Economies of Scale, Outsourcing, Joint Ventures, and Social Efficiency∗

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Abstract

Joint outsourcing is the practice of competing firms outsourcing to a common supplier. This work models joint outsourcing under oligopolistic competition with nonlinear costs. I show that in a covered market, if production technology exhibits economies of scale at the equilibrium quantity for all firms, those firms will always outsource. If each firm’s marginal cost before outsourcing is low relative to the industry’s average cost, joint outsourcing leads to increased prices and decreased consumer welfare. Conversely, if each firm’s average cost is lower than the industry’s average cost, for example if the cost function exhibits economies of scale everywhere, social welfare increases. If firms establish a joint venture instead of jointly outsourcing, prices increase and consumer welfare decreases if the marginal cost of each firm was lower than the joint venture’s marginal cost, for example with linear costs.

1 Introduction

Competing firms in many industries outsource to a common supplier, a practice known as joint outsourcing. For example, in the United States more than 60% of auto parts suppliers make parts for all three major car manufacturers. One justification for the United States government bailing out GM and Chrysler was that if a major car manufacturer fails, many auto parts suppliers would also fail, with serious consequences for the other major car manufacturers (Wall Street Journal, 2008). Sprint Nextel, a major U.S. cell phone service provider, was in talks with Ericsson to outsource maintenance of mobile-phone towers. Both companies assumed the deal would lead to similar deals with AT&T and T-Mobile (Wall Street Journal, 2009a).

I examine how joint outsourcing effects firms’ pricing decisions, and consumer and social welfare. If suppliers are competitive, then firms jointly outsource if their marginal costs are sufficiently below their average cost at the equilibrium quantity. Consumer welfare increases if each firm’s marginal cost without outsourcing is higher than the average cost of the parts

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provider, and the provider is producing for the whole market. I show that if the industry production function exhibits economies of scale everywhere, then firms always outsource, leading to increased social welfare. Additional costs of outsourcing result in firms potentially outsourcing too little or too much to maximize social welfare. If the average cost function is U-shaped, then firms might outsource when it is not socially optimal.

I also examine downstream firms jointly establishing and owning an upstream joint venture (JV). If the JV’s marginal cost when it is producing for the whole market is not sufficiently lower than each individual firm’s marginal cost when it is just producing for itself, then consumers suffer from the JV’s establishment, although firms might establish a JV when it is not socially optimal.

In a covered market, when consumers have no outside option, joint outsourcing allows firms to transform a nonlinear production cost into a constant per-unit procurement cost, which is fully passed down to consumers. In this case, joint outsourcing is removing firms’ costs, and it does not matter how much the joint supplier charges, since the cost is immediately passed down to the consumers. With an uncovered market, firms care about the joint supplier’s price, since not all costs are passed down to the consumers.

I assume that downstream firms, parts suppliers, and any potential joint ventures all have access to the same production technology. This assumption means that nothing is going to get outsourced because of a more efficient factory or production allocation. I assume that the cost function is not sufficiently concave for the second order conditions to be satisfied, and that the average cost and marginal cost either have the traditional U-shape form or decrease everywhere. I also assume that either all competitors outsource to the same parts supplier or none of them do. This weak assumption is consistent with the industries already discussed. If the marginal cost is diminishing, then this is the chicken and egg argument of Caillaud and Jullien (2003), which states that with perfect competition everyone buys from the same supplier, but the supplier derives zero economic profit (renaming a few players in their model). If the industry production quantity is at the point where there are diseconomies of scale, then a firm’s marginal cost should be above the industry’s average cost, and no firm has an incentive to break out of the joint outsourcing arrangement.  

A major difference between this paper and most other outsourcing work is that I consider nonlinear costs. Economies of scale are an important topic in economics, both in the industrial organization and in the international trade literatures. However, in most of the models economies of scale are represented as a fixed cost and a constant marginal cost. While this may be a good approximation in some scenarios, there is no reason to believe that marginal costs are approximately constant in most industries. The motivation for this approximation is that in perfect competition models with nonlinear costs and economies of scale, equilibrium is notoriously hard to guarantee. Sufficient product differentiation makes this task much easier.

I discuss the difference between competing with economies of scale, with the option of

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1I could examine unilateral and group deviations, and look for the core, but this is not the topic of the paper. See Shy and Stenbacka (2003), who show that firms outsource to the same supplier when the production costs are linear.
joint outsourcing, and competing with network effects, with the option of making products compatible.\(^2\) Previous literature had made informal claims that the two phenomena are similar (see for example Liebowitz and Margolis (1994)). I show that they are not the same, for two reasons. The consequences of network effects depend on the demand function, but the curvature of the cost function enters optimal price additively, and in general it is impossible to find a cost function which results in the same price best reply functions as a given network effect function. The second reason is more intuitive, that with network effects, signing up an additional consumer affects every other consumer’s utility, but with economies of scale, an additional consumer just means that this particular consumer’s cost is lower.

I start with describing oligopolistic competition in a covered market (no outside option) with a general cost function. Then, I introduce a competitive parts supplier, and derive the main results of the paper (Section 2). I introduce a joint venture in Section 3, and switch to a not-covered market because otherwise firms would raise prices to capture all of the consumer surplus. I conclude in Section 4.

Shy and Stenbacka (2003) examine firms with the same linear cost outsourcing to competitive suppliers in a covered (Hotelling) market. They show that all downstream firms outsource to the same supplier, and it is socially efficient since this supplier will have the lowest average cost and because of the covered market prices are just transfers from consumers to firms. I assume that firms outsource to the same supplier, and generalize the result to nonlinear costs. I show that outsourcing is socially efficient if the average cost of the industry are lower than the average cost of a firm, and firms outsource if their marginal cost is lower than their average cost – both conditions happen to be satisfied with linear cost like in Shy and Stenbacka (2003). In this paper, without linear costs, outsourcing does not necessarily lead to lowest costs or to increased social welfare, and non-covered market in the JV discussion implies that price changes might result in a lower social welfare, and with a positive cost of joint outsourcing firms might jointly outsource when it is not optimal from the social welfare perspective.

Lewis and Sappington (1991) consider a firm which might produce in-house or outsource to a subcontractor, which cannot be perfectly monitored. I assume away any monitoring issues. Kamien et. al. (1989) study an auction where the winner might subcontract to the losers. Spiegel (1993) considers horizontal outsourcing – one competitor outsourcing to another to allocate production more efficiently, improving social welfare meanwhile. Arya et.al. (2008) show that firms might outsource to a less efficient supplier if that increases rival’s costs. Chen et. al. (2009) show that with quantity competition horizontal outsourcing makes the supplier a Stackelberg follower, resulting in higher prices for horizontal outsourcing. Rossini and Vergari (2009) examine joint ventures and show that joint ventures might be preferred by the firms to vertical integration with suppliers, but the social welfare comparison might go the opposite way for sufficiently low product differentiation or a sufficiently high fixed cost. While demand parameters matter in my model as well, I derive sufficient conditions based just on average and

\(^2\)See Katz and Shapiro (1984) and Alexandrov (2010) for competition with network effects and possible compatibility.
marginal costs.

2 Joint Outsourcing to a Competitive Supplier

2.1 Competition with Nonlinear Costs without Outsourcing

I adopt the setup of Perloff and Salop (1985), and I include nonlinear costs in it.\footnote{I could have used the Salop (1979) circle instead, with similar results.} I only consider symmetric equilibria. I assume that in a symmetric equilibrium a firm does not have an incentive to charge a price that is low enough to induce all consumers to switch to the firm’s product. A sufficient amount of product differentiation, relative to the concavity of the cost function, implies that this assumption is satisfied.

There are \( N \) symmetric firms in the market. Each firm has the same cost function \( C(\bullet) \). The cost function is increasing.

There is a mass \( L \) of consumers. Each consumer has a firm-specific preference, \( \theta_i \) for firm \( i \). For each consumer, the \( \theta \)s are independently and identically distributed, according to a p.d.f. \( g(\bullet) \). A given consumer’s utility from buying firm \( i \)’s product is:

\[
  u_i = t\theta_i - p_i, \tag{1}
\]

where \( t \) is the strength of preferences and is similar to the familiar Hotelling’s travel cost. There is no outside option – each consumer has to buy a product. The lack of an outside option is for analytic convenience, see the next section for a similar setup with an outside option.

**Proposition 1** *In the symmetric equilibrium, all firms charge*

\[
p^* = C' \left( \frac{L}{N} \right) + \frac{t}{M(N)}, \tag{2}
\]

where \( M(N) = N(N-1) \int G^{N-2}(\theta)g^2(\theta)d\theta \).

**Proof.** A consumer buys brand \( i \) if and only if \( u_i > u_j \) for all \( j \neq i \). Thus

\[
  t\theta_i - p_i > t\theta_j - p_j, \tag{3a}
\]

\[
  \theta_j < \theta_i + \frac{p_j - p_i}{t}, \tag{3b}
\]

for all \( j \neq i \). Since \( \theta \)s are i.i.d.,

\[
  q_i = L \int \left[ \prod_{j \neq i} G(\theta_i + \frac{p_j - p_i}{t}) \right] g(\theta_i)d\theta_i. \tag{4}
\]

The firm’s profit is

\[
  \Pi_i = p_i q_i - C(q_i). \tag{5}
\]
and assuming that all firms \( j \neq i \) choose the same price \( \bar{p} \), the FOC is

\[
q_i = (p_i - C'(q_i)) \frac{N - 1}{t} \int G^{N-2}(\theta_i + \frac{\bar{p} - p_i}{t})g^2(\theta_i)d\theta_i = 0, \quad (6)
\]

By the symmetry expectation assumption, and using the symmetric equilibrium condition of \( q_i = \frac{L}{N} \), I get the result in the proposition. The second order conditions come from the Perloff and Salop (1985) paper, endnote 6, adjusted for nonlinear cost (the cost function cannot be too concave). ■

Term \( M(N) \) is the same as in Perloff and Salop (1985) and represents a combination of the particular functional form of the probability distribution function of consumer valuations, and the number of firms in the market. If \( G = 1 - G \) is log-concave, then \( M(N) \) increases in \( N \), and if there are more firms in the market, then the equilibrium price is lower.\(^4\) The above price differs from the Perloff and Salop (1985) price by the cost term in the equation – it would have been just the constant marginal cost with linear costs.

### 2.2 Competitive Supplier

Firms routinely outsource their production to the same supplier as their competitors. Firms also set up joint ventures with competitors on the production side. This is a common occurrence in the telecommunication industry, where coverage providers align their networks and work together on the supply side. Other examples include the automotive industry, where competitors get parts from the same supplier, and electronics, where frequently the same Original Equipment Manufacturer supplies several competitors. I can, instead, assume a nonprofit parts supplier set up by the firms, or a competitor waiting to enter the market, and not letting the upstream firm make a positive profit. Another possibility is that all the firms outsource to one of them; and all the firms compete to be that firm before the outsourcing occurs.

I assume that the products being sold to the companies are the same (companies just brand the products), so that one factory can make products for all the firms, and still enjoy economies (or suffer diseconomies) of scale.

The firms have a choice to outsource to a parts supplier or not. Either all firms enter or none of them do – thus, each firm has to derive more profit with the joint venture than without it. As I have mentioned in the introduction, perfect competition and average costs which do not increase too much result in this assumption, similar to Caillaud and Jullien (2003).

Without outsourcing (from above), the profit of each firm is

\[
\Pi^* = \frac{L}{N} C' \left( \frac{L}{N} \right) + \frac{L}{N} \frac{t}{M(N)} - C \left( \frac{L}{N} \right). \quad (7)
\]

Let us compare this profit with the profit in the presence of a parts supplier. If all firms outsource, then the supplier produces \( L \) units. Since the supplier does not make profit, it charges firms \( \frac{C(L)}{L} \) for each unit. Thus the firms effectively face a linear cost curve and no fixed

\(^4\)See Weyl (2009) and Gabaix et al. (2009) for more detailed results about \( M(N) \) in Perloff and Salop (1985).
costs, and from Perloff and Salop (1985) charge
\[
p^{\text{out}} = \frac{C(L)}{L} + \frac{t}{M(N)},
\]
for a profit of
\[
\Pi^{\text{out}} = L \frac{t}{N M(N)}.
\]

**Proposition 2** Firms choose to jointly outsource if and only if the equilibrium quantity \(\frac{L}{N}\) is below the minimum average cost quantity. In particular, firms always outsource if the cost function exhibits economies of scale at the equilibrium quantity.

**Proof.** With outsourcing, the profits are the same as in the case of no costs – everything is passed directly to the consumers. Due to the full coverage assumption, the demand does not suffer. The difference in profits is
\[
\Delta \Pi = q^* C'(q^*) - C(q^*),
\]
where \(q^* = \frac{L}{N}\) is the equilibrium quantity. The difference can also be expressed as
\[
\Delta \Pi = q^* (MC(q^*) - AC(q^*)).
\]
The expression in parentheses is positive if and only if the equilibrium quantity is above the minimum average cost quantity. 

**Corollary 1** Prices increase and consumer welfare decreases after outsourcing if and only if \(AC(L) > MC\left(\frac{L}{N}\right)\).

If the cost function exhibits economies of scale at the equilibrium production quantity of each firm, then firms outsource. However, conditional on outsourcing, prices and consumer welfare may move in either direction.

**Corollary 2** Social welfare increases with joint outsourcing if the average cost of producing for the whole market is lower than the average cost of each company, \(AC(L) < AC\left(\frac{L}{N}\right)\).

Similarly, social welfare may either increase or decrease after the joint outsourcing decision. Firms are only concerned with the average versus marginal cost comparison at their equilibrium production quantity, since the average cost, irrespective of its magnitude, is fully passed down to the consumers. However, for social welfare, the relevant comparison is the joint supplier’s average cost versus each firm’s average cost.\(^5\)

**Corollary 3** Social welfare increases with joint outsourcing if the production function exhibits economies of scale everywhere.

\(^5\)This works so cleanly because of the covered market assumption, see next section for an un-covered market.
This result generalizes one of the two main results of Shy and Stenbacka (2003): with linear costs, social welfare increases with outsourcing. Their other main result is that firms outsource to the same parts supplier, which I have assumed.

Suppose firms have to pay to jointly outsource (signing a contract or slightly altering the product once they receive it). Then, firms outsource only when it is socially optimal if there is no change in consumer welfare between the two regimes.

Suppose it costs \( F \) for each firm to outsource. Then, firms outsource only if \( \Delta \Pi > F \), where \( \Delta \Pi \) is the change in profits with and without outsourcing. For social welfare, firms should outsource only if \( \Delta SW > F \). Since social welfare is profit plus consumer welfare, firms do not outsource sufficiently if \( \Delta CW > 0 \), and firms outsource too often if \( \Delta CW < 0 \).

From Corollary 1, consumer welfare can change in either direction, and depending on that direction, firms might outsource when it is not socially optimal to, or might not outsource when it would have been socially optimal to.

### 2.3 Comparison with Network Effects and Interconnection

In the network effects literature, there is a notion that economies of scale are similar to network effects (see Liebowitz and Margolis (1994) for example). This is not the case. Compare the following equilibrium prices for the same demand specification, where (12a) is the price with a nonlinear cost function \( C(\bullet) \), and (12b) is the price with a network effects function \( v(\bullet) \) – every consumer enjoys additional \( v(q) \) in value if \( q \) more consumers buy the same product (see Alexandrov (2010)).

\[
p^*_{NonlinearCost} = C'(\frac{L}{N}) + \frac{t}{M(N)}, \quad \text{(12a)}
\]

\[
p^*_{NetEffects} = \frac{t}{M(N)} \left( \frac{1}{N} - v'(\frac{1}{N}) \right) - \frac{\partial E[Q_i]}{\partial p_i}. \quad \text{(12b)}
\]
The difference arises from the fact that nonlinear costs enter additively, while network effects enter multiplicatively. Network effects are a demand-side phenomenon, and a non-additive interaction with the demand parameters is expected. On the other hand, nonlinear costs do not enter the profit function through demand, and thus result in a simpler additive term.

A more intuitive explanation is that one more consumer for a firm with network effects implies that all the consumers in the market like this firm more. On the other hand, one more consumer for a firm with nonlinear costs means that only this consumer’s good costs a little less than previous consumer’s product. Expectations are crucial with network effects, and do not play a role with economies of scale and posted prices. Thus, the rationale behind interconnection does not apply to joint outsourcing.

3 Joint Venture

Many industries are experiencing a wave of a particular type of joint outsourcing – competitors combine and outsource a part of their operations to a joint venture. Local community banks come together to form a bankers’ bank to rip the economies of scale in check processing, loan participation, and student loans (see Brickley et. al., 2009). GM and Toyota have ended their twenty five year-old joint production venture in California, and the Big 3 have several joint research projects (Wall Street Journal, 2009b). Sony and Sharp have established a joint venture (JV) for LCD television production, with Sony also having considered Samsung for the same JV (Forbes, 2008).

If there is some interaction between the JV management and the downstream firms’ management, and they are trying to maximize joint profits, then with the covered market assumption, the JV would charge as much as they can, and all the costs are going to be passed directly to the consumers. The JV lets firms extract as much consumer surplus as they deem necessary.

The only reason not to extract all consumer surplus is elastic supply (absent competition authorities). Thus, I switch to a model where demand is elastic, a differentiated Bertrand duopoly competition.

There are two symmetric firms, say i and j, with demands given by

\[
q_i = A - bp_i + cp_j, \tag{13a}
\]
\[
q_j = A - bp_j + cp_i, \tag{13b}
\]

where \( A > 0 \) and \( b > c > 0 \).

The two firms can set up an upstream JV, at some cost \( F \) for each firm. If they do set up the JV, then first they jointly decide on the wholesale price that JV charges, and then they compete on prices downstream. The solution concept is symmetric Nash. I need to place a restriction on how large the economies of scale can be. I assume that \( C''(\bullet) > -\frac{2}{b} \), otherwise there is no symmetric Nash in pure strategies.

**Lemma 1** Without an upstream JV, firms charge \( p^* = \frac{A}{2b-c} + \frac{b}{2b-c}C'(q_i^*) \).

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Proof. Firm i’s profit is
\[ \Pi_i = (A - bp_i + cp_j)p_i - C(q_i). \] (14)

Differentiating w.r.t. \( p_i \),
\[ \frac{\partial \Pi_i}{\partial p_i} = A - 2bp_i + cp_j + bC'(q_i), \] (15)
the second order conditions are satisfied iff \(-2b - \frac{b^2}{2b}C''(q_i) < 0\), or \(C''(q_i) > -\frac{2}{b} \). In a symmetric equilibrium, \( p_i = p_j \). From the first order conditions we get the result of the lemma. ■

Lemma 2 With an upstream JV, the upstream JV charges a wholesale price of \( w^* = \frac{Ac}{2b(c-b)} + \frac{2b-c}{2b}C'(2q_i^*) \), and the downstream firms charge \( p^* = \frac{A}{2b-c} + \frac{b}{2b-c}w^* = \frac{A}{2(b-c)} + \frac{C'(2q_i^*)}{2} \).

Proof. Suppose that the upstream JV charges \( w \). Then in the second stage, the downstream firms, in equilibrium, charge
\[ p^* = \frac{A}{2b-c} + \frac{b}{2b-c}w^*. \] (16)

Since firms are symmetric, they want to maximize their overall profit with respect to the wholesale price in the first stage.
\[ \Pi_i = q_ip_i - \frac{C(2q_i)}{2}. \] (17)

Each firm sells \( q_i^* = \frac{Ab-(b-c)bw}{2b-c} \) downstream, and thus
\[ \frac{\partial \Pi_i}{\partial w} = -\frac{(b-c)b}{2b-c}p_i + \frac{b}{2b-c}q_i + \frac{(b-c)b}{2b-c}C'(2q_i). \] (18)

The second order condition is satisfied as long as \(-\frac{b}{2b-c} - \frac{(b-c)b}{2b-c} - 2 \left( \frac{(b-c)b}{2b-c} \right)^2 C''(2q_i) < 0\), or \(C''(2q_i) > -\frac{2b-c}{2b(c-b)} - \frac{2b-c}{2b(c-b)^2} \), which is less strict than our assumption on cost concavity. The equation for \( w \) in the lemma is from the FOC. ■

Proposition 3 If marginal cost increases with JV \( (MC(2q^J) > MC(q^{NoJV})) \), then prices increase and consumer welfare decreases.

Proof. From two previous lemmas we need to show that \( p_{NoJV} < p_{JV} \), or
\[ \frac{b}{2b-c}C'(q_i^{NoJV}) < \frac{Ac}{b-c} + \frac{C'(2q_i^{JV})}{2}. \] (19)

The expression above simplifies to
\[ \frac{A}{b-c} - C'(2q_i^{JV}) > \frac{2b}{c} (C'(q_i^{NoJV}) - C'(2q_i^{JV})). \] (20)

The first term is the choke price where the demand is exactly 0. Thus, it must be higher than the marginal cost of the industry’s last unit, making the left hand side term positive. If the expression in the parentheses is negative, then the inequality above holds. ■
Corollary 4  If marginal cost increases with JV (MC(2qJV) ≥ MC(qNoJV)), or does not decrease too fast, then firms establish a JV too often from the society’s point of view.

The difference between the corollary above and the competitive supplier case is that now consumers care about the difference between the marginal cost of the industry versus the marginal cost of the firm, as opposed to the average cost of the industry versus the marginal cost of the firm.

Corollary 5  The condition above is satisfied for linear costs.

In this section I have changed two features of the model: I talked about a JV instead of outsourcing to a competitive supplier, and I have used a model with elastic demand. What happens if we have firms potentially outsourcing to a competitive supplier, when the consumer demand is elastic? With a covered market (inelastic demand), firms would outsource if and only if their cost function exhibits economies of scale at the equilibrium production quantities.

Effectively, outsourcing is a way to get rid of costs because linear costs are just passed to the consumers. This reasoning works in a covered market because the cost pass-through is 1 – if the firm’s cost increases by some amount, the price increases by the same amount. With elastic demand like Bertrand, the pass-through rate is lower than 1, that is firms absorb some of the cost increase. In this case, the firms also care about the average cost of the competitive supplier, and their incentives are more closely aligned with consumer welfare than with covered cost. However, in an uncovered market, any price change affects social welfare, so in general it is not clear whether joint outsourcing is better for society with a covered or with an uncovered market.

4 Conclusion

I have shown which marginal and average cost conditions result in firms jointly outsourcing or setting up a joint venture, and when that joint action reduces consumer and social welfare. Joint outsourcing and joint ventures may be anti-competitive and hurt both consumers and society overall, depending on the average and marginal costs of each firm and the joint producer.

Regulators should examine joint outsourcing and joint venture agreements. Without additional costs of outsourcing, a cost function exhibiting economies of scale everywhere is a sufficient condition for social welfare improvement, although it is not sufficient for consumer welfare improvement. However, if the average cost function is U-shaped, and each firm’s production quantity is in the economies of scale part of the curve, but the total industry quantity is sufficiently into the diseconomies of scale part of the curve, then firms outsource when it is detrimental both to society and to consumers. For joint ventures, the results are even less promising: I have shown that linear costs are sufficient to guarantee lower industry output after the establishment of a JV.
Empirical economists have methods of estimating production functions, and policy-makers could get the relationship between average and marginal costs from these estimates.\(^6\) Possible extensions of this work include empirical estimation of which industries are going to hurt consumers and society by jointly outsourcing, and theoretical investigation of the effects of firms’ asymmetry on their decisions and consumer and social welfare.

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\(^6\)See Ackerberg et. al. (2006) for example.


