The Organization of Expertise in the Presence of Communication

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December 2011

Motivation

It is usually observed

the decision-makers base their decisions on the information provided by specialized experts.

Arrow pointed out (1969, p.30):

"Knowledge arises from deliberate seeking, but it also arises from observations incidental on other activities."

Motivation

More precisely,

a) An uninformed principal has to elicit info from unbiased experts

b) Each expert must gather costly info that has some precision

c) If communication takes place, each agent obtains a more precise signal

d) Communication also introduces the possibility of collusion

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  - Two spies: isolated

1. $\hookrightarrow$*Spy 1: obtains information from the interception of communications. But some piece of information, a priori, does not seem crucial.*
2. $\hookrightarrow$*Spy 2: investigates peoples who have entered and left country A in the past year. But some piece of information, a priori, does not seem crucial.*

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- Nevertheless, the spies may be corrupt and they may coordinate their reports.

- $\Rightarrow$The Director's problem now is whether to allow or not communication between the spies.
- The answer is straightforward....
- The point is *when* to allow communication: after or before to exert effort?

Motivation

$\Longrightarrow$ *The question is:*

Should principals promote or impede communication among experts? If so, when?

$\Downarrow$

Multiagent-principal framework where

communication has conflicting consequences

Some Findings

- If the advantages of cooperation outweigh the disadvantages of collusion,

$$\Longrightarrow \qquad \text{allow communication}$$

- BUT ! *When?*

In the presence of communication and synergy effects between experts, the principal is better off by allowing the experts to communicate before they collect information rather than after they exert effort.

Outline

- The general setting
- The benchmark case: isolated work structure (IWS)
- The organization of the communication work structure (CWS)
  - Communication between experts *after* exerting effort
  - Communication between experts *before* exerting effort
- *Before* or *After*?
- IWS versus CWS
- Concluding remarks

The general setting

- A risk-neutral principal has to take an action {undertake; not undertake} a policy
- If the policy is undertaken, two possible observable monetary outcomes: $S > 0$, when success, or $F < 0$ otherwise; $\Pr(S) = v$.
- If the policy is not undertaken, the policy's outcome is not observed.
- The principal's gross payoff (V) depends on action and policy´s outcomes
- Without additional information, $vS + (1 - v) F < 0$.

The general setting

- The principal hires $n = 2$ agents
- Agents are risk-neutral, unbiased and protected by limited liability
- $e_i \in \{0, 1\}$ where $c(e_i = 0) = 0$ and $c(e_i = 1) = c > 0$
- He will get a signal $\sigma_i^\circ \in \{\underline{\sigma}_i^\circ, \bar{\sigma}_i^\circ\}$, where $\underline{\sigma}_i^\circ$ "bad news" and $\bar{\sigma}_i^\circ$ "good news"
- The signals are independent conditional on the policy's outcome

The general setting

Let $p^i(\cdot)$ denote the precision of the signal obtained by agent i.

$$p^i(\cdot) \equiv \Pr(\bar{\sigma}_i | S) = \Pr(\underline{\sigma}_i | F) \in (0,1)$$

Assumption 1 $p^i(\cdot) = p^i(e_i)$

i. all experts are equally precise

ii. $p^i(e_i = 0) = v$ *and* $p^i(e_i = 1) = a > 1/2, \forall i.$

The general setting

Assumption 2 (when communication takes place) $p^i(e_i, e_j)$

i. $p^i(1, e_j) > p^i(0, e_j) = v, \ \forall \ e_j$

ii. i signal's precision is increasing in e_j

$$p^i(0, e_j) = v; \qquad p^i(1, 0) = a$$

$$p^i(1, 1) = \epsilon > a$$

The general setting

- I assume that two favorable signals make the policy valuable:

$$v(\bar{\sigma}\bar{\sigma})\, S + (1 - v(\bar{\sigma}\bar{\sigma}))\, F > 0$$

where $v(\bar{\sigma}\bar{\sigma}) = \Pr(S \mid \bar{\sigma}\bar{\sigma})$.

- Since $v(\underline{\sigma}\underline{\sigma}) < v(\underline{\sigma}\bar{\sigma}) = v$, then after $\underline{\sigma}\underline{\sigma}$ or $\underline{\sigma}\bar{\sigma}$ the status quo

- The expert's payoff function is

$$t(\cdot) - c(e_i) \geq 0$$

- The principal's net payoff will be

$$V - t(\cdot)$$

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The general setting

- It is worth remarking that:
  - experts produce soft information which is non-verifiable and fully manipulable
  - $\Longrightarrow$ two kinds of problems:
  - (i)to design a contract such that experts exert effort and
  - (ii)to design a contract such that experts truthfully reveal their private information.

Isolated Work Structure (IWS)

The information available to each agent in each phase is:

a. Whether the expert gathers information or not is not observable neither by the principal nor by the other expert.

b. The signal σ_i is not observable neither by the principal nor by the other expert.

The contract that the principal offers must provide experts with incentives to gather information and report it accurately.

Isolated Work Structure (IWS)

- The transfers will be based on reports and on the policy's outcome.
- When the policy is undertaken: $\bar{t}$ when it is success or $\underline{t}$ when it fails.
- When the policy is not undertaken: t_0 when both signals are negative. With conflicting signals: reporting $\bar{\sigma}$ receives t_g, and reporting $\underline{\sigma}$, receives t_b.

Isolated Work Structure

The agency cost for the isolated work structure is
$(T_{IWS} = p(\bar{\sigma}\bar{\sigma})\, v(\bar{\sigma}\bar{\sigma})\, \bar{t} + p(\underline{\sigma}\underline{\sigma})\, t_0 + p(\underline{\sigma}\bar{\sigma})\,(t_b + t_g))$

$$T_{IWS} = 2\frac{c\,[p(\underline{\sigma}) + (1-v)(2a-1)\,a]}{(1-v)(2a-1)\,a}$$

Therefore, the principal's net surplus is

$$a^2 vS + (1-a)^2 (1-v) F - T_{IWS}$$

Communication Work Structure (CWS): after

The information available to each agent in each phase is:

a. Whether or not the expert gathers information is not observable either by the principal or by the other expert.

b. The signal σ_i is not observable by the principal but it is observable by the other expert in the communication phase.

The transfers will be based on reports and on the policy's outcome

Communication Work Structure (CWS): after

AS constraints. If each expert observes $\bar{\sigma}$, they should prefer to report $\bar{\sigma}\bar{\sigma}$ rather than $\underline{\sigma}\underline{\sigma}$ or $\underline{\sigma}\bar{\sigma}$.

$$2v\left(\bar{\sigma}\bar{\sigma}\right)\bar{t} \geq \max\left\{2t_o; t_b + t_g\right\} \quad (1)$$

If each expert observes $\underline{\sigma}$, they should prefer to report $\underline{\sigma}\underline{\sigma}$ rather than $\bar{\sigma}\bar{\sigma}$ or $\underline{\sigma}\bar{\sigma}$.

$$2t_o \geq \max\left\{2v\left(\underline{\sigma}\underline{\sigma}\right)\bar{t}; t_b + t_g\right\} \quad (2)$$

If the experts observe $\bar{\sigma}\underline{\sigma}$, they should prefer to report $\bar{\sigma}\underline{\sigma}$ rather than $\bar{\sigma}\bar{\sigma}$ or $\underline{\sigma}\underline{\sigma}$.

$$t_b + t_g \geq \max\left\{2v\bar{t}; 2t_o\right\}$$

Communication Work Structure (CWS): after

MH incentive constraints on gathering information are such that each expert will not prefer remain uninformed and report either $\underline{\sigma}$ or $\bar{\sigma}$.

$$\begin{aligned} & p\left(\bar{\sigma}\bar{\sigma}\right) v\left(\bar{\sigma}\bar{\sigma}\right) \bar{t} + p\left(\underline{\sigma}\underline{\sigma}\right) t_0 + p\left(\underline{\sigma}\bar{\sigma}\right)\left(t_b + t_g\right) - c \\ \geq \; & p\left(\bar{\sigma}\right) v\left(\bar{\sigma}\right) \bar{t} + p\left(\underline{\sigma}\right) t_g \end{aligned} \tag{3}$$

$$\begin{aligned} & p\left(\bar{\sigma}\bar{\sigma}\right) v\left(\bar{\sigma}\bar{\sigma}\right) \bar{t} + p\left(\underline{\sigma}\underline{\sigma}\right) t_0 + p\left(\underline{\sigma}\bar{\sigma}\right)\left(t_b + t_g\right) - c \\ \geq \; & p\left(\bar{\sigma}\right) t_b + p\left(\underline{\sigma}\right) t_0 \end{aligned} \tag{4}$$

The other problem's constraints the incentive participation constraints and the limited liability constraints.

Communication Work Structure (CWS): after

Hence, the principal's program is:

$$\min_{\bar{t}, t_0, t_g, t_b} p\left(\bar{\sigma}\bar{\sigma}\right) v\left(\bar{\sigma}\bar{\sigma}\right) \bar{t} + p\left(\underline{\sigma}\underline{\sigma}\right) t_0 + p\left(\underline{\sigma}\bar{\sigma}\right)\left(t_b + t_g\right)$$

subject to AS + MH + Participation+ LL constrains.

Communication Work Structure (CWS): before

The information available to each agent in each phase is:

a. Whether or not an expert gathers information is not observable by the principal but it is observable by the other expert.

b. The signal σ_i is not observable by the principal but it is observable by the other expert in the communication phase.

Communication Work Structure (CWS): before

AS constraints. If each expert observes $\bar{\sigma}$, they should prefer to report $\bar{\sigma}\bar{\sigma}$ rather than $\underline{\sigma\sigma}$ or $\underline{\sigma}\bar{\sigma}$.

$$2v\left(\bar{\sigma}\bar{\sigma}\right)\bar{t} \geq \max\left\{2t_o; t_b + t_g\right\} \quad (5)$$

If each expert observes $\underline{\sigma}$, they should prefer to report $\underline{\sigma\sigma}$ rather than $\bar{\sigma}\bar{\sigma}$ or $\underline{\sigma}\bar{\sigma}$.

$$2t_o \geq \max\left\{2v\left(\underline{\sigma\sigma}\right)\bar{t}; t_b + t_g\right\} \quad (6)$$

If the experts observe $\bar{\sigma}\underline{\sigma}$, they should prefer to report $\bar{\sigma}\underline{\sigma}$ rather than $\bar{\sigma}\bar{\sigma}$ or $\underline{\sigma\sigma}$.

$$t_b + t_g 2t_o \geq \max\left\{2v\bar{t}; 2t_o\right\}$$

Communication Work Structure (CWS): before

MH incentive constraints on gathering information are such that each expert will not prefer remain uninformed and report either $\underline{\sigma}$ *or* $\bar{\sigma}$.

$$
\begin{aligned}
& 2\left[p\left(\bar{\sigma}\bar{\sigma}\right)v\left(\bar{\sigma}\bar{\sigma}\right)\bar{t}+p\left(\underline{\sigma}\underline{\sigma}\right)t_0+p\left(\underline{\sigma}\bar{\sigma}\right)\left(t_b+t_g\right)-c\right] \\
\geq \; & \max\left\{2v\bar{t};2t_0;t_b+t_g\right\} \qquad (7)
\end{aligned}
$$

$$
\begin{aligned}
& 2\left[p\left(\bar{\sigma}\bar{\sigma}\right)v\left(\bar{\sigma}\bar{\sigma}\right)\bar{t}+p\left(\underline{\sigma}\underline{\sigma}\right)t_0+p\left(\underline{\sigma}\bar{\sigma}\right)\left(t_b+t_g\right)-c\right] \\
\geq \; & 2\left[p\left(\bar{\sigma}\right)v\left(\bar{\sigma}\right)\bar{t}+p\left(\underline{\sigma}\right)t_0\right]-c \qquad (8)
\end{aligned}
$$

The other problem's constraints the incentive participation constraints and the limited liability constraints.

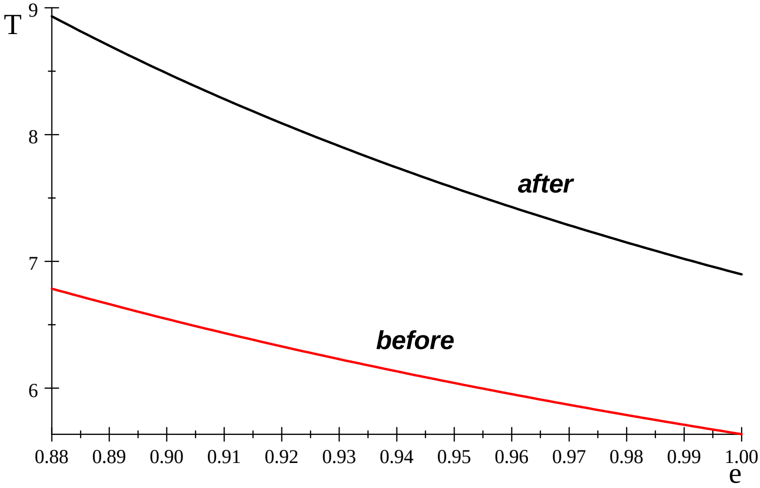
CWS: before or after?

Agency's **cost** $(T_{CWS(\cdot)})$

After $$T_{CWS(F)} = 2\left[\frac{c(1+(1-v)(2\epsilon-1))}{(1-v)[(2\epsilon-1)-p(\bar{\sigma})(2a-1)]}\right]$$

Before $\epsilon - a > a - \frac{1}{2}$ $$T_{CWS(B)} = 2\left[\frac{c(1+(1-v)(2\epsilon-1))}{(1-v)(2\epsilon-1)}\right]$$

CWS with synergy effects: before or after?



CWS: before or after?

Trades-off between organization forms

	after	**before**
signal's prec.	$p^i(e_i, e_j) = \epsilon = p^i(e_i, e_j) = \epsilon$	
collusion	yes (bad)	yes (bad)
effort coord	no (bad)	yes (good)

Proposition *In the presence of communication and synergy effects between experts, the principal is better off by allowing the experts to communicate before they collect information rather than after they exert effort.*

IWS versus CWS with synergy effects

Trades-off between organization forms

	IWS	**CWS (before)**
signal's prec.	$p^i(e_i, e_j) = a < p^i(e_i, e_j) = \epsilon$	
collusion	no (good)	yes (bad)
effort coord	no (bad)	yes (good)

When signal's precision sufficiently increases with communication $(\epsilon - a > a - 1/2)$, *the principal is better off allowing communication between agents before they exert effort rather than not allowing communication at all.*

Concluding Remarks

- *When communication implies not only collusion but also synergy's effects, it is relevant how organize experts.*
- *In that case, the principal will be better off by allowing communication among agents from the outset rather than after.*
- *When communication implies only collusion and the principal cannot avoid communication, it will be better "postpone " the communication*

Related Literature

- Information Revelation
  - Wolinsky (2002)
- Information Acquisition
  - Gromb and Martimort (2007)
- Transparency among peers
  - Winter (2010)

Isolated Work Structure

That is, the agent must prefer to gather information rather than to remain uninformed and report $\underline{\sigma}$:

$$p(\bar{\sigma}\bar{\sigma})\left[v(\bar{\sigma}\bar{\sigma})\,\bar{t}+(1-v(\bar{\sigma}\bar{\sigma}))\,\underline{t}\right]+p(\underline{\sigma\sigma})\,t_0+p(\underline{\sigma}\bar{\sigma})\,(t_b+t_g)-c\geq$$
$$\geq p(\underline{\sigma})\,t_0+p(\bar{\sigma})\,t_b \tag{9}$$

or report $\bar{\sigma}$:

$$p(\bar{\sigma}\bar{\sigma})\left[v(\bar{\sigma}\bar{\sigma})\,\bar{t}+(1-v(\bar{\sigma}\bar{\sigma}))\,\underline{t}\right]+p(\underline{\sigma\sigma})\,t_0+p(\underline{\sigma}\bar{\sigma})\,(t_b+t_g)-c\geq$$
$$\geq p(\bar{\sigma})\left[v(\bar{\sigma})\,\bar{t}+(1-v(\bar{\sigma}))\,\underline{t}\right]+p(\underline{\sigma})\,t_g \tag{10}$$

When an expert observes $\bar{\sigma}$, he should not prefer to report $\underline{\sigma}$.

$$p\left(\bar{\sigma}|\bar{\sigma}\right)\left[v\left(\bar{\sigma}\bar{\sigma}\right)\bar{t}+\left(1-v\left(\bar{\sigma}\bar{\sigma}\right)\right)\underline{t}\right]+p\left(\underline{\sigma}|\bar{\sigma}\right)t_g \geq p\left(\bar{\sigma}|\bar{\sigma}\right)t_b+p\left(\underline{\sigma}|\bar{\sigma}\right)t_0 \quad (11)$$

When he observes $\underline{\sigma}$, he should not prefer to report $\bar{\sigma}$.

$$p\left(\bar{\sigma}|\underline{\sigma}\right)t_b+p\left(\underline{\sigma}|\underline{\sigma}\right)t_o \geq p\left(\bar{\sigma}|\underline{\sigma}\right)\left[v\left(\bar{\sigma}\underline{\sigma}\right)\bar{t}+\left(1-v\left(\bar{\sigma}\underline{\sigma}\right)\right)\underline{t}\right]+p\left(\underline{\sigma}|\underline{\sigma}\right)t_g \quad (12)$$

The contract also must satisfy the incentive participation and limited liability constraints [(5) and (6)]

Isolated Work Structure

Hence, the principal's problem is

$$\min_{\bar{t},\underline{t},t_0,t_b,t_g} p\left(\bar{\sigma}\bar{\sigma}\right)\left[v\left(\bar{\sigma}\bar{\sigma}\right)\bar{t}+\left(1-v\left(\bar{\sigma}\bar{\sigma}\right)\right)\underline{t}\right]+p\left(\underline{\sigma\sigma}\right)t_0+p\left(\underline{\sigma}\bar{\sigma}\right)\left(t_b+t_g\right)$$

subject to (9)-(6).

CWS with synergy effects: before or after?

Principal's net surplus

After	$\epsilon^2 vS + (1-\epsilon)^2 (1-v) F - T_{CWS(F)}$
Before	$\epsilon^2 vS + (1-\epsilon)^2 (1-v) F - T_{CWS(B)}$

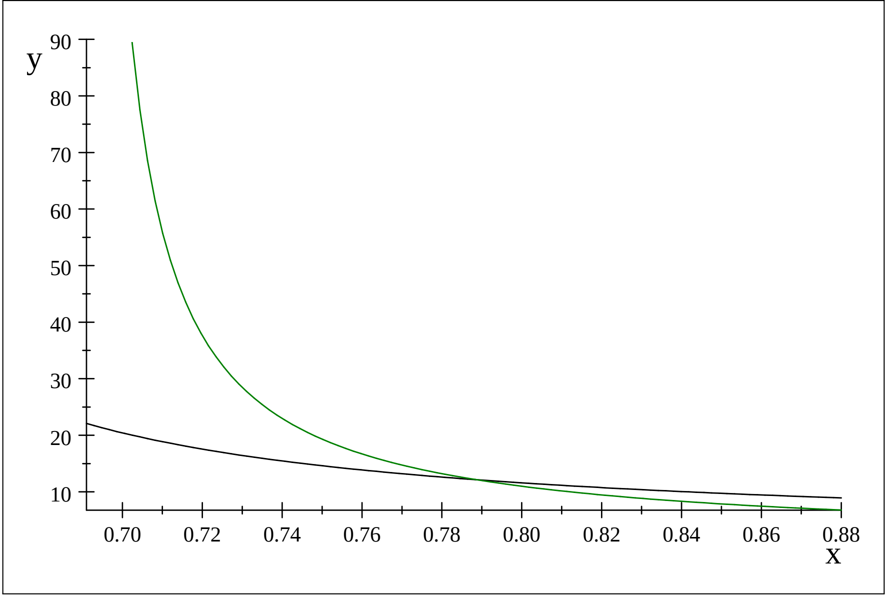
cuentas!!!!!

with synergy

after

$f\left(a, v, \epsilon\right) = \frac{2(1+(1-v)(2\epsilon-1))}{(1-v)((2\epsilon-1)-(av+(1-a)(1-v))(2a-1))}$

$f\left(0.69, 0.45, \epsilon\right) = \frac{2.2\epsilon+0.9}{1.1\epsilon-0.65053}$


y
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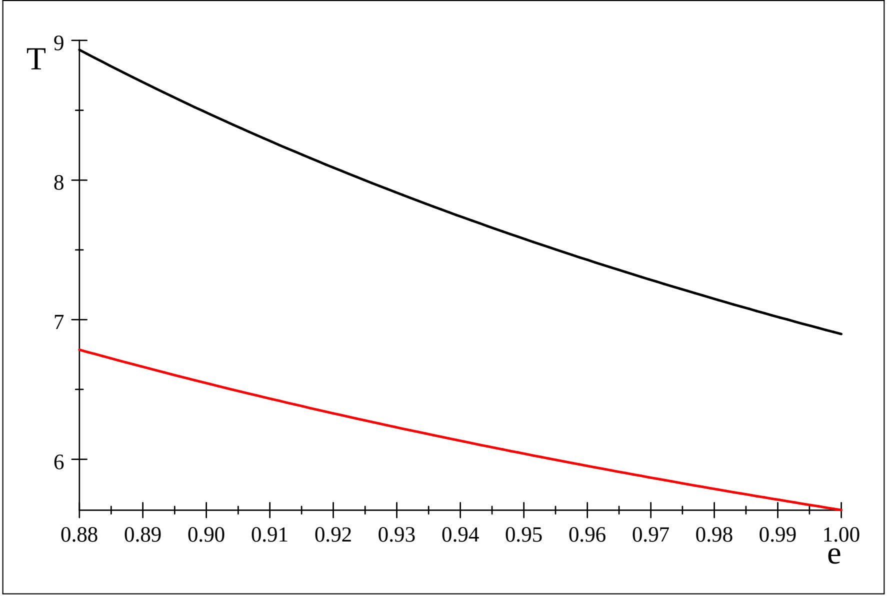
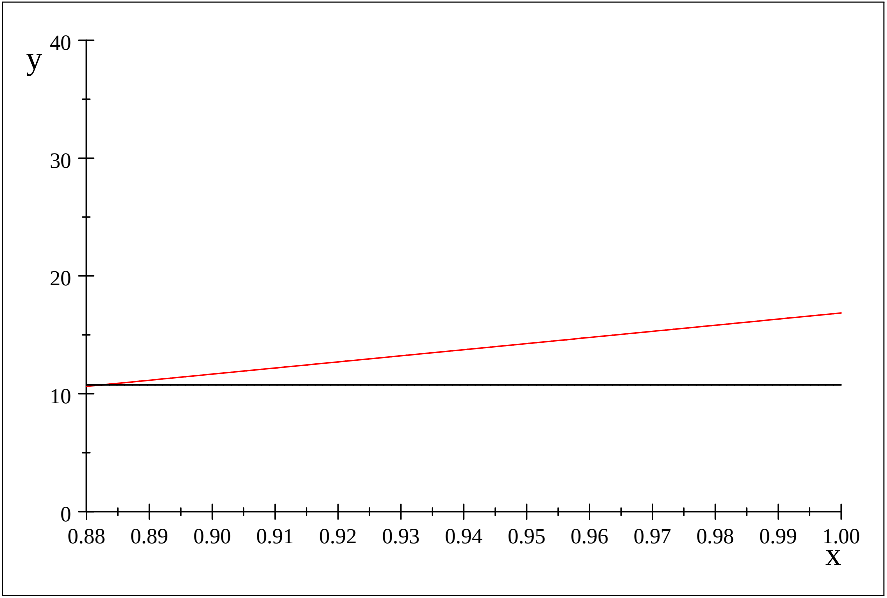


before e-a>a-1/2

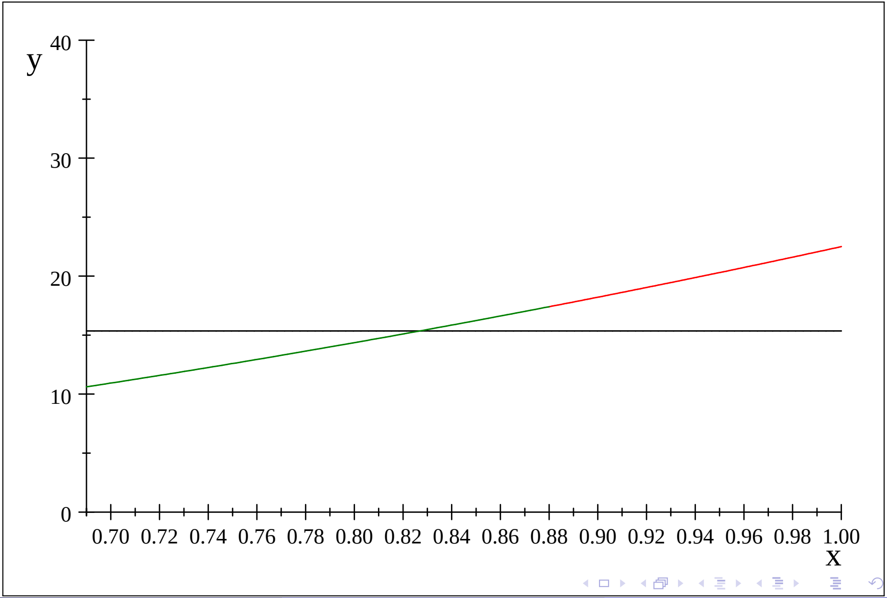
$b(v,\epsilon) = \frac{2(1+(1-v)(2\epsilon-1))}{(1-v)(2\epsilon-1)}$

$b\left(0.45, \epsilon\right) = \frac{2.2\epsilon+0.9}{1.1\epsilon-0.55}$



$b\left(0.45, 0.89\right) = 6.662$

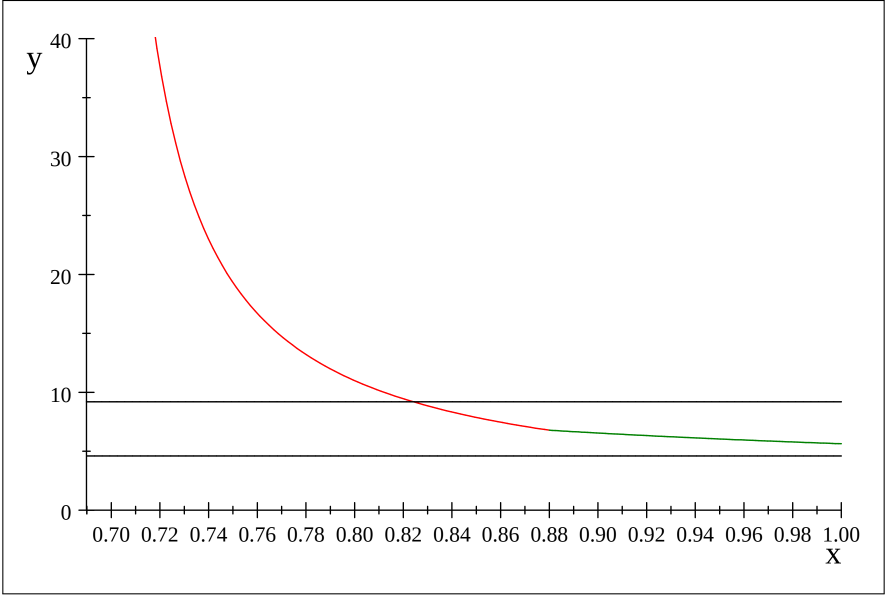
$\epsilon^2 0.45\,(50) - (1-\epsilon)^2$



before e-a$<$a-1/2

$$j\left(a, v, \epsilon\right) = \frac{(1+(1-v)(2\epsilon-1))}{2(1-v)(\epsilon-a)}$$

$$j\left(0.69, 0.45, \epsilon\right) = \frac{1.1\epsilon+0.45}{1.1\epsilon-0.759}$$



$p(\epsilon) = \epsilon^2 0.45(50) - (1-\epsilon)^2(1 - .45) - \frac{1.1\epsilon + 0.45}{1.1\epsilon - 0.759}$

$p(1)$

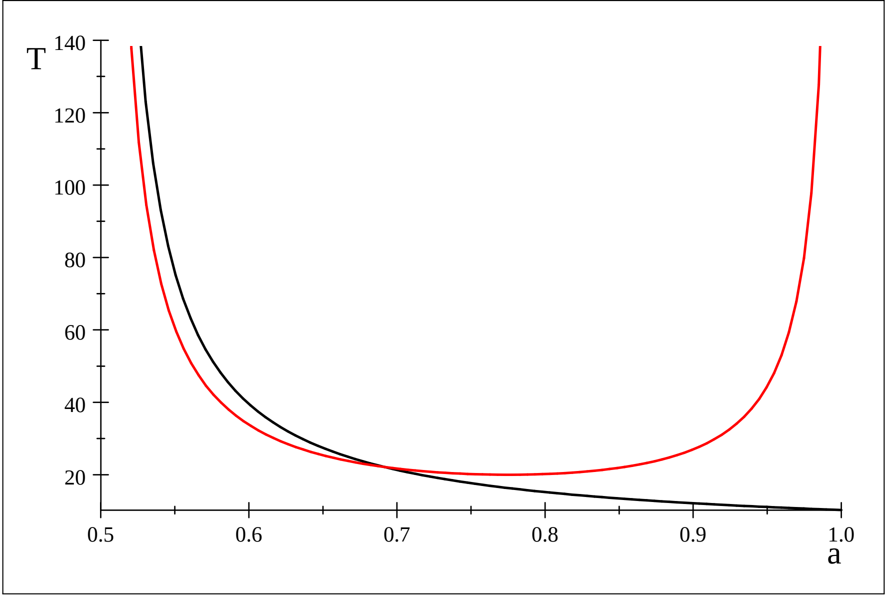
$\frac{9.1978}{2} = 4.5989$

without synergy

after

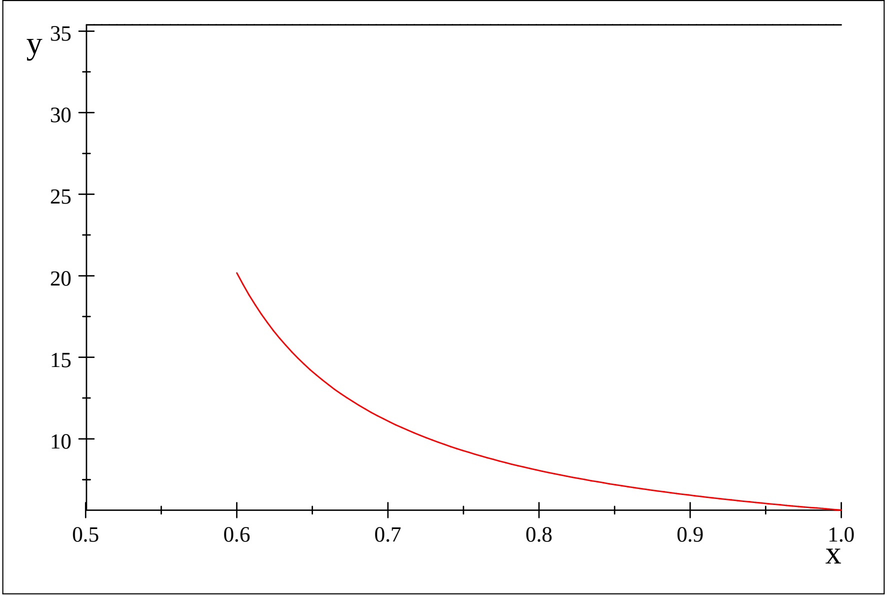
$$t\left(a, v\right) = \frac{2((1-v)(2a-1)+1)}{(2a-1)(1-v)(a(1-v)+(1-a)v)}$$

$$t\left(a, 0.45\right) = \frac{1.8182}{(0.1a+0.45)(2a-1)}\left(2.2a + 0.9\right)$$



before

$$r\left(a,v\right)=\frac{2((1-a)(1-v)(2a-1)+1)-a}{(2a-1)(1-v)(1-a)}$$
$$r\left(a,0.45\right)=\frac{1.\,818\,2}{(2a-1)(a-1)}\left(a+1.\,1\left(2a-1\right)\left(a-1\right)-2\right)$$
IWS
$$w\left(a,v\right)=\frac{2\left(2a^2(1-v)+(1-a)v\right)}{(2a-1)(1-v)a}$$
$$w\left(a,0.45\right)=\frac{1.\,818\,2}{a(2a-1)}\left(2.\,2a^2-0.9a+0.9\right)$$
$$w\left(0.69,0.45\right)=9.\,197\,8$$
$$w\left(0.55,0.45\right)=35.\,388$$
$$0.69+.69-.5=0.88$$


y
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15
10
0.5
0.6
0.7
0.8
0.9
1.0
x