Pipelines and Supply Contracts: Beyond the Holdup Story

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for

Chaire Finance & Développement Durable

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Objectives (1)

Understanding how producer-importer relationships in the EU natural gas market are shaped requires taking into account basic facts:

- Production and consumption generally take place in different countries.
- Transit pipelines require heavy relationship-specific investments.
- Both producers and importers have market power.
- The demand level is crucial to the success of a project.

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Objectives (2)

Intrinsic link between investment and contracts, as noted by Williamson (1979):

Traditional Holdup problem

"When a transaction entails one party committing capital that has little value for other uses, the other party has a strong incentive to appropriate the rents arising from the relationship through opportunistic behavior. Anticipating this risk, also called the "hold-up" problem, buyers and sellers sign long-term contracts."

Objectives (3)

Real-life transactions are complex:

- Pipeline investments can be made by producers / importers (firms or governments)/ large consumers / or consortia.
  Ex: Maghreb-Europe (Sonatrach, Marocco State, Enagas, Transgas)
- Supply contracts: typically Take-or-Pay with oil indexation, but actually space for negotiations and flexibility.
- Importers (sometimes also producers) try to stimulate demand.
  Ex: Blue Stream failure on Turkish market, despite Botas and Gazprom's investments in power plants.

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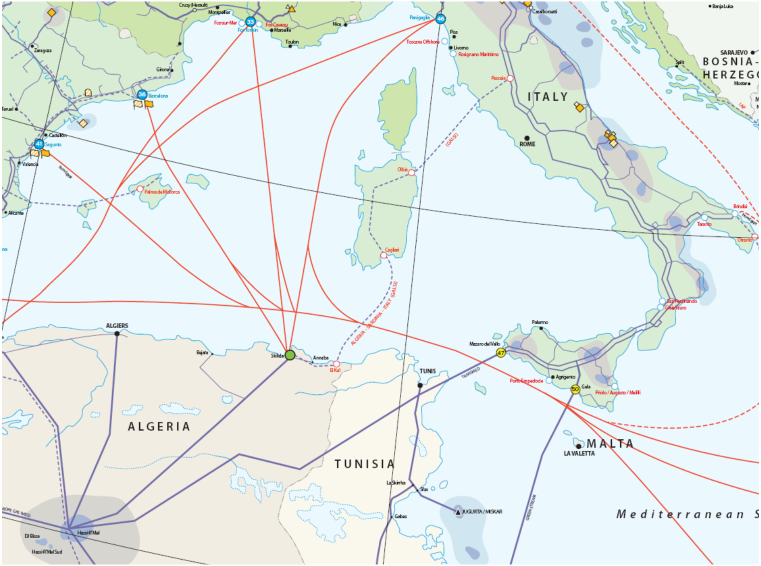
Case Study: Transmed



Case Study: Transmed

The Transmed pipeline: from Algeria to Italy

- 1973: ENI-Sonatrach sign 25-year contract (from 1981 on) to import 11.75 bcm/y natural gas at a price indexed to oil. Construction of the Transmed pipeline begins.
- 1978-83: new Algerian government wants to impose higher prices (oil-linked). ENI has to accept, and obtains a commitment from the Italian government to subsidies that will help natural gas remain competitive.
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Basic Model

General Setting:

- One producer, one importer (marketing firm / government of consumer country / ...)
- Consumption of fuel is bounded by the capacity of some relationship-specific equipment: typically, pipeline size.
- First, investment takes place, then the importer buys fuel from the producer.

We assume a demand function with constant elasticity $\varepsilon > 1$:

$$f(d,p) = d\left(\frac{\varepsilon - 1}{\varepsilon p}\right)^{\varepsilon}.$$

All parameters are common knowledge.

One possible timing of the game:

- The level d of consumer demand is determined by Nature.
- The Importer invests in a pipeline with a certain capacity (A) at a unit cost w.
- The Producer sets a constant unit price (p) for gas.
- The Importer chooses the quantity of gas (q) he wants to buy, up to the pipeline capacity. The Producer extracts and sends the gas at a unit cost c.

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Solving the model backwards

Let g denote the inverse function of f: $f(d,p) = q \Leftrightarrow p = g(d,q)$.

Importer's fuel choice:

- $q = f(d,p)$ if $p \geq g(d,A)$
- $q = A$ if $p \leq g(d,A)$

Producer's price choice:

- The price is such that $\frac{\partial(p*q)}{\partial q} = c$, if and only if the corresponding quantity does not exceed the pipeline size ($q \leq A$). Then $p = \bar{p} \equiv \frac{\varepsilon}{\varepsilon-1}c$.
- Else, the investment choice of the consumer constrains the equilibrium, and the producer has to set a higher price, such that $q = A$: $p = g(d,A)$.

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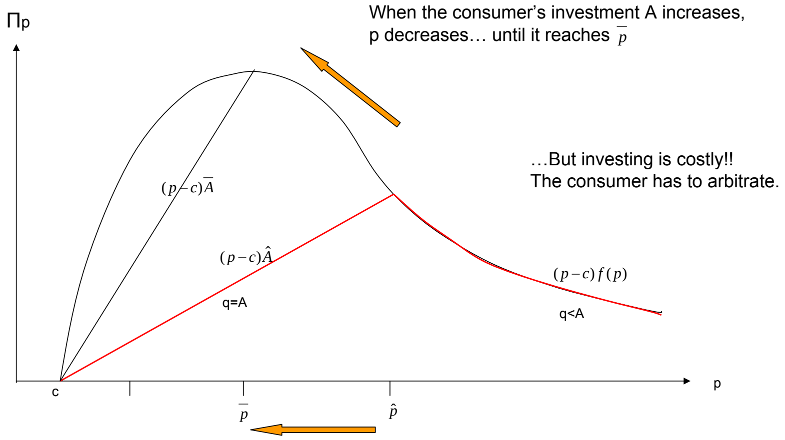
Importer's investment choice



Importer's investment choice

Two cases must be distinguished:

- If he anticipates that the producer will adjust his price so that $q = A$, he just has to solve for A^* that maximizes his surplus. This yields $p^* = \varepsilon w$.
- This anticipation is correct only if the producer cannot set his first-best price $\bar{p}$ because $f(d, \bar{p}) > A^*$. Condition: $\frac{c}{w} < \varepsilon - 1$.
- Else, if $\frac{c}{w} > \varepsilon - 1$ the producer can always set his preferred price $\bar{p}$ and the importer has to adjust A in accordance: $A = f(d, \bar{p})$.

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Basic model: summary

Two regimes can exist:

- When $\frac{c}{w} \leq \varepsilon - 1$, the price is $p^* = \varepsilon w$.
  This is the *investment-constrained* regime.
- When $\frac{c}{w} \geq \varepsilon - 1$,the price is $\bar{p} = \frac{\varepsilon c}{\varepsilon - 1}$.
  This is the *price-constrained* regime.
- Note that in both cases, the pipeline is fully used: $q = A = f(d, p)$. The equilibrium price can be written as $p = \max(\bar{p}, p^*)$.

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Pre-investment contract

We will now examine the case where the producer commits to the price **before** the investment is decided.

Timing of the new game:

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- Obviously, the importer will set $q = A$. But now $w.A$ is not any more a sunk cost, since the importer builds the pipeline after p has been set: the marginal cost of one unit fuel becomes $p + w$.
  The demand function shifts downwards: $q = f(d, p + w)$ instead of $q = f(d, p)$.
- Anticipating this, the producer will choose his profit-maximizing price, as in the price-constrained regime of the basic game.

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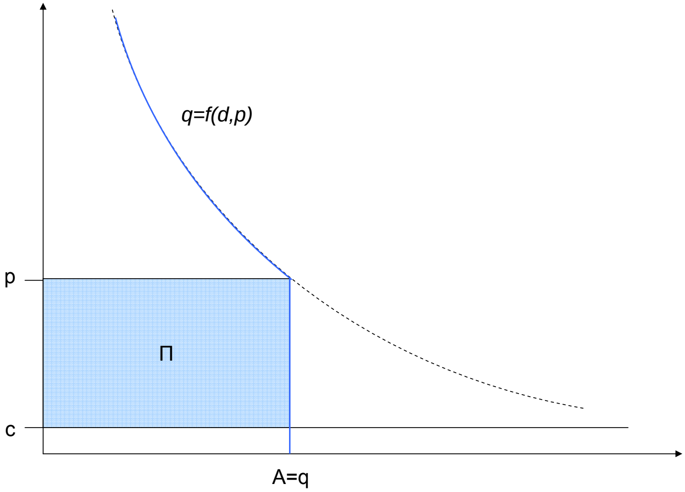
Comparison of investment levels



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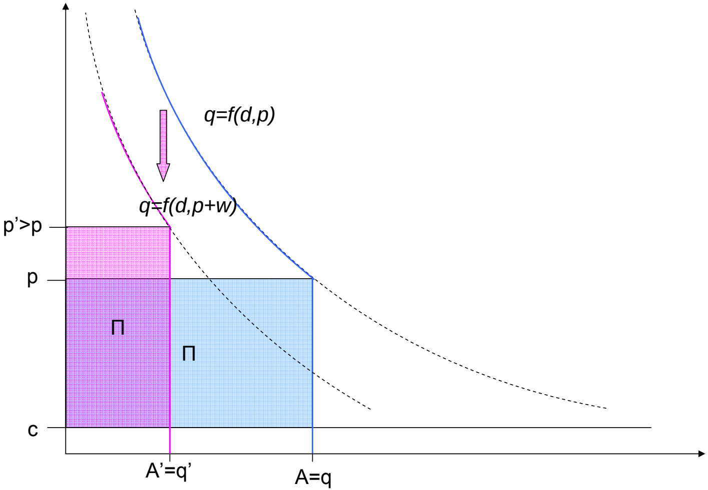

Comparison of investment levels

- If in the basic game the *price-constrained regime* holds ($\frac{c}{w} \geq \varepsilon - 1$), the price is lower than in the new game, and the investment level higher.
- If in the basic game the *investment-constrained regime* holds ($\frac{c}{w} \leq \varepsilon - 1$), by choosing a high A the importer can *commit* to a higher demand function, and obtain a lower price; but this strategy is profitable only if w is not too high.
  - If $\frac{c}{w} \geq \varepsilon - 2$ the investment level is higher in the basic game.
  - If $\frac{c}{w} \leq \varepsilon - 2$ the investment level is lower in the basic game.

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Welfare Comparison

In both games there is under-investment compared to the social optimum. Welfare is always higher when investment is higher.

- If investment is cheap ($\frac{c}{w} \geq \varepsilon - 2$), the investment level is higher in the basic game: committing to the price before investing *reduces welfare*.
- If investment is expensive ($\frac{c}{w} \leq \varepsilon - 2$), the investment level is higher in the new game: committing to the price before investing *increases welfare*.

Asymmetric information about demand

- Now we assume that only the importer knows the demand parameter d (= his "type"). The producer knows solely that $d \in [0; d_{max}]$.
- When choosing the investment level A (observed by the producer), the importer gives a signal about his type.

Asymmetric information about demand

- Under symmetric information, the price was constant whatever d ($\bar{p} = \frac{\varepsilon c}{\varepsilon - 1}$ or $p^* = \varepsilon w$ depending on the regime). An importer with type d invests and buys $A = q = f(d, p)$.
- Under asymmetric information, if the price were the same for all types, the importer would be tempted to cheat ($A < f(d, p)$)in order to save on investment costs, thereby imitating a lower type.
- Anticipating this, the producer will offer different prices according to the investment level he observes, so that a higher type will obtain a lower price.
- The highest type d_{max} obtains the symmetric-equilibrium price, and all other types obtain higher prices.

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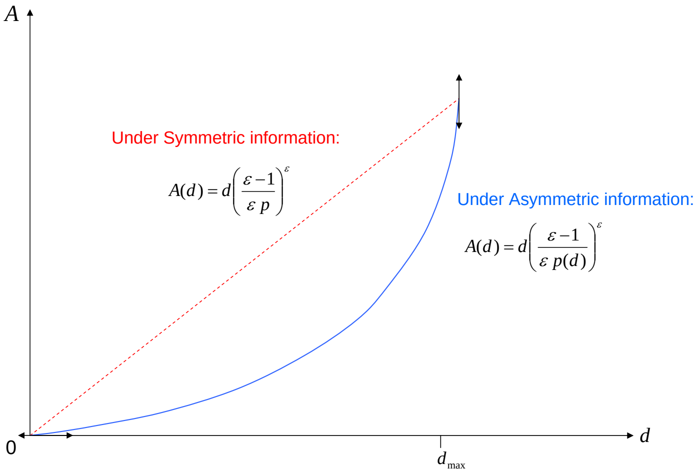
Investment level under asymmetric information:



When the importer can stimulate demand:

We add a step: after Nature determines an initial demand parameter δ, the importer can transform it into d at a cost $C(\delta, d)$. The producer observes neither parameter.

Timing of the new game:

- The level δ of consumer demand is determined by Nature.
- The importer pays $C(\delta, d)$ to stimulate demand. The demand level becomes d.
- The Producer sets a constant unit price (p) for gas.
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When the importer can stimulate demand:

Incentives to stimulate demand:

- Under symmetric information, the importer's utility function writes $U(d) = \alpha.d$, thus the incentives are the same for all types.
- Under asymmetric information, a higher d allows to obtain a lower price from the producer, but this price is always higher than under symmetric information.
  $U(d) = \varphi(d).d$ where $\varphi(d) \leq \alpha$. Therefore
  - When the initial δ is small, there is less to gain by increasing demand under asymmetric information because $\varphi(d)$ will remain small.
  - When the initial δ is large, $\varphi(d)$ will be close to the symmetric-information constant, and in addition, increasing d leads to a price decrease. The incentives to stimulate demand are higher under asymmetric information.

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Endogenous demand: Result

Incentives to stimulate demand:

There exist a threshold $\tilde{\delta}$ such that when the initial demand level is higher than (respectively lower than) $\tilde{\delta}$, the incentives to stimulate demand are higher (resp. lower) under asymmetric information.

Conclusion and way forward

- A general structure to analyze producer-importer relationships has been set up, that can be used as a building block for more detailed models.
- Many variants can be envisaged. For example:
  - Investment by the producer, or by a consortium involving both parties.
  - Contracts are renegotiated or adjusted to evolutions of demand.
  - etc.
- Suggestions are welcome!