4 Vertical Control

The kind of vertical relationship that we are talking about is the case of a monopolistic up-stream firm with its downstream firms. Well, one can always consider the downstream firms as “consumers” and applied what we’ve learned previously. However, unlike “pure” consumers who “consume” the product, downstream firms (industrial buyers) make decisions to transform the product and/or to market it. Because these decisions (pricing, promotional, and/or input decision) made by the downstream firms affect the upstream firms’ profits, the upstream firms will exert vertical control (restraints) on downstream firms to the extent that such control is feasible. Why such controls are sensible? One can trace them back to the existence of externalities between downstream firms and upstream firms.

4.1 Vertical restraints

For a monopolistic upstream and a monopolistic downstream firm, common and simple vertical restraints are: linear pricing, a franchise fee (two-part tariff), resale price maintenance (RPM), and quantity fixing. Denote the price charged by the upstream firm as $p_w$, and the price charged by the downstream firm as $p$. Furthermore, the final demand is: $D(p)$.

- Linear price. Linear price can be expressed as: $T(q) = p_w q$, where $q$ is the quantity chosen by the downstream firm. Note that if downstream firm’s technology is simply to transform one unit of the intermediate good into one unit of the final product, and if downstream firm does not throw away any of the intermediate good, then: $q = D(p)$.

- Franchise fee. This can be specified as a two-part tariff, i.e., $T(q) = A + p_w q$.

- RPM:
  - The upstream firm fixes the final price $p$;
  - Price floor: $p \geq \underline{p}$;
  - Price ceiling: $p \leq \overline{p}$.
• Quantity fixing:
  
  – The upstream firm fixes the quantity \( q \);
  
  – Quantity rationing: \( q \leq \bar{q} \);
  
  – Quantity forcing: \( q \geq q \).

Note that when \( D(\cdot) \) is known, and the downstream firms cannot throw away (or too costly to do so) the intermediate good, then RPM is equivalent to the quantity fixing scheme.

Now, what if there are many downstream firms? Many upstream firms? Or, downstream firms use several inputs to produce the final product?

• Exclusive territories: spatial and/or market segmentation;

• Exclusive dealing;

• Tie-in purchase (or making a product incompatible with complementary products manufactured by other firms) or royalty fee (proportional to the number of units sold downstream when the retailer’s level of sales is observable and verifiable).

4.2 Externalities and vertical restraints

Some fundamental externalities are: double marginalization, downstream moral hazard, and input substitution. The basic idea is that: Any decision made by the downstream firm that increases its demand for the intermediate good by one unit also increases the profit of the upstream firms by \( p_w - c \). So, the problem is: The downstream firm does not take into account the incremental profit of the upstream firm, and tend to make decisions that lead to too few a consumption of the intermediate good. We study what kind of vertical restraints that the upstream firm can use to correct this externality. An important conclusion is that: The elimination of any of these externalities (double marginalization, moral hazard, and input substitution) is welfare enhancing. Vertical integration or vertical restraints need not to be detrimental to welfare, even when they are meant to increase monopoly profit.
4.2.1 Double marginalization (Excessive demand contraction)

The problem  Consider the decentralized situation first. The timing of the event is that the upstream firm (manufacturer) setup a linear (wholesale) price \( p_w \), and the downstream firm (retailer) chooses the price of the final product (consumer price) \( p \) second. Let’s started with the case that the both the manufacturer and the retailer are monopolistic firms. So, it’s a two stage model, we solve the second stage first. To make things easier, we also assume \( D(p) = 1 - p \). The retailer solves:

\[
\max_p \ (p - p_w)D(p) = (p - p_w)(1 - p);
\]

and, the FOC requires:

\[
p = p^*(p_w) = \frac{1 + p_w}{2}.
\]

Thus, the demand for the final good is: \( 1 - p = (1 - p_w)/2 \), and the retailer’s profit is: \( \Pi_r = ((1 - p_w)/2)^2 \).

The manufacturer solves:

\[
\max_{p_w} \ (p_w - c)D(p^*(p_w)) = (p_w - c)(1 - p_w/2);
\]

and the FOC requires:

\[
p_w = \frac{1 + c}{2}.
\]

Thus, the manufacturer’s profit is: \( \Pi_m = (1 - c)^2/8 \). Moreover, the non-integrated profit \( \Pi^{ni} \):

\[
\Pi^{ni} = \Pi_m + \Pi_r = (1 - c)^2/8 + ((1 - c)/4)^2 = \frac{3}{16}(1 - c)^2.
\]

Now, consider the integrated industry’s problem. It solves:

\[
\max_p \ (p - c)D(p) = (p - c)(1 - p);
\]

and, the FOC requires:

\[
p = p^m = \frac{1 + c}{2};
\]

with the integrated profit \( \Pi^i \):

\[
\Pi^i = \Pi^m = \frac{1}{4}(1 - c)^2.
\]
Note that:

- The integrated $p$ is smaller than the non-integrated $p$, so the consumers are better off in the integrated industry;
- $\Pi^i > \Pi^{ni}$, so the integrated industry makes more profit than the non-integrated one.
- The result of double marginalization (excessive demand contraction) is quite general. The first marginalization is when the monopolistic manufacturer chooses a price $p_w > c$. The second marginalization happens when the monopolistic retailer facing marginal cost $p_w$ chooses a price higher than the one facing marginal cost $c$: $c \to p_w \to p^m(p_w) > p^m(c)$.
- So, what’s worse than a monopoly?
- If either the manufacturer or the retailer is competitive (in the sense that it charges its marginal cost), then there is no double marginalization.

**Sufficient vertical restraints**

- Franchise fee: set $p_w = c$. Then the retailer solves:
  \[
  \max_p (p - c)D(p) - A = (p - c)(1 - p) - A;
  \]
  chooses $p = (1 + c)/2$; and, makes profit: $\Pi^m - A = (1 - c)^2/4 - A$. Set $A = \Pi^m$.
- RPM: charge $p_w = p^m$, and set $p = p^m$. A price ceiling: $p \leq p^m$ also works.
- Quantity fixing: charge $p_w = p^m$, and set $q = q^m$ (or quantity forcing: $q \geq q^m$).

There are two notes on the franchise fee. First, it is as if the manufacturer sells the vertical structure to the retailer and ask for a fixed price $A$. Since the whole structure, if owned by a single agent, makes maximum profit $\Pi^m$, so the manufacturer can ask for $A = \Pi^m$. This makes the retailer the “residual claimant” (the receiver of any marginal profit.) Therefore, it has all the incentive to make the correct decisions. As we’ll see,
franchise fee is very powerful. It solves not only the double marginalization problem but also the downstream moral hazard and input substitution distortion.

Second, consider the case that the retailer possesses private information about the retail cost or the final demand. Now the manufacturer cannot tailor the franchise fee to appropriate the retailer’s profit. Nevertheless, using the same idea as in the $2^0$ PD, the manufacturer can use screening devices to appropriate at least some of the profits. To fix the thoughts, say that there are two possible types of the retailer: high retail cost (or low demand) and low retail cost (or high demand). Then optimal two-part tariff has: $p_w > c$, and $A =$ retailer’s profit when the retail cost is high (or demand is low).

On the other hand, when there exists uncertainty with respect to the retail cost or the final demand and the retailer is risk-averse, franchise fee in general is not sufficient. The intuition is that making the retailer claiming all the residual profits, the retailer is bearing too much risk.

4.2.2 Downstream moral hazard

The problem Consider the downstream firm exerts promotional efforts (or services) to make the good more attractive to the consumers. Call these promotional efforts (services) $s$, then $q = D(p, s)$, such that $D_s(p, s) = \partial D(p, s)/\partial s > 0$. The moral hazard problem arises naturally when the upstream firm cannot observe and/or verify these efforts. Denote the per unit cost of providing $s$ promotional efforts as $\Phi(s)$, such that $\Phi'(\cdot) > 0$. The retailer solves:

$$\max_{p, s} [p - p_w - \Phi(s)]D(p, s);$$

and, the manufacturer solves:

$$\max_{p_w} (p_w - c)D(p, s).$$

The integrated industry choose $p^m$ and $s^m$ that solve:

$$\max_{p, s} [p - c - \Phi(s)]D(p, s).$$

Denote: $\Pi^m = (p^m - c - \Phi(s^m))D(p^m, s^m)$. 

We know that the manufacturer charges $p_w > c$. The double marginalization problem still exists here when the retailer chooses $p$. Moreover, now notice that when the choice of $s$ is made, the retailer would not take into account the extra profit for the manufacturer associated with an increase in services: $(p_w - c)D_s(p, s)$. Thus, the retailer provides too few promotional efforts.

**Sufficient vertical restraints**

- Franchise fee: set $p_w = c$, and $A = \Pi^m$.

- RPM: insufficient. Setting $p = p^m$ does not resolve the promotional effort externality. To see this, note that in order for the manufacturer to realize the vertically integrated profit, the solutions to the retailer’s problem have to be: $p^m$ and $s^m$, and $p_w = p - \Phi(s) = p^m - \Phi(s^m)$. Hence, the retailer’s problem (under RPM) becomes:

\[
\max_s \left[ \Phi(s^m) - \Phi(s) \right] D(p^m, s).
\]

Since $\Phi'(s) > 0$, the retailer chooses $s \leq s^m$ (otherwise the profit would be negative).

- Quantity fixing: setting $q = q^m = D(p^m, s^m)$, or, quantity forcing: $q \geq q^m$, is sufficient. Using the same argument as above, $p_w = p^m - \Phi(s^m)$. The retailer’s problem (under quantity forcing) becomes:

\[
\max_{p,s} \left[ p - p^m + \Phi(s^m) - \Phi(s) \right] D(p, s)
\]
\[
\text{s.t. } D(p, s) \geq q^m.
\]

If there is no quantity forcing, the retailer chooses $p$ and $s$ such that $D(p, s) < q^m$. Thus, the constraint is binding; i.e., $D(p, s) = q^m$, and the retailer’s problem becomes:

\[
\max_{p,s} p - \Phi(s)
\]
\[
\text{s.t. } D(p, s) = q^m.
\]

The solution to this constrained maximization problem has the same $p$ and $s$ as those of the integrated (unconstrained) one; i.e., $p = p^m$ and $s = s^m$. 
Note that bilateral moral hazard arises when the manufacturer also exert efforts that are difficult (costly) to confirm. In this case, the franchise fee is not a sufficient instrument: if we make the retailer the residual claimant, then there is no incentive for the manufacturer to expand demands, and vice versa.

### 4.2.3 Input substitution

**The problem** Suppose now the downstream firm imposes two inputs for the final product; e.g., the downstream firm chooses $x$ and $x'$ to produce $q = f(x, x')$. Let $f$ be homo. Let the marginal cost to produce the first input ($x$) be $c$, and $c'$ for the second input ($x'$). Moreover, while the manufacturer of $x$ is a monopoly, the manufacturers of $x'$ are competitive. The retailer is a monopoly.

Under linear pricing, the monopoly manufacturer charges: $p_w > c$, while the competitive manufacturers charge: $p'_w = c'$. Hence, the relative price of inputs for the retailer: $p_w/p'_w = p_w/c'$. But the integrated industry solves:

$$
\max_{x,x'} P(f(x, x')) f(x, x') - cx - c'x';
$$

and has relative price of inputs: $c/c'$. Denote $\Pi^m$ as the maximized profit of the integrated industry, and $x^m$ and $x'^m$ as the optimal inputs. Since $p_w/c' > c/c'$, the retailer thus substitutes toward the second input and “consumes” too little of the monopolistic manufacturer’s intermediate good. Note also that the double marginalization issue still exists because the non-integrated industry has $p_w > c$.

**Sufficient vertical restraints**

- Franchise fee: set $p_w = c$, and $A = P(f(x^m, x'^m)) f(x^m, x'^m) - cx^m - c'x'^m$.

- RPM: insufficient. Setting $p = p^m$ does not resolve input substitution. However, RPM together with tie-in is sufficient. If the retailer is required to purchase $x'$ from the monopolistic manufacturer (who purchases $x'$ from competitive manufacturers at price $c'$), the monopolistic producer can charge: $p_w/p'_w = c/c'$. This (tie-in) resolves
the input substitution problem. Then we can use RPM and set \( p = p_m \) to resolve the downstream marginalization.

- Hence, the monopolistic manufacturer chooses \( p_w \) and \( p_{w'} \) such that:

\[
\begin{align*}
\frac{p_w}{p_{w'}} &= \frac{c}{c'} \\
p_wx^m + p_{w'}x'^m &= p^m f(x^m, x'^m).
\end{align*}
\]

- Note first, cost minimization (downstream firm) requires:

\[
\frac{\partial f}{\partial x}(x, x')/\frac{\partial f}{\partial x'}(x, x') = \frac{p_w}{p_{w'}} = \frac{c}{c'} = \frac{\partial f}{\partial x}(x^m, x'^m)/\frac{\partial f}{\partial x'}(x^m, x'^m),
\]

given the CRTS technology, the solutions have the form: \( \{x = \lambda x^m, x' = \lambda x'^m\} \) for some \( \lambda \geq 0 \). Second,

\[
p_wx + p_{w'}x' = \lambda(p_wx^m + p_{w'}x'^m)
\]

\[
= \lambda p^m f(x^m, x'^m)
\]

\[
= p^m f(x, x'),
\]

or, the downstream firm makes zero profit.

- What if the downstream firm is in a competitive environment?

- Setting \( p_w = c \) and imposing a franchise fee are not sufficient. The monopolistic manufacturer would generate zero profit.

- Tie-in alone is sufficient. There is no downstream marginalization problem.

- A royalty fee on the final product together with \( p_w = c \) is sufficient. It works as if the monopolistic manufacturer taxes the final output: the royalty per unit of output is: \( (p^m q^m - cx^m - cx'^m)/q^m \).
4.3 Intrabrand competition

Consider an environment where there is one upstream manufacturer and many downstream retailers.

4.3.1 Vertical considerations

When the downstream firm is in a competition environment, we need not to worry about the double marginalization distortion since there is no second marginalization. We have already discussed sufficient vertical restraints for the input substitution problem when the downstream firm is in a competitive environment. Hence, the discussion of a competitive downstream sector focuses on the promotional efforts (downstream moral hazard).

Let the demand be: \( q = D(p, s) \). Consider \((p, s)\) as a package of (final) price \( p \) and promotional effort \( s \). Net consumer surplus \( S(p, s) \) can be expressed as: \( S(p, s) \equiv \int_p^\infty D(x, s)dx \).

Assume all retailers are the same, and the per unit cost of \( s \) promotion is: \( \Phi(s) \). The vertically integrated profit is obtained by solving the following problem:

\[
\Pi^m = \max_{p, s} \left[ p - c - \Phi(s) \right] D(p, s).
\]

The FOC for promotional effort \( s \) is:

\[
\left[ p - c - \Phi(s) \right] \frac{\partial D(p, s)}{\partial s} = \Phi'(s)D(p, s).
\]

Denote \( p^m \) and \( s^m \) as the \( p \) and \( s \) that maximize the integrated profit.

In a competitive environment, the retailers’ problem is as if they were maximizing consumer surplus subject to the condition that they make normal profit (competition maximizes social welfare subject to the fact that the input is bought at \( p_w \) instead of \( c \)); i.e.,

\[
\max_{p, s} S(p, s)
\]

s.t. \( p = p_w + \Phi(s), \)

or,

\[
\max_s S(p_w + \Phi(s), s).
\]
The FOC is:
\[
\frac{\partial S(p_w, s)}{\partial p} \Phi'(s) + \frac{\partial S(p_w, s)}{\partial s} = 0,
\]
or,
\[
\frac{\partial S(p_w, s)}{\partial s} = \Phi'(s) D(p_w, s).
\]
Note that: \( \frac{\partial S(p, s)}{\partial p} = -D(p, s) \) and \( \frac{\partial S(p, s)}{\partial s} = \int_p^\infty D_s(x, s) dx \). The RHS of both FOCs are the marginal cost of promotional effort times demand. The LHS of the integrated structure’s FOC for \( s \) is the marginal revenue of increasing promotional effect; the LHS of the non-integrated FOC is the increase in demand for all inframarginal units. This is similar to the case of quality selection. We conclude that: the competitive retailers may provide too few or too many promotional efforts depending on how the promotional efforts are valued by the marginal and inframarginal consumers. One thing is for sure: The provision of services under retail competition is socially optimal given the wholesale price.

For the same reasoning as before, setting \( p_w = c \) and imposing a franchise fee are not sufficient (zero profit). RPM (or quantity fixing) is sufficient: let \( p = p^m \) and charge price \( p_w = p^m - \Phi(s^m) \). This is because competition requires \( p = p_w + \Phi(s) \). Hence, when \( p = p^m \) and \( p_w = p^m - \Phi(s^m) \), \( s = s^m \).

### 4.3.2 Horizontal considerations

The argument that: “competition maximizes social welfare subject to the fact that the input is bought at \( p_w \) instead of \( c \)”, ignores the horizontal externality of promotional efforts among retailers. If the demand is of the form: \( q = D(p, \bar{\pi}) \), where \( \bar{\pi} \) is the maximum efforts offered by any retailer and \( p \) is the lowest price charged by any retailer, \( \bar{\pi} = 0 \) in equilibrium. In this case, promotional effort is a public good, and retailers free-ride on one another. Competition among downstream firms and the non-appropriable nature of promotional effort hurt the consumers.

The manufacturer can use competition-reducing restraints, such as RPM and exclusive territories, to eliminate this distortion.
4.4 Interbrand competition

Now consider an environment where there is many upstream manufacturers and one downstream retailers.

- The manufacturer promotes its product (brand). The retailer may induce the consumers who visit its store to buy a competing brand with a higher profit margin (for example, the competing manufacturer does not incur the same promotional expense). Exclusive dealing can be used as a way to give the manufacturer property right on its promotional efforts.

- Sometimes vertical restraints can be used by manufacturers to loosen upstream competition. Exclusive contracts (exclusive dealing or long-term contract with retailers) can be used as a barrier to entry. Some private contracting tends to excessively foreclose the access to markets by new entrants.