Incomplete Contracts

Ram Singh

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Economic Governance When Contracts are Incomplete

- Property Rights can serve as a tool of economic governance

Question

- What is that PRs enable the owner to do?
- Can PRs affect the outcome - efforts and outputs - when contract are complete?
- Can PRs affect the outcome - efforts and outputs - when contract are incomplete?
- Is there a role for PRs when there are No Wealth constraints?

Grossman and Hart (1986, JPE), Hart and Moore (1990, JPE) and Hart (1995)

Model of Non-contractible Investments I

Suppose

- There are two individuals; managers M1 and M2
- There are two assets (firms) a1 and a2
- M1 works with a1, i.e., is manager of first firm
- M2 works with a2, i.e., is manager of second firm
- a2 is downstream firm
- a1 is upstream firm

Model of Non-contractible Investments II

- So, M2 uses a2 to produce a good called ‘widget’ -
- M1 uses a1 and the ‘widget’ to produce the final output
- For example, you can think of
    - a1 assets of GM,
    - a2 as assets of FB
    - M1 as manager of GM
    - M2 as manager of BF
    - ‘widget’ as Car body
    - ‘final output’ as Car
- The widget/car body and final output is produced at $t = 1$
- The widget/car body is needed at $t = 1$
- However, the ownership structure is decided at time $t = 0$

Model of Non-contractible Investments III

- At $t = 0$, there is uncertainty about the type of the widget/car body that will be most suitable for GM
- This uncertainty - the type of the widget/car body that will be most suitable for GM - is resolved at $t = 1$
- At $t = \frac{1}{2}$, M1 puts in effort/innovation/investment i to increase benefits from production of the final product
  - i makes the assets a1 more productive
  - i does not go in physical assets
- At $t = \frac{1}{2}$, M2 puts in effort/innovation/investment e to reduce the cost of the widget
  - e makes the assets a2 more productive
  - e does not go in physical assets

Model of Non-contractible Investments IV

- Benefit/Income from the final output depends on whether M1 -of GM- and M2 -of FB- work together cooperatively to use a1 and a2 for production.
- For M1-of GM-, the income/revenue is
  - $R(i)$ if the two cooperate/trade with each other. That is,
  - $R(i)$ is the revenue if M2 provides to M1 the most desirable type of car-body. That is,

$$R(i) = R(i|M1, M2, a1, a2)$$

  - $r(i)$ is the revenue if the two Do Not cooperate/trade with each other. That is,
  - $r(i)$ is the revenue if M1 buys the car-body from someone else.

Model of Non-contractible Investments V

- For M2-of FB-, the cost of producing widget also depends on whether the two cooperate/trade with each other. It
  - $C(e)$ if they trade with each other. That is,
  - $C(e)$ is the cost if M2 -of FB- provide to M1 -of GM- the required type of car body. That is,

$$C(e) = C(e|M1, M2, a1, a2)$$

  - $c(e)$ if M1 they trade with somebody else. That is,
  - $c(e)$ is the cost if M2 -of FB- sells the produced car body to some other car company
- e, i, $R(.)$, $r(.)$, $C(.)$, $c(.)$ are all non-verifiable and hence non-contractible

Model of Non-contractible Investments VI

- However,

$$R(i) - C(e) > r(i) - c(e)$$

- That is, from social efficiency perspective, the benefits from investments i and e are strictly greater if M1 and M2 trade with each other, rather than when they do not

The First-Best Investments I

From a first-best perspective, i and e should be chosen so as to solve

$$\max_{i,e}\{R(i) - C(e) - i - e\}$$

Suppose i^* and e^* are the solutions, that is, i^* and e^* solve (0.19) and (0.20), respectively

$$\frac{dR(i)}{di} = 1 \quad (0.1)$$

$$-\frac{dC(e)}{de} = 1 \quad (0.2)$$

Non-Integration under Transaction Cost Theory I

According to Williamson (1985)'s TCT, market fails to coordinate economic activities because of the following reasons: Consider the case of a Buyer and a Seller of an input.

- *Uncertainty*: The nature of buyers' demand changes with time.
- Technology improves. So, the Seller undertake innovation/investment to improve the quality of the product.
- As a result:
  - Repeated negotiations/renegotiations become necessary
- However, negotiations/renegotiations are costly
  - Time and Money costs
- Moreover, at times negotiations/renegotiations will fail, since generally there is informational asymmetry between the trading partners

Non-Integration under Transaction Cost Theory II

- While only the Seller knows the costs of production/innovation; only the Buyer know the benefits from the good purchased
- The Buyer - General Motor - may feel that production/innovation costs for Seller -Fisher body - are low, therefore may offer very low price
- The Seller may feel that innovation is very useful for Buyer and therefore may demand very high price

- Besides, the problem of hold-up will arise
  - Hold-up is inefficient

Non-Integration under Property Rights Theory I

Under Non-integration:

- As before
$$R(i) = R(i|M1, M2, a1, a2)$$
- $r(i)$ the revenue for M1 if the two Do Not cooperate/trade with each other.
- That is,
$$r(i) = r(i|M1, a1)$$
- $$C(e) = C(e|M1, M2, a1, a2)$$
- $c(e)$ the cost for M2 if he trades with somebody else. That is,
- $$c(e) = c(e|M2, a2)$$

Non-Integration under Property Rights Theory II

- Suppose, (for simplicity) the Non-cooperation trade price is $\bar{p}$ for both parties. That is,
  - $\bar{p}$ is the price at which M1 can buy car-body from somebody else
  - $\bar{p}$ is also the price at which M2 can sell his car-body to someone else
- So, M1 can earn $r(i) - \bar{p}$ without M2's cooperation. That is,
- $r(i) - \bar{p}$ is M1's 'outside-option'/'non-cooperation payoff'/'threat position'.
- Similarly, M2 can earn $\bar{p} - c(e)$ without M1's cooperation. That is,
- $\bar{p} - c(e)$ is M2's 'outside-option'/'non-cooperation payoff'/'threat position'

Division of Gains/Surplus I

- If M1 and M2 trade/cooperate with each other, the **total** social gains are

$$R(i) - C(e)$$

- If M1 and M2 Do-Not trade/cooperate with each other, the **total** social gains are

$$r(i) - c(e)$$

- So, if M1 and M2 trade/cooperate with each other, the **additional** social gains are

$$[R(i) - C(e)] - [r(i) - c(e)] \tag{0.3}$$

Division of Gains/Surplus II

Under simple Nash bargaining:

- Each party gets its non-cooperation-payoff, i.e, profit from non-cooperation **plus** half of the surplus from cooperation
- So, M1 will get a total profit of

$$[r(i) - \bar{p}] + \frac{[R(i) - C(e)] - [r(i) - c(e)]}{2} \tag{0.4}$$

- M2 will get a total profit of

$$[\bar{p} - c(e)] + \frac{[R(i) - C(e)] - [r(i) - c(e)]}{2} \tag{0.5}$$

Division of Gains/Surplus III

From another perspective:

- M1's total profit will be
$$\pi_1 = R(i) - p \tag{0.6}$$
- M2's total profit will be
$$\pi_2 = p - C(e), \tag{0.7}$$

  where
- p is the cooperation trade price

Division of Surplus under NI I

p will be chosen such that (from (0.4) and (0.6))

$$\begin{aligned}
\pi_1(.) &= R(i) - p \\
&= [r(i) - \bar{p}] + \frac{[R(i) - C(e)] - [r(i) - c(e)]}{2}, i.e., \\
&= -\bar{p} + \frac{R(i)}{2} + \frac{r(i)}{2} - \frac{C(e)}{2} + \frac{c(e)}{2} \qquad (0.8)
\end{aligned}$$

The chosen price will also be such that (from (0.5) and (0.7))

$$\begin{aligned}
\pi_2(.) &= p - C(e) \\
&= [\bar{p} - c(e)] + \frac{[R(i) - C(e)] - [r(i) - c(e)]}{2}, i.e., \\
&= \bar{p} + \frac{R(i)}{2} - \frac{r(i)}{2} - \frac{C(e)}{2} - \frac{c(e)}{2} \qquad (0.9)
\end{aligned}$$

Division of Surplus under NI II

The price p can be determined either from (0.8) or from (0.9). For instance, from (0.8), p is such that

$$\begin{aligned} R(i) - p &= -\bar{p} + \frac{R(i)}{2} + \frac{r(i)}{2} - \frac{C(e)}{2} + \frac{c(e)}{2}, i.e., \\ p &= \bar{p} + \frac{R(i)}{2} - \frac{r(i)}{2} + \frac{C(e)}{2} - \frac{c(e)}{2} \end{aligned} \tag{0.10}$$

Remark

From (0.8) and (0.9) note that

$$\pi_1(.) + \pi_2(.) = [R(i) - p] + [p - C(e)] = R(i) - C(e)$$

That the role of price is divide gains from the trade between M1 and M2

Division of Surplus under NI III

From ex-ante **net gains** perspective,

- M1's net gain will be

$$\pi_1(.) - i = R(i) - p - i \tag{0.11}$$

- M2's net gain will be

$$\pi_2(.) - e = p - C(e) - e, \tag{0.12}$$

where p is as in (0.10).

Investment Levels under NI I

M1 will choose i to maximize his profit as in (0.11). That will solve

$$
\begin{aligned}
\max_i \{R(i) - p - i\}, i.e.,\\
\max_i \{R(i) - [\bar{p} + \frac{R(i)}{2} - \frac{r(i)}{2} + \frac{C(e)}{2} - \frac{c(e)}{2}] - i\}, i.e.,\\
\max_i \{\frac{R(i)}{2} + \frac{r(i)}{2} - \frac{C(e)}{2} + \frac{c(e)}{2} - i\}, i.e.,\\
\max_i \{\frac{R(i|M1, M2, a1, a2)}{2} + \frac{r(i|M1, a1)}{2} - i\}
\end{aligned} \tag{0.13}
$$

Investment Levels under NI II

Similarly, M2 will choose e to maximize his profit as in (0.12). That is will solve

$$
\begin{aligned}
\max_e \{p - C(e) - e\}, i.e.,\\
\max_e \{\bar{p} + \frac{R(i)}{2} - \frac{r(i)}{2} + \frac{C(e)}{2} - \frac{c(e)}{2} - C(e) - e\}, i.e.,\\
\max_e \{\frac{R(i)}{2} - \frac{r(i)}{2} - \frac{C(e)}{2} - \frac{c(e)}{2} - e\}, i.e.,\\
\max_e \{-\frac{C(e)}{2} - \frac{c(e)}{2} - e\}, i.e.,\\
\min_e \{\frac{C(e|M1, M2, a1, a2)}{2} + \frac{c(e|M2, a2)}{2} + e\}
\end{aligned}
\tag{0.14}
$$

Suppose i_0 and e_0 are the solutions, that is,

Investment Levels under NI III

i_0 and e_0 solve (0.17) and (0.18), respectively

$$\frac{1}{2}\frac{dR(i|M1,M2,a1,a2)}{di}+\frac{1}{2}\frac{dr(i|M1,a1)}{di} = 1 \qquad (0.15)$$

$$-\frac{1}{2}\frac{dC(e)}{de}-\frac{1}{2}\frac{dc(e|M2,a2)}{de} = 1 \qquad (0.16)$$

Letting

$$R'(i|M1,M2,a1,a2)=\frac{dR(i|M1,M2,a1,a2)}{di},$$

$$r'(i|M1,a1)=\frac{dr(i|M1,a1)}{di}$$

$$C'(e|M1,M2,a1,a2)=\frac{dC(e|M1,M2,a1,a2)}{de}$$

$$c'(e|M2,a2)=\frac{dc(e|M1,M2,a1,a2)}{de}$$

Investment Levels under NI IV

i_0 and e_0 solve (0.17) and (0.18), respectively

$$\frac{1}{2}R'(i|M1, M2, a1, a2) + \frac{1}{2}r'(i|M1, a1) = 1 \quad (0.17)$$

$$-\frac{1}{2}C'(e|M1, M2, a1, a2) - \frac{1}{2}c'(e|M2, a2) = 1 \quad (0.18)$$

However, the first-best levels, i.e, i^* and e^* solve (0.19) and (0.20), respectively

$$\frac{dR(i)}{di} = 1 \quad (0.19)$$

$$-\frac{dC(e)}{de} = 1 \quad (0.20)$$

Investment Levels under NI V

We make the following assumptions:

$$R'(i|M1, M2, a1, a2) \geq r'(i|M1, a1) \tag{0.21}$$

$$\|C'(e|M1, M2, a1, a2)\| \geq \|c'(e|M2, a2)\| \tag{0.22}$$

In view of these assumptions, a comparison of (0.19) and (0.20) with (0.17) and (0.18) shows that

$$\begin{aligned} i_0 &< i^* \\ e_0 &< e^* \end{aligned} \tag{0.23}$$

That is, both GM and FB's investment will be less than the first-best level.

The total social surplus under non-integration is

$$S_0 = R(i_0|M1, M2, a1, a2) - C(e_0|M1, M2, a1, a2) - i_0 - e_0$$

Investment Levels under NI VI

However, the First-best total social surplus

$$S^* = R(i^*|M1, M2, a1, a2) - C(e^*|M1, M2, a1, a2) - i^* - e^*$$

It is easy to see that

$$S^* > S_0$$

Question

Why is $S^* > S_0$?

Type-1 Integration I

Following the above logic, it is easy to see that M1 will choose i to maximize his profit. That will solve

$$\max_i\{R(i) - p - i\}, i.e.,$$

$$\max_i\{R(i) - [\bar{p} + \frac{R(i)}{2} - \frac{r(i)}{2} + \frac{C(e)}{2} - \frac{c(e)}{2}] - i\}, i.e.,$$

$$\max_i\{\frac{R(i)}{2} + \frac{r(i)}{2} - \frac{C(e)}{2} + \frac{c(e)}{2} - i\}, i.e.,$$

$$\max_i\{\frac{R(i|M1, M2, a1, a2)}{2} + \frac{r(i|M1, a1, a2)}{2} - i\}$$

Type-1 Integration II

Similarly, M2 will choose e to maximize his profit. That is will solve

$$\max_e\{p - C(e) - e\}, i.e.,$$

$$\max_e\{-\bar{p} + \frac{R(i)}{2} - \frac{r(i)}{2} + \frac{C(e)}{2} - \frac{c(e)}{2} - C(e) - e\}, i.e.,$$

$$\max_e\{\frac{R(i)}{2} - \frac{r(i)}{2} - \frac{C(e)}{2} - \frac{c(e)}{2} - e\}, i.e.,$$

$$\max_e\{-\frac{C(e)}{2} - \frac{c(e)}{2} - e\}, i.e.,$$

$$\min_e\{\frac{C(e|M1, M2, a1, a2)}{2} + \frac{c(e|M2)}{2} + e\}$$

Type-1 Integration III

Suppose i_1 and e_1 are the solutions of foc. That is, i_1 and e_1 solve (0.24) and (0.25), respectively

$$\frac{1}{2}R'(i|M1, M2, a1, a2) + \frac{1}{2}r'(i|M1, a1, a2) = 1 \quad (0.24)$$

$$-\frac{1}{2}C'(e|M1, M2, a1, a2) - \frac{1}{2}c'(e|M2) = 1 \quad (0.25)$$

However, the first-best levels, i.e, i^* and e^* solve respectively

$$\frac{dR(i)}{di} = 1$$

$$-\frac{dC(e)}{de} = 1$$

We make the following assumptions:

$$R'(i|M1, M2, a1, a2) \geq r'(i|M1, a1, a2) \geq r'(i|M1, a1) \quad (0.26)$$

$$\|C'(e|M1, M2, a1, a2)\| \geq \|c'(e|M2, a2)\| \geq \|c'(e|M2)\| \quad (0.27)$$

Type-1 Integration IV

In view of these assumptions, a comparison (0.26) and (0.27) with the conditions for the first-best shows that

$$\begin{aligned} i_0 \leq i_1 &< i^* \\ e_1 \leq e_0 &< e^* \end{aligned} \tag{0.28}$$

That is:

- GM would undertake greater number of innovations if it owns FB than under non-integration
- However, FB manager -as employee of GM - will undertake fewer innovations than under non-integration

The total social surplus under Type-1 integration is

$$S_1 = R(i_1|M1, M2, a1, a2) - C(e_1|M1, M2, a1, a2) - i_1 - e_1$$

It is easy to see that

$$S^* > S_1$$

Type-2 Integration I

FB acquires GM:
Suppose i_2 and e_2 are the solutions of FOCs in this case. It is easy to see that shows that

$$\begin{aligned} i_2 \leq i_0 \leq i_1 \quad &< \quad i^* \\ e_1 \leq e_0 \leq e_2 \leq \quad &< \quad e^* \end{aligned} \tag{0.29}$$

That is:

- FB would undertake greater number of innovations if it owns GM than under non-integration
- However, GM manager -as employee of FB - will undertake fewer innovations than under non-integration

Type-2 Integration II

The total social surplus under Type-1 integration is

$$S_2 = R(i_1|M1, M2, a1, a2) - C(e_1|M1, M2, a1, a2) - i_1 - e_1$$

It is easy to see that

$$S^* > S_2$$

Question

Is $S_0 > S_1$ or $S_1 > S_0$? Is $S_0 > S_2$ or $S_2 > S_0$? Is $S_1 > S_2$ or $S_2 > S_1$?

PRT: Predictions I

The answer to the above questions will vary from situation to situation.

Predictions:

- If $S_0 > \max\{S_1, S_2\}$, there will be non-integration; GM and FB will be independently owned firms
- If $S_1 > \max\{S_0, S_2\}$, there will be type-1 integration; GM will be acquire FB
- If $S_2 > \max\{S_0, S_1\}$, there will be type-2 integration; FB will be acquire GM

The actual outcome will depend on

- the importance of i and e
- the levels of i and e induced by different ownership structure
- the relationship among the assets

PRT: Predictions II

Proposition

If i is more productive than e, type-1 integration will take place, and vice-versa.

Type-1 integration:

- encourages M1 to increase i, recall $i_1 \geq i_0 \geq i_2$
- when i is more productive than e, this leads to higher total surplus
- $S_1 > S_2$ and $S_1 > S_0$

Proposition

If assets $a1$ and $a2$ are independent, non-integration will take place.

Assets $a1$ and $a2$ are independent if

- $r^{'}(i|M1, a1, a2) = r^{'}(i|M1, a1)$ and

PRT: Predictions III

- $c^{'}(e|M2, a1, a2) = c^{'}(e|M2, a2)$,

Therefore,

- Ownership of $a2$ by M1 does not increase i; i.e., i will remain the same as under non-integration
- However, ownership of $a2$ by M1 will decrease e; i.e., e will be less than its level under non-integration
- That is, the non-contractible investment will be higher under non-integration
- So, non-integration will dominate type-1 integration; i.e., $S_0 > S_1$
- Similarly, non-integration will dominate type-2 integration; i.e., $S_0 > S_2$

PRT: Predictions IV

Proposition

If assets $a1$ and $a2$ are strictly complementary, some form of integration will take place.

Assets $a1$ and $a2$ are strictly complementary if

- $r^{'}(i|M1, a1) = r^{'}(i|M1)$ and
- $c^{'}(e|M2, a2) = c^{'}(e|M2)$,

Start from a situation of Non-integration. When $a1$ and $a2$ are strictly complementary

- Ownership of $a1$ by M1 without access to $a2$ is useless; i.e., if $a1$ is transferred to M2, it will not decrease choice of i by M1.
- However, if $a1$ is transferred to M2, it will may increase choice of e by M2.

PRT: Predictions V

- That is, the non-contractible investment will be higher under type-2 integration than under non-integration
- So, Type-2 integration will dominate non-integration; i.e., $S_2 > S_0$
- Similarly, Type-1 integration will dominate non-integration; i.e., $S_1 > S_0$
- The overall outcome will depend on whether $S_1 > S_2$ or $S_2 > S_1$

Proposition

Assets $a1$ and $a2$ will be owned independently. That is, non-integration will exist, if

- $R^{'}(i|M1, M2, a1, a2) \simeq r^{'}(i|M1, a1)$ *and*
- $C^{'}(e|M1, M2, a1, a2) \simeq c^{'}(e|M2, a2)$,

PRT: Predictions VI

- $R^{'}(i|M1, M2, a1, a2) \simeq r^{'}(i|M1, a1)$ and $C^{'}(e|M1, M2, a1, a2) \simeq c^{'}(e|M2, a2)$ imply that the investments i and e are not relationship specific
- This will be the case when market is competitive - there are many equally good trading partners available
- You can verify that under the above condition the effort choice is efficient under non-integration
- Vertical integration will lower investment/efforts of the acquired but will not increase investment/efforts by the acquiring party
- So the assets will be owned independently

PRT Versus TCT

Recall the TCT argues that

- transaction costs are the direct determinants of the size of the firm
- an increase in the transaction costs -due to increase in assets specificity, uncertainty and incomplete contracts - makes vertical integration more likely outcome

In contrast to the TCT, the PRT argues that

- transaction costs are not the direct determinants of the size of the firm
- an increase in the transaction costs does not necessarily leads to vertical integration
- Relative importance of the efforts along with the nature of the relationship between/among assets - whether assets are independent or complementary - are the main determinants of the boundary/size of the firm

PRT and the Real-World I

1. Valuable investments
    - Ownership of Houses and Car, etc:
        - Maintenance efforts of the users are important
        - So, PRT predicts that the users will also be the owners
        - This tends to be the case in the absence of wealth constraints
    - Ownership of firms by employees:
        - Innovative efforts on the part of lower-level employees are not crucial for profitability
        - Innovative efforts on the part of higher-level employees are very crucial for profitability
        - So, PRT predict that the higher-level -not the lower level- employees will have ownership stakes

PRT and the Real-World II

2. Complementary assets
   - Coal-mines and Power plants
     - Power-plants are located close to Coal-mines
     - Power-plants use technology specific to coal type
     - So, the two assets are complementary and tends to be owned jointly; Jaskow (1985)
   - Aluminium refineries and Bauxite-mines
     - Aluminium refineries are located close to Bauxite-mines
     - Aluminium refineries use technology specific to Bauxite type
     - So, the two assets are complementary and tends to be owned jointly; Stuckey (1983)
   - Small size industry. When industry is small
     - the buyers and sellers of the inputs do not have many partners to choose from
     - So, the assets of the two have greater complementarity and tends to be owned jointly through vertical integration; Stigler (1951)

PRT and the Real-World III

- One seller and Many buyer, e.g., one pipeline transporting oil for many refineries
  - the buyers do not have many partners to choose from
  - they are dependent on the assets of the only seller; the assets of the buyer have strict reliance/complementarity with the assets of the seller
  - So, the buyers face risk of hold-up
  - To overcome this, the buyers tends to be joint owners of the sellers assets through partnerships (Klein et al, 1978)

PRT and the Real-World IV

3. Independent Assets
   - University and Computer systems, e.g., DU and J-Store
     - If the two dis-agree on the terms of the trade, they can switch trading partners without much costs
     - That is, the assets are independent and not complementary
     - So, the assets are better owned separately
   - Large size industry - many buyers and many seller. When industry becomes larger
     - the buyers and sellers of the inputs have many partners to choose from
     - So, the assets of the two become independent and tends to be owned independently

PRT and the Real-World V

- Increase in firm size - as the number or the quantity of assets owned increases.
  - in the beginning there is greater complementarity among the assets, due to lumpy production technology, effective supervision etc.
  - however, as the number of assets increases the complementarity gives way to independence,
  - so, there comes a stage when the benefits of independent-ownership/non-integration start to outweigh the benefits of vertical integration, and the firm stops to expand