

# Industrial Economics

## Transaction costs and the “nature of the firm”

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# Outline

- ① The Hotelling Model with Fixed Location
- ② The Hotelling Model with Location Choice
- ③ The Emergence of the Firm

# A. The impact of transaction costs on the monopoly power and profitability of business (the modelling Hotelling - Tirole)

- The example is best developed around the story of two ice vendors on a beach. Location can be seen as an analogy for product differentiation.
- draw graph here

# 1. The simple case with fixed location

- Calculating demand curves
- The cost of travel is  $t$ .
- To develop the demand functions  $D_A$  (corresponding to  $x$  in the graph above)  $D_B$  (corresponding to  $1 - x$ ), one must establish the conditions for the indifference of the buyer  $\tilde{x}$  between the two vendors A and B. It thus holds the following:

$$p_A + t\tilde{x} = p_B + t(1 - \tilde{x})$$

- demand for A:

$$D_A = \tilde{x} = \frac{1}{2} + \frac{p_B - p_A}{2t}$$

- demand for B:

$$D_B = 1 - \tilde{x} = \frac{1}{2} + \frac{p_A - p_B}{2t}$$

# 1. The simple case with fixed location

- Calculation of profit functions with  $c = MC$  and determination of optimal prices
- profit A:

$$\Pi_A = (p_A - c)\tilde{x} = (p_A - c) \left[ \frac{1}{2} + \frac{p_B - p_A}{2t} \right]$$

- profit B:

$$\Pi_B = (p_B - c)(1 - \tilde{x}) = (p_B - c) \left[ \frac{1}{2} + \frac{p_A - p_B}{2t} \right]$$

- profit maximization A:

$$\frac{\partial \Pi_A}{\partial p_A} = 0 \Rightarrow p_A^* = \frac{p_B^* + t + c}{2}$$

- profit maximization B:

$$\frac{\partial \Pi_B}{\partial p_B} = 0 \Rightarrow p_B^* = \frac{p_A^* + t + c}{2}$$

# 1. The simple case with fixed location

- solve

$$p_A^* = \frac{p_B^* + t + c}{2}$$

$$p_B^* = \frac{p_A^* + t + c}{2}$$

for  $p_A^*$  and  $p_B^*$

- This yields  $p_A^* = p_B^* = t + c$
- The profit function can be obtained by plugging in  $p_A^*$ :

$$\Pi_A = (p_A^* - c)\tilde{x} = t\tilde{x}$$

- because of symmetry  $\tilde{x} = 1 - \tilde{x} \Rightarrow \tilde{x} = 1/2$
- $\Pi_A = \Pi_B = \frac{t}{2}$

# 1. The simple case with fixed location

- In a symmetrical equilibrium with fixed location, the profit of the two duopolists is entirely determined by transaction (transport) cost, which determines the monopoly power.
- A cost of  $t = 0$  would imply a lack of differentiation or localization of the product. This would result in a Bertrand competition with zero profits for both firms.

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## 2. The more complex case when firms can choose their location

- draw graph here
- In three steps we will determine (1) the demand functions, (2) the profit functions, and (3) the optimal pricing strategies.

## 2. The more complex case when firms can choose their location

- (1) demand functions

$$D_A = \begin{cases} L & \text{if } p_A < p_B - t(L - a - b) \\ 0 & \text{if } p_A > p_B + t(L - a - b) \\ [\dots] + a & \text{if } |p_A - p_B| \leq t(L - a - b) \end{cases}$$

and

$$D_B = \begin{cases} L & \text{if } p_B < p_A - t(L - a - b) \\ 0 & \text{if } p_B > p_A + t(L - a - b) \\ [\dots] + b & \text{if } |p_A - p_B| \leq t(L - a - b) \end{cases}$$

- The interesting part is to determine [...] (the part of demand that will be shared between the two firms if the price difference is not too large) depending on the position of X.

## 2. The more complex case when firms can choose their location

- We know that X is indifferent between Firm A and Firm B if:

$$p_A + tx = p_B + t(L - a - b - x)$$

- so

$$D_{Ax} = x = \frac{p_B - p_A + t(L - a - b)}{2t}$$

and

$$D_{Bx} = L - a - b - x = \frac{p_A - p_B + t(L - a - b)}{2t}$$

## 2. The more complex case when firms can choose their location

- (2) Determining the profit functions
- profits A

$$\Pi_A = \begin{cases} p_A L & \text{if } p_A < p_B - t(L - a - b) \\ 0 & \text{if } p_A > p_B + t(L - a - b) \\ p_A \left( \left[ \frac{p_B - p_A + t(L - a - b)}{2t} \right] + a \right) & \text{if } |p_A - p_B| \leq t(L - a - b) \end{cases}$$

- profits B

$$D_B = \begin{cases} p_B L & \text{if } p_B < p_A - t(L - a - b) \\ 0 & \text{if } p_B > p_A + t(L - a - b) \\ p_B \left( \left[ \frac{p_A - p_B + t(L - a - b)}{2t} \right] + b \right) & \text{if } |p_A - p_B| \leq t(L - a - b) \end{cases}$$

## 2. The more complex case when firms can choose their location

- In order to better understand the nature of the profit function we will draw the graph for a simplified  $\Pi_A(p_A, \bar{p}_B)$  with a given  $\bar{p}_B$ .
- for simplicity, set  $\bar{p}_B = L = t = 1$  and  $a = b = 1/3$
- This gives as profit function

$$\Pi_A(p_A, \bar{p}_B) = \begin{cases} p_A & \text{if } p_A < 2/3 \\ 0 & \text{if } p_A > 4/3 \\ p_A - \frac{p_A^2}{2} & \text{if } |p_A - 1| \leq 1/3 \Leftrightarrow 2/3 \leq p_A \leq 4/3 \end{cases}$$

- draw graph here
- There exist two discontinuities at price  $p_A = 2/3$  and  $p_A = 4/3$  or more generally at the points where

$$p_A = \bar{p}_B - t(L - a - b) \quad \text{and} \quad p_A = \bar{p}_B + t(L - a - b)$$

## 2. The more complex case when firms can choose their location

- The economic explanation of this discontinuity is as follows:
  - at price  $p_A = 2/3$ , segment  $b$  will switch to firm B and sharing of the segment  $L - a - b$  will begin.
  - at prices higher than  $p_A = 4/3$ , even segment  $a$  will switch to the firm B, which will now have the entire demand.
- In other words for  $p_A = p_B + t(L - a - b) - \epsilon$ , segment  $b$  that was formerly reserved for firm B. switches. This introduces a discontinuity in the profit function.
- Firms will thus in a first step tend to move towards the centre to exploit this discontinuity.
- However, there they will end up at the Bertrand point that is not optimal either with  $\Pi_A = \Pi_B = 0$ . They thus will move back to the extremities.

## 2. The more complex case when firms can choose their location

- (a) D'Aspremont, Gabszewicz and Thisse (1979) showed that there is no stable equilibrium with linear transport costs if firms can choose their location.
- (b) Hotelling had failed to see this in his original 1928 paper and concluded with a tendency towards the centre and minimal differentiation; this holds for both, locational or quality differentiation.

$$\frac{\partial \Pi_A}{\partial a} = \frac{\partial [a + [p_B - p_A + t(L - a - b)]/(2t)]p_A}{\partial a} = \frac{1}{2} > 0$$

- (c) There is however a price in equilibrium when transport costs are quadratic  $t^2$ . In this case a tendency towards the extremities will hold (maximum differentiation). Intuitively this is quite easy, as in this case closeness is important.

## 2. The more complex case when firms can choose their location

- (d) In reality we nevertheless often observe a tendency towards the same location. This is the principle of the shopping mall. This is due to the positive externalities of demand. Sharing infrastructure and reducing research costs improves overall demand. Firms in this case will not compete on location but on product differentiation (English French, Italian, Scandinavian furniture, for instance). The principle of minimum differentiation is thus partially restored.
- In none of these constellations, competitors achieve the location that would minimise transport costs and maximise social welfare at ( $\frac{1}{4}L$  and  $\frac{3}{4}L$ ). There is thus in all of the discussed constellations a divergence between private and social optimality.



## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- The individual business, the firm is at the heart of industrial economics, its size, technical performance and profitability.
- The transaction costs approach is based on the idea that there is substitution at the margin between two alternative mechanisms to coordinate the optimal allocation of scarce inputs in production. These two mechanisms are:
  - ① The coordinating power of the entrepreneur in his individual form. This mode is characterised by planning, conscious organization, rationality, principle of verticality, command and control...
  - ② The coordinating power of the market. This mode is characterised by the price mechanism, unconscious auto-organization, automatic, principle of horizontality, s...
- Inside a business, the price mechanism no longer applies. So if the price mechanism is so wonderful (invisible hand), Coase asked why do firms exist?

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## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- Arguments for the existence of firms and for increasing their size:
  - ① Employees prefer to work for someone else rather than themselves (Knight), as working for someone else lowers the risk. An employment contract is like an insurance policy against changes in income. Important in this context is the distinction between risk and uncertainty. Insurance insures against risk, where the probability distribution is known. The entrepreneur ensures against uncertainty, residual risk where the probability distribution is not known. However he is also the claimant of any excess profits. In the end the entrepreneur is less risk-averse than his employees. Indeed many entrepreneurs are wealthy men. This provides a degree of self-insurance.
  - ② Consumers prefer products made by firms for reasons of legal liability or branding.

# Ronald Coase (1910 - 2013)

- Only person who received the Nobel Prize in 1991 essentially for two non-technical articles, “The Theory of the Firm” (1937) and “The Problem of Social Cost” (1960). The two articles deal with the border between economic non-economic, or in other words the power and the limits of markets.
- Somebody remarked that Coase “never looked at a number in his life.” This is untrue, he wrote a number of empirical studies, but still remains outside the technical mainstream.

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- 3. The most important reason for the existence of a firm are market transactions costs according to Coase. These include:
  - ① The costs of using the price mechanism; researching prices and product information; “marketing costs”; employing specialists can reduce but not eliminate these costs.
  - ② Negotiating and concluding contracts, especially short-term contracts for small amount; again specialized intervention and standardisation can reduce the cost but do not eliminate it; a labour contract thus substitutes for a whole series of smaller specific contracts.

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- ③ Controlling, monitoring and enforcing contracts, especially with respect to quality risk. In a standard contract, it is the supplier who chooses how a product is built. This can result in quality issues, especially when observing quality is difficult but important - think of restaurants. Coase stipulates that being able to determine how a good is produced is the main difference between a labour contract and a regular contract. Alternatively, the contract would become very complicated.
- ④ Transaction taxes such as value added tax (VAT) ;
- ⑤ The opportunity cost of creating monopolies and raise prices.

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- Of course there are also transaction costs inside a firm. In particular, Coase postulates a declining marginal ability of the entrepreneur to coordinate the allocation of scarce resources.
- The firm and the market thus substitute any additional transactions at the margin until the optimal size of the firm is reached.

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- The contribution of Williamson
- Oliver Williamson (1932- ) has refined Coase's transaction cost approach on the basis of two additional assumptions:
  - Bounded rationality
  - Opportunistic behavior (contractual hold ups, which is possible outside but not inside the firm) ;
- In Williamson's work, the notion of *asset specificity* is central. The more goods are specific, the more complex the contracts need to be and the higher are the transaction costs and the scope for opportunistic behavior
- A second central notion is the *uncertainty and frequency* of a transaction. The more specific an asset and the more frequent are transactions, the higher the tendency for internalisation in the firm.



## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- Williamson expands the dichotomy proposed by Coase (impersonal market or firm) to a continuum of regulations, long-term contracts etc. These intermediate forms of allocation can also be subjected to external auditors, arbitrators or judges (“trilateral contracts”).
- Williamson proposes to base the theory of the firm on the combination of two elements: a behavioural component and an environmental component.

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- The behavioural component
- Williamson built a conceptual model in which it assumes that agents obey certain rules of behavior based on two key behavioural assumptions: bounded rationality and opportunism.
- Bounded rationality is a result of the assumption of Herbert Simon's work. It is based on the observation that individuals have limited cognitive abilities.

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- The traditional assumption of rationality (“hyper-rationality”) neglects the internal structure of the firm, which is represented only by a production function.
- However, in the case of bounded rationality, the organizational form is economically significant: it influences decision making in particular because the firm consists of subgroups for the different units but also for producing various components, financing, marketing, research, ...

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- Bounded rationality has two important consequences
  - ① the ex ante contract costs increase
  - ② the ex-post contract costs increase
- Indeed bounded rationality implies that economic agents cannot foresee all eventualities. *Contracts are necessarily incomplete*, because:
  - ① Contingencies may not be foreseeable at the contracting time.
  - ② Even if they could be foreseen, there may be too many contingencies to write into the contract.
  - ③ The contract monitoring and enforcement is becoming increasingly costly.

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- Opportunism is an original concept developed by Williamson.
- An opportunistic agent seeks his personal interests with an additional nuance: it is ready to use to his advantage trickery or cheating without that these terms imply a moral judgment.
- Opportunism, as Williamson defined as: “self-interest with guile” (Williamson, 1985), originates from two components: the cost of information and the complementarity of assets.
- If the terms of the contract are ambiguous, which they always are, it is likely that one of the two contracting parties will use this to its advantage (example: price indexing without specifying the index that will serve as a reference and the supplier will seek to choose the index that is most favorable to him).
- For opportunism to play a role, it is not necessary to assume that all people are likely to use cunning: it is sufficient that the risk exists.

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- The environmental element
- Williamson seeks to specify the economic variables for understanding the emergence of opportunism and therefore that affect transaction costs. Three variables play a decisive role :
  - Asset specificity of the transaction
  - The uncertainty of the transaction
  - Frequency of transactions

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- Asset specificity
- contracts are becoming more difficult to write.
- The transaction may imply the investment into a specific asset for the production of the traded good.
- Take, for example the purchase by firm A of a particular chemical component from B. Firm B will need to invest into a new production line.
- A problem arises as the price of an imported raw material changes. Firm B will opportunistically raise price with little risk if A has no other supplier.
- Conversely, if A is the only customer of B (monopsony), opportunism of A can occur.

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- Asset specificity includes:
  - Specificity of a site
  - Specificity of physical assets
  - Specificity of human capital or intangible assets (patents etc.)
- The key element of the definition is that a specific asset in an activity cannot be used in another job without there being depreciated sharply (link with the notion of sunk cost).



## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- The uncertainty and frequency of transactions
- Both parameters directly affect transaction costs and therefore the likely organization of an exchange within a firm rather than on the market.
- All things being equal, the greater uncertainty, the more transaction costs on the market are expensive and therefore the tendency to internalize is strong.
- Uncertainty increases the supplier's default probability and that of non-compliance with contract clauses.
- Occasional transactions are entrusted to the market and recurring transactions are internalized.

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- The analysis in terms of transaction costs is therefore based on the combination of the following: bounded rationality, opportunism, the degree of asset specificity and the frequency of transactions.
- The aim of the economy of transaction costs is to determine a control structure (governance structure) that minimizes transaction costs.
- Williamson's structure distinguishes four types of regulating a transaction:
  - ① the standard market contract,
  - ② a trilateral contract with arbitration,
  - ③ a customised or personalised contract, or
  - ④ integration into the firm.

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- The modalities of organising transactions according to Williamson

Frequency	Low	Market	Trilateral contract (arbitration)	
	High	Market	Customised Contract	Integration
		Low	Average	High
			Asset specificity	

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- This diagram summarizes the typology of Williamson for selection of control mode related to a given investment project :
- In case the specificity of the assets is low, the market type of contract is the most effective to reduce transaction costs. The firm can take advantage of competition between suppliers to protect against their possible opportunism.
- In case the specificity of the asset is average to high, and the frequency of transactions is low the control mode to minimize transaction costs is the trilateral agreement. The trilateral agreement includes specific clauses to protect the firm against the opportunism of its supplier due to the specificity of assets. In case of conflict, the interpretation of these specific clauses will be subject to an “arbitration structure”, hence the term trilateral agreement.

## B. The emergence of the firm through market transaction costs (Coase and Williamson)

- If asset specificity is average and frequency of transactions high personalised contracts are the most effective to minimize transaction costs. The high frequency of transactions increases the likelihood of conflict between the co-entrepreneurs who would nevertheless like to avoid the costs of arbitration by a third party. Such customized long-term contracts often contain specific clauses for resolving conflicts.
- The alternative is vertical integration and a larger firm - we are back to Coase.