Disclosure Standards for Vertical Contracts

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Abstract

Disclosure standards promoting transparency have expanded in virtually all economic arenas. One area in which such transparency has been slow to flourish is in the disclosure of vertical (wholesale) contracts. Casual intuition suggests such disclosures would be beneficial in protecting consumers and retailers alike from discriminatory supplier practices. In this paper, we formally investigate the welfare consequences of disclosure of vertical contracts. In particular, we find that when supplier power is concentrated, disclosure provides a means through which a powerful supplier can use its (observed) wholesale prices to coordinate retail behavior of its wholesale customers. From the retail consumer's perspective, such coordination is unwanted, and leads them to favor opacity of contracts. In contrast, when supplier power is dispersed, disclosure of contracts becomes a conduit through which suppliers compete indirectly via their retail surrogates. Retail consumers welcome the increased competition that accompanies such disclosures. In short, we find that the efficacy of disclosure standards for vertical contracts depends critically on supplier concentration in input markets.
1. Introduction

In the past few decades, the proliferation of regulations promoting disclosure has proceeded seemingly unabated. One arena in which expanded disclosure is particularly apparent is in the realm of retail markets. As recent examples, regulators have compelled hospitals to post pricing for patients, stipulated "sticker price" and fuel economy labels for automobile sales, required disclosure of textbook prices to faculty adopters, demanded displays of nutrition information from fast-food chains, and even sought to mandate disclosure of funeral prices, each in the name of consumer protection and enhanced competition. Prior to these initiatives, attempts at establishing retail price disclosure standards have seen varied levels of success in markets such as alcoholic beverages, prescription drugs, and eye exams. While such disclosures have mostly served to hinder price discrimination and favoritism, thereby promoting greater competition, they have also created potential for greater collusion in some markets (Austin and Gravelle 2008). These dual consequences of retail price disclosure have largely echoed the theoretical research noting both societal upsides and downsides of enhanced disclosures (e.g., Stigler 1964; Varian 1980; Schultz 2005).

While the spread of price transparency in the retail arena has continued, the wholesale prices offered to vertical partners have largely been permitted to remain confidential. There are, of course, exceptions. Danish efforts to increase competition in the market for the supply of ready-mix concrete led to efforts to mandate disclosure of wholesale pricing contracts (Albaek et al. 1997). More recently, strong efforts at both the state and federal level in the US have pushed for disclosure of medical equipment and

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1 Subsequent to such disclosure rules, wholesale prices actually increased, prompting a rescission of the requirements. The primary explanation for this unintended price increase is that disclosure served to facilitate collusion among suppliers in the wholesale market, much like it has been shown to do in some retail markets (Albaek et al. 1997) As will be seen shortly, the present paper will provide a complementary explanation for this phenomenon, one reliant on how disclosures change a supplier's ability to manage coordination amongst retailers.
pharmaceutical costs incurred at the wholesale level so as to undercut favored pricing agreements and (the perception of) secret concessions.

The dichotomy between disclosure standards for retail and wholesale prices is typically explained on the grounds that pricing in a wholesale market entails different considerations than in the retail market, and these considerations may point to the differential regulatory treatment. For one, supply markets are often characterized by limited competition (or even monopoly), so the effects of disclosure on competition in that market are inherently more muted. Second, buyers in the supply market are not ultimate consumers but instead face competition of their own when selling in retail markets. In this paper, we seek to model these two key characteristics of supply markets so as to examine the consequences of disclosure (and nondisclosure) of vertical pricing contracts therein.

We represent the feature that wholesale buyers encounter their own competition by presuming there are \( n \) retail providers of a differentiated final good, each of whom rely on a supplier for a key input. To capture the feature that supply markets are often limited in competition, we presume each retailer has only one supplier upon which it can rely. With this basic setting as a backdrop, we investigate the consequences of disclosure (or, conversely, confidentiality) requirements on supply chain behavior and retail competition. The paper finds that the distinct features of supply markets make confidentiality more attractive to retailers and even end consumers than conventional wisdom would suggest. Relatedly, we demonstrate that the extent to which supplier power is concentrated is a key determinant of the efficacy of mandatory disclosure rules.

To get a feel for the underlying forces at work, consider the case of two retailers. First, say the retailers are each served by a separate (dedicated) supplier as, for example, when a Burger King franchise competes with a nearby McDonalds franchise. In this case, each supplier’s motivation in setting wholesale prices changes depending on the prevailing disclosure standards. When contracts are required to be disclosed, the supplier
recognizes any price cuts it offers to its wholesale customer will give the customer a two-fold advantage in retail competition: the direct savings will permit its customer to be aggressive and, cognizant of this, the retail rival will consequently cede market share. Absent disclosure of contracts, however, the supplier cannot use its wholesale price to influence the retail competitor, only its own customer. As a result, with confidentiality, wholesale prices are higher. Such higher wholesale prices under confidentiality stand to hurt consumers (due to the ensuing increase in retail prices), and even hinder industry profit (due to the detrimental effect of double marginalization).

If, on the other hand, both retailers rely on a single (common) supplier, the supplier’s incentives are radically different. This common supplier case corresponds with, for example, two competing electronics retailers who each sell Sony televisions. With both of its customers competing fiercely in the retail realm, the supplier now seeks a means through which it can soften retail competition and foster a more cooperative environment. When contracts are disclosed, the supplier can use a high wholesale price for one customer to signal a softened retail stance to another. The end result is inflated wholesale prices. In contrast, confidentiality prevents the supplier from using its wholesale prices to undercut retail competition. In this case, then, confidentiality points to lower wholesale prices and greater welfare.

In short, in the dedicated supplier setting, each supplier's intent is to give its customer base (those with whom it shares a de facto alliance) a leg up in competition. In this case, welfare is enhanced by requiring wholesale prices be disclosed since such disclosures strengthen competition between its customer base and the other supplier's customer base (which we deem inter-alliance competition). In contrast, in the common supplier setting, the supplier's intent is to soften competition between its own customers (deemed intra-alliance competition). In this case, confidentiality is welfare enhancing since disclosures only weaken intra-alliance competition.

These basic concerns – impact on inter-alliance and intra-alliance competition –
are simultaneously present and balanced in the more general case of $n$ retailers. The more even the bifurcation in the supply market (i.e., each supplier’s retail reach is comparable), the more disclosed contracts are used as a tool to give a supplier’s customers an edge in retail competition. But, as the retail reliance on one supplier increases (in effect, the higher the Hirfindahl index of the supply market), the more disclosed contracts are used to soften retail competition via higher wholesale prices. As a consequence, confidentiality becomes more desirable, both from a consumer and an overall welfare perspective, the greater the concentration of power in the supply market.

We detail two key variants to the analysis both to enrich the conclusions and to examine their robustness. First, we endogenize the costs that form the basis for the supplier’s chosen pricing. More specifically, we consider how each disclosure regime influences the supplier’s choice of cost-cutting investment, i.e., its preferred tradeoff between fixed and variable costs. In this case, if supplier power is concentrated, the disclosure of contracts provides the dominant supplier with a useful strategic tool. In particular, with a common supplier, price disclosure permits the supplier to soften competition and extract a greater share of the ensuing industry profits, thus encouraging it to make greater cost cutting investments. The more important such investments are in developing supply chain efficiency, the more attractive disclosure becomes. In contrast to conventional wisdom, then, it is the supplier who is the impetus for disclosure; confidentiality, when it arises, is driven by retailers and consumers. On the other hand, when retailers rely on separate suppliers, the supplier actually has greater incentives to invest in cost cutting when confidentiality is in place: disclosure creates a prisoners' dilemma of sorts among the suppliers which, in turn, dampens incentives to invest. Despite this added consideration, with dedicated suppliers, the shrinkage of wholesale prices under disclosure is the pressing consideration in divining the welfare enhancing disclosure standard.

Second, we examine how more complex contractual arrangements in the supply
chain alter the conclusion. In particular, we revisit the analysis under two-part tariff contracts. The typical view is that two-part tariff contracts lead to a fully coordinated supply chain and thereby preclude any strategic wholesale pricing considerations. However, in the presence of retail competition and confidentiality of contracts, this is not necessarily the case. That is, even with two-part tariffs, a sole supplier finds it hard to commit to a variable charge above its marginal cost to soften competition when the terms are not disclosed (instead, it has incentives for unilateral deviation to provide concessions to a customer). Similarly, without disclosure, dedicated suppliers find it hard to commit to a variable charge below marginal cost to give their customer an edge. Thus, the variable charges under two-part tariffs have similar properties as those under standard linear wholesale prices: with high (low) concentration of supplier power, variable charges are greater (lower) under disclosure of contract terms. As such, though contract terms are of course different, the basic conclusions in the main setup persist in the case of two-part tariffs.

This research is related to both the supply chain (vertical) and competitive (horizontal) information sharing literatures. In terms of supply chain information sharing, the literature focuses primarily on a retailer’s (supplier’s) decision to share stochastic private information with its supplier (retailer) (e.g., Li 2002; Li and Zhang 2008). This research concludes that even when a retailer seeks to share information with its supplier, it does so only if the supplier can credibly guard such information from the retailer’s competitors. In contrast, the present paper finds that strict confidentiality between supply chain partners is not necessarily preferred (either by the partners or by society as a whole) when the information shared is not exogenous and stochastic but rather arises endogenously as a result of contractual terms.

Relatedly, the vast literature on horizontal information sharing explores competitors’ desires to share information with each other (e.g., Gal-Or 1985; Li 1985). One clear conclusion of this literature is that under Cournot competition, each retail
competitor opts to publicly disclose (withhold) its cost (demand) information due to competitive ramifications. In the present analysis, where the information disclosed is necessarily cost-related (it is the retailer’s prevailing wholesale price), a stark difference arises. When the cost information is not stochastic but rather strategically set, the retailers' strong desire to disclose information is perturbed. In fact, when retail firms rely on a common supplier, the retailers (and society as a whole) prefer to maintain confidentiality of cost terms. In contrast, when the wholesale market is bifurcated equally among suppliers, the reverse incentives arise. Thus, the endogenous and strategic nature of wholesale prices makes them distinct from other costs when it comes to disclosure policies. As a result, our results suggest that the nature of the retail market and the wholesale market jointly determine the efficacy of full disclosure regulation.

In this vein, the current paper also builds on the literature on observability of supply chain contract terms and secret price concessions (e.g., O'Brien and Shaffer 1992; McAfee and Schwartz 1994; Rey and Verge 2004). While this literature is ostensibly aimed at examining means for supplier commitment in the absence of observable contracts, it also identifies the equilibrium outcomes under a common supplier and contract nondisclosure. Our analysis extends this literature along two dimensions, by comparing welfare implications of disclosure and nondisclosure regimes and the critical tie-in to supplier concentration. In this sense, the present analysis seeks to find what characteristics of supply markets would nudge regulators towards (or away from) mandatory disclosure regulation.

The paper proceeds as follows. Section 2 presents the basic model. Section 3 presents the results: 3.1 identifies the equilibrium outcomes under each disclosure regime; 3.2 contrasts the disclosure regimes; 3.3 considers the effect of endogenous

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2 As auditors are apt to point out, another potential difference is that contractual terms are by their very nature more easily audited/confirmed. Information about stochastic costs or forecasts thereof, on the other hand, are more easily managed. The consequences of such earnings management in this realm is investigated in Bagnoli and Watts (2009).
supplier costs; and 3.4 considers the consequence of two-part tariff contracting. Section 4 concludes the paper.

2. Model

We study a basic formulation of supply chain interactions with a focus on the consequences of varying the degree of transparency of contractual terms. In particular, \( n \) retail firms are (Cournot) rivals in a downstream (final good) market. The (inverse) demand function for the final good for firm \( i \) is

\[
p_i = a - q_i - \gamma \sum_{j \neq i} q_j, \quad i, j = 1, \ldots, n; \quad i \neq j,
\]

where \( p_i \) denotes the market price for firm \( i \)'s good, and \( q_i \) and \( q_j \) denote the quantities supplied by firms \( i \) and \( j \), respectively. The parameter \( \gamma, 0 < \gamma \leq 1 \), represents the degree of substitution among the competing products with the extreme values of 0 and 1 corresponding to the cases of independent goods and perfect substitutes, respectively.

The retail firms rely on key inputs supplied by one of two independent upstream suppliers, denoted suppliers \( A \) and \( B \). In particular, retailers \( 1, \ldots, m \) each rely on the input provided by supplier \( A \) in creating their final product. In turn, retailers \( m+1, \ldots, n \) rely on supplier \( B \)'s input. For example, suppliers \( A \) and \( B \) may be franchisors such as McDonalds and Burger King, where retailers \( 1, \ldots, m \) are franchises of supplier \( A \) and the retailers \( m+1, \ldots, n \) are franchises of supplier \( B \). Without loss of generality, say supplier \( A \) has more customers, i.e., \( m \geq n - m \), or \( m \geq n/2 \). For each retailer, one unit of the final product requires one unit of the input. For each supplier, the unit cost of making the input is \( c, 0 \leq c < a \). The supplier sets a (wholesale) unit price \( w_i \) for input procured by its retail customer, firm \( i \), and each retail firm responds by procuring the number of units it desires.\(^3\)

While each firm is, of course, aware of its own procurement terms (i.e., firm \( i \) knows \( w_i \)), whether or not it is aware of its rivals' procurement terms depends on the

\(^3\) The input buyers’ conversion and selling costs are readily incorporated into the analysis. In particular, following Singh and Vives (1984), the intercept \( a \) can be viewed as being net of downstream costs.
transparency of the reporting system in place. We consider the outcomes under two distinct disclosure standards: (i) full disclosure wherein \((w_1,\ldots,w_n)\) is disclosed to all firms prior to competition; and (ii) a confidential regime wherein the retail firms are not made aware of the procurement terms of their retail rivals. In evaluating the efficacy of each disclosure standard regime, we employ the standard welfare measure that reflects a weighted sum of firm profits and consumer surplus (e.g., Baron 1988; Baron and Myerson 1982): 

\[
W = \Pi_A + \Pi_B + \sum_{i=1}^{n} \Pi_i + \beta CS ,
\]

where \(\Pi_A\) and \(\Pi_B\) reflect the profits of suppliers \(A\) and \(B\), respectively, \(\Pi_i, i = 1,\ldots,n\), reflects the profit of retailer \(i\), and \(CS\) reflects consumer surplus. In the welfare expression \(\beta \geq 1\), reflecting that standard setters may be equally concerned with all economy participants or may place more (or all) emphasis on consumers' fates (Shapiro 1986; Baron 1988).

In the analysis that follows, we identify the unique (Perfect Bayesian) Nash equilibrium that satisfies the standard assumption of passive beliefs (e.g., Hart and Tirole 1990; O’Brien and Shaffer 1992; McAfee and Schwartz 1994; Rey and Tirole 2006). Passive beliefs present a natural restriction on potential equilibria by requiring that when a firm does not directly observe its rivals' pricing, its beliefs about the contract offered to a rival are not influenced by off-equilibrium contract offers to itself. The sequence of events is summarized in Figure 1.

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**Disclosure standards are established.** Suppliers \(A\) and \(B\) set wholesale prices \(w_1,\ldots,w_m\) and \(w_{m+1},\ldots,w_n\), respectively. Contract terms are revealed in accordance with the disclosure standard. The retail firms simultaneously choose quantities, \(q_1,\ldots,q_n\). Retail purchases are made, and firms realize profits.

_Figure 1. Timeline._
3. Results

3.1. Equilibrium

To set the stage for evaluation of disclosure standards for supply chains, we first derive the equilibrium outcomes under each disclosure regime.

3.1.1 Full Disclosure of Contracts

With full disclosure, each retailer knows both its own wholesale price and those of its competitors prior to engaging in retail competition. This advance warning of its competitors' positions, of course, refines a firm's behavior in the retail market. Though we will provide a complete characterization of the equilibrium outcome for any \( m \) and \( n \) in due course, it will prove convenient to rely on the case of \( n = 2 \) to demonstrate the key forces in the analysis. With \( n = 2 \), the effect of \( m \) is quite clear: for \( m = 1 \), each retailer relies on a different supplier (i.e., dedicated suppliers), whereas for \( m = 2 \), each retailer relies on the same supplier (i.e., a sole supplier). The case of dedicated suppliers implied by \( m = 1 \) reflects a circumstance where the competing retailers rely on distinct inputs to produce related outputs. For example, the dedicated supplier case could reflect competing fast-food franchises each of whom has a different franchisor; or, it could reflect the sales and distribution of different cell phone plan providers (retailers) who each have exclusive distribution arrangements with different cell phone manufacturers. In contrast, the case of \( m = 2 \) represents the circumstance where both competing retailers rely on the same supplier for their retail product. For example, different retail outlets each rely on Apple for the supply of iPod products. Such a sole supplier arrangement is perhaps the most commonly studied supply chain wherein all retailers are captives of a monopoly supplier. We next derive the outcomes in each of these cases.

First, consider the case of dedicated suppliers (\( m = 1 \)). Working backwards in the game, given disclosed supplier terms and its conjecture of retailer \( j \)'s output, \( \tilde{q}_j \), retailer \( i \)
chooses its output in the retail realm, \( q_i \), to solve:

\[
\text{Max}_{q_i} \quad [a - q_i - \gamma \tilde{q}_j]q_i - w_i q_i.
\]  

(1)

The first-order condition of (1) yields firm \( i \)'s reaction function \( q_i(w_i, \tilde{q}_j) = \frac{a - w_i - \gamma \tilde{q}_j}{2} \). Given observability of wholesale prices, each firm chooses quantities knowing the other's wholesale price. Thus, using the two reaction functions taken together with the equilibrium conditions \( \tilde{q}_1 = q_1 \) and \( \tilde{q}_2 = q_2 \) yields the retail equilibrium as a function of the disclosed wholesale prices (the superscript "\( d \)" indicates disclosure):

\[
q_i^d(w_1, w_2) = \frac{2[a - w_i] - \gamma[a - w_j]}{4 - \gamma^2}.
\]  

(2)

The quantities \( q_1^d(w_1, w_2) \) and \( q_2^d(w_1, w_2) \) in (2) serve as the induced demand function for supplier A and B, respectively. Thus, supplier A chooses \( w_1 \) and supplier B chooses \( w_2 \) to maximize their respective profits as noted in (3):

\[
\text{Max}_{w_1} \quad [w_1 - c]q_1^d(w_1, w_2) \quad \text{and} \quad \text{Max}_{w_2} \quad [w_2 - c]q_2^d(w_1, w_2).
\]  

(3)

Jointly solving the first-order conditions associated with (3) reveals \( w_i^d \), the suppliers' equilibrium wholesale prices. Substituting these prices in (2) yields the equilibrium quantities denoted \( q_i^d = q_i^d(w_1^d, w_2^d) \). Given the equilibrium characterization, firm profits, consumer surplus, and total welfare are readily obtained. In particular, retailer \( i \)'s profit is \( \Pi_i^d = [a - q_i^d - \gamma q_j^d - w_i^d]q_i^d \), supplier profits are \( \Pi_A^d = [w_1^d - c]q_1^d \) and \( \Pi_B^d = [w_2^d - c]q_2^d \), and consumer surplus is \( CS^d = \frac{1}{2} \left[ (q_1^d)^2 + 2 \gamma q_1^d q_2^d + (q_2^d)^2 \right] \). Taken together, these yield total welfare of \( W^d = \Pi_A^d + \Pi_B^d + \Pi_1^d + \Pi_2^d + \beta CS^d \). These outcomes are detailed in Lemma 1(i).

Now, consider how the outcome is different under a common supplier \((m = 2)\). In
this case, the retail subgame is as before, but the wholesale price determination is different. Instead of two suppliers simultaneously setting the wholesale price of their respective customers, one supplier sets the wholesale price for both customers. In particular, supplier A chooses wholesale prices to solve:

\[
\begin{align*}
\text{Max}_{w_1, w_2} \quad & [w_1 - c]q_1^d(w_1, w_2) + [w_2 - c]q_2^d(w_1, w_2). \\
\end{align*}
\] (4)

The first-order conditions of (4) reveal the supplier's chosen wholesale prices: \(w_i^d = c + \frac{a - c}{2} \). As before, when substituted into \(q_i^d(w_1, w_2)\), equilibrium retail quantities obtain; substituting these into the firm profits, consumer surplus, and total welfare formulae, in turn, yields equilibrium profit and welfare expressions. Lemma 1(ii) summarizes the results of this exercise. (All proofs are provided in the Appendix.)

**Lemma 1.** In the \(n = 2\) case, under full disclosure, the equilibrium outcome is:

(i) with dedicated suppliers (\(m = 1\)):

(a) \(w_1^d = w_2^d = c + \frac{a - c}{2} \gamma \); \(q_1^d = q_2^d = \frac{2[a - c]}{4 - \gamma} \gamma \); 

(b) \(\Pi_1^d = \Pi_2^d = \left(\frac{2[a - c]}{4 - \gamma} \gamma \right)^2 \); \(\Pi_A^d = \Pi_B^d = \frac{2[a - c]^2[2 - \gamma]}{4 - \gamma}^2[2 + \gamma] \gamma \); 

(c) \(CS^d = \frac{4[a - c]^2[1 + \gamma]}{[4 - \gamma]^2[2 + \gamma]^2} \) and \(W^d = \frac{4[a - c]^2[6 + \beta(1 + \gamma) - 2 \gamma]}{[4 - \gamma]^2[2 + \gamma]^2} \).

(ii) with a common supplier (\(m = 2\)):

(a) \(w_1^d = w_2^d = c + \frac{a - c}{2} \gamma \); \(q_1^d = q_2^d = \frac{a - c}{2[2 + \gamma]} \); 

(b) \(\Pi_1^d = \Pi_2^d = \left(\frac{a - c}{2[2 + \gamma]} \right)^2 \); \(\Pi_A^d = \frac{[a - c]^2}{2[2 + \gamma]} \); \(\Pi_B^d = 0 \); 

(c) \(CS^d = \frac{[a - c]^2[1 + \gamma]}{4[2 + \gamma]^2} \) and \(W^d = \frac{[a - c]^2[6 + \beta(1 + \gamma) + 2 \gamma]}{4[2 + \gamma]^2} \).
From the Lemma, a key difference in wholesale pricing between the dedicated and common supplier cases is worth noting. For any $\gamma > 0$, the wholesale price is higher under a common supplier than under dedicated suppliers. The reason for this is that with dedicated relationships, each supplier has incentives to drive down its wholesale price to put its customer in a position of competitive advantage in retail competition. In effect, with $m = 1$, there is a *de facto* alliance between a supplier and its retailer, and each supplier's focus is on obtaining an edge in inter-alliance competition.

In contrast, under a common supplier ($m = 2$), inter-alliance competition is moot since both retailers form an alliance with supplier $A$. In this case, the supplier's focus is squarely on softening intra-alliance competition. In particular, the supplier's aim is to induce retail providers to raise retail prices, and the supplier does so by raising the wholesale price it charges the buyers.\(^4\)

The above intuition is borne out by formally examining the supplier's tradeoff between profit margins and purchase quantities when setting its prices in (3) and (4). In the dedicated supplier case of (3), an increase in $w_1$ entails two effects: an increase in the profit margin, $(w_1 - c)$, and a decrease in quantities sold to retailer 1, $q_1^d(w_1, w_2)$. On the other hand, with a common supplier in (4), an increase in $w_1$ entails three effects: an increase in the profit margin, $(w_1 - c)$, a decrease in quantities sold to retailer 1, $q_1^d(w_1, w_2)$, and an increase in quantities sold to retailer 2, $q_2^d(w_1, w_2)$. This last effect provides an added incentive for the common supplier to boost wholesale prices.

A natural consequence of increased retail competition with dedicated suppliers is that consumer surplus is higher in the $m = 1$ case. However, this greater consumer surplus does not come at the expense of industry profit. Recall, the increased inter-alliance competition comes in the form of reduced wholesale prices and, thus, a reduction in the double-marginalization problem that typically plagues such supply chains. In other

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\(^4\) Such a strategic role of observed wholesale prices in raising retail prices has been noted elsewhere (e.g., Sappington and Unel 2005).
words, welfare is higher under a dedicated supplier for all $\beta$.

These basic forces – strengthening inter-alliance competition (the only issue in the $m = 1$ case) vs. softening intra-alliance competition (the only issue in the $m = 2$ case) – are both simultaneously present and balanced in the more general setup of $n$ retailers. The balancing depends critically on each supplier's market share. In particular, as supplier $A$'s market share increases ($m$ increases), its sphere of influence expands and, as a result, its focus is less on increasing the share of the retail market for its wholesale customers and more on increasing wholesale prices so as to extract more of its customers' already sizable retail profits. In other words, with increasing $m$, supplier $A$'s focus shifts more towards softening intra-alliance competition resulting in higher wholesale prices and lower retail quantities. Formally, in Lemma 2, which details the equilibrium outcome under full disclosure for all $(m,n)$, $w_i^d$ is increasing and $q_i^d$ is decreasing in $m$. In contrast, with increasing $m$, supplier $B$'s wholesale market share decreases ($n-m$ decreases). With its sphere of influence shrinking, supplier $B$'s focus on giving its wholesale customers an edge in competition becomes even sharper. Thus, in Lemma 2, $w_B^d$ is decreasing and $q_B^d$ is increasing in $m$.

**Lemma 2.** Under full disclosure, the equilibrium outcome is:

\[
\begin{align*}
    w_i^d(m,n) &= c + \frac{[a-c]2-\gamma[4+\gamma(n+m-2)]}{16+8\gamma[n-2]-\gamma^2[4(n-1)-3m(n-m)]} \\
    &= w_A^d, \text{ if } i = 1, \ldots, m; \\
    w_i^d(m,n) &= c + \frac{[a-c]2-\gamma[4+\gamma(2n-m-2)]}{16+8\gamma[n-2]-\gamma^2[4(n-1)-3m(n-m)]} \\
    &= w_B^d, \text{ if } i = m+1, \ldots, n; \\
    q_i^d(m,n) &= \frac{[a-c][2+\gamma(n+m-2)][2+\gamma(n-m-1)]}{16+8\gamma[n-2]-\gamma^2[4(n-1)-3m(n-m)]} \\
    &= q_A^d, \text{ if } i = 1, \ldots, m; \\
    q_i^d(m,n) &= \frac{[a-c][2+\gamma(2n-m-2)][2+\gamma(m-1)]}{16+8\gamma[n-2]-\gamma^2[4(n-1)-3m(n-m)]} \\
    &= q_B^d, \text{ if } i = m+1, \ldots, n.
\end{align*}
\]
(b) \( \Pi_i^d(m,n) = [q^d_A]^2 \), if \( i = 1,...,m; \) \( \Pi_i^d(m,n) = [q^d_B]^2 \), if \( i = m+1,...,n; \)

\[ \Pi_A^d(m,n) = m[w_A^d - c]q^d_A; \quad \Pi_B^d(m,n) = [n-m][w_B^d - c]q^d_B. \]

(c) \( CS^d(m,n) = \left\{ \right. \left[ 1/2 \right] m(q^d_A)^2 + (n-m)(q^d_B)^2 + m(m-1)\gamma(q^d_A)^2 + (n-m)(n-m-1)\gamma(q^d_B)^2 + 2m(n-m)\gamma q^d_A q^d_B \left\}; \text{ and} \right. \)

\[ W^d(m,n) = m[q^d_A]^2 + [n-m][q^d_B]^2 + m[w_A^d - c]q^d_A + [n-m][w_B^d - c]q^d_B \]

\[ + \beta \left[ 1/2 \right] m(q^d_A)^2 + (n-m)(q^d_B)^2 + m(m-1)\gamma(q^d_A)^2 + (n-m)(n-m-1)\gamma(q^d_B)^2 + 2m(n-m)\gamma q^d_A q^d_B \].

Overall, the equilibrium outcome under full disclosure of contracts reflects two competing supplier desires: (i) higher wholesale prices help support softer retail competition among the supplier's own customers; and (ii) lower wholesale prices give the supplier's customers an edge in competition over their rivals and leads to stiffer retail competition. The relative size of each supplier's customer base determines the weight each places on (i) and (ii). We next consider how nondisclosure of contractual terms changes this balancing act and affects the equilibrium outcomes.

### 3.1.2 Confidential Contracts

Without disclosure of contracts, each retailer knows only its own wholesale price and relies on its conjectures of others' wholesale prices when engaging in retail competition. Again, to help highlight the underlying forces, consider the case of \( n = 2 \) with dedicated suppliers \( (m=1) \). Working backwards in the game, firm \( i \)'s reaction function in the retail realm is obtained by solving (1), \( q_i(w_i,\tilde{q}_j) = [a - w_i - \gamma \tilde{q}_j] / 2 \) as before. With wholesale prices unobservable this, rather than (2), now serves as the induced demand function from the suppliers' perspective. Notice, the induced demand function, denoted \( q^\phi_i(w_i,\tilde{q}_j), \) reflects passive beliefs in that the supplier's price quote to any retailer does not alter the recipient's conjectures about offers to its rivals (the superscript "\( \phi \)" indicates no disclosure):
\[ q_i^\phi (w_i, \tilde{q}_j) = \frac{a - w_i - \gamma \tilde{q}_j}{2}. \] (5)

Given the induced demand function in (5), supplier A (B) chooses \( w_1 \) (\( w_2 \)) to maximize its profit as noted in (6):

\[
\begin{align*}
\operatorname*{Max}_{w_1} & \quad [w_1 - c]q_1^\phi (w_1, \tilde{q}_2) \quad \text{and} \\
\operatorname*{Max}_{w_2} & \quad [w_2 - c]q_2^\phi (w_2, \tilde{q}_1).
\end{align*}
\] (6)

Jointly solving the reaction functions in (5), the first-order conditions associated with (6), and the equilibrium conditions \( \tilde{q}_1 = q_1^\phi \) and \( \tilde{q}_2 = q_2^\phi \) reveals the equilibrium wholesale prices \( w_i^d \) and quantities \( q_i^\phi \) under confidentiality with \( m = 1 \). Lemma 3(i) presents these values, and also the corresponding equilibrium values for retailer profits (\( \Pi_i^\phi \)), supplier profits (\( \Pi_A^\phi \) and \( \Pi_B^\phi \)), consumer surplus (\( CS^\phi \)), and total welfare (\( W^\phi \)).

The equilibrium outcome proceeds similarly under a common supplier, except that supplier A jointly determines both wholesale prices. In particular, supplier A chooses wholesale prices to solve:

\[
\begin{align*}
\operatorname*{Max}_{w_1, w_2} & \quad [w_1 - c]q_1^\phi (w_1, \tilde{q}_2) + [w_2 - c]q_2^\phi (w_2, \tilde{q}_1).
\end{align*}
\] (7)

Jointly solving the reaction functions in (5), the first-order conditions associated with (7), and the equilibrium conditions \( \tilde{q}_1 = q_1^\phi \) and \( \tilde{q}_2 = q_2^\phi \) reveals the equilibrium wholesale prices and quantities under confidentiality with \( m = 2 \).

Interestingly, and in contrast to the full disclosure case, the equilibrium outcome under confidentiality is the same for both \( m = 1 \) and \( m = 2 \). Intuitively, with non disclosure of contractual terms, the supplier is unable to use the wholesale price it charges to one retailer to influence the behavior of other retailers. As a result, the supplier's pricing to one retailer does not depend on the nature of its relationship with others. The equilibrium outcome under confidentiality is summarized in Lemma 3.
Lemma 3. In the \( n = 2 \) case, under confidentiality, the equilibrium outcome is:

(i) with dedicated suppliers \((m = 1)\):

\[
\begin{align*}
(a) \quad w_1^\phi &= w_2^\phi = c + \frac{2[a-c]}{4 + \gamma}; \quad q_1^\phi = q_2^\phi = \frac{a-c}{4 + \gamma}; \\
(b) \quad \Pi_1^\phi &= \Pi_2^\phi = \left(\frac{a-c}{4 + \gamma}\right)^2; \quad \Pi_A^\phi = \Pi_B^\phi = \frac{2[a-c]^2}{(4 + \gamma)^2}; \\
(c) \quad CS^\phi = \frac{[a-c]^2(1 + \gamma)}{(4 + \gamma)^2} \quad \text{and} \quad W^\phi = \frac{[a-c]^2(6 + \beta(1 + \gamma))}{(4 + \gamma)^2}.
\end{align*}
\]

(ii) with a common supplier \((m = 2)\):

\[
\begin{align*}
(a) \quad w_1^\phi &= w_2^\phi = c + \frac{2[a-c]}{4 + \gamma}; \quad q_1^\phi = q_2^\phi = \frac{a-c}{4 + \gamma}; \\
(b) \quad \Pi_1^\phi &= \Pi_2^\phi = \left(\frac{a-c}{4 + \gamma}\right)^2; \quad \Pi_A^\phi = \frac{4[a-c]^2}{(4 + \gamma)^2}; \quad \Pi_B^\phi = 0; \\
(c) \quad CS^\phi = \frac{[a-c]^2(1 + \gamma)}{(4 + \gamma)^2} \quad \text{and} \quad W^\phi = \frac{[a-c]^2(6 + \beta(1 + \gamma))}{(4 + \gamma)^2}.
\end{align*}
\]

In effect, under confidentiality, the suppliers are unable to influence either intra-alliance or inter-alliance competition. This is because the ability to so influence rests critically on a supplier adjusting a retailer's price terms with the expectation that not only the retailer but also its rivals will respond to such changes. The confidentiality of contracts blocks the spillover to rivals. As a consequence, the wholesale price under confidentiality lies between the low wholesale price with \( m = 1 \) under full disclosure and the high wholesale price with \( m = 2 \) under full disclosure.

To see the above formally, consider the induced demand functions in (2) and (5). The supplier is disciplined in its price setting by the retailer's demand reaction, and the effectiveness of this discipline is tied to whether wholesale prices are disclosed or kept confidential. From (2), under full disclosure, the demand sensitivity is:
\[
\frac{\partial q_i^d (w_1, w_2)}{\partial w_i} = \frac{-2}{4 - \gamma^2} \quad \text{for } m = 1; \text{ and}
\]
\[
\frac{\partial [q_1^d (w_1, w_2) + q_2^d (w_1, w_2)]}{\partial w_i} = \frac{-1}{2 + \gamma} \quad \text{for } m = 2. \quad (8)
\]

Similarly, from (5), under confidentiality, the demand sensitivity is:
\[
\frac{\partial q_i^\phi (w_i, \tilde{q}_j)}{\partial w_i} = \frac{-1}{2} \quad \text{for } m = 1; \text{ and}
\]
\[
\frac{\partial [q_1^\phi (w_1, \tilde{q}_2) + q_2^\phi (w_2, \tilde{q}_1)]}{\partial w_i} = \frac{-1}{2} \quad \text{for } m = 2. \quad (9)
\]

The ranking of the sensitivity expressions follows immediately from (8) and (9):
\[
\frac{\partial q_i^d (w_1, w_2)}{\partial w_i} < \frac{\partial q_i^\phi (w_i, \tilde{q}_j)}{\partial w_i} = \frac{\partial [q_1^\phi (w_1, \tilde{q}_2) + q_2^\phi (w_2, \tilde{q}_1)]}{\partial w_i} < \frac{\partial [q_1^d (w_1, w_2) + q_2^d (w_1, w_2)]}{\partial w_i}. \quad (10)
\]

The following conclusions follow. First, the equality in (10) implies the discipline on supplier pricing under confidentiality is unaffected by whether the supplier provides to one retailer or to both retailers; this is in line with the equilibrium outcome in Lemma 3 being unaffected by \( m \). Second, the initial inequality in (10) implies the discipline on the dedicated supplier's pricing is weaker in the confidential regime; thus, the wholesale price in the no disclosure regime is higher than the disclosed price for \( m = 1 \). Third, the last inequality in (10) implies the discipline on the common supplier's pricing is more stringent in the confidential regime; thus, the confidential wholesale price is lower than the disclosed price for \( m = 2 \).

The basic equilibrium forces from the case of two retailers persist in the case of \( n \) retailers. And, in contrast to the full disclosure regime, under confidentiality each supplier-retailer relationship is independent of the customer base of each supplier, and only the total number of retailers matters. The following lemma summarizes the outcomes under confidentiality.
Lemma 4. Under confidentiality, the equilibrium outcome is:

(a) \[ w_i^\phi(m,n) = c + \frac{2[a-c]}{4 + \gamma[n-1]}, \text{ for } i = 1,\ldots,n; \]
\[ q_i^\phi(m,n) = \frac{a-c}{4 + \gamma[n-1]}, \text{ if } i = 1,\ldots,n; \]

(b) \[ \Pi_i^d(m,n) = \left( \frac{a-c}{4 + \gamma[n-1]} \right)^2, \text{ for } i = 1,\ldots,n; \]
\[ \Pi_A^\phi(m,n) = \frac{2m[a-c]^2}{[4 + \gamma(n-1)]^2}; \quad \Pi_B^\phi(m,n) = \frac{2[n-m][a-c]^2}{[4 + \gamma(n-1)]^2}; \]

(c) \[ CS^\phi(m,n) = \frac{[a-c]^2[1 + \gamma(n-1)]n}{2[4 + \gamma(n-1)]^2}; \text{ and} \]
\[ W^\phi(m,n) = \frac{[a-c]^2[6 + \beta(1 + \gamma(n-1))]n}{2[4 + \gamma(n-1)]^2}. \]

Given the characterization of the equilibrium outcomes under each disclosure regime, we next conduct a welfare comparison to determine the relative efficacy of each.

3.2. Comparison of Disclosure Regimes

In comparing the equilibria among the two regimes, we garner intuition by beginning with the familiar case of \( n = 2 \). Recall, with dedicated suppliers \( (m = 1) \), each supplier views the full disclosure regime as an invitation to cut its wholesale price in an attempt to drive away its customer's rivals. Since both suppliers have this incentive, it leads to a "race to the bottom" in price setting. This prisoners' dilemma in wholesale pricing alleviates inherent inefficiencies in the supply chain (due to double marginalization) and creates a circumstance where, despite no competition in the supply market (each is a monopolist), the suppliers compete indirectly through their retail surrogates. The decreased double marginalization problem and increased retail competition stand to benefit the industry and consumers alike.
In contrast, with confidentiality of pricing terms, the supplier is no longer able to use price cuts to influence competition in the retail market. The end result is higher wholesale prices and, thus, higher retail prices. In this case, confidentiality serves only to magnify supply chain inefficiencies and undercut retail competition.

With a common supplier \((m = 2)\), an entirely different picture arises. Under full disclosure, the sole supplier has incentives to raise its wholesale price to soften retail competition and thereby promote more cooperation among its partners. Besides softening competition in the retail market, then, the higher wholesale prices exacerbate efficiency losses due to double marginalization and can undercut consumer surplus. In contrast, confidentiality again disables the supplier's indirect influence on one retailer via the prices charged to another. As a result, it prescribes a lower wholesale price. The consequence is that with a common supplier, confidentiality is a boon to both consumers and the industry. These intuitive results are borne out formally in Proposition 1 which contrasts total welfare to determine the preferred regime.

*Proposition 1. In the \(n = 2\) case, the preferred regime is:*

(i) full disclosure with dedicated suppliers \((m = 1)\) and

(ii) confidentiality with a common supplier \((m = 2)\).

The main take away from Proposition 1 is that the nature of supply market concentration is a key factor in determining the desirability of full disclosure. Though the expressions become a bit more cumbersome in the case of \(n\) retailers, the essence of the result persists. In particular, with \(n\) retailers, the larger \(m\), the larger the concentration in the supply market. In a sense, \(m\) roughly proxies for the Hirfindahl index (or similarly, the concentration ratio) in the supply market.\(^5\) The greater \(m\), the more prominent

---

\(^5\) Of course, this is not a precise connection, because the Hirfindahl index depends on the quantities chosen in equilibrium. Thus, the Hirfindahl index would vary based on the disclosure regime itself rather than just the \(m/n\) concentration ratio.
supplier A, and the more concerned supplier A is with softening competition among its customers and the less it is concerned about its customers' ability to compete against other retailers. Accordingly, as \( m \) increases, the prominent supplier views full disclosure of vertical contracts as an invitation to increase its wholesale prices and soften intra-alliance competition. Consistent with this notion, the higher \( m \), the more attractive is confidentiality from a welfare perspective. This argument is confirmed formally in Proposition 2.

**Proposition 2.** There exists an \( m^* \), \( m^* < n \), such that confidentiality (full disclosure) is the preferred regime if and only if \( m \geq m^* \) \( (m < m^*) \). Further,

- For \( \gamma \leq \frac{n-2}{n-1} \), \( m^* = \frac{n}{2} \).
- For \( \frac{n-2}{n-1} < \gamma < 1 \), \( \frac{n}{2} < m^* < \frac{n}{2} + \frac{1}{2} \sqrt{\frac{n[4+3n]}{3+4n}} \) and is increasing in \( \gamma \), and
- For \( \gamma = 1 \), \( m^* = \frac{n}{2} + \frac{1}{2} \sqrt{\frac{n[4+3n]}{3+4n}} \).

Intuitively, for \( m = n \), there is effectively a common supplier for the entire retail market and, thus, the only force present is that wholesale prices are increased under full disclosure to soften competition. For lower \( m \) values, a supplier weighs the benefits of softened competition among its customers from a higher wholesale price with the cost of retail market share lost to the customers of the other supplier. Recall, this latter feature entails a prisoners' dilemma in that the two suppliers are each tempted to cut costs which creates the potential for such cost cuts to spiral downward in a race to the bottom. As such, the greater the retail competition, the more prominent is this race to the bottom. Importantly, from an efficiency standpoint, this "bottom" is still too high due to double-marginalization. In fact, \( m^* \), the \( m \)-value below which full disclosure is welfare enhancing due to its ability to create intense competition-by-proxy among the suppliers is increasing in \( \gamma \), reflecting that the greater retail competition, the easier it is for these
competitive pressures to bubble over in the supply market. Yet, even for $\gamma = 1$, $m^* < n$, reflecting that such competition-by-proxy effect is sure to be overwhelmed once a supplier has sufficient market concentration.

Notice the $m^*$-cutoff characterization in Proposition 2 applies for any weighing of consumer and firm preferences (i.e., all $\beta$ values). Of course, the precise value of $m^*$ does depend on $\beta$. Further, from Proposition 2, the value of $m^*$ can be expressed succinctly in closed form for the extreme values of $\gamma$. For intermediate values of $\gamma$, the value of $m^*$ is more complex and is affected by $n$, $\gamma$, and $\beta$. To see its derivation and the nature of comparative statics, consider an example with $n = 4$ and $\beta = 1$. A comparison of welfare with $\gamma = 3/4$ for various values of $m$ is presented in Panel A of Figure 2. The preferred regime depending on $m$ and $\gamma$ is presented in Panel B.

![Panel A. Welfare as $m$ Changes. Panel B. Preferred Regime as $\gamma$ and $m$ Change.](image)

**Figure 2. Example.**

### 3.3 Endogenous Supplier Costs

The wholesale price set by a supplier is impacted by its underlying production costs and the disclosure standards in place. In order to hone in exclusively on the latter, the analysis thus far presumes that supplier costs (denoted by $c$) are the same irrespective
of the disclosure regime in place. As an added benefit, such presumption of deterministic supplier costs permits a stark contrast to existing work on disclosure of uncertain costs. In particular, the focus is on disclosure of strategic costs (retailer's wholesale price) rather than stochastic costs.

In this section, we extend the theme of identifying strategic repercussions of disclosure standards to endogenize supplier costs. That is, instead of presuming that the unit cost of each supplier is \( c \), consider the outcome if \( c \) can be affected by supplier investments. In particular, say supplier \( i \)'s cost is \( c_i = \bar{c} - \delta \), where \( \delta \) reflects supplier cost-cutting efforts, and the fixed cost (investment) incurred to enact such cost reductions is \( k\delta^2/2 \).\(^6\) Also, for simplicity, we examine the \( n = 2 \) case.

With investments, the consequences of full disclosure (or confidentiality) for wholesale prices and production decisions are as before, except the prevailing disclosure standard also influences the suppliers' investment incentives.\(^7\) Denote the equilibrium investment level of the participating suppliers as a function of \( m \) by \( \delta^d(m) \) under full disclosure and by \( \delta^\phi(m) \) under confidentiality. The following lemma identifies the equilibrium investment levels in each regime and for each supply market structure.

**Lemma 5.** The equilibrium supplier investment levels are:

(i) with dedicated suppliers \((m = 1)\):

\[
\delta^d(1) = \frac{4[a - c][8 - \gamma^2]}{[4 - \gamma][4 + \gamma][2 + \gamma]k - 4[8 - \gamma^2]}; \quad \text{and} \quad \delta^\phi(1) = \frac{16[a - c]}{[4 - \gamma][4 + \gamma]^2k - 16}.
\]

---

\(^6\) To obtain nontrivial solutions, we presume \( k \) is sufficiently large that each supplier prefers an interior level of cost reduction. The necessary and sufficient condition for this to be the case throughout this section is \( k \geq 1/[2+\gamma] \).

\(^7\) Consistent with this line of inquiry, Chen and Sappington (2010) demonstrate that the structure of vertical channels can influence the degree to which a supplier engages in cost-cutting innovation. In a complementary way, the present paper demonstrates that the disclosure environment too can influence such innovation.
(ii) with a common supplier \((m = 2)\):

\[
\delta^d(2) = \frac{a - \tau}{[2 + \gamma]k - 1} \quad \text{and} \quad \delta^\Phi(2) = \frac{8[a - \tau]}{[4 + \gamma]^2k - 8}.
\]

With dedicated suppliers, recall that disclosure prompted a prisoners' dilemma of wholesale price cuts from the suppliers' perspectives. Thus, confidentiality creates an environment where, all else equal, suppliers stand to increase their share of the industry profits. As a result, confidentiality comes with the added benefit of prompting additional supplier investment, i.e., \(\delta^\Phi(1) > \delta^d(1)\). From Proposition 1, with equal costs across regimes, full disclosure ensures greater welfare due to the retailer cost savings from lower wholesale prices. The consideration of endogenous supplier costs points to an opposite welfare effect in that full disclosure leads to cost increases due to lower supplier investment. Given the symmetry of investment among the two suppliers, one can readily identify the net effect of these two by replacing \(c\) with \(\bar{c} - \delta^d(1)\) in the profit expressions and adjusting welfare by \(k[\delta^d(1)]^2 / 2\) in Lemma 1(i), and replacing \(c\) with \(\bar{c} - \delta^\Phi(1)\) and adjusting welfare by \(k[\delta^\Phi(1)]^2 / 2\) in Lemma 3(i). Then, comparing welfare across regimes reveals that full disclosure is again the preferred regime for all \(k\) and \(\beta\). In effect, with dedicated suppliers, the direct reduction in wholesale prices induced by disclosure is of first-order importance whereas the indirect increase due to diminished investment incentives is a second-order effect.

The key forces are different under a common supplier. In this case, disclosure provides the supplier an opportunity to encourage retail cooperation and, thereby, boost its own profit. This added profit, in turn, promotes investment incentives relative to those under confidentiality, i.e., \(\delta^d(2) > \delta^\Phi(2)\). Again, this provides an offsetting force to the welfare effect noted in Proposition 1 where supplier costs were exogenous. In particular, a welfare comparison can be obtained by replacing \(c\) with \(\bar{c} - \delta^d(2)\) in the profit expressions and adjusting welfare by \(k[\delta^d(2)]^2 / 2\) in Lemma 1(ii), and replacing \(c\) with
$\bar{c} - \delta^\phi(2)$ and adjusting welfare by $k[\delta^\phi(2)]^2 / 2$ in Lemma 3(ii). Comparing welfare across regimes reveals that confidentiality is the preferred regime for sufficiently large $k$. However, for small values of $k$, the induced investment effect becomes more pronounced, and can be pronounced enough that full disclosure can become the preferred regime when endogenous costs are considered. Proposition 3 details these results.

**Proposition 3.** With endogenous investments:

(i) Supplier costs are lower under confidentiality for $m = 1$ (i.e., $\delta^\phi(1) > \delta^d(1)$) and lower under full disclosure for $m = 2$ (i.e., $\delta^d(2) > \delta^\phi(2)$);

(ii) For $m = 1$, the preferred regime is full disclosure. For $m = 2$, the preferred regime is confidentiality (full disclosure) if and only if $k \geq k^*$ ($k < k^*$).

### 3.4. Two-Part Tariffs

Although linear (wholesale) prices are prevalent in practice and routinely undergird investigations of supply chain efficiencies, many have noted that at times richer two-part tariff contracts can provide an avenue to achieve vertical efficiency. Given this observation, we next revisit the analysis under two part tariff contracts. That is, for each customer a supplier stipulates a take-it-or-leave-it contract offer of $(F_i, w_i)$, where $F_i$ represents in the fixed fee to be paid to the supplier and $w_i$ represents the unit wholesale price. In a world with one retailer and one supplier, it is well known that such a contract permits the monopoly outcome (full supply chain coordination) to be achieved. However, with multiple retailers, this is not as clear cut. To see this most simply, consider the case of $n = 2$. The following lemma presents the equilibrium pricing under two-part tariff contracts for each regime and under each market structure.
Lemma 6. The equilibrium two-part tariff terms are:

(i) with dedicated suppliers ($m = 1$):

\[ w_1^d = w_2^d = c - \frac{(a-c)\gamma^2}{4 + \gamma(2-\gamma)}; \quad \text{and} \quad F_1^d = F_2^d = \left(\frac{2(a-c)}{4 + \gamma(2-\gamma)}\right)^2; \]

\[ w_1^\phi = w_2^\phi = c; \quad \text{and} \quad F_1^\phi = F_2^\phi = \left(\frac{a-c}{2 + \gamma}\right)^2. \]

(ii) with a common supplier ($m = 2$):

\[ w_1^d = w_2^d = c + \frac{(a-c)\gamma}{2(1+\gamma)}; \quad \text{and} \quad F_1^d = F_2^d = \left(\frac{a-c}{2(1+\gamma)}\right)^2; \]

\[ w_1^\phi = w_2^\phi = c; \quad \text{and} \quad F_1^\phi = F_2^\phi = \left(\frac{a-c}{2 + \gamma}\right)^2. \]

Notice the parallel to results in the single-tariff (linear pricing) case studied earlier. First, under full disclosure, the wholesale prices is lower for $m = 1$ relative to $m = 2$. With $m = 1$, promoting inter-alliance competition is in the forefront while, with $m = 2$, softening intra-alliance competition is key. Second, under confidentiality, the solution is unaffected by $m$. That is, given the inability to influence rival behavior, the supplier treats each retailer in an independent fashion. Third, the confidential wholesale price is intermediate to the low disclosed wholesale price under $m = 1$ and the high disclosed wholesale price under $m = 2$.

To refine the intuition underlying the lemma and to identify the welfare consequences, consider first the outcome under dedicated suppliers. With two suppliers seeking to extract retail market share via their surrogates, the optimal variable charge in the case of full disclosure entails below marginal cost pricing. In other words, to promote its customer in the retail market, the supplier is willing to undercut its unit prices so much that it loses marginally on each unit sold, knowing it can extract retail profit via the fixed fee. The end result is again a prisoners' dilemma in pricing. In contrast, with confidential
contracts, a supplier is unable to influence retail competition. In this case, it treats each retailer in an independent fashion, and sets marginal cost pricing to maximize the profits of that particular relationship (knowing its pricing will not change rival behavior). As a consequence, confidentiality leads to familiar Cournot outcomes. Note, then, that with two part tariffs the same essential tensions arise: disclosure promotes lower unit prices and thereby can promote greater social welfare.

As far as the common supplier outcome, again the intuition from before carries forward to the two-part tariff case. A sole supplier who relies on disclosed contract terms can use a unit charge above marginal cost to help reduce competitive pressures in the retail market and can then use the fixed fee to extract the larger surplus. In fact, in this case, the sole supplier fully exploits its power to achieve monopoly outcomes. Under confidentiality, the supplier cannot use the unit charge to one party to influence the behavior of another and, thus, relies instead on marginal cost pricing, leading to Cournot outcomes. Thus, with a common supplier, confidentiality is the regime with no double marginalization problems and, thereby, greater welfare. This intuition is confirmed formally in Proposition 4, a result akin to Proposition 1.

*Proposition 4.* With two-part tariffs, in the $n = 2$ case, the preferred regime is:

(i) full disclosure with dedicated suppliers ($m = 1$) and

(ii) confidentiality with a common supplier ($m = 2$).

In short, not only does consideration of two-part tariffs not derail the underlying conclusions herein, it points to a unifying theme in that the nature of the supply market (not the nature of contracts) is the key feature in divining the efficacy of disclosure standards for vertical contracts.
4. Conclusion

In this paper, we examine the oft-discussed and at times contentious issue of disclosure of vertical contracts. While conventional wisdom suggests that suppliers keep contracts under wraps as a means to exploit retailers and consumers, we find that the underlying forces may be more subtle. In particular, when retailers rely on a common supplier for inputs, full disclosure of contracts provides the supplier a means through which to soften retail competition among the firms. In this case, then, disclosure actually harms consumers. In contrast, for retailers who rely on different suppliers for inputs, disclosure of contracts creates an environment wherein a supplier wants to cut its wholesale price to its retailer to give that retailer an edge in downstream competition. As a consequence, disclosure benefits consumers and enhances welfare. With these dual roles of disclosure in play, the nature of the supply market (and concentration therein) becomes a critical determinant of the efficacy of disclosure.

While we initially investigate this question in a standard formulation of supply chain interactions, we also investigate the consequences of endogenous supplier costs and two-part tariff contracts. In each case, the basic results are shown to be robust to the variations; yet, each variation introduces subtle additional considerations. In particular, supplier investment incentives push in a direction that mute welfare differences between the regimes. And, two-part tariff arrangements prescribe both below and above marginal cost transfers with disclosure depending on supplier concentration, while marginal cost pricing is the norm under confidentiality.

With the focus herein exclusively on the nature of vertical and horizontal relationships, future work could also layer in capital market considerations to the analysis. For example, while capital markets typically view disclosure in a positive light, it may be interesting to examine how capital markets would perceive disclosure when endogenous strategic consequences of wholesale prices and investments studied here are
in play. Relatedly, examining how this market perception varies for different firms along the vertical and/or horizontal spectrum may provide additional insights.
APPENDIX

Proof of Lemma 1. The proof is provided in the text. Equivalently, the proof follows by substituting $n = 2$ in the proof of Lemma 2 presented next.

Proof of Lemma 2. Denote retailer $j$'s equilibrium quantity by $\tilde{q}_j$. Anticipating that rivals will put their equilibrium quantities on the market, retailer $i$ solves:

$$\max_{q_i} \left[ a - q_i - \gamma \sum_{j=1, j \neq i}^{n} \tilde{q}_j q_i - w_i q_i, \quad i = 1, ..., n. \right] \quad (A1)$$

The first-order condition of (A1) yields:

$$a - 2q_i - \gamma \sum_{j=1, j \neq i}^{n} \tilde{q}_j - w_i = 0, \quad i = 1, ..., n. \quad (A2)$$

In equilibrium, $\tilde{q}_j = q_j$ for all $j$. Substituting this equilibrium condition in (A2), and summing over all $i$, yields:

$$\sum_{j=1, j \neq i}^{n} q_j = \frac{na - \sum_{k=1}^{n} w_k}{2 + [n - 1]\gamma} - q_i. \quad (A3)$$

Substituting (A3) into (A2), with $\tilde{q}_j = q_j$, yields retailer $i$'s equilibrium quantity as a function of the wholesale prices:

$$q_i(w_1, ..., w_n) = \frac{a[2 - \gamma] - [2 + (n - 1)\gamma]w_i + \sum_{k=1}^{n} w_k}{[2 - \gamma][2 + (n - 1)\gamma]}. \quad (A4)$$

(A4) serves as the induced demand function for suppliers $A$ and $B$, and each solves for wholesale prices, as shown in (A5):

$$\max_{w_1, ..., w_m} \sum_{i=1}^{m} [w_i - c]q_i(w_1, ..., w_n) \quad \text{and} \quad \max_{w_{m+1}, ..., w_n} \sum_{i=m+1}^{n} [w_i - c]q_i(w_1, ..., w_n). \quad (A5)$$

The first-order conditions of (A5) yield:

$$a[2 - \gamma] - 2[2 + (n - 2)\gamma]w_i + \gamma \sum_{j=1, j \neq i}^{n} [w_j - c] + \sum_{j=1}^{n} [w_j - c] = 0, \quad i = 1, ..., m; \text{ and}$$

$$a[2 - \gamma] - 2[2 + (n - 2)\gamma]w_i + \gamma \sum_{j=1, j \neq i}^{n} [w_j - c] + \sum_{j=m+1}^{n} [w_j - c] = 0, \quad i = m+1, ..., n. \quad (A6)$$
From symmetry, it follows that all customers of a given supplier are charged the same wholesale price in equilibrium. That is, in equilibrium, \( w_1 = w_2 = \ldots = w_m \) and \( w_{m+1} = w_{m+2} = \ldots = w_n \). We denote the former by \( w^d_A \) and the latter by \( w^d_B \). Substituting these into (A6) yields:

\[
a[2 - \gamma] - 2[2 + (n - 2)\gamma][w^d_A - c] + \gamma[2(m - 1)(w^d_A - c) + (n - m)(w^d_B - c)] = 0 \quad \text{and} \quad a[2 - \gamma] - 2[2 + (n - 2)\gamma][w^d_B - c] + \gamma[2(n - m - 1)(w^d_B - c) + m(w^d_A - c)] = 0. \tag{A7}
\]

Solving the two linear equations in (A7) for \( w^d_A \) and \( w^d_B \) yields the wholesale prices in Lemma 2(a). From (A4), the equilibrium quantities can be written as:

\[
q^d_A = \frac{a[2 - \gamma] - [2 + (n - 1)\gamma]w^d_A + [mw^d_A + (n - m)w^d_B]}{2 - \gamma[2 + (n - 1)\gamma]} \quad \text{and} \quad q^d_B = \frac{a[2 - \gamma] - [2 + (n - 1)\gamma]w^d_B + [mw^d_A + (n - m)w^d_B]}{2 - \gamma[2 + (n - 1)\gamma]}.
\tag{A8}
\]

Substituting wholesale prices from Lemma 2(a) in (A8) yields the quantities in Lemma 2(a). Also, from (A1), the retailer's profits can be expressed as:

\[
\Pi^d_i(m,n) = [a - q^d_A - \gamma(m - 1)q^d_A - \gamma(n - m)q^d_B - w^d_A]q^d_A, \quad \text{if } i = 1, \ldots, m; \quad \text{and} \quad \Pi^d_i(m,n) = [a - q^d_B - \gamma mq^d_A - \gamma(n - m - 1)q^d_B - w^d_B]q^d_B, \quad \text{if } i = m+1, \ldots, n. \tag{A9}
\]

Substituting wholesale prices and output levels from Lemma 2(a) in (A9), and simplifying, yields the retailers' profits in Lemma 2(b). Each supplier's profit in Lemma 2(b) follows directly from (A5).

With linear demand, consumer surplus is given by:

\[
[1 / 2]\sum_{i=1}^n q_i^2 + \gamma \sum_{i=1}^n \sum_{j \neq i} q_i q_j. \tag{A10}
\]

Using \( q^d_A \) for \( q_i, \ i = 1, \ldots, m, \) and \( q^d_B \) for \( q_i, \ i = m+1, \ldots, n, \) in (A10) yields the consumer surplus expression in Lemma 2(c). Finally, welfare is simply the sum of the profits of the \( n \)-retailers, the two suppliers, and consumer surplus with the last term weighted by \( \beta \), i.e.,

\[
W^d(m,n) = \sum_{i=1}^n \Pi^d_i(m,n) + \Pi^d_A(m,n) + \Pi^d_B(m,n) + \beta CS^d(m,n).
\]

This completes the proof of Lemma 2.

**Proof of Lemma 3.** The proof is provided in the text. Equivalently, the proof follows by substituting \( n = 2 \) in the proof of Lemma 4 presented next.
Proof of Lemma 4. Given passive beliefs, each retailer presumes its rivals will receive equilibrium terms from the supplier and, accordingly, each rival will choose its equilibrium quantity. Denote retailer \( j \)'s equilibrium quantity by \( \tilde{q}_j \). In response, retailer \( i \) solves (A1), and the first-order condition of this problem presented in (A2) can be rewritten as:

\[
q_i \left( \sum_{j=1}^{n} \tilde{q}_j, w_i \right) = \frac{1}{2} \left[ a - \gamma \left( \sum_{j=1}^{n} \tilde{q}_j - w_i \right) \right]. \tag{A11}
\]

Under confidentiality, since each retailer is unaware of rivals' wholesale prices, (A11) serves as the induced demand function for suppliers \( A \) and \( B \), and each solves for wholesale prices, as shown in (A12):

\[
\text{Max}_{w_1, \ldots, w_m} \sum_{i=1}^{m} [w_i - c]q_i \left( \sum_{j=1}^{n} \tilde{q}_j, w_i \right) \quad \text{and} \quad \text{Max}_{w_{m+1}, \ldots, w_n} \sum_{i=m+1}^{n} [w_i - c]q_i \left( \sum_{j=1}^{n} \tilde{q}_j, w_i \right). \tag{A12}
\]

Solving the first-order condition of (A12) yields:

\[
w_i \left( \sum_{j=1 \neq i}^{n} \tilde{q}_j \right) = \frac{1}{2} \left[ a + c - \gamma \sum_{j=1}^{n} \tilde{q}_j \right]. \tag{A13}
\]

Substituting wholesale price from (A13) into (A11), and using the equilibrium condition, \( \tilde{q}_j = q_j \) for all \( j \), yields:

\[
q_i = \frac{1}{4} \left[ a - c - \gamma \sum_{j=1 \neq i}^{n} q_j \right]. \tag{A14}
\]

Summing (A14) over all \( i \), yields:

\[
\sum_{j=1 \neq i}^{n} q_j = \frac{n[a - c]}{4 + \gamma [n - 1]} - q_i. \tag{A15}
\]

Substituting (A15) into (A14), and solving for \( q_i \) yields \( q_i^\phi (m, n) \) in Lemma 4(a). Using \( q_i^\phi (m, n) \) in (A13) yields \( w_i^\phi (m, n) \) in Lemma 4(a). Also, from (A1), the retailer's profits can be expressed as:

\[
\Pi_i^\phi (m, n) = [a - q_i^\phi (m, n) - \gamma (n - 1)q_i^\phi (m, n) - w_i^\phi (m, n)]q_i^\phi (m, n). \tag{A16}
\]

Substituting wholesale prices and output levels from Lemma 4(a) in (A16), and
simplifying, yields the retailers' profits in Lemma 4(b). Each supplier's profit in Lemma 4(b) follows directly from (A12).

Using \( q_i^\phi(m,n) \) for \( q_i \) in (A10) yields consumer surplus in Lemma 4(c). Finally, welfare is \( W^\phi(m,n) = \sum_{i=1}^n \Pi^\phi_i(m,n) + \Pi_A^\phi(m,n) + \Pi_B^\phi(m,n) + \beta CS^\phi(m,n) \). This completes the proof of Lemma 4. \( \blacksquare \)

**Proof of Proposition 1.**

(i) Consider the \( m = 1 \) case. Using \( W^d \) from Lemma 1(i) and \( W^\phi \) from Lemma 3(i):

\[
W^d - W^\phi = \frac{[a-c]^2 \gamma^2 [2(16 - 4 \gamma - 5 \gamma^2) + \beta (16 + 20 \gamma + 3 \gamma^2 - \gamma^3)]}{[4 + \gamma]^2 [2 + \gamma]^2 [4 - \gamma]^2} > 0. \quad (A17)
\]

(ii) Consider the \( m = 2 \) case. Using \( W^d \) from Lemma 1(ii) and \( W^\phi \) from Lemma 3(ii):

\[
W^d - W^\phi = -\frac{[a-c]^2 \gamma [2(8 + \gamma - \gamma^2) + \beta (8 + 11 \gamma + 3 \gamma^2)]}{4[4 + \gamma]^2 [2 + \gamma]^2} < 0. \quad (A18)
\]

**Proof of Proposition 2.** Using \( W^d(m,n) \) from Lemma 2(c), \( W^\phi(m,n) \) from Lemma 4(c), and noting \( \beta \geq 1, n/2 \leq m \leq n, \) and \( n \geq 2, \) some tedious algebra can be used to verify \( W^d(m,n) - W^\phi(m,n) \) is decreasing in \( m. \) Further, at \( m = n, \) the welfare difference is negative as noted below:

\[
W^d(n,n) - W^\phi(n,n) =
- \frac{[a-c]^2 \gamma n[n-1][2(8 + \gamma - \gamma^2(n-1)^2 + \gamma n) + \beta (8 + 11 \gamma (n-1) + 3 \gamma^2 (n-1)^2)]}{8[4 + \gamma(n-1)]^2 [2 + \gamma(n-1)]^2} < 0. \quad (A19)
\]

Thus, it follows that there exists an \( m^* \in \{n/2, n\}, \) such that \( W^d(m,n) - W^\phi(m,n) < 0 \) if and only if \( m \geq m^* \). Further, \( m^* = n/2 \) if and only if \( W^d(n/2,n) - W^\phi(n/2,n) \leq 0 \). Again, using Lemma 2(c) and Lemma 4(c):

\[
W^d(n/2,n) - W^\phi(n/2,n) =
\frac{2[a-c]^2 \gamma n[n-1][\gamma(n-1) - (n-2)]A}{[8 + \gamma(n-4)]^2 [2 + \gamma(n-1)]^2 [4 + \gamma(n-1)]^2}
\]

where

\[
A = 32 - \gamma^3 [n-2][n-1] + \gamma [6n - 20] + \gamma^2 [-2 + 8n - 6n^2] + \beta [16 + \gamma^2 (n-3)[n-1]^2 + 5\gamma [5n - 6] + \gamma^2 [17 - 27n + 10n^2]] > 0. \quad (A20)
\]

From (A20), \( W^d(n/2,n) - W^\phi(n/2,n) \leq 0 \) and, hence, \( m^* = n/2, \) if and only if \( \gamma \leq \frac{n-2}{n-1}. \)
From above, for $\gamma \in \left(\frac{n - 2}{n - 1}, 1\right]$, $m^* \in (n/2, n)$. Also, in this $\gamma$-interval, $m^*$ is strictly increasing in $\gamma$, i.e., $\frac{dm^*}{d\gamma} > 0$. While the expression for $\frac{dm^*}{d\gamma}$ is cumbersome, the minimum value for $\frac{dm^*}{d\gamma}$, obtained at $\gamma = 1$ and $\beta \to \infty$, is easy to derive and equals:

$$\lim_{\beta \to \infty} \frac{dm^*}{d\gamma} = \left\{ \frac{n - 1}{4n - 3 + 27n^2 + 12n^3} \right\} \frac{4n + 3}{4n + 3}^{3/2} [n(3n + 4)]^{1/2} > 0. \quad (A21)$$

From (A21), then, the maximum value of $m^*$ is obtained at $\gamma = 1$. Solving $W^d(m, n) - W^p(m, n) = 0$ at $\gamma = 1$, yields $m^* = \frac{n}{2} + \frac{1}{2} \sqrt{\frac{n[3n + 4]}{4n + 3}}$. Thus, this value is the upper bound on $m^*$. This completes the proof of Proposition 2.

**Proof of Lemma 5.**

(i) Consider the $m = 1$ case. Under full disclosure, for given investments, $\delta_A$ and $\delta_B$, the analysis proceeds as in section 3.1.1 (or, equivalently, as in the proof of Lemma 2 with $n = 2$ and $m = 1$). This process yields supplier profits of:

$$\Pi_A = \frac{2\left((a - \sigma + 2\delta_A)(4 + \gamma)(2 - \gamma) + 2\gamma(\delta_A - \delta_B)^2\right)}{[4 - \gamma]^2[4 + \gamma]^2[2 - \gamma][2 + \gamma]} - \frac{k\delta_A^2}{2}$$

and

$$\Pi_B = \frac{2\left((a - \sigma + 2\delta_B)(4 + \gamma)(2 - \gamma) + 2\gamma(\delta_B - \delta_A)^2\right)}{[4 - \gamma]^2[4 + \gamma]^2[2 - \gamma][2 + \gamma]} - \frac{k\delta_B^2}{2}. \quad (A22)$$

Supplier $A$ ($B$) chooses $\delta_A$ ($\delta_B$) to maximize $\Pi_A$ ($\Pi_B$) in (A22). Jointly solving the first-order conditions for these problems yields optimal investments in the $m = 1$ disclosure regime:

$$\delta_A = \delta_B = \frac{4[a - \sigma][8 - \gamma^2]}{[4 - \gamma][4 + \gamma][2 + \gamma]} - 4[8 - \gamma^2] \equiv \delta^d(1).$$

Under confidentiality, for given investments, $\delta_A$ and $\delta_B$, the analysis proceeds as in section 3.1.2 (or, equivalently, as in the proof of Lemma 4 with $n = 2$ and $m = 1$). This process yields supplier profits of:

$$\Pi_A = \frac{2\left((a - \sigma + 2\delta_A)(4 + \gamma) + \gamma(\delta_A - \delta_B)^2\right)}{[4 - \gamma]^2[4 + \gamma]^2} - \frac{k\delta_A^2}{2}$$

and
\[
\Pi_B = \frac{2\left( (a - \bar{e} + \delta_B)(4 - \gamma) + \gamma(\delta_B - \delta_A) \right)^2}{[4 - \gamma]^2[4 + \gamma]^2} - \frac{k\delta_B^2}{2}.
\]

(A23)

Supplier A (B) chooses \( \delta_A (\delta_B) \) to maximize \( \Pi_A (\Pi_B) \) in (A23). Jointly solving the first-order conditions for these problems yields optimal investments in the \( m = 1 \) confidential regime:

\[\delta_A = \delta_B = \frac{16[a - \bar{e}]}{[4 - \gamma][4 + \gamma]^2 k - 16} = \delta^\phi (1).\]

(ii) Consider the \( m = 2 \) case. Since each retailer procures from a common supplier, whose cost is \( \bar{e} - \delta_A \), supplier A's profit in the full disclosure case is as in Lemma 1(ii) adjusted for investment cost and with \( c \) replaced by \( \bar{e} - \delta_A \). That is, supplier A's profit is:

\[\Pi_A = \frac{4(a - \bar{e} + \delta_A)^2}{[4 + \gamma]^2} - \frac{k\delta_A^2}{2}.
\]

(A24)

The supplier chooses \( \delta_A \) to maximize (A24), and the first-order condition yields optimal investments in the \( m = 2 \) full disclosure regime:

\[\delta_A = \frac{a - \bar{e}}{[2 + \gamma]k - 1} = \delta^d (2).
\]

Under confidentiality, supplier A's profit is as in Lemma 3(ii) adjusted for investment cost and with \( c \) replaced by \( \bar{e} - \delta_A \). That is, supplier A's profit is:

\[\Pi_A = \frac{4(a - \bar{e} + \delta_A)^2}{[4 + \gamma]^2} - \frac{k\delta_A^2}{2}.
\]

(A25)

The supplier chooses \( \delta_A \) to maximize (A25), and the first-order condition yields optimal investments in the \( m = 2 \) confidential regime:

\[\delta_A = \frac{8[a - \bar{e}]}{[4 + \gamma]^2 k - 8} = \delta^\phi (2).
\]

This completes the proof of Lemma 5.

**Proof of Proposition 3.**

(i) In the \( m = 1 \) case, supplier costs are lower under confidentiality. This follows from the fact that given \( k \geq \frac{1}{2 + \gamma} \):

\[\delta^d (1) - \delta^\phi (1) = \frac{4[a - \bar{e}][4 - \gamma][4 + \gamma]^3 k}{[(4 - \gamma)(4 + \gamma)^2 k - 16(4 - \gamma)^2(4 + \gamma)(2 + \gamma)k - 4(8 - \gamma^2)]} < 0.
\]
In the $m = 2$ case, supplier costs are lower under full disclosure. This follows from the fact that given $k \geq \frac{1}{2 + \gamma}$:
\[
\delta^d(2) - \delta^\phi(2) = \frac{[a - c] \gamma^2 k}{(2 + \gamma)k - 1}(4 + \gamma)^2 k - 8 > 0.
\]

(ii) In the $m = 1$ case, welfare is higher under full disclosure. The welfare expressions under full disclosure and confidentiality are as in Lemma 1(i), with $c$ replaced by $\bar{c} - \delta^d(1)$ and adjustment for supplier investments, and Lemma 3(i), with $c$ replaced by $\bar{c} - \delta^\phi(1)$ with appropriate adjustment for supplier investments, respectively. That is, the difference in welfare equals:
\[
W^d - W^\phi = \left(4[a - \bar{c} + \delta^d(1)]^2[6 + \beta(1 + \gamma) - \gamma^2] - k[\delta^d(1)]^2\right) - \left(\frac{[a - \bar{c} + \delta^\phi(1)]^2[6 + \beta(1 + \gamma)]}{4 + \gamma} - k[\delta^\phi(1)]^2\right) > 0.
\]

The inequality above follows from tedious algebra noting $\beta \geq 1$, $0 < \gamma \leq 1$, $k \geq 1/(2 + \gamma)$, and utilizing the expressions for $\delta^d(1)$ and $\delta^\phi(1)$ from Lemma 5(i).

In the $m = 2$ case, Lemma 1(ii) and Lemma 3(ii) apply. Adjusting these welfare expressions as explained above, and using $\delta^d(2)$ and $\delta^\phi(2)$ from Lemma 5(ii), the difference in welfare equals:
\[
W^d - W^\phi = \left(\frac{[a - \bar{c} + \delta^d(2)]^2[6 + \beta(1 + \gamma) + 2\gamma]}{4[2 + \gamma]^2} - k[\delta^d(2)]^2\right) - \left(\frac{[a - \bar{c} + \delta^\phi(2)]^2[6 + \beta(1 + \gamma)]}{4 + \gamma} - k[\delta^\phi(2)]^2\right) < 0.
\]

This completes the proof of Proposition 3.

Proof of Lemma 6.

(i) Consider the $m = 1$ full disclosure setting. The equilibrium quantities as a function of the wholesale prices are as in (A4) with $n = 2$. That is, $q_1(w_1,w_2)$ and $q_2(w_1,w_2)$ serve as induced demand functions for suppliers $A$ and $B$, respectively. Since each supplier can use a fixed transfer to extract profits from its retailer, each selects wholesale price to maximize its respective supply chain profit:
\[
\text{Max}_{w_1} [a - q_1(w_1,w_2) - \gamma q_2(w_1,w_2) - c] f_l(w_1,w_2) \quad \text{and}
\]
\[
\text{Max}_{w_2} \left[ a - q_2(w_1, w_2) - \gamma q_1(w_1, w_2) - c \right] q_2(w_1, w_2). \tag{A26}
\]

Jointly solving the first-order conditions associated with (A26) yields:
\[
w_1^d = w_2^d = c - \frac{[a - c] \gamma^2}{4 + \gamma[2 - \gamma]}. \tag{A27}
\]

Each supplier chooses fixed transfer to extract its retail customer's profit. Thus, using (A33), the fixed transfers are:
\[
F_1^d = [a - q_1(w_1^d, w_2^d) - \gamma q_2(w_1^d, w_2^d) - w_1^d \gamma q_1(w_1^d, w_2^d)] = \left( \frac{2[a - c]}{4 + \gamma[2 - \gamma]} \right)^2 \quad \text{and}
\]
\[
F_2^d = [a - q_2(w_1^d, w_2^d) - \gamma q_1(w_1^d, w_2^d) - w_2^d \gamma q_2(w_1^d, w_2^d)] = \left( \frac{2[a - c]}{4 + \gamma[2 - \gamma]} \right)^2.
\]

Consider the \(m = 1\) confidential setting. The equilibrium quantities as a function of the wholesale prices are as in (A11) with \(n = 2\). That is, \(q_1(q_2, w_1)\) and \(q_2(q_1, w_2)\) serve as induced demand functions for suppliers \(A\) and \(B\), respectively. Each supplier selects wholesale price to maximize its respective supply chain profit:
\[
\text{Max}_{w_1} \left[ a - q_1(\tilde{q}_2, w_1) - \gamma \tilde{q}_2 - c \right] q_1(\tilde{q}_2, w_1) \quad \text{and}
\]
\[
\text{Max}_{w_2} \left[ a - q_2(\tilde{q}_1, w_2) - \gamma \tilde{q}_1 - c \right] q_2(\tilde{q}_1, w_2). \tag{A28}
\]

Jointly solving the first-order conditions associated with (A28) yields:
\[
w_1^\phi = w_2^\phi = c. \tag{A29}
\]

Using wholesale price from (A29), the demand for each supplier is \(q_1(\tilde{q}_2, c)\) and \(q_2(\tilde{q}_1, c)\). Solving the equilibrium condition \(q_1(\tilde{q}_2, c) = \tilde{q}_1\) and \(q_2(\tilde{q}_1, c) = \tilde{q}_2\), yields \(q_1 = \tilde{q}_1 = q_2 = \tilde{q}_2 = \frac{a - c}{2 + \gamma}\). Using (A29), the fixed transfers are:
\[
F_1^\phi = F_2^\phi = \left[ a - \frac{a - c}{2 + \gamma} - \gamma \frac{a - c}{2 + \gamma} - c \right] \frac{a - c}{2 + \gamma} = \left( \frac{a - c}{2 + \gamma} \right)^2.
\]

(ii) Consider the \(m = 2\) full disclosure setting. The common supplier, supplier \(A\), selects wholesale prices to maximize industry profit:
\[
\text{Max}_{w_1, w_2} \sum_{i=1}^{2} \left[ a - q_i(w_i, w_2) - \gamma q_j(w_1, w_2) - c \right] q_i(w_i, w_2). \tag{A30}
\]

Solving the first-order conditions associated with (A30) yields:
\[ w_1^d = w_2^d = c + \frac{(a-c)\gamma}{2[1+\gamma]} . \]

(A31)

The supplier chooses fixed transfers to extract its retail customer's profit. Thus, using (A31), the fixed transfers are:

\[ F_1^d = [a - q_1(w_1^d, w_2^d) - \gamma q_2(w_1^d, w_2^d) - w_1^d]q_1(w_1^d, w_2^d) = \left( \frac{a-c}{2[1+\gamma]} \right)^2 \]

and

\[ F_2^d = [a - q_2(w_1^d, w_2^d) - \gamma q_1(w_1^d, w_2^d) - w_2^d]q_2(w_1^d, w_2^d) = \left( \frac{a-c}{2[1+\gamma]} \right)^2 . \]

Finally, consider the \( m = 2 \) confidential setting. Supplier \( A \) selects wholesale prices to maximize industry profit:

\[ \text{Max} \sum_{i=1}^2 [a - q_i(\tilde{q}_j, w_i) - \gamma \tilde{q}_j - c]q_i(\tilde{q}_j, w_i) . \]

(A32)

Jointly solving the first-order conditions associated with (A32) yields:

\[ w_1^\phi = w_2^\phi = c . \]

(A33)

Using wholesale price from (A33), the demand for each supplier is \( q_1(\tilde{q}_2, c) \) and \( q_2(\tilde{q}_1, c) \). Solving the equilibrium condition \( q_1(\tilde{q}_2, c) = \tilde{q}_1 \) and \( q_2(\tilde{q}_1, c) = \tilde{q}_2 \), yields \( q_1 = \tilde{q}_1 = q_2 = \tilde{q}_2 = \frac{a-c}{2 + \gamma} \). Using (A33), the fixed transfers are:

\[ F_1^\phi = F_2^\phi = [a - \frac{a-c}{2 + \gamma} - \gamma \frac{a-c}{2 + \gamma} - c] \frac{a-c}{2 + \gamma} = \left( \frac{a-c}{2 + \gamma} \right)^2 . \]

This completes the proof of Lemma 6.

Proof of Proposition 4.

Given quantities \( q_1 \) and \( q_2 \), the expression for welfare is:

\[ \sum_{i=1}^2 [a - q_i^2 - \gamma q_j^2 - c]q_i + \beta [q_1^2 + q_2^2 + 2\gamma q_1 q_2] . \]

(A34)

(i) Consider the \( m = 1 \) full disclosure case. Using wholesale prices from Lemma 6(i), retailer \( i \)'s equilibrium quantity is \( q_i(w_1^d, w_2^d) = \frac{2[a-c]}{4 + \gamma[2 - \gamma]} \). Using this in (A34), yields:

\[ W^d = \frac{4[a-c]^2[2 + \beta(1 + \gamma) - \gamma^2]}{[4 + \gamma(2 - \gamma)]^2} . \]

(A35)

Consider the \( m = 1 \) confidentiality case. Using wholesale prices from Lemma
6(i), retailer $i$'s equilibrium quantity is $\frac{a-c}{2+\gamma}$. Using this in (A34), yields:

$$W^\phi = \frac{[a-c]^2[2 + \beta(1 + \gamma)]}{[2 + \gamma]}. \tag{A36}$$

From (A35) and (A36):

$$W^d - W^\phi = \frac{[a-c]^2 \gamma^2[\beta(8 + 12\gamma + 3\gamma^2 - \gamma^3) - 2\gamma(4 + 3\gamma)]}{[8(1 + \gamma) - \gamma^3]^2} > 0.$$

The inequality above follows from $\beta \geq 1$ and $0 < \gamma \leq 1$.

(ii) Consider the $m = 2$ full disclosure case. Using wholesale prices from Lemma 6(ii), retailer $i$’s equilibrium quantity is $q_i(w_1^d, w_2^d) = \frac{a-c}{2[1 + \gamma]}$. Using this in (A34), yields:

$$W^d = \frac{[a-c]^2[2 + \beta]}{4[1 + \gamma]} . \tag{A37}$$

Consider the $m = 2$ confidentiality case. Using wholesale prices from Lemma 6(ii), retailer $i$’s equilibrium quantity is $\frac{a-c}{2+\gamma}$. Using this in (A34), yields:

$$W^\phi = \frac{[a-c]^2[2 + \beta(1 + \gamma)]}{[2 + \gamma]^2}. \tag{A38}$$

From (A37) and (A38):

$$W^d - W^\phi = -\frac{[a-c]^2 \gamma[\beta(4 + 3\gamma) - 2\gamma]}{4[1 + \gamma][2 + \gamma]^2} < 0.$$

This completes the proof of Proposition 4. $\blacksquare$
References


