cost of incentivising the agent when using the stick is x

What is the cheapest way for the principle to incentivise the agent?
- Provide the required incentives for the agent, for the minimum cost.

Principle compares using the stick and carrot, to pure carrot.

Bonus is only paid in probability p, such that the state of nature is good.

If the IC holds this means that the agent is working hard in every period.
- Designing the right contract generates a situation in which the agent *does* work hard every period.
- The other cost, in addition to the bonus, is the probability that the agent is dismissed.
- This occurs if the state of nature is bad (1-p) **but the signal is misleading** and the principle believes the state of nature was good. The agent is dismissed.

Probability that state of nature is bad and signal is misleading

- $(1-p)(1-q)x$

so the agent is dismissed in a stick and carrot contract

So the 2 options which the principle has: simply pay a higher bonus (pure carrot) OR pay a lower bonus but bear the expected cost of dismissing the agent (stick and carrot).

When is this cost high/low?
- We are interested in transparency/ accuracy of the signal
- If the signal is accurate (q=1)

- $(1-p)(1-q)x$

Then this (the cost of wrongly dismissing the agent in a stick and carrot contract) is very low, and therefore the principle is justified in using a stick and carrot contract.

Optimal to use stick and carrot contract when signal is accurate (q=1), (e.g, Ancient Egypt) because cost associated with stick and carrot contract (falsely dismissing the agent) is very low.
- *If q is very small (Mesopotamia) then it could be case that RHS is higher (cost of stick and carrot is higher than cost of pure carrot) so pure carrot will be used.*

$$pb_C \leq pb_S + (1-p)(1-q)x$$

If:

$$OF_1(d=0) \leq OF_1(d=1)$$

↔

$$pb_C \leq pb_S + (1-p)(1-q)x$$

↔

$$q \leq \hat{q} = \frac{(1-p)x}{p\gamma\delta + (1-p)x}$$

→ *'Pure Carrot'* and otherwise: *Stick & Carrot:*

If **q < q^** then we will use pure carrot contract.
- Looking at different regions of the world, they differ in terms of transparency of economic activity, with the implication of different types of contracts
- Pure carrot is optimal for low q
- Stick and carrot is optima for high q

If x is sufficiently high, q^ > 0.5
- $\hat{q} < 1$
- For $x > p\gamma\delta/(1-p)$, $\hat{q} > 1/2$

→ For some set of parameters:
- 'pure carrot' is optimal for low q
- 'stick & carrot' is optimal for high q

In terms of why q matters:
(1-p)(1-q) is expected probability of dismissal [bad state of nature and incorrect signal]
Expected cost of dismissal:
(1-p)(1-q)x

Intuition: a principal relying on a "stick" to incentivise the agent has to incur the cost of dismissal x with probability:

$$(1-p)(1-q)$$

→ The expected cost of using the "stick":

$$(1-p)(1-q)x$$

is decreasing with the quality of information q

Calculating the expected income of the principle

Expected Income in the first period

Pure Carrot

The expected income of the agent

$$I_c = \gamma + p\gamma$$

The expected income of the principal

$$\pi_c = p(H-L) + L - I_c$$

Efficient outcome:

$$I_c + \pi_c = p(H-L) + L$$

Stick & Carrot

The expected income of the Agent

$$I_s = \gamma + p(1 - q\delta)\gamma$$

is decreasing with q

Agents prefers for q to be low (q=0.5).
He wants a bad signal so that's he's more likely to get away with shirking

The intuition for the decline of I with q above $\hat{q}$:
Holding constant the bonus, b, a higher q implies a lower probability of dismissal, increasing the value of employment. Therefore, as q increases b has to decline to hold the incentive constraint binding.

The expected income of the principal

$$\pi_s = p(H-L) + L - I_s - (1-p)(1-q)x$$

is increasing with q

inefficient outcome:

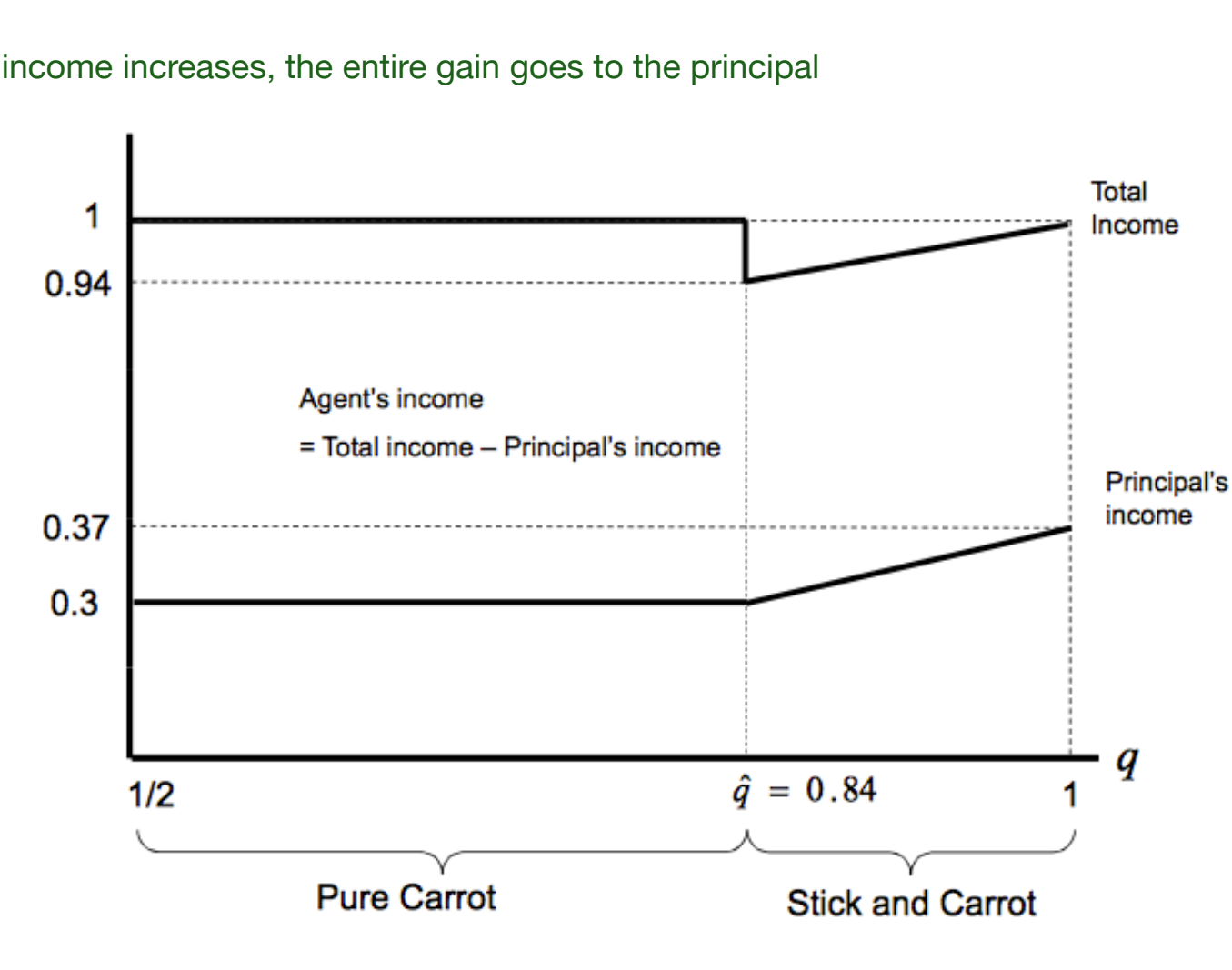
$$I_s + \pi_s = p(H-L) + L - (1-p)(1-q)x$$

inefficiency declines with q within the 'stick & carrot'

Figure is taken from the paper, so is for the more general case.
On x-axis is the accuracy of the signal for information, or transparency of economic activity
On y-axis is income (total and for principal- difference is income of agent)

- With pure stick total income is 1 (there is no waste in the economy) and income of the agent is high
- Once accuracy of signal surpasses, q^ it is optimal for the principle to use the stick and carrot contract, which reduces the agent's payoff. Threshold level of accuracy of signal, above which principle chooses the stick and carrot
- Total income falls once the stick enters the contract: because there are wasted resources in the economy due to the cost x of replacing agents - an inefficiency arises (1-p)(1-q)x
- As q increases there is less and less wasted resources as the signal becomes perfect
- Once the stick is in the contract, the more accurate the signal, the less the stick is used, because punishment rarely happens
- Punishment is effective when it is correlated with the behaviour of the person you want to incentive.
- When q is high, punishment is correlated with behaviour, otherwise it is just random and cannot provide an incentive

As total income increases, the entire gain goes to the principal



Conclusions:
- Opacity vs transparency can lead to de facto property rights and increase the welfare of subjects
- Ownership of land doesn't increase incentives to exert effort - it is granted by the elite because at low transparency it is too costly for the elite to expropriate the subjects.

Standard reason in the literature for granting property rights:
The explanation for granting property rights (protecting property - public goods), from a non-benevolent govt because it creates incentives for farmers to exert high effort.

What Moav and Neeman (2012) say is that one should make a distinction between property rights over output or over factors of production.
- **Over output the standard explanation is correct: govt provides property rights to grant incentives**
- **For factors of production, it is not clear why ex-post the government would like to suddenly take the land away (as the king will not become a farmer & will have to find a new tennant)**
- **But there may be a benefit in not granting property rights over land by telling the farmers "we give you this land to use, but it's not really yours. If you don't perform well we'll take the land and give it to a different farmer."**
- This generates incentives, despite going in the opposite way to the standard argument.

Arguments are reconciled by looking at incentives wrt factors of production and output.
The standard argument of granting property rights to create incentives is relevant for output, but not factors, like land.
- The only reason why the elite may not use this threat is if it is too expensive to use (low quality signal makes cost of dismissal high). By not using this threat (granting property rights) incentives to work hard are actually reduced - because the farmer's land will not be taken away regardless of effort.

As the model shows, the tax rate should be lower (the farmer can retain more output) which is the bonus.

Conclusions:
- Opacity can lead to de facto property rights and increase the welfare of subjects
- Ownership of land doesn't increase incentives to exert effort - it is granted by the elite because at low transparency it is too costly for the elite to expropriate the subjects
- Transparency can lead to micro management by the elite and reduced efficiency

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In reality, there isn't a contract between the elite and each farmer. There is a hierarchy with many tiers of command
- In ancient Egypt, the Pharaoh didn't have a contract with each farmer. There were heads of regions etc.
- The moral hazard problem exists at each point in the hierarchy (misreporting)

The prediction is the same:
- That in high transparency economics (Ancient Egypt - Nilometer) the heads of the villages would be officials of the centre also subject to dismissal.
- But if there is low transparency, village heads would be autonomous

Extension: State Concentration

A key aspect of state government is the multi-tiered hierarchy of control
- Our model can be interpreted as a series of principal-agent interactions at the different tiers of the hierarchy – each tier like the one we analyze

State Concentration
We can think of two main cases:

Ancient Egypt

1. Local farming is transparent to both local officials and the state
   - In this case there would be a stick & carrot farming contract and a stick & carrot contract to local officials

Implies: Peripheral centres are *weak*
- This is the story of Egypt: historians define them as a civilisation without cities (they weren't administrative)
  - In Egypt, information went straight to the centre

Extension: State Concentration

Outcome depends on who knows what
Two main cases:
1. Local farming is transparent to both local officials and the state
- "stick & carrot" farming contract and "stick & carrot" contract to local officials
- peripheral centers are *weak*

Ancient Lower Mesopotamia

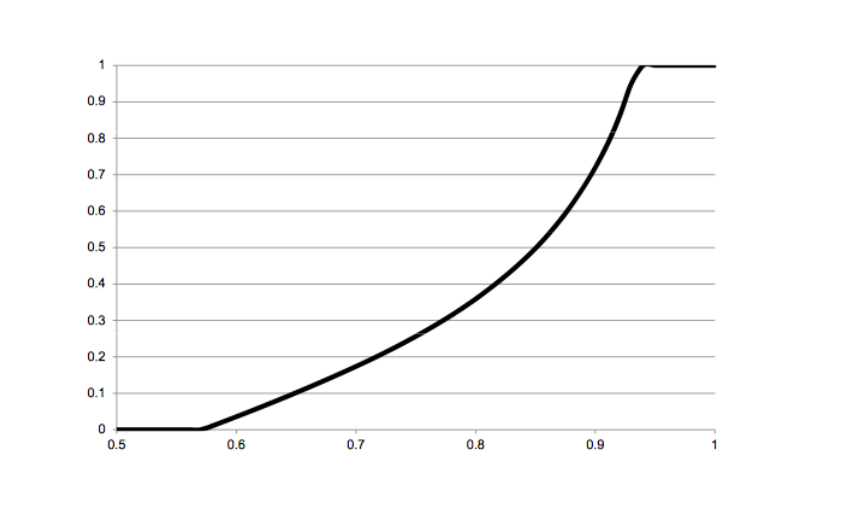
1. Local farming is transparent to local officials but not to the state
   - So there would be a stick & carrot farming contract, but a pure carrot contract between officials and the state

Implies: Peripheral Centres are *strong*
- City states

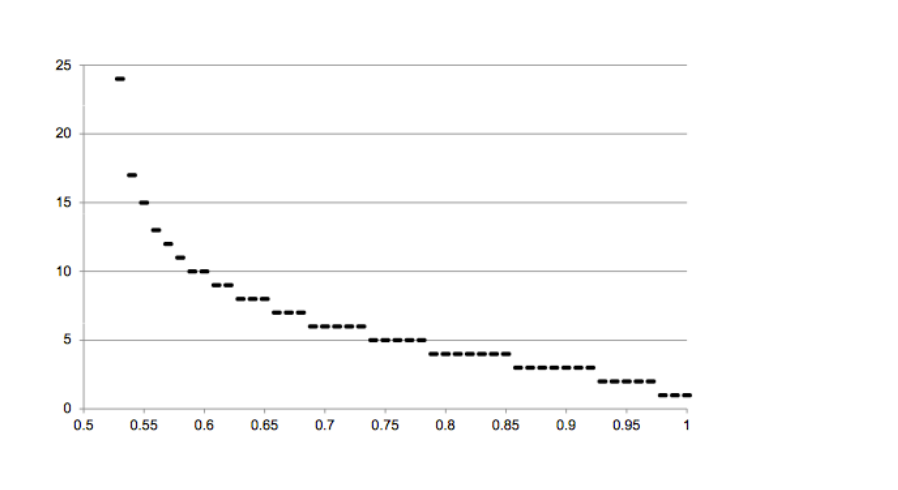
Extension: State Concentration

Outcome depends on who knows what
Two main cases:
2. Local farming is transparent to local officials *but not* to the state
- "stick & carrot" farming contract and "pure carrot" contract to local officials
- peripheral centers are *strong*

The dismissal probability *d* as a function of *q* when *d* is continuous



Warnings are possible:
The optimal number of times in which output is low and the signal is good leading to the dismissal of the agent as a function of *q*



Part 4. Applications

Why is it that some regions are poor and some are wealthy?
- Poverty trap models explain persistence but not why a country is poor to begin with
  - Modern literature looks at deep-rooted factors:
  - Geography, institutions, geography that affects institutions

We're looking at 3 regions here:
- Egypt (most transparent) - Nile River
- Lower Mesopotamia (mid transparent) - River system
- Upper Mesopotamia (least transparent) - rain

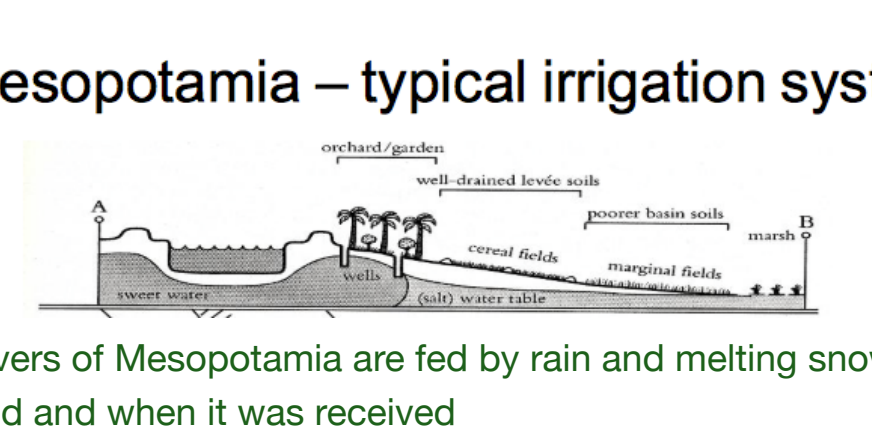
Part 4. Application: Mesopotamia and Ancient Egypt

- The Old Testament refers to Egypt as a "house of bondage"
- This expressed disapproval of Pharaonic land tenure institutions, where farmers were serfs who tilled land that they did not own
- In ancient Israel and Upper Mesopotamia, owner-operated farming was common and sometimes the norm
- Land tenure in Southern (lower) Mesopotamia was more like in Egypt

More tennant farmers in Egypt (rather than owning their land) because transparency lent itself to stick and carrot contract: 'slave'
In Upper Mesopotamia, farmers owned land (low incentives)

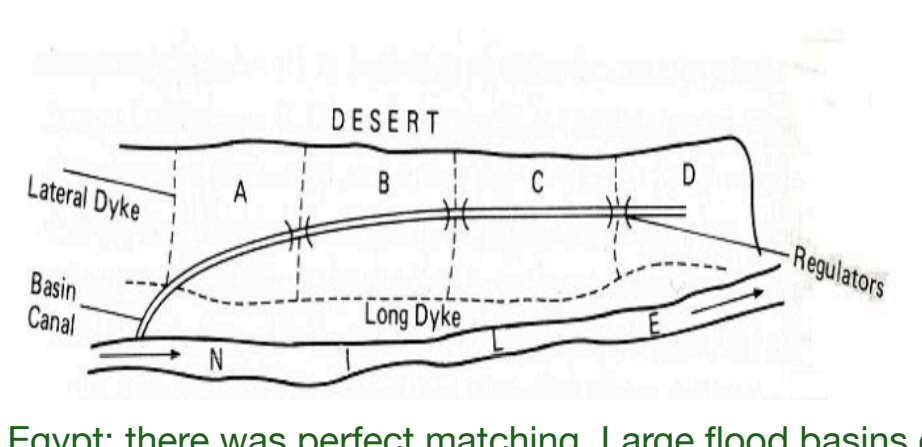
What is the deep rooted factor here?
The timing of the flow of the rivers.

Mesopotamia – typical irrigation system



The rivers of Mesopotamia are fed by rain and melting snows - risk of flooding - mismatch between when water was needed and when it was received
- Therefore, canal system instigated

Egypt – typical irrigation system



Unlike, Egypt: there was perfect matching. Large flood basins caught water, which stood for 40 day, then drained back.

A simple geographical difference: the timing of the flow of the river and its matching to the farming season created different irrigation systems - which created the big difference in transparency.
- **Here, transparency is very high: Nilometer gave very accurate signal which went to the centre**
- **Made the stick and carrot contract more suitability - which gave a bigger incentive to farmers**

Nilometer

- The Nilometer: indicator for the inundation height of the Nile
- Cooper (1976:366): "On the basis of the Nile flood recorded by the Nilometer, the government knew in advance what revenue to anticipate."

Application: Ancient Egypt and Mesopotamia

In terms of application we have a theory which explains why farmers were tennant-serfs without title to the land they cultivated in Egypt and Lower Mesopotamia.
The local elite of Lower Mesopotamia had full control of the supply of water and therefore a lot information.
Much of the land in upper Mesopotamia was rain-fed, so didn't provide this ability to the local elite, which meant that land was privately owned.

Land ownership

Our theory can explain why:
- Egyptian farmers were tenant-serfs, without title to the land that they cultivated
- Much of the land in Upper Mesopotamia was cultivated by its direct owners
  (Records for private real estate transaction and loan contracts, that would be typically secured by land, are abundant in ancient Mesopotamia and hardly exist in ancient Egypt)

Tennant-farmers do not own land & have no property rights, so no disputes

Legal Disputes

Our theory can explain why legal disputes were resolved:
- in Egypt by local noblemen without legal codes
- in Mesopotamia by court process, guided by law codes issued by the state

In Mesopotamia, information didn't go straight to centre, which is why local elite was autonomous and had power.
- The state was not highly concentrated, unlike Egypt.

State Concentration

Our theory can explain why:
- The local nobles and the regional governors in Egypt were agents of the Pharaoh, subject to dismissal
- The cities in Egypt were administrative centers
- The cities in Mesopotamia retained much power, controlled by the local elite

Strong central state with high state capacity in Egypt rose faster -> pyramids

State Capacity

Our theory can explain why the central state in Egypt:
- rose much faster than in Mesopotamia
- was much more stable
- could siphon off a greater share of the country's produce
  (This enabled the construction of the great pyramids in the mid-third millennium)

I expect you to know models we went over in detail.
Just two models:
Galor-Zeira (1993) model and this Moav Neeman (2012) model
Also, conspicuous consumption story.

Conclusions

- The prevailing view is that asymmetry of information is a hindrance for efficiency
- We argue that lack of transparency could protect the freedom and well-being of agents

Conclusions

- The existing literature abstracts from the role of appropriabililty in explaining differences in state capacity, concentration, and institutions
- We argue that geographical differences affect the degree of transparency and thereby state's capacity, concentration and institutions