2022-01

Working paper. Economics

ISSN 2340-5031

DISCLOSURE REGIME OF CONTRACT TERMS AND BARGAINING IN VERTICAL MARKETS.

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Serie disponible en http://hdl.handle.net/10016/11

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Disclosure Regime of Contract Terms and Bargaining in Vertical Markets

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February 16, 2022

Abstract

We consider a vertically related market where an upstream monopolist supplies two downstream Cournot competitors. We allow the vertical contract terms to be either interim observable or secret. We address a dichotomy in the literature by endogenizing the disclosure regime of contract terms. The latter could be set via a Non-Disclosure Agreement. Firms bargain over both the disclosure regime and the contract terms. Our results indicate that when firms trade over two-part tariffs, universal interim observability is the unique equilibrium no matter the bargaining power distribution or the product differentiation. Yet, when firms trade over linear tariffs there may be a multiplicity of equilibria. We also show that under competing vertical chains we get universal interim observability as a unique equilibrium no matter the upstream structure. Our results qualitatively hold under Bertrand competition too. Our welfare analysis indicates that universal interim observability and two-part tariffs yield the highest consumer surplus and total welfare.

Keywords: bilateral contracting; vertical relations; two-part tariffs; bargaining; non-disclosure agreements; secret contracts;

JEL classification: D43; L13; L14

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1 Introduction

Regulators all over the world demand for more disclosure in wholesale contracts, but the efficacy of such policy is still unclear (Marotta-Wugler, 2012). There are many examples of forced or voluntary disclosure. During the 1990s Denmark enforced disclosure of wholesale contracts in the ready mix concrete market to increase competition. In the USA, strong efforts have pushed for disclosure in both medical equipment and pharmaceuticals to undercut prices (Arya and Mittendorf, 2011). Even though Nestlè controls 80% of the processed coffee market in Chile, it publicly announces the wholesale prices given to its retailers (Noton and Elberg, 2016).

However, there are also examples of less disclosure. California voted a secrecy friendly law, prohibiting wholesalers from advertising their prices (Arya and Mittendorf, 2011). Moreover, anecdotal evidence indicates that Airbus and Boeing (a duopoly in wide-body airplanes) disclose an initial price per airplane type at their websites, but never the final price achieved after the bargains with customers. The bottom line is that, in real life, different markets follow different disclosure regimes.

Besides real life examples, the research and academic treatment of disclosure is also dichotomized. For a two-tier vertical market consisting of few upstream and downstream firms, some researchers argue that the latter may not observe their rivals' contract terms before making their output decision (Katz, 1991; O'Brien and Shaffer, 1992; McAfee and Schwartz, 1994, 1995; Rey and Verge, 2004; Rey and Tirole, 2006; Rey and Verge, 2008; Arya and Mittendorf, 2011; Gaudin, 2019). Therefore, they may not react optimally, lacking the strategic aspect of their actions.[1] This *secrecy* of rival contract terms may be caused by several reasons, e.g., (i) each downstream firm fears that its rivals could receive secret deals from the upstream firm(s), (ii) the rival contract terms are too complex to follow, (iii) it is impossible to verify contracts at court, or (iv) the upstream firm(s) tend to renegotiate often.[2] Therefore, the downstream firms have to form *beliefs* about their rivals' contract terms. In most of the cases, these beliefs are assumed *passive*.[3]

[1]This situation is labeled with many verbally different albeit equivalent terms like: *secrecy* (McAfee and Schwartz, 1994; Rey and Tirole, 2006; Rey and Verge, 2008), *unobservability* (Katz, 1991; Rey and Verge, 2004), or *confidentiality* (Arya and Mittendorf, 2011; Liu and Wang, 2014). In our analysis, we prefer the first term.

[2]Knowing the number of rival costs but not the rule in which they are calculated does not change the disclosure regime. Katz (1991) mentions an illustrative example: in the US, the Securities and Exchange Commission requires firms to announce the amount of managerial compensation, but not the rule in which this compensation is calculated. Thus, any potential investor (upstream supplier of money) could not evaluate what the agent's incentives are.

[3]Among many, literature highlights three types of beliefs: symmetric, passive and wary beliefs. Symmetric beliefs state that retailers treat unexpected off-equilibrium offers from suppliers as perfectly correlated with the offers made to their rivals. Thus, each retailer believes that his rivals receive the same off-equilibrium

On the other hand, some researchers argue that each retailer can *observe* and verify rival terms before making its output decision (Rey and Stiglitz, 1988; Katz, 1988; Horn and Wolinsky, 1988; Chen, 2001; de Fontenay and Gans, 2005; Inderst and Wey, 2006; Milliou and Petrakis, 2007; Marx and Shaffer, 2007; Iozzi and Valletti, 2014; Gaudin, 2017). Katz (1991) provides a list with several authors using *interim observable* contracts and a useful discussion.[4]

We answer this vivid ongoing debate by endogenizing the vertical contract's disclosure regime in a *renegotiation proof* bargaining. We let involved upstream and downstream firms to decide the regime which is optimal for them, based on the specificities of the industry at hand. For a contract to remain secret, *both* members of the vertical chain must have incentives to keep the contract terms secret. For a contract to become interim observable, *at least* one member of the vertical chain must have incentives to announce the contract terms before the downstream competition stage.

Practically, the involved parties agree to a disclosure regime through a legal contract called *Non-Disclosure Agreement* (hereafter NDA). For the NDA to be valid, both parties must sign it. If at least one of them decides not to sign it, then there is no legal restriction to disclose the trading terms of the vertical agreement. An NDA is considered in most of the courts worldwide as a binding pre-contractual arrangement, and as such is no cheap talk (Schwartz and Scott, 2007). If one party violates the NDA, it can be brought to court and be penalized, including equitable relief from the subsequent monetary damage. So, three states-of-the-world may emerge: (i) the case where both members of each one of the vertical pairs sign NDAs (what we call *universal secrecy*), (ii) at least one member of each vertical pair denies signing the NDA (*universal interim observability*), and (iii) a *hybrid* case where one vertical pair signs an NDA while the other pair does not.

No one could deny that the contract terms of the vertical agreements are of paramount importance. Nevertheless, the disclosure regime of those contract terms could, also, play a

offer as it does. Passive beliefs state that no matter what off-equilibrium offer is received by the retailer, the retailer believes that its rivals have reached an equilibrium. Thus, the offers it receives are uncorrelated with the rival offers. Both symmetry and passive beliefs view off-equilibrium offers as trembles by the suppliers. On the contrary, under wary beliefs, retailers believe that any off-equilibrium offer is a deliberate choice: even if the offers are off-equilibrium, they are optimal given the rival offers. (McAfee and Schwartz, 1994). Note that wary and symmetric beliefs may lead to non-tractable equilibrium outcomes (Hart and Tirole, 1990; McAfee and Schwartz, 1994), or even in situations where a perfect Bayesian Nash equilibrium may fail to exist (McAfee and Schwartz, 1995; Rey and Verge, 2004).

[4]Under fully observable or else *public* contracts, the upstream firm can publicly commit to the terms of all contracts offered. So, each downstream firm observes all rival contract terms before deciding to accept its contract terms. Therefore, the upstream firm does not face any commitment problem in this case. But, under *interim observability* downstream firms observe each other's contract terms after signing and before competing in the downstream market. This exacerbates the upstream firm's commitment problem (opportunistic behavior).

vital role in the competition process (Arya and Mittendorf, 2011). Moreover, one could argue that the disclosure regime of a vertical contract could be characterized as a *vertical restraint* since, through an NDA, it is a contractual provision. Vertical restraints have attracted much attention due to their effect on competition. Two important and negative effects of vertical restraints are (i) the competition softening between some parties of the agreement and (ii) the facilitation of downstream collusion through the manipulation of prices. The latter, in turn, could cause negative effects in the competition and can harm consumers (European Commission, 2010).

To address our research question, we consider in our main model a two-tier vertical market, consisting of a common upstream supplier and two differentiated downstream Cournot competitors trading via two-part tariffs. We consider a two-stage game. In the first stage, we let the upstream monopolist and each of the downstream firms to *simultaneously* decide both on whether to sign an NDA or not *and* bargain over their vertical contract's terms. In the second stage, downstream firms simultaneously choose their outputs. To check the robustness of our results, we consider several extensions: (i) linear tariffs, (ii) competing vertical chains, and (iii) Bertrand competition in the product market.

Our main results are clear albeit somewhat surprising. Under two-part tariffs and a common upstream monopolist supplier, the only sustainable equilibrium is for all vertical pairs to disclose their contract terms (not to sign NDAs), what we call *universal interim observability*. This result holds no matter the degree of product substitutability or the upstream supplier's bargaining power. The intuition behind this result is straightforward: a deviation to secrecy could only increase wholesale prices, leading to less profits and output for the downstream firm. This reasoning applies also in the case of competing vertical chains or Bertrand competition in the product market.

However, when vertical trading is over linear tariffs, multiplicity of equilibria may arise: The universal interim observability is, again, an equilibrium albeit not unique. For a particular combination of product substitutability and bargaining power firms have no incentive to deviate from any disclosure regime. In this case, a situation may arise where ex post symmetric firms may choose different disclosure regimes and end up ex-post asymmetric. This result holds no matter the mode of downstream competition.

Under competing vertical chains the unique equilibrium is the universal interim observability regime, no matter the contract type used in vertical trading or the other model specificities. An exclusive upstream supplier views downstream competition as inter-brand, facilitating disclosure since this increases downstream output.

The rest of the paper is structured as follows. Section 2 offers a literature review. Section 3 describes the structure of the market, the disclosure regimes under consideration, the timing of the game, and the bargaining framework. Section 4 studies our main model, characterizing the disclosure regime that arises in equilibrium and also offers a welfare analysis. Section 5 checks the robustness of our findings by characterizing the equilibrium outcome of a few extensions. And section 6 concludes. All proofs and most of the equilibrium outcomes are relegated into the Appendix.

2 Literature Review

This paper fits in the broader literature of vertical contracting. The main issue of this literature is the commitment problem an upstream monopolist faces when it comes to trade with multiple downstream retailers that compete in the product market (Horn and Wolinsky, 1988; O'Brien and Shaffer, 1992; McAfee and Schwartz, 1994, 1995; Rey and Verge, 2004; Milliou and Petrakis, 2007). However, to the best of our knowledge, no paper in this literature endogenizes the choice of the disclosure regime of contract terms.

Two papers that are somewhat related to ours are Arya and Mittendorf (2011) and Liu and Wang (2014). Arya and Mittendorf (2011) consider a two-tier industry, with Cournot competition downstream over a homogeneous product, with the upstream supplier unilaterally deciding on the wholesale prices. The disclosure regime is set exogenously. We depart from Arya and Mittendorf (2011) in three important aspects: (i) we endogenize the disclosure regime decision, (ii) we assume that involved parties bargain over their contract terms, and (ii) we extend the analysis by allowing for product differentiation and by characterizing the equilibrium under linear tariffs.

In a similar vein, Liu and Wang (2014) study a two-tier industry with differentiated Cournot downstream competition and linear tariffs. The differences with our model are: (i) they do not allow for two-part tariff contracts, (ii) they consider that the supplier(s) decide over the disclosure regime, and (iii) there is no bargaining over contract terms. None of these papers explores the role of the retailers' bargaining power as both assume that the supplier(s) unilaterally set wholesale prices. These papers account for a single common and for two exclusive suppliers, with Arya and Mittendorf (2011) accounting also for price competition in the product market.

We also contribute to the literature on vertical foreclosure. Hart and Tirole (1990) show that under secret contracting, exclusive arrangements can help an upstream monopolist to re-establish its market power. Rey and Tirole (2006) provide an excellent analysis of vertical foreclosure, featuring the anticompetitive motives for upstream firms to use exclusive secret arrangements in order to foreclose downstream retailers. In line with this literature, we show that an upstream monopolist could push for the disclosure regime that allows it to re-establish its market power, increasing profits and softening downstream competition.

3 The Model

3.1 Market structure and disclosure regimes

Consider a two-tier industry where an upstream monopolist, U, supplies an essential input to two downstream firms, D_1 and D_2. The latter produce imperfectly substitute goods using U's input in an "one-to-one" proportion. U has a constant marginal cost $c > 0$. D_is only face the cost induced by the vertical contract in action: either (i) a two-part tariff consisting of a fixed fee $F_i > 0$ and a wholesale price $w_i > 0$, or (ii) a linear tariff consisting of w_i only. Firms face linear inverse demands $p_i(q_1, q_2) = a - q_i - \gamma q_j$, $i = 1, 2 \neq j$, where $a > c$ is the market size and $0 < \gamma < 1$ denotes products' substitutability.[5] Firms' *gross* profits are:

$$\begin{aligned}\pi_i(q_1, q_2) &= (p_i(q_1, q_2) - w_i)q_i \\ \pi_U(q_1, q_2) &= \sum_{i=1}^{2}(w_i - c)q_i \qquad (1)\end{aligned}$$

In case of linear tariffs, gross equal net profits: $\Pi_X(q_1, q_2) = \pi_i(q_1, q_2)$, $X = \{1, 2, U\}$. In case of two-part tariffs net profits are: $\Pi_i(q_1, q_2) = \pi_i(q_1, q_2) - F_i, i = 1, 2$, and $\Pi_U(q_1, q_2) \equiv \pi_U(q_1, q_2) + F_1 + F_2$. We consider two disclosure regimes: (i) interim observability, and (ii) secrecy. Each retailer is aware of its own contract terms, but whether it is aware of its rival's contract terms before making its output decision depends on the disclosure regime in place. In particular:

Under *interim observability*, the contract terms agreed by pair (U, D_i) are observed by the rival pair (U, D_j) after the end of the vertical contracting stage and before the downstream firms choose their outputs (Rey and Verge, 2004).[6] The vertical contract's acceptance decision is based on beliefs. In what follows, we assume *passive beliefs*.[7]

Under *secrecy*, the vertical contract terms agreed by pair (U, D_i) cannot be observed

[5] As in Singh and Vives (1984), we assume a unit mass of identical consumers, each having a quadratic utility function $u(q_i, q_j) = a(q_i + q_j) - (q_i^2 + q_j^2 + 2\gamma q_i q_j)/2 + m$, with m denoting the quantity of the numeraire sector's composite good whose price is normalized to one.

[6] Note that observing either one of the two instruments (w_i, F_i) leads to a straightforward extraction of the other (in equilibrium). Therefore, partial observability in that sense is meaningless.

[7] Passive beliefs state that D_i will handle any out-of-equilibrium offer from U as a "tremble", uncorrelated with any offer from U to D_j. D_i believes that under any offer received from U, the pair (U, D_j) has reached an equilibrium outcome. Passive beliefs go hand-in-hand with pairwise proofness and are appropriate when we perceive the generalized asymmetric Nash bargaining solution as the limit equilibrium of an alternating offers-counter-offers non-cooperative bargaining game (Binmore et al., 1986). This solution concept is widely used in the relevant literature, e.g., Horn and Wolinsky (1988) or Milliou and Petrakis (2007).

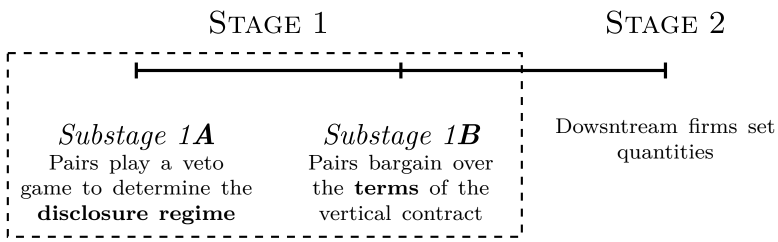

Figure 1: Game Timeline

by the rival pair (U, D_j) up until their output decision. For a vertical contract to remain secret, both members of each pair should keep the contract terms secret. Again, vertical contract's acceptance decisions are based on passive beliefs. Notice that under secrecy, each downstream firm does not observe either the out-of-equilibrium contract offers during the bargaining process nor the ultimate equilibrium bargaining outcome (Arya and Mittendorf, 2011).

3.2 Sequence of events and bargaining framework

Figure 1 presents the timeline of the game.

In particular, we consider a two-stage game where the sequence of events is as follows.[8] *Stage 1* is the bargaining stage. Each downstream firm negotiates with an agent representing the upstream monopolist over the terms of the vertical contract forming a bargaining pair. Stage 1 consists of two substages with *unobservable* actions across bargaining pairs.

In *substage 1A*, bargaining pairs play simultaneous "veto games" to determine the disclosure regime each of its vertical contract. In particular, the bargaining parties simultaneously vote on whether to sign a *Non-Disclosure Agreement* (NDA) or not. If *both* parties vote "yes" (i.e., both sign the NDA), the vertical contract terms will remain secret. Otherwise, if *at least one* member of the bargaining pair votes "no" (i.e., at least one does not sign the NDA), the vertical contract terms will become interim observable. This is in the spirit of renegotiation–proofness: If both parties benefit from signing an NDA, no one can prevent them from doing so (Dewatripont, 1988; Petrakis and Vlassis, 2000; Petrakis and Skartados, 2021).

In *substage 1B*, bargaining pairs simultaneously negotiate over the *terms* of the vertical contract. In particular, if the vertical contract in action is a two-part tariff, the bargaining agenda contains a fixed fee F_i plus a wholesale price w_i. Else, if the vertical contract is a

[8]This timing reflects the idea that long-run decisions (such as the vertical contract's terms) have considerable effects on short-run decisions (such as the output choice).

linear tariff, the bargaining agenda contains only the wholesale price w_i. In each bargaining session, the upstream supplier and the downstream firm have bargaining powers β and $1-\beta$ respectively, where $0 < \beta < 1$.[9] In addition, following the bulk of the literature, we assume that the negotiated outcome of a bargaining pair is *non-contingent* on whether the rival pair has reached or not an agreement.[10]

Stage 2 is the market competition stage. The downstream firms simultaneously choose their output. To solve the game we employ perfect Bayesian Nash equilibrium and restrict attention to pure strategies. In particular, to solve stage 2 we evoke Nash equilibrium, while to solve stage 1 we evoke the *Nash-in-Nash* solution concept (Collard-Wexler et al., 2017; Rey and Verge, 2020), i.e., the Nash equilibrium between simultaneous generalized Nash bargaining solutions.[11]

In particular, in stage 1 we use the generalized Nash bargaining solution to determine the terms of the vertical contracts of each bargaining pair. As actions are unobservable across bargaining pairs within stage 1, each pair, while negotiating over the contract terms, takes as given the equilibrium terms of the rival pair. This is anticipated during the veto game, in which case each party within the bargaining pair votes in favor of disclosing or not, given the equilibrium terms of the rival pair. Nash equilibrium is then a natural solution concept to determine the vertical contract's terms in stage 1.

4 Equilibrium analysis

We consider three types of disclosure regimes: (i) universal interim observability, denoted by the superscript $\mathcal{O}$, where both vertical pairs (U, D_i) do not sign NDAs, (ii) universal secrecy, denoted by $\mathcal{S}$, where both vertical pairs sign NDAs, and (iii) a hybrid regime, denoted by $\mathcal{H}$, where one vertical pair deals under interim observability, while the other deals under

[9] The bargaining power distribution is assumed to be exogenous and symmetric across firms. It is determined by various factors, such as the legal framework, the firm's internal organization, and the delegating abilities of the agents.

[10] Non-contingency states that any breakdown in the negotiations between each of the downstream firms and the upstream monopolist will be non-permanent and non-irrevocable, and this is common knowledge (Horn and Wolinsky, 1988). The implicit assumption here is that a breakdown in the negotiations between (U, D_i) is *non-observable* by (U, D_j), leaving D_j to keep producing the duopoly output. An equally reasonable alternative assumption in the literature is that (U, D_i)'s negotiations breakdown is observable by (U, D_j). In the latter case, D_j produces the monopoly output (Nocke and Rey, 2018; Rey and Verge, 2020). Note that our main results are robust to this alternative scenario.

[11] This version of the Nash-in-Nash solution concept focuses on outcomes such that no member of a contracting pair has incentives to unilaterally alter its decision on the disclosure regime, taking as given the equilibrium disclosure regime of the other pair. A known caveat of this solution concept is that it does not account for multilateral deviations that may, under some circumstances, lead to the non-existence of equilibrium (Rey and Verge, 2004).

secrecy. We will examine each regime separately. Remember that vertical trading takes place via two-part tariff contracts.

4.1 Secret contracts

Consider stage 2. Under secrecy, D_i is unable to observe the contract terms $(\tilde{w_j}, \tilde{F_j})$ agreed by the rival pair (U, D_j) before it makes its output choice.[12] So, D_i is unable to (verifiably) calculate $\tilde{q_j} = \frac{1}{2}(\alpha - \tilde{w_j} - \gamma\tilde{\tilde{q_i}})$. Therefore, it is treated as "constant".[13] Maximizing gross profits $\pi_i(w_i, \tilde{q_j}) = (p_i(q_i, \tilde{q_j}) - w_i)q_i$ (since fixed fees have been determined in a previous stage) with respect to q_i (henceforth *wrt*), we get the following first-order conditions (henceforth *focs*):

$$q_i^{\mathcal{S}}(w_i, \tilde{q_j}) = \frac{1}{2}(\alpha - w_i - \gamma\tilde{q_j}) \tag{2}$$

Intuitively, D_i is unable to replace the constant passive belief $\tilde{q_j}$ with a credible and verifiable equilibrium value. D_i knows that D_j faces the same problem, who also has to form beliefs about $\tilde{q_i}$. Consequently, both downstream firms act as monopolists over the residual demand: $q_i^{\mathcal{S}}(w_i, \tilde{q_j}) = \frac{1}{2}(A(\tilde{q_j}) - w_i)$ where $A(\tilde{q_j}) = \alpha - \gamma\tilde{q_j}$. Hence, $\pi_i^{\mathcal{S}}(w_i, \tilde{q_j}) = [q_i^{\mathcal{S}}(w_i, \tilde{q_j})]^2$, and $\pi_U^{\mathcal{S}}(w_i, \tilde{q_j}) = (w_i - c)q_i^{\mathcal{S}}(w_i, \tilde{q_j}) + (w_j - c)\tilde{q_j}$. It is easy to check that second-order conditions hold.

Moving to stage 1, D_i and U, taking as given the rival contract (w_j, F_j), bargain over (w_i, F_i) to maximize the following generalized Nash bargain product:

$$[\pi_i^{\mathcal{S}}(w_i, \tilde{q_j}) - F_i]^{1-\beta}\ [\pi_U^{\mathcal{S}}(w_i, \tilde{q_j}) + F_i + F_j - d_i(\tilde{w_j}, \tilde{q_j}, \tilde{F_j})]^{\beta} \tag{3}$$

where: $d_i(\tilde{w_j}, \tilde{q_j}, \tilde{F_j}) = (\tilde{w_j} - c)\tilde{q_j} + \tilde{F_j}$ is U's non-contingent duopoly disagreement payoff. In the event of a disagreement with U, D_i is out of the market. So, its disagreement payoff is nil.[14]

As the bargaining pair (U, D_i) possess two instruments, namely the wholesale price w_i and the fixed fee F_i, its chooses the first instrument to maximize their joint surplus ex-

[12] As Rey and Verge (2004) point out, under quantity competition and secret contracts (as in this particular case), passive beliefs are equivalent to wary beliefs.

[13] Based on Brandenburger and Dekel (1993), $\tilde{w_j}$ is the "level 1" belief D_i forms for D_j's wholesale price, while $\tilde{\tilde{q_i}}$ is the "level 2" belief D_i forms for D_j's belief over D_i's equilibrium output. So, q_i depends on D_i's constant *belief* about $\tilde{q_j}$, and *not* the actual q_j (Rey and Verge, 2004).

[14] The implicit assumption here is that a breakdown in negotiations between (U, D_i) remains unobserved by (U, D_j) leading to a duopoly outside option (i.e., D_j does not adjust its output). Negotiations' breakdown are most often not covered by the NDAs and they are probably noted by the rival firms. All in all, our main results are robust to the alternative scenario where the breakdown in negotiations between (U, D_i) is observed by (U, D_j) which leads to a monopoly outside option in the form of $(\tilde{w_j} - c)q_j^m(\tilde{w_j}) + \tilde{F_j}$, where $q_j^m(\tilde{w_j}) = \frac{a - \tilde{w_j}}{2}$.

cess of the disagreement payoff, i.e., $\pi_i^{\mathcal{S}}(w_i, \tilde{q}_j) + \pi_U^{\mathcal{S}}(w_i, \tilde{q}_j) + F_j - (\tilde{w}_j - c)\tilde{q}_j - \tilde{F}_j$, and the second instrument to apportion it to the two members of the pair according to their respective bargaining powers (O'Brien and Shaffer, 1992). Maximizing (3) wrt F_i we get: $F_i^*(w_i, \tilde{w}_j, \tilde{q}_j, F_j, \tilde{F}_j) = \beta\pi_i^{\mathcal{S}}(w_i, \tilde{q}_j) - (1-\beta)(\pi_U^{\mathcal{S}}(w_i, \tilde{q}_j) + F_j - d_i(\tilde{w}_j, \tilde{q}_j, \tilde{F}_j))$. Maximizing excess joint surplus wrt w_i we get $w_i^* = c$. Substituting back to F_i^* and assuming that in equilibrium beliefs are true, i.e. $\tilde{q}_i = q_i^*$, we get the following equilibrium outcome:

$$
\begin{aligned}
w_1^{\mathcal{S}} &= w_2^{\mathcal{S}} = c \\
F_1^{\mathcal{S}} &= F_2^{\mathcal{S}} = \frac{\beta(a-c)^2}{(2+\gamma)^2} \\
q_1^{\mathcal{S}} &= q_2^{\mathcal{S}} = \frac{a-c}{2+\gamma}
\end{aligned} \tag{4}
$$

This intuitive result, which is first stated by Hart and Tirole (1988) and further analyzed by O'Brien and Shaffer (1992), McAfee and Schwartz (1994), and Rey and Verge (2004), underlines U's commitment problem. In fear of an opportunistic secret discount to its rival D_j, D_i is unable to accept any wholesale price above marginal cost. This prevents U from exerting its monopoly power even when it has full bargaining power. Further, note that the two bargaining pairs' maximization problems are independent, and marginal cost pricing is a dominant strategy for each pair.

En route to our proof, assume that universal secrecy is a candidate equilibrium. In order to arise in equilibrium, it must be renegotiation-proof: Given the rival pair's (U, D_j) equilibrium outcome $(w_j, F_j) = (c, \frac{\beta(a-c)^2}{(2+\gamma)^2})$, the (U, D_i) pair should not have incentives to renegotiate its contract terms (by deviating to interim observability). In other words, the deviation consists of pair (U, D_i) moving to interim observability, given that pair (U, D_j) sticks to secrecy. This is possible if and only if such a deviation can lead to higher net profits for at least one member of the pair. If it can not, then the candidate equilibrium is sustainable. The following Lemma summarizes our results. Its proof is in the Appendix.

Lemma 1. *Universal secrecy never arises in equilibrium.*

The intuition behind this result is the following. Let the deviation values have the superscript d. If, in stage 1, pair (U, D_i) deviates to interim observability (given that the rival pair sticks to secrecy), it sets a wholesale price below marginal cost $w_i^d < c$. U acts opportunistically by making D_i more aggressive in the product market (at the expense of D_j) and compensates this subsidization by setting a higher fixed fee $F_i^d > F_i^{\mathcal{S}}$. In stage 2, D_i produces more $q_i^d > q_i^{\mathcal{S}}$, while D_j (due to the downward-sloping reaction function) reacts by producing less $q_j^d < q_j^{\mathcal{S}}$. Yet, the aggregate output is higher $q_i^d + q_j^d > q_i^{\mathcal{S}} + q_j^{\mathcal{S}}$, since the direct effect of w_i^d to q_i^d dominates the indirect to q_j^d. Therefore, by exploiting D_j, both members of the (U, D_i) pair gain higher profits under deviation. So, universal secrecy does not arise in equilibrium. We will now move to the case of universal interim observability.

4.2 Interim observable contracts

Under interim observability, both firms observe the rivals' contract terms just after the successful ending of the stage 1's bargaining. In stage 2, D_i chooses q_i to maximize its gross profits: $\pi_i(q_i, q_j) = (\alpha - q_i - \gamma q_j - w_i)q_i$ (since fixed fees are determined in a previous stage), given the rival's output. The focs give rise to the following reaction function: $q_i(w_i, q_j) = \frac{1}{2}(\alpha - w_i - \gamma \tilde{q}_j)$. A decrease in w_i moves q_i upwards, making D_i a more aggressive competitor in the product market. Solving the system of these two reaction functions (and having in mind that in equilibrium, beliefs are true) we get the induced demands expressed in terms of wholesale prices: $q_i^{\mathcal{O}}(w_i, w_j) = \frac{\alpha(2-\gamma)-2w_i+\gamma w_j}{4-\gamma^2}$, while $\pi_i^{\mathcal{O}}(w_i, w_j) = [q_i^{\mathcal{O}}(w_i, w_j)]^2$, and $\pi_U^{\mathcal{O}}(w_i, w_j) = \sum_{i=1}^{2}(w_i - c)q_i^{\mathcal{O}}(w_i, w_j)$. It is easy to check that second-order conditions hold.

In stage 1, D_i and U, taking as given the rival's contract terms (w_j, F_j), bargain over (w_i, F_i) to maximize the following generalized Nash bargaining product:

$$[\pi_i^{\mathcal{O}}(w_i, w_j) - F_i]^{1-\beta}\ [\pi_U^{\mathcal{O}}(w_i, w_j) + F_i + F_j - d_i(\tilde{\tilde{w}}_i, \tilde{w}_j, \tilde{F}_j)]^{\beta} \tag{5}$$

where: $d_i(\tilde{\tilde{w}}_i, \tilde{w}_j, \tilde{F}_j) = (\tilde{w}_j - c)q_j(\tilde{\tilde{w}}_i, \tilde{w}_j) + \tilde{F}_j$ is U's non-contingent duopoly disagreement payoff.[15] Again, D_i's disagreement payoff is nil.

Following a similar two-step procedure as in the previous case, the (U, D_i) pair uses w_i to maximize its joint profits (excess of the disagreement payoff), i.e., $\pi_i^{\mathcal{O}}(w_i, w_j) + \pi_U^{\mathcal{O}}(w_i, w_j) + F_j - (\tilde{w}_j - c)q_j(\tilde{\tilde{w}}_i, \tilde{w}_j) - \tilde{F}_j$, and F_i to apportion the maximized "pie" to each party according to its respective bargaining power β and $1 - \beta$. Maximizing (5) wrt F_i we get: $F_i^*(w_i, w_j) = \beta\pi_i^{\mathcal{O}}(w_i, w_j) - (1-\beta)(\pi_U^{\mathcal{O}}(w_i, w_j) + F_j - d_i(\tilde{\tilde{w}}_i, \tilde{w}_j, \tilde{F}_j))$. Solving the system of reaction functions $w_i(w_j)$ resulting from the first step of this procedure and substituting back to F_i and q_i we get the following equilibrium values:

$$\begin{aligned}
w_1^{\mathcal{O}} &= w_2^{\mathcal{O}} = c - \frac{\gamma^2(a-c)}{2(2-\gamma^2)} \\
F_1^{\mathcal{O}} &= F_2^{\mathcal{O}} = \frac{(2-\gamma)[\gamma^2 + \beta(2-\gamma-\gamma^2)](a-c)}{4(2-\gamma^2)^2} \\
q_1^{\mathcal{O}} &= q_2^{\mathcal{O}} = \frac{(2-\gamma)(a-c)}{2(2-\gamma^2)}
\end{aligned} \tag{6}$$

[15]Note that $\tilde{\tilde{w}}_i$ is constant and states what D_i believes that D_j believes on D_i's wholesale price in equilibrium.

Note that $w_i^{\mathcal{O}} < c$ since under interim observable contracts, U's commitment problem is more severe compared to secret contracts. Under interim observability, U has incentives to secretly agree on a wholesale price below marginal cost to make D_i more aggressive in the product market. Then, it can outweigh its losses from input subsidization by charging a higher fixed fee F_i. This strategic effect is absent under secrecy – since the two maximization problems are independent and marginal cost pricing is a dominant strategy for both D_is – in which case U has no incentives to agree to any wholesale price below marginal cost. In this sense, U's opportunistic behavior is more pronounced under interim observable than under secret contracts. D_j anticipating this, it will only accept a wholesale price below marginal cost.

Let universal interim observability be a candidate equilibrium. To show whether it is a sustainable equilibrium (renegotiation-proof), we follow the same reasoning as above. The following Lemma summarizes the results of this disclosure regime. Its proof is in the Appendix.

Lemma 2. *Universal interim observability always arises in equilibrium.*

The intuition is as follows. Assume that pair (U, D_i) deviates to secrecy (given that the rival pair (U, D_j) sticks to interim observability). For reasons explained in the previous subsection, the wholesale price goes up to marginal cost pricing $w_i^d = c > w_i^{\mathcal{O}}$, making D_i to produce less $q_i^d < q_i^{\mathcal{O}}$ and pay a decreased fixed fee $F_i^d < F_i^{\mathcal{O}}$. Due to its downward-sloping reaction function, D_j produces more $q_j^d > q_j^{\mathcal{O}}$. However, aggregate output is reduced $q_i^d + q_j^d < q_i^{\mathcal{O}} + q_j^{\mathcal{O}}$, since the direct effect dominates. Therefore, U's deviation profits are reduced compared to the ones in the candidate equilibrium. So, U would never accept such deviation, and without its signature in the NDA, a deviation to secrecy is not possible.

We will now move to hybrid case where one pair bargains over secrecy while the other pair bargains over interim observability.

4.3 Hybrid contracts

Without loss of generality, assume that U bargains with D_j under secrecy, and with D_i under interim observability. In Stage 2, the two focs give rise to the following reaction functions:

$$q_i^{\mathcal{H}}(w_i, q_j) = \frac{1}{2}(\alpha - w_i - \gamma q_j)$$
$$q_j^{\mathcal{H}}(w_j, \tilde{q}_i) = \frac{1}{2}(\alpha - w_j - \gamma \tilde{q}_i)$$

D_i observes D_j's contract terms, so it can react optimally. Yet, D_j cannot observe D_i's contract terms, so it has to form passive beliefs in the form of $\tilde{q}_i$.

In Stage 1, the two generalized (asymmetric) Nash bargaining products are:

$$[\pi_i^{\mathcal{H}}(w_i,w_j)-F_i]^{1-\beta}[\pi_U^{\mathcal{H}}(w_i,w_j)+F_i+F_j-(\tilde{w}_j-c)q_j(\tilde{\tilde{w}}_i,\tilde{w}_j)-\tilde{F}_j]^{\beta}$$
$$[\pi_j^{\mathcal{H}}(w_j,\tilde{q}_i)-F_j]^{1-\beta}[\pi_U^{\mathcal{H}}(w_j,\tilde{q}_i)+F_i+F_j-(\tilde{w}_i-c)\tilde{q}_i-\tilde{F}_i]^{\beta}$$

where: $\pi_i^{\mathcal{H}}(w_i,w_j)$ and $\pi_U^{\mathcal{H}}(w_i,w_j)$ as in the universal interim observability regime, while $\pi_j^{\mathcal{H}}(w_j,\tilde{q}_i)$ and $\pi_U^{\mathcal{H}}(w_j,\tilde{q}_i)$ as in the universal secrecy regime. Following the standard two-step procedure described above, we get the following equilibrium values:

$$\begin{aligned}
w_1^{\mathcal{H}} &= c-\frac{\gamma^2(2-\gamma)(a-c)}{4(2-\gamma^2)}\\
w_2^{\mathcal{H}} &= c\\
F_1^{\mathcal{H}} &= \frac{(2-\gamma)^2[2\beta+\gamma^2(1-\beta)](a-c)^2}{8(2-\gamma^2)^2}\\
F_2^{\mathcal{H}} &= \frac{\beta[4-\gamma(2-\gamma)]^2(a-c)^2}{16(2-\gamma^2)^2}\\
q_1^{\mathcal{H}} &= \frac{(2-\gamma)(a-c)}{2(2-\gamma^2)}\\
q_2^{\mathcal{H}} &= \frac{(4-\gamma(2+\gamma))(a-c)}{4(2-\gamma^2)}
\end{aligned}\tag{7}$$

Note that $w_1^{\mathcal{H}}<w_2^{\mathcal{H}}$. Since (U,D_i) bargain over interim observability, it ends up with a wholesale price below marginal cost for the reasons described in the relevant universal disclosure regime. Similarly, (U,D_j) who bargain over secrecy end up with marginal cost pricing.

Let the hybrid regime be a candidate equilibrium. To show that it arises in equilibrium, we must prove that it is renegotiation-proof. Note that there are two different deviations: (i) (U,D_j) deviating to interim observability, given that the rival pair sticks to interim observability, and (ii) (U,D_i) deviating to secrecy, given that the rival pair sticks to secrecy. In both deviations we move from disclosure asymmetry to disclosure symmetry. Therefore, their analysis and intuition is not far from the two universal disclosure regimes described in detail above. The following Lemma summarizes the results of this disclosure regime. Its proof is in the Appendix.

Lemma 3. *The hybrid regime never arises in equilibrium.*

In the first case, where (U,D_j) deviates to interim observability, given that (U,D_i) sticks to interim observability, we end up with equilibrium values equal to (6). D_j accepts a deviation wholesale price below marginal cost at the expense of a higher deviation fixed fee.

This leads to an increased deviation output, and (since direct effect dominates) to a higher deviation aggregate output. Both members of the bargaining pair are in favor of such a deviation, therefore this renegotiation is possible.

In the second case, where (U, D_i) deviates to secrecy, given that (U, D_j) sticks to secrecy, we end up with deviation equilibrium values equal to (4). D_i accepts a higher deviation wholesale price (equal to marginal cost) to gain a lower deviation fixed fee. This leads to lower output and net profits. Since direct effect dominates, D_j's Cournot-style response is positive, albeit weaker, therefore aggregate output decreases in deviation. This situation is unfavorable for both members of the bargaining pair. Since it takes two to sign the NDA, this renegotiation is never possible.

Since in at least one deviation firms have incentives to renegotiate, the hybrid regime cannot arise in equilibrium.

4.4 Equilibrium disclosure regime

The following Proposition 1 summarizes our previous results.

Proposition 1. *Under Cournot competition, upstream bottleneck and two-part tariffs, universal interim observability is the unique equilibrium disclosure regime.*

Proposition 1 derives naturally from Lemmas 1, 2, and 3. In particular, in Lemma 2 we show that no firm ever has incentives to deviate from universal interim observability regime. So, this disclosure regime arises in equilibrium for all β's and γ's. And second, in Lemmas 1 and 3 we show that firms always have incentives to deviate from the other two disclosure regimes (i.e., secret and hybrid). So, universal interim observability is the sole sustainable equilibrium under all constellations of model parameters.

4.5 Welfare analysis

In this section, we discuss the welfare implications of the alternative disclosure regimes. Consumer surplus is equal to $CS = 1/2(q_1^2 + q_2^2 + 2\gamma q_1 q_2)$.[16] Producer surplus PS is equal to the sum of net profits of downstream firms and the upstream supplier. And total welfare TW is equal to the sum of CS and PS. The following Proposition summarizes our results. Its proof is in the Appendix.

Proposition 2. *Under Cournot competition and upstream bottleneck, the maximum CS is attained under universal interim observability.*

[16] We obtain CS by substituting $p_i = a - q_i - \gamma q_j$ into $u(q_i, q_j) - p_i q_i - p_j q_j$.

Proposition 2 states that the universal interim observability regime maximizes consumer surplus and total welfare. The intuition behind this result is straightforward. Under universal interim observability both wholesale prices are below marginal cost, while under universal secrecy are equal to marginal cost. Under the hybrid regime there is a mixed situation where one wholesale price is above and the other below marginal cost. This is related to U's commitment problem. Consequently, aggregate output under universal interim observability is higher compared to universal secrecy, with the hybrid regime standing in the middle. Since consumer surplus is positively related with aggregate output, it is easy to see that consumer surplus under universal interim observability should be the biggest out of the three. Interestingly, due to the market expansion effect, producer surplus increases with lower wholesale prices, leading to an overall increase in total welfare.

Therefore, under two-part tariffs universal interim observability does not only emerge as a unique equilibrium but it is also desirable from a social point of view.

5 Extensions

In this section we will discuss a few extensions of our main model to highlight the robustness of our findings. In particular, we will consider: (i) the case where firms bargain over linear tariffs, (ii) the case where each downstream firm is exclusively supplied by a single upstream supplier, and finally (iii) the case of Bertrand competition in the product market.

5.1 Linear tariffs

We will now move to the case where both vertical pairs trade with linear tariffs. In this case, the gross profits reported in (1) are equal to net profits, i.e., $\pi_i \equiv \Pi_i$, and $\pi_U \equiv \Pi_U$ since there are no fixed fees. Keeping all other specifications and timing as in the main model, stage 2 is the same as under two-part tariffs. Therefore, the respective equilibrium values per disclosure regime also hold here. Moving to stage 1, bargaining pairs solve the following generalized Nash products:

$$[(p_i(\cdot) - w_i)q_i(\cdot)]^{1-\beta}[(w_1 - c)q_1(\cdot) + (w_2 - c)q_2(\cdot) - (\tilde{w}_j - c)\tilde{q}_j(\cdot)]^{\beta} \tag{8}$$

Following a similar reasoning as in the main model, under universal interim observability: $p_i(\cdot) = p_i(w_i, w_j)$, $q_i(\cdot) = q_i(w_i, w_j)$, and $\tilde{q}_j(\cdot) = q_j(\tilde{\tilde{w}}_i, \tilde{w}_j)$. Under universal secrecy: $p_i(\cdot) = p_i(w_i, \tilde{q}_j)$, $q_i(\cdot) = q_i(w_i, \tilde{q}_j)$, and $\tilde{q}_j(\cdot) = \tilde{q}_j$. And under the hybrid regime: $p_i(\cdot) \equiv p_i(w_i, w_j)$, $q_i(\cdot) \equiv q_i(w_i, w_j)$, and $\tilde{q}_j(\cdot) \equiv q_j(\tilde{\tilde{w}}_i, \tilde{w}_j)$; while $p_j(\cdot) \equiv p_j(w_j, \tilde{q}_i)$, $q_j(\cdot) \equiv q_j(w_j, \tilde{q}_i)$, and $\tilde{q}_i(\cdot) \equiv \tilde{q}_i$.

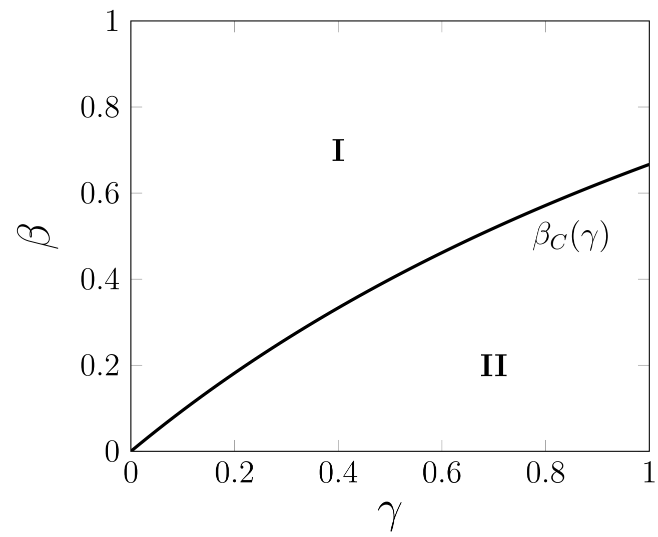

Figure 2: *Equilibria under Cournot competition, linear tariffs, and an upstream monopolist. Areas I & II: Universal interim observability (unique). Line $\beta = \beta_C(\gamma)$: Multiple equilibria.*

Bargaining pairs choose wholesale price to maximize (8) given the specifications of each disclosure regime. The focs give rise to the equilibrium outcome stated in the Appendix. The following Proposition 3 summarizes the equilibrium configuration of the disclosure regimes, while Figure 2 depicts them. Its proof is in the Appendix.

Proposition 3. *Under Cournot competition, upstream bottleneck and linear tariffs:*

(i)The universal interim observability regime is the unique equilibrium if and only if $\beta \neq \beta_C(\gamma)$, where $\beta_C(\gamma) = \frac{2\gamma}{2+\gamma}$.

(ii) For $\beta = \beta_C(\gamma)$ there are multiple equilibria: the universal interim observability, the universal secrecy and the hybrid regime all are equilibria.

Proposition 3 inform us that the universal interim observability regime is always an equilibrium, albeit it is unique if and only if $\beta \neq \beta_C(\gamma) = \frac{2\gamma}{2+\gamma}$. For $\beta = \beta_C(\gamma)$, all three disclosure regimes are equilibria. In this case, ex-ante symmetric firms may end up in a hybrid regime equilibrium turning to be ex-post asymmetric regarding vertical contract terms, market shares, and profits.

The intuition behind this result is as follows. Remember that under linear tariffs, wholesale prices are always above marginal cost since there is no second instrument to compensate a subsidization of the upstream supplier to its downstream retailers.

Universal interim observability arises in equilibrium for different reasons compared to the two-part tariffs case of the main model. As Figure 2 depicts, when U's bargaining power is "relatively high" compared to product differentiation (i.e., Area I where $\beta > \beta_C(\gamma)$) the downstream firms have no incentives to deviate to secrecy as they are afraid of their exploitation from a "relatively strong" upstream supplier. A deviation to secrecy would increase wholesale prices $w_i^d > w_i^{\mathcal{LO}}$ and decrease output, leading to lower equilibrium net profits for the deviating downstream firm $\pi_i^d < \pi_i^{\mathcal{LO}}$. However, in this area U's net profits increase with deviation, making it a favorable move. Since "it takes two to tango" (i.e., we need both to sign the NDA), for $\beta > \beta_C(\gamma)$ a deviation to secrecy is not possible.

However, when U's bargaining power is "relatively low" compared to product differentiation (i.e., Area II where $\beta < \beta_C(\gamma)$, see Figure 2), U has no incentives to deviate to secrecy since the deviation wholesale prices fall below the equilibrium ones $w_i^d < w_i^{\mathcal{LO}}$, leading to lower deviation net upstream profits $\pi_U^d < \pi_U^{\mathcal{LO}}$. Its low bargaining power does not allow U to set a high wholesale price to enjoy significant part of the downstream profits. Hence, in this region, D_i's net profits increase with deviation. Again, since the deviation is not beneficial for both members of the bargaining pair it as not a possible one.

A similar reasoning applies also in the case of universal secrecy. For $\beta > \beta_C(\gamma)$, deviation wholesale price is above its equilibrium value $w_i^d > w_i^{\mathcal{LS}}$. This increases upstream's deviation net profits, giving U the incentives to deviate (Remember that it takes at least one to deviate from secrecy to interim observability). On the other hand, for $\beta < \beta_C(\gamma)$ we get $q_i^d > q_i^{\mathcal{LS}}$ which increases downstream net profits offering D_i incentives to deviate.

Interestingly, for $\beta = \beta_C(\gamma)$ deviation net profits equal the equilibrium ones for both members of the bargaining pair. Therefore, none has incentives to deviate, making universal secrecy an equilibrium disclosure regime on the line $\beta = \beta_C(\gamma)$.

Lastly, consider the hybrid regime case. As in the main model, we consider two deviations: (i) pair (U, D_i) deviating to secrecy given that the rival pair sticks to secrecy, and (ii) pair (U, D_j) deviating to interim observability given that the rival pair sticks to interim observability. Consider deviation (i). Following a similar reasoning as in the universal interim observability regime, the downstream firm has incentives to deviate to secrecy (sign an NDA) for $\beta < \beta_C(\gamma)$, while the upstream firm has such incentives for $\beta > \beta_C(\gamma)$. Since "it takes two to tango", deviation (i) would never happen. On the other hand, a deviation from secrecy to interim observability need only one member of the pair not to sign the NDA, so deviation (ii) could happen exactly for $\beta = \beta_C(\gamma)$. Since one of the two possible deviations of the hybrid regime is not possible, the hybrid regime arises in equilibrium only for $\beta = \beta_C(\gamma)$.

Finally, our welfare analysis indicates that $CS^{\mathcal{LS}} < CS^{\mathcal{LH}}$ and $TW^{\mathcal{LS}} < TW^{\mathcal{LH}}$ for all βs and γs. However $CS^{\mathcal{LO}} < CS^{\mathcal{LS}}$ and $TW^{\mathcal{LO}} < TW^{\mathcal{LS}}$ if and only if $\beta < \beta_C(\gamma)$. Note that $CS^{\mathcal{LO}} < CS^{\mathcal{LH}}$ and $TW^{\mathcal{LO}} < TW^{\mathcal{LH}}$ for all β's and γ's. The equilibrium values are stated in the Appendix. Hence, given Proposition 2, the contract type does not play any role on the attainment of the maximum welfare.

5.2 Competing vertical chains

Consider the case where each D_i is exclusively supplied by a dedicated U_i. This forms two competing vertical chains $(U_i, D_i), i = 1, 2$. Besides the profound lack of the upstream bottleneck, in this setup there is another difference. A single upstream monopolist (as in the main model) views downstream competition as intra-brand, having incentives to facilitate downstream collusion. On the other hand, an exclusive supplier views downstream competition as inter-brand, having incentives to hinder downstream collusion. Note that the upstream firms' gross profits now are: $\pi_{U_i}(q_1, q_2) = (w_i - c)q_i, i = 1, 2$. Stage 2 is the same as in the main model. However, in stage 1 the generalized Nash bargaining product now is: $[(p_i - w_i)q_i - F_i]^{1-\beta}[(w_i - c)q_i + F_i]^{\beta}$ under two-part tariffs (For linear tariffs, $F_i \equiv 0$). Obviously, an exclusive upstream supplier U_i is locked-in with its respective downstream firm D_i. Therefore, U_i's outside option is nil. All other specifications and timing remain the same as in the main model. The equilibrium outcomes are reported in the Appendix. The following Proposition summarizes our findings. Its proof is in the Appendix.

Proposition 4. *Under competing vertical chains and Cournot competition, the universal interim observability is the unique equilibrium under both two-part tariffs and linear contracts.*

Consider the case of two-part tariffs which is denoted by the superscript $\mathcal{EX}, X = \{O, S, H\}$. Under universal secrecy, the equilibrium outcome of competing vertical chains is the same as in the case of an upstream monopolist. This result underlines the effect of no disclosure in the market outcome. Since the downstream firms do not observe rival contract terms before they decide on their outputs, they are unable to strategically use the vertical contract to influence the upstream supplier to their favor. This lack of strategic manipulation works on the other way as well. Since it can not use the vertical contract to ease downstream competition, the upstream supplier is condemned to treat its downstream partner as part of a separate vertical chain.

This is not the case under interim observable contracts. The inter-brand competition faced by the competing vertical chains intensifies downstream competition only when the downstream firms can observe rival choices before making their own and respond strategically.

Under hybrid contracts, we consider two possible deviations: (i) pair (U_i, D_i) deviating to secrecy given that the rival pair (U_j, D_j) sticks to secrecy, and (ii) pair (U_j, D_j) deviating to interim observability given that the rival pair (U_i, D_i) sticks to interim observability. Deviation (i) is desirable for both members of the vertical chain (since it increases their net profits), while deviation (ii) is undesirable for both members of the vertical chain (since it decreases their net profits). Therefore, in this configuration and due to deviation (i), the hybrid regime could not arise in equilibrium.

Now, consider the case of linear tariffs, which is denoted by the superscript $\mathcal{WX}, X = \{O, S, H\}$. Under universal secrecy, a deviation to interim observability leads to lower wholesale price and higher output for the deviating downstream firm. In turn, these two increase its net deviation profitability. So, a deviation to interim observability is always preferable from D_is point of view, which is enough to make universal secrecy a non-sustainable equilibrium. Under universal interim observability it holds exactly the opposite: a deviation to secrecy leads to a wholesale price increase which in turn is making deviation output to decrease. Since "it takes two to tango", D_i would never prefer such a deviation, making universal interim observability a sustainable equilibrium for all βs and γs. In the hybrid regime we get two possible deviations: (i) the pair under interim observability to deviate to secrecy, given that the other pair sticks to secrecy, and (ii) the pair under secrecy to deviate to interim observability given that the other pair sticks to interim observability. Consider deviation (i). This would increase deviation wholesale prices and decrease deviation output for the downstream firm, leading to less net deviation profits. So, it never has incentives to deviate. Now, let us consider deviation (ii). For the opposite reasons compared to (i), the downstream firm always has incentives to deviate to interim observability. Therefore, in this extension, the hybrid regime could not arise in equilibrium.

Finally, our welfare analysis indicates that the following inequalities hold: $X^{\mathcal{WS}} < X^{\mathcal{WH}} < X^{\mathcal{WO}} < X^{\mathcal{ES}} < X^{\mathcal{EH}} < X^{\mathcal{EO}}, X = \{CS, TW\}$ for all β's and γ's. Under competing vertical chains, the maximum CS and TW are attained under two-part tariffs and universal interim observability (where wholesale prices are below marginal cost and output is larger compared to the other configurations), while the minimum CS and TW are attained under linear tariffs and universal secrecy. Given Proposition 2 and the welfare analysis of the previous extension 5.1, we conclude that neither the structure of the upstream market nor the contract type play any role on the attainment of the maximum welfare. No matter linear or two-part tariffs, and common or exclusive upstream supplier(s), the maximum consumer surplus and total welfare are obtained under universal interim observability.

5.3 Bertrand competition

Consider the case where downstream firms compete in prices in the final market. All other specifications are as in the main model hold. By inverting the (symmetric inverse) demand functions $p_i(q_1, q_2) = a - q_i - \gamma q_j, i = 1, 2 \neq j$, we get $q_i(p_1, p_2) = \frac{a(q-\gamma)-p_i+\gamma p_j}{1-\gamma^2}$, where $a > c > 0$, and $\gamma \in (0, 1)$. Firms' gross profits now are: $\pi_i(p_1, p_2) = (p_i - c)q_i(p_1, p_2)$, and $\pi_U(p_1, p_2) = \sum_{i=1}^{2}(w_i - c)q_i(p_1, p_2)$. As in the main model, gross equal net profits only when firms trade over linear tariffs. However, when firms trade over two-part tariffs, net

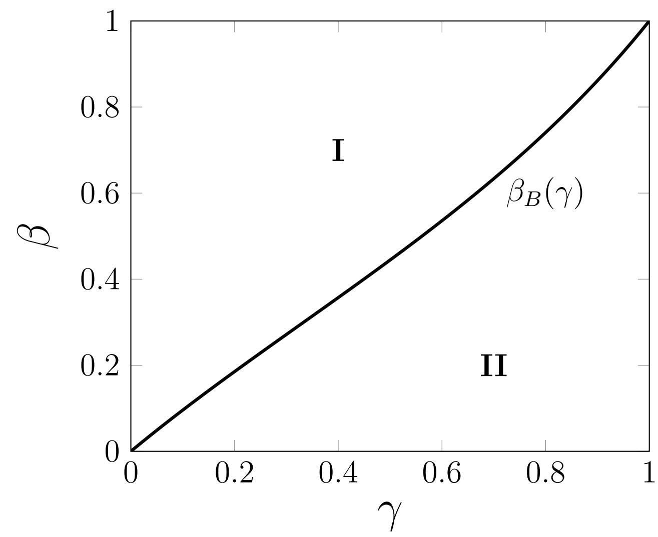

Figure 3: *Equilibria under Bertrand competition, linear tariffs, and an upstream monopolist. Areas I & II: Universal interim observability (unique). Line $\beta = \beta_B(\gamma)$: Multiple equilibria.*

profits are: $\pi_i(p_1, p_2) - F_i$, and $\pi_U(p_1, p_2) + F_1 + F_2$ respectively. Maximizing gross profits over prices, and following a similar procedure as in the main model, we get the equilibrium outcome stated in the Appendix.[17] The following Proposition summarizes our findings. Its proof is in the Appendix. Figure 3 depicts the situation arising under linear tariffs,

Proposition 5. *Under Bertrand competition and:*

(i) an upstream monopolist trading over two-part tariffs, the universal interim observability regime is the unique equilibrium.

(ii) an upstream monopolist trading over linear tariffs, for $\beta \neq \beta_B(\gamma) = \frac{2\gamma}{2+\gamma-\gamma^2}$ the universal interim observability regime is the unique equilibrium; while for $\beta = \beta_B(\gamma)$ there are multiple equilibria: all three disclosure regimes may arise in equilibrium.

(iii) competing vertical chains, the universal interim observability regime is the unique equilibrium under both linear and two-part tariffs.

Proposition 5 suggests that the mode of the downstream competition does not qualitatively alter the equilibrium results. What seems to matter is the contract type which may lead to multiplicity of equilibria. Consider Figure 3. As in the Cournot competition case, when U's bargaining power is "relatively high" compared to product differentiation (i.e., Area I where $\beta > \beta_B(\gamma) = \frac{2\gamma}{2+\gamma-\gamma^2}$), the downstream firms have no incentives to deviate to secrecy as they are afraid of their exploitation from a "relatively strong" U. A deviation to secrecy

[17]Superscript $\mathcal{BX}$ denotes a common upstream firm and two-part tariffs, $\mathcal{BLX}$ denotes a common upstream firm and linear tariffs, $\mathcal{BEX}$ competing vertical chains and two-part tariffs, while $\mathcal{BWX}$ competing vertical chains and linear tariffs, where: $X = \{O, S, H\}$.

would increase wholesale prices and decrease output, leading to lower equilibrium net profits for the deviating downstream firm. However, when β is "relatively low" (i.e., Area II where $\beta < \beta_B(\gamma)$), U has no incentives to deviate to secrecy since the deviation wholesale prices fall below the equilibrium ones leading to lower deviation net upstream profits. So, the deviation is not favorable for anyone of the members of the bargaining pair.

Our welfare analysis indicates that under Bertrand competition and a common upstream supplier the following inequalities hold: $CS^{\mathcal{BLO}} < CS^{\mathcal{BLS}} < CS^{\mathcal{BS}}$ for all β's and γ's, and $CS^{\mathcal{BLO}} < CS^{\mathcal{BLH}} < CS^{\mathcal{BLS}}$ if and only if $\beta < \beta_B(\gamma) = \frac{2\gamma}{2+\gamma-\gamma^2}$, and $CS^{\mathcal{BO}} < CS^{\mathcal{BH}} < CS^{\mathcal{BS}}$, while $CS^{\mathcal{BO}} < CS^{\mathcal{BLS}} < CS^{\mathcal{BS}}$ if and only if $\gamma > 0.8685$.

Similarly, under Bertrand competition and competing vertical chains: $CS^{\mathcal{BWO}} < CS^{\mathcal{BWH}} < CS^{\mathcal{BWS}} < CS^{\mathcal{BES}}$ for all β's and γ's, and $CS^{\mathcal{BEO}} < CS^{\mathcal{BEH}}$ if and only if $\beta > 0.2139$, and $CS^{\mathcal{BEH}} < CS^{\mathcal{BES}}$ if and only if $\beta > 0.3046$. Under Bertrand competition and a common upstream firm, maximum CS is attained under two-part tariffs and universal secrecy. If $\beta < \beta_B(\gamma) = \frac{2\gamma}{2+\gamma-\gamma^2}$ (resp. $\beta > \beta_B(\gamma)$), minimum CS is attained under linear tariffs and universal interim observability (resp. hybrid regime). Under Bertrand competition and competing vertical chains and for $\beta > 0.3046$ (resp. $\beta < 0.3046$), hybrid regime (resp. universal secrecy) could generate the highest CS. The minimum CS is attained for linear tariffs and universal interim observability.

6 Concluding Remarks

We consider a two-tier industry where an upstream monopolist supplies two downstream firms and vertical trading is over two-part tariffs. Our aim is to endogenize involved firms' decision to sign (or not) a Non-Disclosure Agreement (NDA). NDAs are important pre-contractual arrangements, and in most of jurisdictions are not cheap talk. When both members of the vertical bargaining pair sign the NDA their contract terms remain secret. Else, if at least one member decides not to sign the NDA, contract terms become interim observable.

Our motivation is to resolve a dichotomy in the relevant literature: some researchers assume secrecy and others interim observability of contract terms, neither of them with solid justification. We assume three disclosure regimes: universal interim observability (all vertical pairs sign NDAs), universal secrecy (no vertical pair sign an NDA) and the hybrid regime (only some vertical pairs sign NDAs).

Our results indicate the following. The universal interim observability regime is the unique equilibrium in the presence of re-negotiations since no member of the vertical pair has incentives to deviate from it. In particular, a deviation would increase the wholesale price for the downstream firm, and decrease aggregate output for the upstream monopolist.

To check the robustness of our findings, we consider several extensions. First, the case of vertical trading over linear tariffs. The universal interim observability still arises in equilibrium but it is not anymore unique. For very particular values of bargaining power and product differentiation, all three disclosure regimes may arise in equilibrium. Therefore, in case of the hybrid regime arises, ex ante symmetric firms may end up to be ex post asymmetric. We thus indicate that the contract type could be an important factor shaping the equilibrium disclosure regime. Second, the case of competing vertical chains. Our analysis indicates that the universal interim observability is the unique equilibrium no matter the contract type. Therefore, this extension is in line with the main model under two-part tariffs, but partially in contrast to the linear tariffs case. We thus indicate that the structure of the upstream market may affect the equilibrium disclosure regime. Third, the case of Bertrand competition in the downstream market. The results are similar to those in the main model (under both two-part or linear tariffs) with only one difference: The narrow locus where we encounter multiple equilibria is quantitatively (but not qualitatively) different. Therefore, we indicate that the mode of downstream competition does not qualitatively affect the equilibrium disclosure regime.

Our welfare analysis indicates that the universal interim observability and two-part tariffs is a combination that leads to the highest consumer surplus and total welfare. This holds in all of our extensions too. Linear tariffs lead to the lowest consumer surplus and total welfare. However, the disclosure regime under which this happens varies across the extensions of our main model. Hence policymakers should push for further observability of contract temrs since this could increase welfare no matter the contract type, the mode or the intensity of downstream competition, and the distribution of bargaining power.

As a suggestion for future research, it would be interesting to discover the reasons why in some markets universal secrecy arises in equilibrium. Is it because the bargaining power distribution and market parameters allow for multiple equilibria, or is it due to other reasons? This would be nice to be backed by empirical data.

7 Appendix

7.1 Equilibrium outcome under linear tariffs

A. Universal secrecy

$$w_1^{\mathcal{LS}} = w_2^{\mathcal{LS}} = c + \frac{2\beta(a-c)}{4+\gamma(2-\beta)}$$

$$q_1^{\mathcal{LS}} = q_2^{\mathcal{LS}} = \frac{(2-\beta)(a-c)}{4+\gamma(2-\beta)}$$

B. Universal interim observability

$$w_1^{\mathcal{LO}} = w_2^{\mathcal{LO}} = c + \frac{\beta(2-\gamma)(a-c)}{4+2\beta\gamma}$$
$$q_1^{\mathcal{LO}} = q_2^{\mathcal{LO}} = \frac{[4-\beta(2+\gamma)](a-c)}{2(2+\gamma)(2-\beta\gamma)}$$

C. Hybrid regime

$$w_1^{\mathcal{LH}} = c + \frac{\beta(2-\gamma)[8-2\gamma^2+\beta\gamma(4+\gamma)](a-c)}{32-4\gamma^2[2-\beta(1-\beta)]}$$
$$w_2^{\mathcal{LH}} = c + \frac{\beta(2-\gamma)(4+\beta\gamma)(a-c)}{16-2\gamma^2[2-\beta(1-\beta)]}$$
$$q_1^{\mathcal{LH}} = \frac{(2(2-\beta)-(2-(2-\beta)\beta)\gamma)(a-c)}{8-\gamma^2[2-\beta(1-\beta)]}$$
$$q_2^{\mathcal{LH}} = \frac{(2-\beta)(2-\gamma)(4+\beta\gamma)(a-c)}{32-4\gamma^2[2-\beta(1-\beta)]}$$

D. Welfare analysis

$$CS^{\mathcal{LS}} = \frac{(1+\gamma)(2-\beta)^2(a-c)^2}{(4+\gamma(2-\beta))^2}$$
$$CS^{\mathcal{LO}} = \frac{(1+\gamma)[4-\beta(2+\gamma)]^2(a-c)^2}{4(2+\gamma)^2(2-\beta\gamma)^2}$$
$$CS^{\mathcal{LH}} = \frac{(a-c)^2}{32(8-\gamma^2(2-\beta(1-\beta)))^2}[128(2-\beta)^2+32\beta\gamma(2-\beta)(4-3\beta)+ \\ +4(-96+\beta(112+\beta(-40+\beta(-4+5\beta))))\gamma^2+4(2-\beta)^3(4-3\beta)\gamma^3+ \\ +(2-\beta)\beta(16-7(2-\beta)\beta)\gamma^4]$$
$$TW^{\mathcal{LS}} = \frac{(2-\beta)[2(3+\gamma)+\beta(1+\gamma)](a-c)^2}{(4+\gamma(2-\beta))^2}$$
$$TW^{\mathcal{LO}} = \frac{(4-\beta(2+\gamma))[4(3+\gamma)+\beta(2+\gamma)(1-3\gamma)](a-c)^2}{4(2+\gamma)^2(2-\beta\gamma)^2}$$
$$TW^{\mathcal{LH}} = \frac{(a-c)^2}{32(8-\gamma^2(2-\beta(1-\beta)))^2}[128(2-\gamma)^2(3+\gamma)-\beta^4\gamma^2(20-(36-\gamma)\gamma)- \\ -32\beta(2-\gamma)(8-\gamma(8+3\gamma))-4\beta^3\gamma(24+\gamma(-36+\gamma(22+\gamma)))- \\ -4\beta^2(32+\gamma(16+\gamma(40-\gamma(28+3\gamma))))]$$

7.2 Equilibrium outcomes: Competing vertical chains

7.2.1 Two-part tariffs

A. Universal secrecy

$$
\begin{aligned}
w_1^{\mathcal{ES}} &= w_2^{\mathcal{ES}} = c \\
F_1^{\mathcal{ES}} &= F_2^{\mathcal{ES}} = \frac{\beta(a-c)^2}{(2+\gamma)^2} \\
q_1^{\mathcal{ES}} &= q_2^{\mathcal{ES}} = \frac{a-c}{2+\gamma}
\end{aligned}
$$

B. Universal interim observability

$$
\begin{aligned}
w_1^{\mathcal{EO}} &= w_2^{\mathcal{EO}} = c + \frac{\gamma^2(a-c)}{4+\gamma(2-\gamma)} \\
F_1^{\mathcal{EO}} &= F_2^{\mathcal{EO}} = \frac{2[2\beta+\gamma^2(1-\beta)](a-c)^2}{(4+\gamma(2-\gamma))^2} \\
q_1^{\mathcal{EO}} &= q_2^{\mathcal{EO}} = \frac{2(a-c)}{4+\gamma(2-\gamma)}
\end{aligned}
$$

C. Hybrid regime

$$
\begin{aligned}
w_1^{\mathcal{EH}} &= c - \frac{\gamma^2(2-\gamma)(a-c)}{4(2-\gamma^2)} \\
w_2^{\mathcal{EH}} &= c \\
F_1^{\mathcal{EH}} &= \frac{(2-\gamma)^2[2\beta+\gamma^2(1-\beta)](a-c)^2}{8(2-\gamma^2)^2} \\
F_2^{\mathcal{EH}} &= \frac{\beta[4-\gamma(2-\gamma)]^2(a-c)^2}{16(2-\gamma^2)^2} \\
q_1^{\mathcal{EH}} &= \frac{(2-\gamma)(a-c)}{2(2-\gamma^2)} \\
q_2^{\mathcal{EH}} &= \frac{(4-\gamma(2+\gamma))(a-c)}{4(2-\gamma^2)}
\end{aligned}
$$

D. Welfare analysis

$$
\begin{aligned}
CS^{\mathcal{ES}} &= \frac{(1+\gamma)(a-c)^2}{(2+\gamma)^2} \\
CS^{\mathcal{EO}} &= \frac{4(1+\gamma)(a-c)^2}{(4+\gamma(2-\gamma))^2}
\end{aligned}
$$

$$
\begin{aligned}
CS^{\mathcal{EH}} &= \frac{[32-\gamma^2(32-\gamma(4+5\gamma))](a-c)^2}{32(2-\gamma^2)^2} \\
TW^{\mathcal{ES}} &= \frac{(3+\gamma)(a-c)^2}{(2+\gamma)^2} \\
TW^{\mathcal{EO}} &= \frac{4(3+\gamma(1-\gamma))(a-c)^2}{(4+\gamma(2-\gamma))^2} \\
TW^{\mathcal{EH}} &= \frac{[96-\gamma(64+\gamma(48-\gamma(28+3\gamma)))](a-c)^2}{32(2-\gamma^2)^2}
\end{aligned}
$$

7.2.2 Linear tariffs

A. Universal secrecy

$$
\begin{aligned}
w_1^{\mathcal{WS}} = w_2^{\mathcal{WS}} &= c + \frac{2\beta(a-c)}{4+\gamma(2-\beta)} \\
q_1^{\mathcal{WS}} = q_2^{\mathcal{WS}} &= \frac{(2-\beta)(a-c)}{4+\gamma(2-\beta)}
\end{aligned}
$$

B. Universal interim observability

$$
\begin{aligned}
w_1^{\mathcal{WO}} = w_2^{\mathcal{WO}} &= c + \frac{\beta(2-\gamma)(a-c)}{4-\beta\gamma} \\
q_1^{\mathcal{WO}} = q_2^{\mathcal{WO}} &= \frac{2(2-\beta)(a-c)}{(2+\gamma)(4-\beta\gamma)}
\end{aligned}
$$

C. Hybrid regime

$$
\begin{aligned}
w_1^{\mathcal{WH}} &= c + \frac{\beta(4-\gamma^2)[4-\gamma(2-\beta)](a-c)}{32-2\gamma^2[4-\beta(2-\beta)]} \\
w_2^{\mathcal{WH}} &= c + \frac{\beta(2-\gamma)(4+\beta\gamma)(a-c)}{16-\gamma^2[4-\beta(2-\beta)]} \\
q_1^{\mathcal{WH}} &= \frac{(2-\beta)[4-\gamma(2-\beta)](a-c)}{16-\gamma^2[4-\beta(2-\beta)]} \\
q_2^{\mathcal{WH}} &= \frac{(2-\beta)(2-\gamma)(4+\beta\gamma)(a-c)}{32-2\gamma^2[4-\beta(2-\beta)]}
\end{aligned}
$$

D. Welfare analysis

$$
\begin{aligned}
CS^{\mathcal{WS}} &= \frac{(1+\gamma)(2-\beta)^2(a-c)^2}{(4+\gamma(2-\beta))^2} \\
CS^{\mathcal{WO}} &= \frac{4(1+\gamma)(2-\beta)^2(a-c)^2}{(2+\gamma)^2(4-\beta\gamma)^2}
\end{aligned}
$$

$$CS^{\mathcal{WH}} = \frac{(2-\beta)^2(a-c)^2}{8(16-\gamma^2(4-\beta(2-\beta)))^2}[32(2-\gamma)^2(1+\gamma)+$$
$$+8\beta\gamma(4-\gamma)(2-\gamma)(1+\gamma)+\beta^2\gamma^2(8+\gamma(4-3\gamma))]$$
$$TW^{\mathcal{WS}} = \frac{(2-\beta)[2(3+\gamma)+\beta(1+\gamma)](a-c)^2}{(4+\gamma(2-\beta))^2}$$
$$TW^{\mathcal{WO}} = \frac{4(2-\beta)[2(3+\gamma)+\beta(1-\gamma-\gamma^2)](a-c)^2}{(2+\gamma)^2(4-\beta\gamma)^2}$$
$$TW^{\mathcal{WH}} = \frac{(2-\beta)(a-c)^2}{8(16-\gamma^2(4-\beta(2-\beta)))^2}[64(2-\gamma)^2(3+\gamma)+\beta^3\gamma^2(8-\gamma(12-\gamma))+$$

7.3 Equilibrium outcomes under Bertrand competition

7.3.1 Common upstream supplier

7.3.1.1 Two-part tariffs

A. Universal secrecy

$$w_1^{\mathcal{BS}} = w_2^{\mathcal{BS}} = c$$
$$F_1^{\mathcal{BS}} = F_2^{\mathcal{BS}} = \frac{\beta(1-\gamma)(a-c)^2}{(2-\gamma)^2(1+\gamma)}$$
$$q_1^{\mathcal{BS}} = q_2^{\mathcal{BS}} = \frac{a-c}{2+\gamma(1-\gamma)}$$

B. Universal interim observability

$$w_1^{\mathcal{BO}} = w_2^{\mathcal{BO}} = c + \frac{1}{4}\gamma^2(a-c)$$
$$F_1^{\mathcal{BO}} = F_2^{\mathcal{BO}} = \frac{(2+\gamma)(\beta(2-\gamma)-\gamma^2)(a-c)^2}{16(1+\gamma)}$$
$$q_1^{\mathcal{BO}} = q_2^{\mathcal{BO}} = \frac{(2+\gamma)(a-c)}{4(1+\gamma)}$$

C. Hybrid regime

$$w_1^{\mathcal{BH}} = c + \frac{\gamma^2(2+\gamma)(a-c)}{8(1+\gamma)}$$
$$w_2^{\mathcal{BH}} = c + \frac{\gamma^3(2+\gamma)(a-c)}{8(1+\gamma)}$$

$$F_1^{\mathcal{BH}} = \frac{(2+\gamma)^2(\gamma^2-\beta(2-\gamma^2))(a-c)^2}{32(1+\gamma)^2}$$
$$F_2^{\mathcal{BH}} = \frac{(4+\gamma(2+\gamma))[\gamma^3(2+\gamma)-\beta(4+\gamma(2-3\gamma))](a-c)^2}{64(1+\gamma)^2}$$
$$q_1^{\mathcal{BH}} = \frac{(2+\gamma)(a-c)}{4(1+\gamma)}$$
$$q_2^{\mathcal{BH}} = \frac{(4+\gamma(2+\gamma))(a-c)}{8(1+\gamma)}$$

D. Welfare analysis

$$CS^{\mathcal{BS}} = \frac{(a-c)^2}{(1+\gamma)(2-\gamma)^2}$$
$$CS^{\mathcal{BO}} = \frac{(2+\gamma)^2(a-c)^2}{16(1+\gamma)}$$
$$CS^{\mathcal{BH}} = \frac{[32+\gamma(64+\gamma(48+5\gamma(4+\gamma)))](a-c)^2}{128(1+\gamma)^2}$$
$$TW^{\mathcal{BS}} = \frac{(3-2\gamma)(a-c)^2}{(1+\gamma)(2-\gamma)^2}$$
$$TW^{\mathcal{BO}} = \frac{(2+\gamma)(6-\gamma)(a-c)^2}{16(1+\gamma)}$$
$$TW^{\mathcal{BH}} = \frac{(3-2\gamma)(a-c)^2}{(1+\gamma)(2-\gamma)^2}$$

7.3.1.2 Linear tariffs

A. Universal secrecy

$$w_1^{\mathcal{BLS}} = w_2^{\mathcal{BLS}} = c + \frac{2\beta(1-\gamma)(a-c)}{4-\gamma(2+\beta)}$$
$$q_1^{\mathcal{BLS}} = q_2^{\mathcal{BLS}} = \frac{(2-\beta)(a-c)}{(1+\gamma)(4-\gamma(2+\beta))}$$

B. Universal interim observability

$$w_1^{\mathcal{BLO}} = w_2^{\mathcal{BLO}} = c + \frac{\beta(2-\gamma-\gamma^2)(a-c)}{4-2\gamma(\beta+\gamma)}$$
$$q_1^{\mathcal{BLO}} = q_2^{\mathcal{BLO}} = \frac{[4-2\gamma^2-\beta(2-\gamma)(1+\gamma)](a-c)}{2(2-\gamma)(1+\gamma)(2-\gamma(\beta+\gamma)}$$

C. Hybrid regime

$$w_1^{\mathcal{BLH}} = c + \frac{\beta(2-\gamma-\gamma^2)[8-4\beta\gamma+\gamma^2(2+\beta)](a-c)}{32-4(6+\beta+3\beta^2)\gamma^2+2(2+\beta+\beta^2)\gamma^4}$$
$$w_2^{\mathcal{BLH}} = c + \frac{\beta(2-\gamma-\gamma^2)[8-\gamma(4\gamma-\beta(6-\gamma^2))](a-c)}{32-4(6+\beta+3\beta^2)\gamma^2+2(2+\beta+\beta^2)\gamma^4}$$
$$q_1^{\mathcal{BLH}} = \frac{2[\beta^2\gamma(1+\gamma)+\beta(2-\gamma^2)-(2+\gamma)(2-\gamma^2)](a-c)}{(1+\gamma)[16-2(6+\beta+3\beta^2)\gamma^2+(2+\beta+\beta^2)\gamma^4]}$$
$$q_2^{\mathcal{BLH}} = \frac{(2+\gamma)[8-4\gamma^2-\gamma\beta^2(3-\gamma)(1+\gamma)-2\beta(2-\gamma-\gamma^2)](a-c)}{2(1+\gamma)[16-2(6+\beta+3\beta^2)\gamma^2+(2+\beta+\beta^2)\gamma^4]}$$

D. Welfare analysis

$$CS^{\mathcal{BLS}} = \frac{(2-\beta)^2(a-c)^2}{(1+\gamma)(4-\gamma(2+\beta))^2}$$
$$CS^{\mathcal{BLO}} = \frac{[4-2\gamma^2-\beta(2-\gamma)(1+\gamma)]^2(a-c)^2}{4(1+\gamma)(2-\gamma)^2(2-\gamma(\beta+\gamma))^2}$$
$$\begin{aligned}CS^{\mathcal{BLH}} =& \frac{(a-c)^2}{8(1+\gamma)^2[16-2(6+\beta+3\beta^2)\gamma^2+(2+\beta+\beta^2)\gamma^4]^2}[\beta^4\gamma^2(1+\gamma)^3(52+8\gamma-11\gamma^2+\gamma^3)-\\ &-32(1+\gamma)(4+2\gamma-2\gamma^2-\gamma^3)^2+4\beta^3\gamma(1+\gamma)^2(40+4\gamma-30\gamma^2-7\gamma^3+3\gamma^4)-16\beta(32+48\gamma-\\ &-20\gamma^2-58\gamma^3-14\gamma^4+15\gamma^5+8\gamma^6+\gamma^7)+4\beta^2(32-48\gamma-248\gamma^2-180\gamma^3+73\gamma^4+116\gamma^5+\\ &+27\gamma^6-6\gamma^7-2\gamma^8)]\end{aligned}$$
$$TW^{\mathcal{BLS}} = \frac{(2-\beta)[6+\beta-2\gamma(2+\beta)](a-c)^2}{(1+\gamma)(4-\gamma(2+\beta))^2}$$
$$TW^{\mathcal{BLO}} = \frac{(4-2\gamma^2-\beta(2-\gamma)(1+\gamma))[\beta(2-\gamma)(1-3\gamma)+2(3-2\gamma)(2-\gamma^2))](a-c)^2}{4(2-\gamma)^2(1+\gamma)(2-\gamma(\beta+\gamma))^2}$$
$$\begin{aligned}TW^{\mathcal{BLH}} =& \frac{(a-c)^2}{8(1+\gamma)(16-2(6+\beta+3\beta^2)\gamma^2+(2+\beta+\beta^2)\gamma^4)^2}[32(2+\gamma)^2(3-2\gamma)(2-\gamma^2)^2-\\ &-16\beta(2+\gamma)(2-\gamma^2)(8-\gamma(8+\gamma-4\gamma^2+\gamma^3))-\beta^4\gamma^2(1+\gamma)(52-\gamma(180+\\ &+\gamma(27-\gamma(54+\gamma(5-4\gamma)))))-4\beta^3\gamma(40-\gamma(1+\gamma)(52-\gamma(6+\gamma(11+\\ &+\gamma(7-\gamma-\gamma^2)))))-4\beta^2(32+\gamma(80+\gamma(168-\gamma(36+\gamma(155+\gamma(9-2\gamma(18+\\ &+(2-\gamma)\gamma)))))))]\end{aligned}$$

7.3.2 Competing vertical chains

7.3.2.1 Two-part tariffs

A. Universal secrecy

$$\begin{aligned}
w_1^{\mathcal{BES}} &= w_2^{\mathcal{BES}} = c \\
F_1^{\mathcal{BES}} &= F_2^{\mathcal{BES}} = \frac{\beta(1-\gamma)(a-c)^2}{(1+\gamma)(2-\gamma)^2} \\
q_1^{\mathcal{BES}} &= q_2^{\mathcal{BES}} = \frac{a-c}{2+\gamma(1-\gamma)}
\end{aligned}$$

B. Universal interim observability

$$\begin{aligned}
w_1^{\mathcal{BEO}} &= w_2^{\mathcal{BEO}} = c + \frac{\gamma^2(1-\gamma)(a-c)}{4-\gamma(2+\gamma)} \\
F_1^{\mathcal{BEO}} &= F_2^{\mathcal{BEO}} = \frac{(1-\gamma)(2-\gamma^2)(2\beta-\gamma^2)(a-c)^2}{(1+\gamma)[4-\gamma(2+\gamma)]^2} \\
q_1^{\mathcal{BEO}} &= q_2^{\mathcal{BEO}} = \frac{(2-\gamma^2)(a-c)}{(1+\gamma)(4-\gamma(2+\gamma))}
\end{aligned}$$

C. Hybrid regime

$$\begin{aligned}
w_1^{\mathcal{BEH}} &= c + \frac{\gamma^2(2-\gamma-\gamma^2)(a-c)}{4(2-\gamma^2)} \\
w_2^{\mathcal{BEH}} &= c \\
F_1^{\mathcal{BEH}} &= \frac{(1-\gamma)(2+\gamma)^2(2\beta-\gamma^2)(a-c)^2}{16(1+\gamma)(2-\gamma^2)} \\
F_2^{\mathcal{BEH}} &= \frac{\beta(1-\gamma)(4+\gamma(2-\gamma))^2(a-c)^2}{16(1+\gamma)(2-\gamma^2)^2} \\
q_1^{\mathcal{BEH}} &= \frac{(2+\gamma)(a-c)}{4(1+\gamma)} \\
q_2^{\mathcal{BEH}} &= \frac{(4+\gamma(2-\gamma))(a-c)}{4(1+\gamma)(2-\gamma^2)}
\end{aligned}$$

D. Welfare analysis

$$\begin{aligned}
CS^{\mathcal{BES}} =& \frac{(a-c)^2}{(1+\gamma)(2-\gamma)^2} \\
CS^{\mathcal{BEO}} =& \frac{(2-\gamma^2)^2(a-c)^2}{(1+\gamma)[4-\gamma(2+\gamma)]^2} \\
CS^{\mathcal{BEH}} =& \frac{[32+g(32-\gamma(16+\gamma(20-\gamma-3\gamma^2)))](a-c)^2}{32(1+\gamma)(2-\gamma^2)^2} \\
TW^{\mathcal{BES}} =& \frac{(3-2\gamma)(a-c)^2}{(1+\gamma)(2-\gamma)^2}
\end{aligned}$$

$$TW^{\mathcal{BEO}} = \frac{(2-\gamma^2)(6-\gamma(4+\gamma))(a-c)^2}{(1+\gamma)(4-\gamma(2+\gamma))^2}$$

$$TW^{\mathcal{BEH}} = \frac{[96+\gamma(32-\gamma(96+\gamma(1-\gamma)(28+5\gamma)))](a-c)^2}{32(1+\gamma)(2-\gamma^2)^2}$$

7.3.2.2 Linear tariffs

A. Universal secrecy

$$w_1^{\mathcal{BWS}} = w_2^{\mathcal{BWS}} = c + \frac{2\beta(1-\gamma)(a-c)}{4-\gamma(2+\beta)}$$

$$q_1^{\mathcal{BWS}} = q_2^{\mathcal{BWS}} = \frac{(2-\beta)(a-c)}{(1+\gamma)(4-\gamma(2+\beta))}$$

B. Universal interim observability

$$w_1^{\mathcal{BWO}} = w_2^{\mathcal{BWO}} = c + \frac{\beta(2-\gamma-\gamma^2)(a-c)}{4-\gamma(\beta-2\gamma)}$$

$$q_1^{\mathcal{BWO}} = q_2^{\mathcal{BWO}} = \frac{(2-\beta)(2-\gamma^2)(a-c)}{(1+\gamma)(2-\gamma)(4-\gamma(\beta+2\gamma)}$$

C. Hybrid regime

$$w_1^{\mathcal{BWH}} = c + \frac{\beta(2-\gamma)(1-\gamma)(2+\gamma)(4+(2+\beta)\gamma)(a-c)}{32-2(12+\beta(2+\beta))\gamma^2+2(2+\beta)\gamma^4}$$

$$w_2^{\mathcal{BWH}} = c + \frac{\beta(4+(\beta-2\gamma)\gamma)(2-\gamma-\gamma^2)(a-c)}{16-(12+\beta(2+\beta))\gamma^2+(2+\beta)\gamma^4}$$

$$q_1^{\mathcal{BWH}} = \frac{(2-\beta)(2-\gamma^2)(4+\gamma(2+\beta))(a-c)}{2(1+\gamma)(16-(12+\beta(2+\beta))\gamma^2+(2+\beta)\gamma^4)}$$

$$q_2^{\mathcal{BWH}} = \frac{(2-\beta)(2+\gamma)(4+\gamma(\beta-2\gamma))(a-c)}{2(1+\gamma)(16-(12+\beta(2+\beta))\gamma^2+(2+\beta)\gamma^4)}$$

D. Welfare analysis

$$CS^{\mathcal{BWS}} = \frac{(2-\beta)^2(a-c)^2}{(1+\gamma)(4-\gamma(2+\beta))^2}$$

$$CS^{\mathcal{BWO}} = \frac{(2-\beta)^2(2-\gamma^2)^2(a-c)^2}{(1+\gamma)(2-\gamma)^2(4-\gamma(\beta+2\gamma)^2}$$

$$CS^{\mathcal{BWH}} = \frac{(2-\beta)^2(a-c)^2}{8(1+\gamma)^2(16-(12+\beta(2+\beta))\gamma^2+(2+\beta)\gamma^4)^2}[(2+\gamma)^2(4+(b-2\gamma)\gamma)^2+ \\ +2\gamma(2+\gamma)(4+(2+b)\gamma)(4+(b-2\gamma)\gamma)(2-\gamma^2)+(4+(2+b)\gamma)^2(2-\gamma^2)^2]$$

$$
\begin{aligned}
TW^{\mathcal{BWS}} =& \frac{(2-\beta)(6+\beta-2\gamma(2+\beta))(a-c)^2}{(1+\gamma)(4-\gamma(2+\beta))^2} \\
TW^{\mathcal{BWO}} =& \frac{(2-\beta)(2-\gamma^2)[\beta(2-\gamma(4-\gamma))+2(3-2\gamma)(2-\gamma^2)](a-c)^2}{(1+\gamma)(2-\gamma)^2(4-\gamma(\beta+2\gamma))^2} \\
TW^{\mathcal{BWH}} =& \frac{(2-\beta)(a-c)^2}{8(1+\gamma)(16-(12+\beta(2+\beta))\gamma^2+(2+\beta)\gamma^4)^2}[16(2+\gamma)^2(3-2\gamma)(2-\gamma^2)^2- \\
& -8\beta(2+\gamma)(2-\gamma^2)(4+3\gamma(2-\gamma)(1-\gamma-\gamma^2))+\beta^3\gamma^2(8-\gamma(12+\gamma(7-3\gamma)))+ \\
& +2\beta^2\gamma(32-\gamma(16+\gamma(56+\gamma-\gamma^2(23+2(2-\gamma)\gamma))))]
\end{aligned}
$$

7.4 Proofs

Proof of Lemma 1. Consider the case of universal secrecy. Substituting (4) back to (1), and accounting for the equilibrium fixed fees $F_i^{\mathcal{S}}$, we get firms' *net* profits under this disclosure regime:

$$
\begin{aligned}
\Pi_1^{\mathcal{S}} = \Pi_2^{\mathcal{S}} &= \frac{(1-\beta)(a-c)^2}{(2+\gamma)^2} \\
\Pi_U^{\mathcal{S}} &= \frac{2\beta(a-c)^2}{(2+\gamma)^2}
\end{aligned}
$$

For a deviation from this regime all we need is *at least one* member of the pair (U, D_i) to unilaterally deviate and make their vertical contract terms interim observable, given that the other pair (U, D_j) sticks to secrecy and its respective equilibrium contract terms are $(w_j^{\mathcal{S}}, F_j^{\mathcal{S}})$. Let the deviation values be denoted by the superscript d. Say that pair (U, D_1) deviates and renegotiates over the following generalized Nash product:

$$
\begin{aligned}
&[(a-q_1^d(w_1^d,w_2^{\mathcal{S}})-\gamma q_2^d(w_1^d,w_2^{\mathcal{S}})-w_1^d)q_1^d(w_1^d,w_2^{\mathcal{S}})-F_1^d]^{1-\beta}\ [(w_1^d-c)q_1^d(w_1^d,w_2^{\mathcal{S}})+ \\
&+(w_2^{\mathcal{S}}-c)q_2^d(w_1^d,w_2^{\mathcal{S}})+F_1^d+F_2^{\mathcal{S}}-(w_2^{\mathcal{S}}-c)q_2^d(w_1^d,w_2^{\mathcal{S}})-F_2^{\mathcal{S}}]^{\beta}
\end{aligned}
$$

where: $q_1^d(w_1^d,w_2^{\mathcal{S}}) = \frac{a(2-\gamma)-2w_1^d-\gamma w_2^{\mathcal{S}}}{4-\gamma^2}$, and $q_2^d(w_1^d,w_2^{\mathcal{S}}) = \frac{a(2-\gamma)-2w_2^{\mathcal{S}}-\gamma w_1^d}{4-\gamma^2}$ are the induced demands expressed in w_i-terms. Note that $(w_2^{\mathcal{S}}, F_2^{\mathcal{S}})$ are the equilibrium values stated in (4). Maximizing the above Nash product over F_1^d, and then maximizing joint profits (excess of the outside option) $(a-q_1^d(w_1^d,w_2^{\mathcal{S}})-\gamma q_2^d(w_1^d,w_2^{\mathcal{S}})-c)q_1^d(w_1^d,w_2^{\mathcal{S}})$ over w_1^d, and solving the system of these two focs, we get the following deviation results (profits are *net*):

$$
w_1^d = c - \frac{\gamma^2(2-\gamma)(a-c)}{4(2-\gamma^2)}
$$

$$F_1^d = \frac{(2-\gamma)^2(2\beta+\gamma^2(1-\beta))(a-c)^2}{8(2-\gamma^2)^2}$$
$$\Pi_1^d = \frac{(1-\beta)(2-\gamma)^2(a-c)^2}{8(2-\gamma^2)}$$
$$\Pi_U^d = \frac{\beta(32-16\gamma^2+\gamma^4)(a-c)}{8(2+\gamma)^2(2-\gamma^2)}$$

As $\Pi_U^{\mathcal{S}} < \Pi_U^d$ for all β and γ, U always benefits deviating from secrecy to interim observability. Further, $\Pi_1^{\mathcal{S}} < \Pi_1^d$ for all β and γ. So, the incentives not to sign the NDA and deviate to interim observability are *bilateral*. Due to symmetry, the same reasoning applies in a possible deviation of pair (U, D_2) to interim observability given that pair (U, D_1) sticks to secrecy. Therefore, universal secrecy never arises in equilibrium ■

Proof of Lemma 2. Consider the case of universal interim observability. Substituting (6) back to (1), and accounting for the equilibrium fixed fees $F_i^{\mathcal{O}}$, we get firms' *net* profits under this disclosure regime:

$$\Pi_1^{\mathcal{O}} = \Pi_2^{\mathcal{O}} = \frac{(1-\beta)(1-\gamma)(4-\gamma^2)(a-c)^2}{4(2-\gamma^2)^2}$$
$$\Pi_U^{\mathcal{O}} = \frac{\beta(2-\gamma)(2-\gamma-\gamma^2)(a-c)^2}{2(2-\gamma^2)^2}$$

For a deviation from this regime all we need is *both* members of pair (U, D_i) to have incentives to sign the NDA and switch to secrecy, given that the other pair (U, D_j) sticks to interim observability. Let the deviation values be denoted by the superscript d. Say that pair (U, D_1) deviates by renegotiating over the following generalized Nash product:

$$[(a-R_1^d(w_1^d)-\gamma\tilde{q}_2-w_1^d)R_1^d(w_1^d)-F_1^d]^{1-\beta}\ [(w_1^d-c)R_1^d(w_1^d)+(w_2^{\mathcal{O}}-c)\tilde{q}_2+F_1^d+F_2^{\mathcal{O}}-(w_2^{\mathcal{O}}-c)\tilde{q}_2-F_2^{\mathcal{O}}]^{\beta}$$

where: $R_1^d(w_1^d) = 1/2(a-\gamma\tilde{q}_2-w_1^d)$ is the reaction function of D_1 in stage 2, and $\tilde{q}_2$ is the passive belief formed by D_1 over D_2's output in equilibrium. Note that $(w_2^{\mathcal{O}}, F_2^{\mathcal{O}})$ are the equilibrium values stated in (6). Following a standard procedure, we maximize the above generalized Nash product over F_1^d, and we then maximize joint profits (excess of the outside option) $(a-R_1^d(w_1^d)-\gamma\tilde{q}_2-c)R_1^d(w_1^d)$ over w_1^d. Solving the system of these two focs, we get the following deviation results (profits are *net*):

$$w_1^d = c$$
$$F_1^d = \frac{\beta[8-\gamma(4+\gamma(4-\gamma))]^2(a-c)^2}{4(8-6\gamma^2+\gamma^4)^2}$$

$$\Pi_1^d = \frac{(1-\beta)[8-\gamma(4+\gamma(4-\gamma))]^2(a-c)^2}{4(8-6\gamma^2+\gamma^4)^2}$$
$$\Pi_U^d = \frac{[\gamma^7+\beta(128-\gamma(128+\gamma(96-\gamma(96+\gamma(20-20\gamma+\gamma^3)))))-4\gamma^5](a-c)^2}{4(8-6\gamma^2+\gamma^4)^2}$$

As $\Pi_U^{\mathcal{O}} > \Pi_U^d$ for all β and γ, U never benefits from signing the NDA. So, a deviation is not profitable. Due to symmetry, the same reasoning applies in a deviation of pair (U, D_2) to secrecy given that pair (U, D_1) sticks to interim observability. Therefore, universal interim observability always arises in equilibrium ■

Proof of Lemma 3. Consider the case of the hybrid regime. Substituting (7) back to (1), and accounting for the equilibrium fixed fees $F_i^{\mathcal{H}}$ and $F_j^{\mathcal{H}}$, we get firms' *net* profits under this disclosure regime:

$$\Pi_1^{\mathcal{H}} = \frac{(1-\beta)(2-\gamma)^2(a-c)^2}{8(2-\gamma^2)}$$
$$\Pi_2^{\mathcal{H}} = \frac{(1-\beta)(4-\gamma(2+\gamma))^2(a-c)^2}{16(2-\gamma^2)^2}$$
$$\Pi_U^{\mathcal{H}} = \frac{\beta[32-\gamma(32+\gamma(8-\gamma(12-\gamma)))](a-c)^2}{16(2-\gamma^2)^2}$$

Since symmetry does not apply here, we have to deal with two asymmetric deviations. Let the deviation values be denoted by the superscript d. First, let's consider the case where pair (U, D_1) deviates to secrecy, given that pair (U, D_2) sticks to secrecy. The former pair bargains over the following generalized Nash product:

$$[(a - R_1^d(w_1^d) - \gamma\tilde{q}_2 - w_1^d)R_1^d(w_1^d) - F_1^d]^{1-\beta}\ [(w_1^d - c)R_1^d(w_1^d) + (w_2^{\mathcal{H}} - c)\tilde{q}_2 + \\ + F_1^d + F_2^{\mathcal{H}} - (w_2^{\mathcal{H}} - c)\tilde{q}_2 - F_2^{\mathcal{H}}]^{\beta}$$

where: $R_1^d(w_1^d)$ as before, and $(w_2^{\mathcal{H}}, F_2^{\mathcal{H}})$ from (7). Following the standard procedure we get (profits are *net*):

$$w_1^d = c$$
$$F_1^d = \frac{\beta(a-c)^2}{(2+\gamma)^2}$$
$$\Pi_1^d = \frac{(1-\beta)(a-c)^2}{(2+\gamma)^2}$$
$$\Pi_U^d = \frac{\beta[16(2-\gamma^2)^2+(4-\gamma(2+\gamma))(2+\gamma)^2](a-c)^2}{16(2+\gamma)^2(2-\gamma^2)^2}$$

Since $\Pi_U^{\mathcal{H}} > \Pi_U^d \forall \beta, \gamma$, U would never sign the NDA. Therefore, pair (U, D_1) would never deviate to secrecy. Moreover, note that also $\Pi_1^{\mathcal{H}} > \Pi_1^d \forall \beta, \gamma$, so D_1 would never sign the NDA either. However, for the hybrid regime to arise in equilibrium we should also consider the deviation of the other pair as well.

Consider now the case where pair (U, D_2) deviates to interim observability, given that pair (U, D_1) sticks to interim observability. The former pair bargains over the following generalized Nash product:

$$[(a - q_2^d(w_1^{\mathcal{H}}, w_2^d) - \gamma q_1^d(w_1^{\mathcal{H}}, w_2^d) - w_2^d)q_2^d(w_1^{\mathcal{H}}, w_2^d) - F_2^d]^{1-\beta}\ [(w_1^d - c)q_1^d(w_1^{\mathcal{H}}, w_2^d) + \\ + (w_2^{\mathcal{H}} - c)q_2^d(w_1^{\mathcal{H}}, w_2^d) + F_1^{\mathcal{H}} + F_2^d - (w_1^{\mathcal{H}} - c)q_1^d(w_1^{\mathcal{H}}, w_2^d) - F_1^{\mathcal{H}}]^{\beta}$$

where: $q_2^d(w_1^{\mathcal{H}}, w_2^d)$ as above, and $(w_1^{\mathcal{H}}, F_1^{\mathcal{H}})$ from (7). Following the standard procedure we get the deviation results (profits are *net*):

$$\begin{aligned} w_2^d =& c - \frac{\gamma^2(4-\gamma^2)(4-\gamma(2+\gamma))(a-c)}{16(2-\gamma^2)^2} \\ F_2^d =& \frac{(4-\gamma^2)^2(4-\gamma(2+\gamma))^2(2\beta+(1-\beta)\gamma^2)(a-c)^2}{128(2-\gamma^2)^4} \\ \Pi_2^d =& \frac{(1-\beta)(4-\gamma^2)^2(4-\gamma(2+\gamma))^2(a-c)^2}{128(2-\gamma^2)^3} \\ \Pi_U^d =& \frac{(2-\gamma)(a-c)^2}{128(2-\gamma^2)^3}[2\gamma^5(4-\gamma(2+\gamma)) + \beta(2-\gamma)(128- \\ & \gamma^2(128+\gamma(16-\gamma(32+\gamma(8+\gamma)))))] \end{aligned}$$

As $\Pi_U^{\mathcal{H}} < \Pi_U^d$ for all β and γ, U always benefits from deviating from secrecy to interim observability. Further, $\Pi_2^{\mathcal{H}} < \Pi_1^d$ for all β and γ. So, the incentives not to sign the NDA and deviate to interim observability are *bilateral.* Therefore, the hybrid regime never arises in equilibrium since pair (U, D_2) always has incentives to deviate to interim observability ■

Proof of Proposition 2. Substituting the equilibrium outcome of each case into consumer surplus $CS = 1/2(q_1^2 + q_2^2 + 2\gamma q_1 q_2)$ we get the following equilibrium expressions:

$$\begin{aligned} CS^{\mathcal{S}} =& \frac{(1+\gamma)(a-c)^2}{(2+\gamma)^2} \\ CS^{\mathcal{O}} =& \frac{(2-\gamma)^2(1+\gamma)(a-c)^2}{4(2-\gamma^2)^2} \\ CS^{\mathcal{H}} =& \frac{[32-\gamma^2(32-\gamma(4+5\gamma))](a-c)^2}{32(2-\gamma^2)^2} \end{aligned}$$

By adding CS and producer surplus PS (net profits per disclosure regime can be found in the above proofs of Lemmas 1, 2, and 3 as well as in the proof of Propositions 3, 4, and 5 below) we get the following total welfare TW per case and regime:

$$TW^{\mathcal{S}} = \frac{(3+\gamma)(a-c)^2}{(2+\gamma)^2}$$
$$TW^{\mathcal{O}} = \frac{(2-\gamma)(6-\gamma-3\gamma^2)(a-c)^2}{4(2-\gamma^2)^2}$$
$$TW^{\mathcal{H}} = \frac{[96-\gamma(64+\gamma(48-\gamma(28+3\gamma)))](a-c)^2}{32(2-\gamma^2)^2}$$

The equilibrium values of CS and TW under linear tariffs (for all three disclosure regimes) are stated in section 7.1.D above. It can readily be verified that, under two-part tariffs, the following inequalities hold: $CS^{\mathcal{S}} < CS^{\mathcal{H}} < CS^{\mathcal{O}}$ and $TW^{\mathcal{S}} < TW^{\mathcal{H}} < TW^{\mathcal{O}}$ for all βs and γs. Moreover, under linear tariffs, we get: $X^{\mathcal{LS}} < X^{\mathcal{LH}}\ \forall \beta, \gamma$, while $X^{\mathcal{LS}} < X^{\mathcal{LO}}$ if and only if $\beta < \beta_C(\gamma) = \frac{2\gamma}{2+\gamma}$, where $X = \{CS, TW\}$. Therefore the largest consumer surplus and total welfare are attained under universal interim observability and two-part tariffs ■

Proof of Proposition 3. In what follows we show that universal interim observability is a sustainable equilibrium for all β, γ. However, it is unique only for $\beta \neq \beta_C(\gamma) = \frac{2\gamma}{2+\gamma}$. In particular, for $\beta = \beta_C(\gamma)$ all three disclosure regimes may arise in equilibrium.

Substituting the equilibrium values reported in the Appendix 7.1 back to (1) we get firms' *net* profits under all disclosure regimes:

$$\Pi_1^{\mathcal{LS}} = \Pi_2^{\mathcal{LS}} = \frac{(2-\beta)^2(a-c)^2}{(4+(2-\beta)\gamma)^2}$$
$$\Pi_U^{\mathcal{LS}} = \frac{4\beta(2-\beta)(a-c)^2}{(4+(2-\beta)\gamma)^2}$$
$$\Pi_1^{\mathcal{LO}} = \Pi_2^{\mathcal{LO}} = \frac{(4-\beta(2+\gamma))^2(a-c)^2}{4(2+\gamma)^2(2-\beta\gamma)^2}$$
$$\Pi_U^{\mathcal{LO}} = \frac{\beta(2-\gamma)(4-\beta(2+\gamma))^2(a-c)^2}{2(2+\gamma)(2-\beta\gamma)^2}$$
$$\Pi_1^{\mathcal{LH}} = \frac{(2(2-\beta)+(2-(2-\beta)\beta)\gamma)^2(a-c)^2}{[8-\gamma^2(2-\beta(1-\beta))]^2}$$
$$\Pi_2^{\mathcal{LH}} = \frac{(2-\beta)^2(2-\gamma)^2(4+\beta\gamma)^2(a-c)^2}{16[8-\gamma^2(2-\beta(1-\beta))]^2}$$
$$\Pi_U^{\mathcal{LH}} = \frac{\beta(2-\gamma)(a-c)^2}{8[8-\gamma^2(2-\beta(1-\beta))]^2}[64(2-\beta)-16\gamma(1-\beta)(4-3\beta)-2(8+\beta(8- \\ -\beta(12-5\beta)))\gamma^2+(2-\beta)^3\gamma^3]$$

First, let us consider the case of universal interim observability. For a deviation from this regime all we need is *both* members of pair (U, D_1) to have incentives to sign an NDA and switch to secrecy, given that the other pair (U, D_2) sticks to interim observability. Deviation values are denoted by the superscript d. Say that pair (U, D_1) bargains over the following generalized Nash product:

$$[(a - R_1^d(w_1^d) - \gamma\tilde{q}_2 - w_1^d)R_1^d(w_1^d)]^{1-\beta}\ [(w_1^d - c)R_1^d(w_1^d) + (w_2^{\mathcal{LO}} - c)\tilde{q}_2 - (w_2^{\mathcal{LO}} - c)\tilde{q}_2]^{\beta}$$

where: $R_1^d(w_1^d) = 1/2(a - \gamma\tilde{q}_2 - w_1^d)$ is the reaction function of D_1 in stage 2, and $\tilde{q}_2$ is the passive belief formed by D_1 over D_2's output in equilibrium. Following the standard procedure, we maximize the above Nash product over w_1^d. Solving the foc we get the deviation results (profits are *net*):

$$\begin{aligned} w_1^d =& c + \frac{\beta(2-\gamma)(4-\beta\gamma)(a-c)}{(2-\beta\gamma)(8-\gamma^2(2-\beta))} \\ \Pi_1^d =& \frac{(2-\beta)^2(2-\gamma)^2(4-\beta\gamma)^2(a-c)^2}{4(2-\beta\gamma)^2(8-\gamma^2(2-\beta))^2} \\ \Pi_U^d =& \frac{\beta(2-\gamma)[64(2-\beta) + \sum_{n=1}^4 \theta_n\gamma^n](a-c)^2}{2(2-\beta\gamma)^2(8-\gamma^2(2-\beta))^2} \end{aligned}$$

where: $\theta_1 = -16(4 + \beta - \beta^2)$, $\theta_2 = -2(8 - 24\beta + 8\beta^2 + \beta^3)$, $\theta_3 = (2-\beta)^2(2+\beta)$, and $\theta_4 = -(2-\beta)^2\beta$. Note that U deviates if $\Pi_U^{\mathcal{LO}} < \Pi_U^d$ which holds if and only if $\beta < \beta_C(\gamma) = \frac{2\gamma}{2+\gamma}$. And D_1 deviates if $\Pi_1^{\mathcal{LO}} < \Pi_1^d$ which holds if and only if $\beta > \beta_C(\gamma)$. Since it takes two to sign the NDA to deviate to secrecy, a deviation is not possible. Due to symmetry, the same reasoning applies in a deviation of pair (U, D_2) to secrecy given that pair (U, D_1) sticks to interim observability. Therefore, universal interim observability arises in equilibrium for all βs and γs.

Now, let us consider the case of universal secrecy. For a deviation from this regime all we need is at least one member of pair (U, D_1) to unilaterally deviate to interim observability, given that the other pair (U, D_2) sticks to secrecy. Say that pair (U, D_1) deviates to interim observability and renegotiates over the following generalized Nash product:

$$\begin{aligned} &[(a - q_1^d(w_1^d, w_2^{\mathcal{LS}}) - \gamma q_2^d(w_1^d, w_2^{\mathcal{LS}}) - w_1^d)q_1^d(w_1^d, w_2^{\mathcal{LS}})]^{1-\beta}\ [(w_1^d - c)q_1^d(w_1^d, w_2^{\mathcal{LS}}) + \\ &+ (w_2^{\mathcal{LS}} - c)q_2^d(w_1^d, w_2^{\mathcal{LS}}) - (w_2^{\mathcal{LS}} - c)q_2^d(w_1^d, w_2^{\mathcal{LS}})]^{\beta} \end{aligned}$$

where: $q_1^d(w_1^d, w_2^{\mathcal{LS}}) = \frac{a(2-\gamma) - 2w_1^d - \gamma w_2^{\mathcal{LS}}}{4-\gamma^2}$, and $q_2^d(w_1^d, w_2^{\mathcal{LS}}) = \frac{a(2-\gamma) - 2w_2^{\mathcal{LS}} - \gamma w_1^d}{4-\gamma^2}$. Maximizing the above Nash product over w_1^d, and solving the system of focs, we get the following deviation results (profits are *net*):

$$w_1^d = c + \frac{a-c}{32+8\gamma(2-\beta)}\left[8(2+\beta)+2(2-\beta)\beta\gamma-(4-\beta^2)\gamma^2+\sqrt{(2-\beta)(2-\gamma)\Psi}\right]$$
$$\Pi_1^d = \frac{(a-c)^2}{(4-\gamma^2)^2(16+4\gamma(2-\beta))^2}\left[8(2-\beta)-2(2-\beta)\beta\gamma-(2-\beta)^2\gamma^2+\sqrt{(2-\beta)(2-\gamma)\Psi}\right]^2$$
$$\Pi_U^d = \frac{\beta(a-c)^2}{(16+4\gamma(2-\beta))^2}\Big[\beta^3(-2+\gamma)\gamma^2-2\beta^2\gamma(8+3\gamma(2+\gamma))+2(2+\gamma)[48-4\gamma^2+$$
$$+\sqrt{(2-\beta)\Omega}]-\beta[4(2+\gamma)(12-\gamma(4+3\gamma))-\gamma\sqrt{(2-b)\Omega}]\Big]$$

where: $\Psi = 32\beta-16(1-3\beta)\beta\gamma+2(8-\beta(20-\beta(14+\beta)))\gamma^2+(2-\beta)^3\gamma^3-32(2+\gamma)$, and $\Omega = 64(2-b)+32b(2-3b)\gamma-4(2-b)(8-b(4+b))\gamma^2-4b(4-b(4+b))\gamma^3+(2-b)^3\gamma^4$.

Note that $\Pi_U^{\mathcal{LS}} < \Pi_U^d$ if and only if $\beta > \beta_C(\gamma) = \frac{2\gamma}{2+\gamma}$. Further, $\Pi_1^{\mathcal{LS}} < \Pi_1^d$ if and only if $\beta < \beta_C(\gamma)$. So, for $\beta = \beta_C(\gamma)$ no firm from pair (U, D_1) has incentives to deviate from secrecy, given that the other pair (U, D_2) sticks to secrecy as well. Due to symmetry, the same reasoning applies in a possible deviation of pair (U, D_2) to interim observability given that pair (U, D_1) sticks to secrecy. Therefore, for $\beta = \beta_C(\gamma)$ universal secrecy arises as an equilibrium disclosure regime.

Finally, consider the case of the hybrid regime. Since symmetry does not apply here, we have to deal with two asymmetric deviations. First, let's consider the case where pair (U, D_1) deviates to secrecy, given that pair (U, D_2) sticks to secrecy. The deviating pair bargains over the following generalized Nash product:

$$[(a-R_1^d(w_1^d)-\gamma\tilde{q}_2-w_1^d)R_1^d(w_1^d)]^{1-\beta}\,[(w_1^d-c)R_1^d(w_1^d)+(w_2^{\mathcal{LH}}-c)\tilde{q}_2-(w_2^{\mathcal{LH}}-c)\tilde{q}_2]^\beta$$

where: $R_1^d(w_1^d)$ as before, and $w_2^{\mathcal{LH}}$ from the equilibrium values stated in the Appendix 7.1. Following the standard procedure we get (profits are *net*):

$$w_1^d = c+\frac{\beta(2-\gamma)[16+4\beta\gamma-(4-(2-\beta)\beta)\gamma^2](a-c)}{(8-(2-\beta)\gamma^2)(8-(2-(1-\beta)\beta)\gamma^2)}$$
$$\Pi_1^d = \frac{(2-\beta)^2(2-\gamma)^2(\beta^2\gamma^2-2\beta\gamma(2+\gamma)-4(4-\gamma^2))^2(a-c)^2}{4(8-(2-\beta)\gamma^2)^2(8-(2-\beta+\beta^2)\gamma^2)^2}$$
$$\Pi_U^d = \frac{\beta(2-\gamma)[1024(2-\beta)-512(2-\beta)(1-\beta)\gamma-64(4-\beta)^2\gamma^2+\sum_{n=3}^{6}\phi_n\gamma^n](a-c)^2}{2(8-(2-\beta)\gamma^2)^2(8-(2-(1-\beta)\beta)\gamma^2)^2}$$

where: $\phi_3 = 16(32-\beta(52-\beta(32-(10-\beta)\beta)))$, $\phi_4 = 2(2-\beta)(32+\beta(8-\beta(4-\beta(6+\beta))))$, $\phi_5 = -(2-\beta)^2(16-(6-\beta)(2-\beta)\beta)$, and $\phi_6 = (2-\beta)^2\beta(2-(1-\beta)\beta)$. Since $\Pi_U^{\mathcal{LH}} > \Pi_U^d \forall \beta, \gamma$, U would never sign the NDA. Therefore, pair (U, D_1) would never deviate to secrecy. Also

$\Pi_1^{\mathcal{LH}} > \Pi_1^d \forall \beta, \gamma$, so D_1 would never sign the NDA either. However, for the hybrid regime to arise in equilibrium we should also consider the deviation of the other pair as well.

Consider next the case where pair (U, D_2) deviates to interim observability, given that pair (U, D_1) sticks to interim observability. The former pair bargains over the following generalized Nash product:

$$[(a - q_2^d(w_1^{\mathcal{LH}}, w_2^d) - \gamma q_1^d(w_1^{\mathcal{LH}}, w_2^d) - w_2^d) q_2^d(w_1^{\mathcal{LH}}, w_2^d)]^{1-\beta} \, [(w_1^d - c) q_1^d(w_1^{\mathcal{LH}}, w_2^d) + \\ + (w_2^{\mathcal{LH}} - c) q_2^d(w_1^{\mathcal{LH}}, w_2^d) - (w_1^{\mathcal{LH}} - c) q_1^d(w_1^{\mathcal{LH}}, w_2^d)]^{\beta}$$

where: $q_2^d(w_1^{\mathcal{LH}}, w_2^d)$ as above, and $w_1^{\mathcal{LH}}$ from the Appendix 7.1. Following the standard procedure we get the deviation results (profits are *net*):

$$\begin{aligned}
w_1^d =& c + \frac{\beta(2-\gamma)[16 - \gamma(4\gamma - \beta(8 + \gamma(2 - 2\gamma + \beta(2+\gamma))))](a-c)}{(8 - (2-\beta)\gamma^2)(8 - (2 - (1-\beta)\beta)\gamma^2)} \\
\Pi_1^d =& \frac{[16(2-\beta) + 8\beta\gamma(1-\beta) - 2(4 - \beta(4 - \beta - \beta^2))\gamma^2 - (2-\beta)(1-\beta)\beta\gamma^3]^2 (a-c)^2}{16(2+\gamma)^2(8 - (2 - (1-\beta)\beta)\gamma^2)^2} \\
\Pi_U^d =& \frac{\beta(2-\gamma)[256(2-\beta) - 256(1-\beta)^2\gamma + \sum_{n=2}^{5} \psi_n \gamma^n](a-c)^2}{32(8 - (2 - (1-\beta)\beta)\gamma^2)^2}
\end{aligned}$$

where: $\psi_2 = -32(4 - \beta^2(5 - 3\beta))$, $\psi_3 = 16(2-\beta)(1-\beta)(2 - \beta(2+\beta))$, $\psi_4 = 2(2-\beta)^2\beta(4 - \beta(4+\beta))$, and $\psi_5 = (2-\beta)^3\beta^2$. Interestingly, $\Pi_U^{\mathcal{LH}} < \Pi_U^d$ if and only if $\beta < \beta_C(\gamma)$. At the same time, $\Pi_2^{\mathcal{LH}} < \Pi_1^d$ if and only if $\beta > \beta_C(\gamma)$. Therefore, exactly for $\beta = \beta_C(\gamma) = \frac{2\gamma}{2+\gamma}$, the hybrid regime arises in equilibrium.

Combining the above, we conclude that the universal interim observability regime is an equilibrium for all βs and γs, but it is unique only for $\beta \neq \beta_C$, because for $\beta = \beta_C$ all three disclosure regimes are equilibria ■

Proof of Proposition 4. Here we will show that universal interim observability is the only disclosure regime that arises in equilibrium under linear or two-part tariffs, competing vertical chains and Cournot competition. We will follow a methodology similar to the previous cases.

We will start with the case of two-part tariffs. Substituting the equilibrium values found in the Appendix 7.2 back to (1) we get firms' *net* profits under all disclosure regimes:

$$\begin{aligned}
\Pi_1^{\mathcal{ES}} &= \pi_2^{\mathcal{ES}} = \frac{(1-\beta)(a-c)^2}{(2+\gamma)^2} \\
\Pi_{U_1}^{\mathcal{ES}} &= \pi_{U_2}^{\mathcal{ES}} = \frac{\beta(a-c)^2}{(2+\gamma)^2} \\
\Pi_1^{\mathcal{EO}} &= \pi_2^{\mathcal{EO}} = \frac{2(1-\beta)(2-\gamma^2)(a-c)^2}{(4+\gamma(2-\gamma))^2}
\end{aligned}$$

$$\Pi_{U_1}^{\mathcal{EO}} = \pi_{U_2}^{\mathcal{EO}} = \frac{2\beta(2-\gamma^2)(a-c)^2}{(4+\gamma(2-\gamma))^2}$$
$$\Pi_1^{\mathcal{EH}} = \frac{(1-\beta)(2-\gamma)^2(a-c)^2}{8(2-\gamma^2)}$$
$$\Pi_2^{\mathcal{EH}} = \frac{(1-\beta)(4-\gamma(2+\gamma))^2(a-c)^2}{16(2-\gamma^2)^2}$$
$$\Pi_{U_1}^{\mathcal{EH}} = \frac{\beta(2-\gamma)^2(a-c)^2}{8(2-\gamma^2)}$$
$$\Pi_{U_2}^{\mathcal{EH}} = \frac{\beta(4-\gamma(2+\gamma))^2(a-c)^2}{16(2-\gamma^2)^2}$$

Consider the case of universal interim observability. For a deviation from this regime all we need is *both* members of pair (U_i, D_i) to have incentives to sign the NDA and switch to secrecy, given that the other pair (U_j, D_j) sticks to interim observability. Say that pair (U_1, D_1) bargains over the following generalized Nash product:

$$[(a - R_1^d(w_1^d) - \gamma\tilde{q}_2 - w_1^d)R_1^d(w_1^d) - F_1^d]^{1-\beta}\ [(w_1^d - c)R_1^d(w_1^d) + F_1^d]^{\beta}$$

where: $R_1^d(w_1^d) = 1/2(a - \gamma\tilde{q}_2 - w_1^d)$ is the reaction function of D_1 in stage 2, and $\tilde{q}_2$ is the passive belief formed by D_1 over D_2's output in equilibrium. Following the standard procedure, we maximize the above Nash product over F_1^d, and then maximize joint profits (excess of the outside option) $(a - R_1^d(w_1^d) - \gamma q_2^{\mathcal{S}} - c)R_1^d(w_1^d)$ over w_1^d. Solving the system of these two focs, we get the following deviation outcome:

$$w_1^d = c$$
$$F_1^d = \frac{16\beta(2-\gamma^2)^2(a-c)^2}{(4+\gamma(2-\gamma))^2(4-\gamma^2)^2}$$
$$\Pi_1^d = \frac{16(1-\beta)(2-\gamma^2)^2(a-c)^2}{(4+\gamma(2-\gamma))^2(4-\gamma^2)^2}$$
$$\Pi_{U_1}^d = \frac{16\beta(2-\gamma^2)^2(a-c)^2}{(4+\gamma(2-\gamma))^2(4-\gamma^2)^2}$$

As $\Pi_{U_1}^{\mathcal{O}} > \Pi_{U_1}^d$ for all β and γ, U never benefits from signing the NDA. So, a deviation is not profitable. Also, $\Pi_1^{\mathcal{O}} > \Pi_1^d$. Due to symmetry, the same reasoning applies in a deviation of pair (U_2, D_2) to secrecy given that pair (U_1, D_1) sticks to interim observability. Therefore, universal interim observability always arises in equilibrium.

Now, let us consider the case of universal secrecy. Following the standard procedure, we solve the system of the resulting focs to get the deviation results:

$$\begin{aligned}
w_1^d &= c - \frac{\gamma^2(2-\gamma)(a-c)}{4(2-\gamma^2)} \\
F_1^d &= \frac{(2-\gamma)^2(2\beta+\gamma^2(1-\beta))(a-c)^2}{8(2-\gamma^2)^2} \\
\Pi_1^d &= \frac{(1-\beta)(2-\gamma)^2(a-c)^2}{8(2-\gamma^2)} \\
\Pi_{U_1}^d &= \frac{\beta(2-\gamma)^2(a-c)^2}{8(2-\gamma^2)}
\end{aligned}$$

Since $\Pi_1^{\mathcal{S}} < \Pi_1^d$ and $\Pi_{U_1}^{\mathcal{S}} < \Pi_{U_1}^d$ $\forall \beta, \gamma$, both D_1 and U_1 always have incentives to deviate to interim observability (we need at least one of them). Therefore, universal secrecy never arises in equilibrium.

Finally, we consider the case of the hybrid regime. We assume that pair (U_1, D_1) bargains over interim observability while the rival pair (U_2, D_2) bargains over secrecy. Following the standard procedure, we solve the system of the resulting focs to get the deviation results:

$$\begin{aligned}
&\text{Deviation (i)} \\
w_1^d =& c \\
F_1^d =& \frac{\beta(a-c)^2}{(2+\gamma)^2} \\
\Pi_1^d =& \frac{(1-\beta)(a-c)^2}{(2+\gamma)^2} \\
\Pi_{U_1}^d =& \frac{\beta(a-c)^2}{(2+\gamma)^2} \\
&\text{Deviation (ii)} \\
w_2^d =& c - \frac{\gamma^2(4-\gamma^2)(4-\gamma(2+\gamma))(a-c)^2}{16(2-\gamma^2)^2} \\
F_2^d =& \frac{(4-\gamma^2)^2(4-\gamma(2+\gamma))^2(2\beta+\gamma^2(1-\beta))^2(a-c)^2}{128(2-\gamma^2)^4} \\
\Pi_2^d =& \frac{(1-\beta)(4-\gamma^2)^2(4-\gamma(2+\gamma))^2(a-c)^2}{128(2-\gamma^2)^3} \\
\Pi_{U_2}^d =& \frac{\beta(4-\gamma^2)^2(4-\gamma(2+\gamma))^2(a-c)^2}{128(2-\gamma^2)^3}
\end{aligned}$$

where deviation (i) is for pair (U_1, D_1) to deviate to secrecy, given that the rival pair (U_2, D_2) sticks to secrecy. And deviation (ii) is for pair (U_2, D_2) to deviate to interim observability, given that the rival pair (U_1, D_1) sticks to interim observability. Consider deviation (i). See that $\Pi_1^{\mathcal{EH}} > \Pi_1^d \; \forall \beta, \gamma$, therefore D_1 would never sign an NDA. Now, consider deviation (ii). Note that $w_2^{\mathcal{EH}} > w_2^d$ while $\Pi_2^{\mathcal{EH}} < \Pi_2^d \; \forall \beta, \gamma$. So, D_2 has incentives to deviate to interim observability. Therefore, the hybrid regime could not arise in equilibrium.

Having that in mind, we will now move to the case of linear tariffs. Under the latter we apply the same reasoning as above and as the proof of Proposition 3. Therefore, we will only state here the equilibrium net profits and the deviation results per disclosure regime. Remember that since there are no fixed fees, gross equal net profits.

Consider the case of universal interim observability. Equilibrium and deviation values are as follows.

$$\begin{aligned}
\Pi_1^{\mathcal{WO}} = \Pi_2^{\mathcal{WO}} =& \frac{4(2-\beta)^2(a-c)^2}{(2+\gamma)^2(4-\beta\gamma)^2} \\
\Pi_{U_1}^{\mathcal{WO}} = \Pi_{U_2}^{\mathcal{WO}} =& \frac{2\beta(2-\beta)(2-\gamma)(a-c)^2}{(2+\gamma)(4-\beta\gamma)^2} \\
w_1^d =& c + \frac{8\beta(2-\gamma)(a-c)}{(4-\beta\gamma)(8-\gamma^2(2-\beta))} \\
\Pi_1^d =& \frac{16(2-\beta)^2(2-\gamma)^2(a-c)^2}{(4-\beta\gamma)^2(8-\gamma^2(2-\beta))^2} \\
\Pi_{U_1}^d =& \frac{32\beta(2-\beta)(2-\gamma)^2(a-c)^2}{(4-\beta\gamma)^2(8-\gamma^2(2-\beta))^2}
\end{aligned}$$

where the deviation results here (superscript d) refer to the case of pair (U_1, D_1) deviating to secrecy given that the rival pair (U_2, D_2) sticks to interim observability. Is is easy to show that $\Pi_1^{\mathcal{WO}} > \Pi_1^d$ for all βs and γs (since $w_1^{\mathcal{WO}} < w_1^d$), therefore D_1 never has incentives to deviate to secrecy. Since "it takes two to tango", the universal interim observability regime always arises in equilibrium.

Now, let us move to the case of universal secrecy. Equilibrium and deviation values are as follows.

$$\begin{aligned}
\Pi_1^{\mathcal{WS}} = \Pi_2^{\mathcal{WS}} =& \frac{(2-\beta)^2(a-c)^2}{(4+(2-\beta)\gamma)^2} \\
\Pi_{U_1}^{\mathcal{WS}} = \Pi_{U_2}^{\mathcal{WS}} =& \frac{2\beta(2-\beta)(a-c)^2}{(4+(2-\beta)\gamma)^2} \\
w_1^d =& c + \frac{\beta(8-\gamma^2(2-\beta))(a-c)}{4(4+(2-\beta)\gamma)} \\
\Pi_1^d =& \frac{(2-\beta)^2(8-(2-\beta)\gamma^2)^2(a-c)^2}{4(4-\gamma^2)^2(4+(2-\beta)\gamma)^2} \\
\Pi_{U_1}^d =& \frac{\beta(2-\beta)(8-(2-\beta)\gamma^2)^2(a-c)^2}{8(4-\gamma^2)^2(4+(2-\beta)\gamma)^2}
\end{aligned}$$

where the deviation results here (superscript d) refer to the case of pair (U_1, D_1) deviating to interim observability given that the rival pair (U_2, D_2) sticks to secrecy. Note that $\Pi_1^{\mathcal{WS}} < \Pi_1^d$ for all βs and γs (note that $w_1^{\mathcal{WS}} > w_1^d$), therefore D_1 always has incentives to deviate to interim observability. Since at least one members of the bargaining pair has incentives to deviate, the universal secrecy could never arise in equilibrium.

Finally, let us consider the case of the hybrid regime. Equilibrium and deviation values are as follows.

$$
\begin{aligned}
\Pi_1^{\mathcal{WH}} =& \frac{(2-\beta)^2(4-\gamma(2-\beta))^2(a-c)^2}{(16-\gamma^2(4-\beta(2-\beta)))^2} \\
\Pi_2^{\mathcal{WH}} =& \frac{(2-\beta)^2(2-\gamma)^2(4+\beta\gamma)^2(a-c)^2}{4(16-\gamma^2(4-\beta(2-\beta)))^2} \\
\Pi_{U_1}^{\mathcal{WH}} =& \frac{\beta(2-\beta)(4-\gamma^2)(4-\gamma(2-\beta))^2(a-c)^2}{2(16-\gamma^2(4-\beta(2-\beta)))^2} \\
\Pi_{U_2}^{\mathcal{WH}} =& \frac{\beta(2-\beta)(2-\gamma)^2(4+\beta\gamma)^2(a-c)^2}{2(16-\gamma^2(4-\beta(2-\beta)))^2} \\
& \text{Deviation (i)} \\
w_1^d =& c + \frac{4\beta(4-\gamma^2)(4-\gamma(2-\beta))(a-c)}{(8-(2-\beta)\gamma^2)(16-(4-(2-\beta)\beta)\gamma^2)} \\
\Pi_1^d =& \frac{4(2-\beta)^2(4-\gamma^2)^2(4-\gamma(2-\beta))^2(a-c)^2}{(8-(2-\beta)\gamma^2)^2(16-(4-(2-\beta)\beta)\gamma^2)^2} \\
\Pi_{U_1}^d =& \frac{8\beta(2-\beta)(4-\gamma^2)^2(4-\gamma(2-\beta))^2(a-c)^2}{(8-(2-\beta)\gamma^2)^2(16-(4-(2-\beta)\beta)\gamma^2)^2} \\
& \text{Deviation (ii)} \\
w_2^d =& c + \frac{\beta(2-\gamma)(4+\beta\gamma)(8-\gamma^2(2-\beta))(a-c)}{128-8\gamma^2(4-\beta(2-\beta))} \\
\Pi_2^d =& \frac{(2-\beta)^2(4+\beta\gamma)^2(8-\gamma^2(2-\beta))^2(a-c)^2}{16(2+\gamma)^2(16-\gamma^2(4-\beta(2-\beta)))^2} \\
\Pi_{U_2}^d =& \frac{\beta(2-\beta)(2-\gamma)(4+\beta\gamma)^2(8-\gamma^2(2-\beta))^2(a-c)^2}{32(2+\gamma)(16-\gamma^2(4-\beta(2-\beta)))^2}
\end{aligned}
$$

where deviation (i) is for pair (U_1, D_1) to deviate to secrecy, given that the rival pair (U_2, D_2) sticks to secrecy. And deviation (ii) is for pair (U_2, D_2) to deviate to interim observability, given that the rival pair (U_1, D_1) sticks to interim observability. The proof is similar to the two-part tariffs case. Consider deviation (i). See that $\Pi_1^{\mathcal{WH}} > \Pi_1^d \ \forall \beta, \gamma$, therefore D_1 would never sign an NDA. Now, consider deviation (ii). Note that $\Pi_2^{\mathcal{WH}} < \Pi_2^d \ \forall \beta, \gamma$. So, D_2 has incentives to deviate to interim observability. Therefore, the hybrid regime could not arise in equilibrium. ■

Proof of Proposition 5 Having in mind the proofs of the previous Propositions, we follow a similar methodology in this case too. We will show that under two part tariffs (and no matter the structure of the upstream market) and under linear tariffs and competing vertical chains, universal interim observability is the unique equilibrium. However, under linear tariffs and a common upstream supplier we get a multiplicity of equilibria (as in the Cournot case): universal interim observability is everywhere an equilibrium, but for $\beta = \beta_B(\gamma) = \frac{2\gamma}{2+\gamma-\gamma^2}$ all three equilibria may arise. Check Appendix 7.3 for equilibrium values. We will examine each case separately.

First, let us consider the case of a common upstream supplier trading over two-part tariffs. Check Appendix 7.3.1. The equilibrium and deviation values under all three disclosure regimes are the following.

Under universal interim observability we get:

$$\begin{aligned}
\Pi_1^{\mathcal{BO}} = \Pi_2^{\mathcal{BO}} =& \frac{(1-\beta)(4-\gamma^2)(a-c)^2}{16(1+\gamma)} \\
\Pi_U^{\mathcal{BO}} =& \frac{\beta(4-\gamma^2)(a-c)^2}{8(1+\gamma)} \\
w_1^d =& c + \frac{1}{4}\gamma^3(a-c) \\
F_1^d =& \frac{(8+4\gamma-\gamma^3-\gamma^4)(4\gamma^3-\gamma^5-\beta(8-(2-\gamma)\gamma(2+3\gamma)))(a-c)}{16(1+\gamma)(4-\gamma^2)^2} \\
\Pi_1^d =& \frac{(1-\beta)(8+4\gamma-\gamma^3-\gamma^4)(8-(2-\gamma)\gamma(2+3\gamma))(a-c)^2}{16(1+\gamma)(4-\gamma^2)^2} \\
\Pi_U^d =& \frac{(4\gamma^5-\gamma^7-\beta(128-96\gamma^2+20\gamma^4+8\gamma^5-3\gamma^7))(a-c)^2}{16(1+\gamma)(4-\gamma^2)^2}
\end{aligned}$$

Note that $\Pi_U^{\mathcal{BO}} > \Pi_U^d$, therefore U has no incentives to sign an NDA. So, universal interim observability arises in equilibrium.

Under universal secrecy we get:

$$\begin{aligned}
\Pi_1^{\mathcal{BS}} = \Pi_2^{\mathcal{BS}} =& \frac{(1-\beta)(1-\gamma)(a-c)^2}{(1+\gamma)(2-\gamma)^2} \\
\Pi_U^{\mathcal{BS}} =& \frac{2\beta(1-\gamma)(a-c)^2}{(1+\gamma)(2-\gamma)^2} \\
w_1^d =& c + \frac{\gamma^2(2-\gamma-\gamma^2)(a-c)}{4(2-\gamma^2)} \\
F_1^d =& \frac{(1-\gamma)(2+\gamma)^2(2\beta-\gamma^2)(a-c)^2}{16(1+\gamma)(2-\gamma^2)}
\end{aligned}$$

$$\Pi_1^d = \frac{(1-\beta)(1-\gamma)(2+\gamma)^2(a-c)^2}{8(1+\gamma)(2-\gamma^2)}$$
$$\Pi_U^d = \frac{\beta(1-\gamma)(32-16\gamma^2+\gamma^4)(a-c)^2}{8(1+\gamma)(2-\gamma^2)(2-\gamma^2)}$$

Since $\Pi_U^{\mathcal{BS}} < \Pi_U^d$, U always has incentives to deviate to interim observability. So, universal secrecy could not arise in equilibrium.

Under the hybrid regime we get:

$$\Pi_1^{\mathcal{BH}} = \frac{(1-\beta)(2+\gamma)^2(2-\gamma^2)(a-c)^2}{32(1+\gamma)^2}$$
$$\Pi_2^{\mathcal{BH}} = \frac{(1-\beta)(4+\gamma(2+\gamma))(4+\gamma(2-3\gamma))(a-c)^2}{64(1+\gamma)^2}$$
$$\Pi_U^{\mathcal{BH}} = \frac{\beta(32+\gamma(32-\gamma(8+\gamma(12+5\gamma))))(a-c)^2}{64(1+\gamma)^2}$$

Deviation (i)

$$w_1^d = c + \frac{\gamma^4(2+\gamma)(a-c)}{8(1+\gamma)}$$
$$F_1^d = \frac{(8-\gamma^4)(\gamma^4(4-\gamma^2)-\beta(8-8\gamma^2+3\gamma^4))(a-c)^2}{64(2-\gamma)^2(1+\gamma)^2}$$
$$\Pi_1^d = \frac{(1-\beta)(8-\gamma^4)(8-8\gamma^2+3\gamma^4)(a-c)^2}{64(1+\gamma)^2(2-\gamma)^2}$$
$$\Pi_U^d = \frac{(128\beta(1-\gamma^2)+8\beta\gamma^3(2+2\gamma+\gamma^2)-(4-5\beta)\gamma^6+(1-3\beta)\gamma^8)))(a-c)^2}{64(2-\gamma)^2(1+\gamma)^2}$$

Deviation (ii)

$$w_2^d = c + \frac{\gamma^2(2+\gamma)(2+\gamma(1-2\gamma))(a-c)}{8(1+\gamma)(2-\gamma^2)}$$
$$F_2^d = \frac{(2+\gamma)^2(\beta(4-(4-\gamma)\gamma^2)-\gamma^2(2+\gamma(1-2\gamma)))(a-c)^2}{32(1+\gamma)^2(2-\gamma^2)}$$
$$\Pi_2^d = \frac{(1-\beta)(2+\gamma)^2(4-\gamma^2(4-\gamma))(a-c)^2}{32(1+\gamma)^2(2-\gamma^2)}$$
$$\Pi_U^d = \frac{(2+\gamma)(\gamma^5+2\beta(2-\gamma)(1+\gamma)(2+\gamma)(4-\gamma(2+\gamma)))(a-c)^2}{64(1+\gamma)^2(2-\gamma^2)}$$

As in the previous cases, under the hybrid regime pair (U, D_1) deals under interim observability while pair (U, D_2) deals under secrecy. Further, deviation (i) refers to pair (U, D_1) deviating to secrecy given that the rival pair sticks to interim observability. While deviation (ii) refers to pair (U, D_2) deviating to interim observability given that the rival pair sticks to interim observability. Consider deviation (i). Since $\Pi_U^{\mathcal{BH}} > \Pi_U^d$, U never has incentives to sign an NDA. On the other hand, under deviation (ii) $\Pi_U^{\mathcal{BH}} < \Pi_U^d$ so U always has incentives to deviate to interim observability.

Now, we will move to the case of a common upstream supplier trading over linear tariffs. Under universal interim observability we get:

$$\begin{aligned}
\Pi_1^{\mathcal{BLO}} = \Pi_2^{\mathcal{BLO}} =& \frac{(1-\gamma)(4-2\gamma^2-\beta(2-\gamma)(1+\gamma))^2(a-c)^2}{4(1+\gamma)(2-\gamma)^2(2-\gamma(\beta+\gamma))^2} \\
\Pi_U^{\mathcal{BLO}} =& \frac{\beta(2-\gamma-\gamma^2)(4-2\gamma^2-\beta(2-\gamma)(1+\gamma))^2(a-c)^2}{2(1+\gamma)(2-\gamma)(2-\gamma(\beta+\gamma))^2} \\
w_1^d =& c + \frac{\beta(2-\gamma-\gamma^2)(4-\gamma(\beta+2\gamma))(a-c)}{(8-\gamma^2(2+\beta))(2-\gamma(\beta+\gamma))} \\
\Pi_1^d =& \frac{(1-\gamma)(2-\beta)^2(2+\gamma)^2(4-\gamma(\beta+2\gamma))^2(a-c)^2}{4(1+\gamma)(8-\gamma^2(2+\beta))^2(2-\gamma(\beta+\gamma))^2} \\
\Pi_U^d =& \frac{\beta[\sigma_1\beta+\sigma_2\beta^2+\sigma_3\beta^3+\sigma_4\beta^4](a-c)^2}{4(1+\gamma)(8-\gamma^2(2+\beta))^2(2-\gamma(\beta+\gamma))^2}
\end{aligned}$$

where: $\sigma_1 = 8(1-\gamma)(2+\gamma)^2(2-\gamma^2)(8-3\gamma^2)$, $\sigma_2 = -4(1-\gamma)(2+\gamma)^3(8+\gamma(2-(6-\gamma)\gamma))$, $\sigma_3 = -2\gamma(1-\gamma)(2+\gamma)(16+\gamma(16+\gamma(2-\gamma(4+\gamma))))$, and $\sigma_4 = -\gamma^2(8-6\gamma^2-\gamma^4-\gamma^5)$.

In a qualitatively similar way as in the Cournot case, $\Pi_1^{\mathcal{BLO}} < \Pi_1^d$ if and only if $\beta < \beta_B(\gamma) = \frac{2\gamma}{2+\gamma-\gamma^2}$, while $\Pi_1^{\mathcal{BLO}} < \Pi_1^d$ if and only if $\beta > \beta_B(\gamma)$. So, universal interim observability arises in equilibrium.

Under universal secrecy we get:

$$\begin{aligned}
\Pi_1^{\mathcal{BLS}} = \Pi_2^{\mathcal{BLS}} =& \frac{(1-\gamma)(2-\beta)^2(a-c)^2}{(1+\gamma)(4-\gamma(2+\beta))^2} \\
\Pi_U^{\mathcal{BLS}} =& \frac{4\beta(1-\gamma)(2-\beta)(a-c)^2}{(1+\gamma)(4-\gamma(2+\beta))^2} \\
w_1^d =& c + \frac{(1-\gamma)[8(2+\beta)+2(2-\beta)\beta\gamma-(2+\beta)^2\gamma^2-\sqrt{\Theta}](a-c)}{4(2-\gamma^2)(4-\gamma(2+\beta))} \\
\Pi_1^d =& \frac{(1-\gamma)[16-4\gamma^2-4\beta(2+\gamma)+\beta^2\gamma(2+\gamma)+\sqrt{\Theta}](a-c)}{16(1+\gamma)(4-\gamma^2)^2(4-\gamma(2+\beta))^2} \\
\Pi_U^d =& \frac{\beta(1-\gamma)(a-c)^2}{8(1+\gamma)(2-\gamma)(2-\gamma^2)(4-\gamma(2+\beta))^2}[\beta^3\gamma^2(2+\gamma)+ \\
& + 2\beta^2\gamma(8-(10-\gamma)\gamma) - 2(2-\gamma)(48-20\gamma^2+\sqrt{\Theta})+ \\
& + \beta(96-8\gamma^2+12\gamma^3+\gamma(-80+\sqrt{\Theta})]
\end{aligned}$$

where $\Theta = (2-\beta)(2+\gamma)(8(2-\gamma)^2(2+\gamma)-4\beta(2-\gamma)^3-\beta^3\gamma^2(2+\gamma)-2\beta^2\gamma(24-(18-\gamma)\gamma))$.

Again, as in the Cournot case $\Pi_1^{\mathcal{BLS}} > \Pi_1^d$ if and only if $\beta > \beta_B(\gamma)$, while $\Pi_U^{\mathcal{BLS}} > \Pi_U^d$ if and only if $\beta < \beta_B(\gamma)$. So, exactly for $\beta = \beta_B(\gamma)$ universal secrecy arises in equilibrium.

Under the hybrid regime we get:

$$\Pi_1^{\mathcal{BLH}} = \frac{4(1-\gamma)[\beta^2\gamma(1+\gamma)+\beta(2-\gamma^2)-(2+\gamma)(2-\gamma^2)](a-c)^2}{(1+\gamma)(16-2(6+\beta+3\beta^2)\gamma^2+(2+\beta+\beta^2)\gamma^4)^2}$$

$$\Pi_2^{\mathcal{BLH}} = \frac{(1-\gamma)(2+\gamma)^2[8-4\gamma^2-\beta^2\gamma(3-\gamma)(1+\gamma)-2\beta(2-\gamma-\gamma^2)](a-c)^2}{4(1+\gamma)(16-2(6+\beta+3\beta^2)\gamma^2+(2+\beta+\beta^2)\gamma^4)^2}$$

$$\Pi_U^{\mathcal{BLH}} = \frac{\beta(1-\gamma)(2+\gamma)(a-c)^2}{4(1+\gamma)(16-2(6+\beta+3\beta^2)\gamma^2+(2+\beta+\beta^2)\gamma^4)^2}[8(2+\gamma)(2-\gamma^2)(8-3\gamma^2)- \\ -4\beta(4-\gamma)(2+\gamma)(2-\gamma^2)(2-\gamma(3+\gamma))-2\beta^2\gamma(2-\gamma^2)(40+\gamma(20- \\ -3\gamma(1+\gamma)))-\beta^3\gamma^2(52+\gamma(54-\gamma(10+13\gamma-\gamma^3)))]$$

Deviation (i)

$$w_1^d = c + \frac{\beta(1-\gamma)(2+\gamma)(2-\gamma^2)[32-\gamma(8\gamma-\beta^2\gamma(6-\gamma^2)-4\beta(6-\gamma-\gamma^2))](a-c)}{2(8-\gamma^2(2+\beta))(16-2(6+\beta+3\beta^2)\gamma^2+(2+\beta+\beta^2)\gamma^4)}$$

$$\Pi_1^d = \frac{(1-\gamma)(2+\gamma)^2(a-c)^2}{4(1+\gamma)(8-\gamma^2(2+\beta))^2(16-2(6+\beta+3\beta^2)\gamma^2+(2+\beta+\beta^2)\gamma^4)^2}[8\beta(2-\gamma) \\ (2-\gamma^2)+\beta^3\gamma^2(6-7\gamma^2+\gamma^4)-8(8-6\gamma^2+\gamma^4)+4\beta^2\gamma(6+\gamma(2-5\gamma+\gamma^3))]$$

$$\Pi_U^d = \frac{\beta(1-\gamma)(2+\gamma)(a-c)^2}{4(1+\gamma)(8-\gamma^2(2+\beta))^2(16-2(6+\beta+3\beta^2)\gamma^2+(2+\beta+\beta^2)\gamma^4)^2}[128 \\ (2-\gamma)^2(2+\gamma)^3(2-\gamma^2)^2-\beta^5\gamma^4(1+\gamma)(6-\gamma^2)^2(4-\gamma(1+\gamma)(2-\gamma^2))+ \\ +16\beta(2-\gamma)(2+\gamma)^2(2-\gamma^2)(-32+\gamma(4+\gamma)(16-\gamma(2+\gamma(8-3\gamma))))+ \\ +2\beta^4\gamma^3(1+\gamma)(6-\gamma^2)(96-\gamma(112+\gamma(88-\gamma(58+\gamma(4+\gamma)(7-4\gamma)))))- \\ -8\beta^2(2-\gamma)\gamma(2+\gamma)(2-\gamma^2)(192+\gamma(40-\gamma(104-\gamma(2+\gamma(26+(3-\gamma)\gamma)))))- \\ -4\beta^3\gamma^2(1536+\gamma(576-\gamma(2240+\gamma(576-\gamma(1268+\gamma(292-\gamma(304+ \\ +\gamma(72-\gamma(27+7\gamma)))))))))]$$

Deviation (ii)

$$w_2^d = c + \frac{\beta(2-\gamma-\gamma^2)[32+8\beta\gamma-4(6+\beta+2\beta^2)\gamma^2-\beta(2+\beta)\gamma^3+2(2+\beta+\beta^2)\gamma^4](a-c)}{4[32-4(10+\beta+3\beta^2)\gamma^2+4(4+\beta+2\beta^2)\gamma^4-(2+\beta+\beta^2)\gamma^6]}$$

$$\Pi_2^d = \frac{(2-\beta)^2(1-\gamma)[32+8\beta\gamma-4(6+\beta+2\beta^2)\gamma^2-\beta(2+\beta)\gamma^3+2(2+\beta+\beta^2)\gamma^4]^2(a-c)^2}{16(2-\gamma)^2(1+\gamma)(16-2(6+\beta+3\beta^2)\gamma^2+(2+\beta+\beta^2)\gamma^4)^2}$$

$$\Pi_U^d = \frac{\beta(1-\gamma)(2+\gamma)(a-c)^2}{16(2-\gamma)(1+\gamma)(2-\gamma^2)(16-2(6+\beta+3\beta^2)\gamma^2+(2+\beta+\beta^2)\gamma^4)^2}[64(8-6\gamma^2+\gamma^4)^2+ \\ +16\beta^4\gamma^3(8+\gamma(1-2\gamma))-\beta^5\gamma^4(8+\gamma-2\gamma^2)^2-16\beta(2-\gamma)(2+\gamma)(2-\gamma^2)(16- \\ -\gamma(20+\gamma(4-\gamma(7-2\gamma))))+4\beta^3\gamma^2(48-\gamma(112+\gamma(32-\gamma(58-\gamma-5\gamma^2))))- \\ -16\beta^2\gamma(96+\gamma(48-\gamma(80+\gamma(52-\gamma(16+17\gamma-2\gamma^3)))))]$$

In a similar reasoning, we get that especially for $\beta = \beta_B(\gamma) = \frac{2\gamma}{2+\gamma}$, the hybrid regime arises in equilibrium. Summing up all the previous results we get that universal interim observability is a sustainable disclosure regime for all βs and γs, albeit it is unique for $\beta \neq \beta_B(\gamma)$, since for $\beta = \beta_B(\gamma)$ all three disclosure regimes arise in equilibrium.

In what follows, we will move to the case of competing vertical chains $(U_i, D_i), i = 1, 2$. Let us first consider the case of two-part tariffs.

Under universal interim observability we get:

$$\begin{aligned}
\Pi_1^{\mathcal{BEO}} = \Pi_2^{\mathcal{BEO}} =& \frac{2(1-\beta)(1-\gamma)(2-\gamma^2)(a-c)^2}{(1+\gamma)(4-\gamma(2+\gamma))^2} \\
\Pi_{U_1}^{\mathcal{BEO}} = \Pi_{U_2}^{\mathcal{BEO}} =& \frac{2\beta(1-\gamma)(2-\gamma^2)(a-c)^2}{(1+\gamma)(4-\gamma(2+\gamma))^2} \\
w_1^d =& c \\
F_1^d =& \frac{16\beta(1-\gamma)(2-\gamma^2)^2(a-c)^2}{(1+\gamma)(4-\gamma^2)^2(4-\gamma(2+\gamma))^2} \\
\Pi_i^d =& \frac{16(1-\beta)(1-\gamma)(2-\gamma^2)^2(a-c)^2}{(1+\gamma)(4-\gamma^2)^2(4-\gamma(2+\gamma))^2} \\
\Pi_{U_i}^d =& \frac{16\beta(1-\gamma)(2-\gamma^2)^2(a-c)^2}{(1+\gamma)(4-\gamma^2)^2(4-\gamma(2+\gamma))^2}
\end{aligned}$$

Consider that pair (U_i, D_i) deviates to secrecy given that the rival pair (U_j, D_j) sticks to interim observability. Note that $\Pi_{U_i}^{\mathcal{BEO}} > \Pi_U^d, i = 1, 2$ for all βs and γs, therefore no U_i has incentives to sign an NDA. So, universal interim observability arises in equilibrium. Moreover, the same reasoning applies for the downstream firms as well, i.e., $\Pi_{D_i}^{\mathcal{BEO}} > \Pi_i^d, i = 1, 2$ for all βs and γs.

Under universal secrecy we get:

$$\begin{aligned}
\Pi_1^{\mathcal{BES}} = \Pi_2^{\mathcal{BES}} =& \frac{(1-\beta)(1-\gamma)(a-c)^2}{(1+\gamma)(2-\gamma)^2} \\
\Pi_{U_1}^{\mathcal{BES}} = \Pi_{U_2}^{\mathcal{BES}} =& \frac{\beta(1-\gamma)(a-c)^2}{(1+\gamma)(2-\gamma)^2} \\
w_1^d =& c + \frac{\gamma^2(2-\gamma-\gamma^2)(a-c)}{4(2-\gamma^2)} \\
F_1^d =& \frac{(1-\gamma)(2+\gamma)^2(2\beta-\gamma^2)(a-c)^2}{16(1+\gamma)(2-\gamma^2)} \\
\Pi_i^d =& \frac{(1-\beta)(1-\gamma)(2+\gamma)^2(a-c)^2}{8(1+\gamma)(2-\gamma^2)} \\
\Pi_{U_i}^d =& \frac{\beta(1-\gamma)(2+\gamma)^2(a-c)^2}{8(1+\gamma)(2-\gamma^2)}
\end{aligned}$$

Since $\Pi_{U_i}^{\mathcal{BES}} < \Pi_{U_i}^{d}$, for all βs and γs, U_i always has incentives to deviate to interim observability. The same holds for the downstream firm as well, i.e., $\Pi_{D_i}^{\mathcal{BES}} < \Pi_i^d$, for all βs and γs. So, universal secrecy could not arise in equilibrium.

Under the hybrid regime we get:

$$\begin{aligned}
\Pi_1^{\mathcal{BEH}} =& \frac{(1-\beta)(1-\gamma)(2+\gamma)^2(a-c)^2}{8(1+\gamma)(2-\gamma^2)}\\
\Pi_2^{\mathcal{BEH}} =& \frac{(1-\beta)(1-\gamma)(4+\gamma(2-\gamma))^2(a-c)^2}{16(1+\gamma)(2-\gamma^2)^2}\\
\Pi_{U_1}^{\mathcal{BEH}} =& \frac{\beta(1-\gamma)(2+\gamma)^2(a-c)^2}{8(1+\gamma)(2-\gamma^2)}\\
\Pi_{U_2}^{\mathcal{BEH}} =& \frac{\beta(1-\gamma)(4+\gamma(2-\gamma))^2(a-c)^2}{16(1+\gamma)(2-\gamma^2)^2}
\end{aligned}$$

Deviation (i)

$$\begin{aligned}
w_1^d =& c\\
F_1^d =& \frac{\beta(1-\gamma)(a-c)^2}{(2-\gamma)^2(1+\gamma)}\\
\Pi_1^d =& \frac{(1-\beta)(1-\gamma)(a-c)^2}{(2-\gamma)^2(1+\gamma)}\\
\Pi_{U_1}^d =& \frac{\beta(1-\gamma)(a-c)^2}{(2-\gamma)^2(1+\gamma)}
\end{aligned}$$

Deviation (ii)

$$\begin{aligned}
w_2^d =& c + \frac{\gamma^2(1-\gamma)(4-\gamma^2)(4+\gamma(2-\gamma))(a-c)}{16(2-\gamma^2)^2}\\
F_2^d =& \frac{(1-\gamma)(4-\gamma^2)^2(2\beta-\gamma^2)(4+\gamma(2-\gamma))^2(a-c)^2}{256(1+\gamma)(2-\gamma^2)^3}\\
\Pi_2^d =& \frac{(1-\beta)(1-\gamma)(2-\gamma)^2(2+\gamma)^2(4+\gamma(2-\gamma))^2(a-c)^2}{128(1+\gamma)(2-\gamma^2)^3}\\
\Pi_{U_2}^d =& \frac{\beta(1-\gamma)(2-\gamma)^2(2+\gamma)^2(4+\gamma(2-\gamma))^2(a-c)^2}{128(1+\gamma)(2-\gamma^2)^3}
\end{aligned}$$

Note that in deviation (i) no firm from pair (U_1, D_1) has incentives to deviate to secrecy. However, in deviation (ii) both D_2 and U_2 have incentives to deviate to interim observability.

Finally, we consider the case of competing vertical chains and linear tariffs.

Under universal interim observability we get:

$$\Pi_1^{\mathcal{BWO}} = \Pi_2^{\mathcal{BWO}} = \frac{(1-\gamma)(2-\beta)^2(2-\gamma^2)^2(a-c)^2}{(1+\gamma)(2-\gamma)^2(4-\gamma(\beta+2\gamma))^2}$$

$$\Pi_{U_1}^{\mathcal{BWO}} = \Pi_{U_2}^{\mathcal{BWO}} = \frac{\beta(1-\gamma)(2-\beta)(2+\gamma)(2-\gamma^2)(a-c)^2}{(1+\gamma)(2-\gamma)^2(4-\gamma(\beta+2\gamma))^2}$$

$$w_1^d = c + \frac{4\beta(1-\gamma)(2+\gamma)(2-\gamma^2)(a-c)}{(8-\gamma^2(2+\beta))(4-\gamma(\beta+2\gamma))}$$

$$\Pi_i^d = \frac{4(2-\beta)^2(1-\gamma)(2+\gamma)^2(2-\gamma^2)^2(a-c)^2}{(1+\gamma)(8-\gamma^2(2+\beta))^2(4-\gamma(\beta+2\gamma))^2}$$

$$\Pi_{U_i}^d = \frac{8\beta(2-\beta)(1-\gamma)(2+\gamma)^2(2-\gamma^2)^2(a-c)^2}{(1+\gamma)(8-\gamma^2(2+\beta))^2(4-\gamma(\beta+2\gamma))^2}$$

Consider that pair (U_i, D_i) deviates to secrecy given that the rival pair (U_j, D_j) sticks to interim observability. Note that $\Pi_{U_i}^{\mathcal{BWO}} > \Pi_U^d, i = 1, 2$ for all βs and γs, therefore no U_i has incentives to sign an NDA. So, universal interim observability arises in equilibrium. Moreover, the same reasoning applies for the downstream firms as well, i.e., $\Pi_{D_i}^{\mathcal{BWO}} > \Pi_i^d, i = 1, 2$ for all βs and γs.

Under universal secrecy we get:

$$\Pi_1^{\mathcal{BWS}} = \Pi_2^{\mathcal{BWS}} = \frac{(1-\gamma)(2-\beta)^2(a-c)^2}{(1+\gamma)(4-\gamma(2+\beta))^2}$$

$$\Pi_{U_1}^{\mathcal{BWS}} = \Pi_{U_2}^{\mathcal{BWS}} = \frac{2\beta(1-\gamma)(2-\beta)(a-c)^2}{(1+\gamma)(4-\gamma(2+\beta))^2}$$

$$w_1^d = c + \frac{\beta(1-\gamma)(8-\gamma^2(2+\beta))(a-c)}{2(2-\gamma^2)(4-\gamma(2+\beta))}$$

$$\Pi_i^d = \frac{(1-\gamma)(2-\beta)^2(8-\gamma^2(2+\beta))^2(a-c)^2}{4(1+\gamma)(4-\gamma^2)^2(4-\gamma(2+\beta))^2}$$

$$\Pi_{U_i}^d = \frac{\beta(1-\gamma)(2-\beta)(8-\gamma^2(2+\beta))^2(a-c)^2}{4(1+\gamma)(2-\gamma^2)(4-\gamma^2)(4-\gamma(2+\beta))^2}$$

Since $\Pi_{U_i}^{\mathcal{BWS}} < \Pi_{U_i}^d$, for all βs and γs, U_i always has incentives to deviate to interim observability. The same holds for the downstream firm as well. So, universal secrecy could not arise in equilibrium.

Under the hybrid regime we get:

$$\Pi_1^{\mathcal{BWH}} = \frac{(1-\gamma)(2-\beta)^2(2-\gamma^2)^2(4+\gamma(2+\beta))^2(a-c)^2}{4(1+\gamma)(16-(12+\beta(2+\beta))\gamma^2+(2+\beta)\gamma^4)^2}$$

$$\Pi_2^{\mathcal{BWH}} = \frac{(1-\gamma)(2-\beta)^2(2+\gamma)^2(4+\gamma(\beta-2\gamma))^2(a-c)^2}{4(1+\gamma)(16-(12+\beta(2+\beta))\gamma^2+(2+\beta)\gamma^4)^2}$$

$$\Pi_{U_1}^{\mathcal{BWH}} = \frac{\beta(1-\gamma)(2-\beta)(2-\gamma^2)(4-\gamma^2)(4+\gamma(2+\beta))^2(a-c)^2}{4(1+\gamma)(16-(12+\beta(2+\beta))\gamma^2+(2+\beta)\gamma^4)^2}$$

$$\Pi_{U_2}^{\mathcal{BWH}} = \frac{\beta(1-\gamma)(2-\beta)(2+\gamma)^2(4+\gamma(\beta-2\gamma))^2(a-c)^2}{2(1+\gamma)(16-(12+\beta(2+\beta))\gamma^2+(2+\beta)\gamma^4)^2}$$

Deviation (i)

$$
\begin{aligned}
w_1^d =& c + \frac{2\beta(2-\gamma)(1-\gamma)(2+\gamma)(4+(2+\beta)\gamma)(2-\gamma^2)(a-c)}{128-8(16+\beta(4+\beta))\gamma^2+(2+\beta)(20+\beta(2+\beta))\gamma^4-(2+\beta)^2\gamma^6} \\
\Pi_1^d =& \frac{(2-\beta)^2(1-\gamma)(4+(2+\beta)\gamma)^2(8-6\gamma^2+\gamma^4)^2(a-c)^2}{(1+\gamma)(8-(2+\beta)\gamma^2)^2(16-(12+2\beta+\beta^2)\gamma^2+(2+\beta)\gamma^4)^2} \\
\Pi_{U_1}^d =& \frac{2\beta(2-\beta)(1-\gamma)(4+(2+\beta)\gamma)^2(8-6\gamma^2+\gamma^4)^2(a-c)^2}{(1+\gamma)(8-(2+\beta)\gamma^2)^2(16-(12+2\beta+\beta^2)\gamma^2+(2+\beta)\gamma^4)^2}
\end{aligned}
$$

Deviation (ii)

$$
\begin{aligned}
w_2^d =& c + \frac{\beta(4+(\beta-2\gamma)\gamma)(2-\gamma-\gamma^2)(8-(2+\beta)\gamma^2)(a-c)}{128-8(20+\beta(2+\beta))\gamma^2+4(16+\beta(4+\beta))\gamma^4-4(2+\beta)\gamma^6} \\
\Pi_2^d =& \frac{(2-\beta)^2(1-\gamma)(4+(\beta-2\gamma)\gamma)^2(8-(2+\beta)\gamma^2)^2(a-c)^2}{16(2-\gamma)^2(1+\gamma)(16-(12+\beta(2+\beta))\gamma^2+(2+\beta)\gamma^4)^2} \\
\Pi_{U_2}^d =& \frac{(2-\beta)\beta(1-\gamma)(2+\gamma)(4+(\beta-2\gamma)\gamma)^2(8-(2+\beta)\gamma^2)^2(a-c)^2}{16(2-\gamma)(2-\gamma^2)(1+\gamma)(16-(12+\beta(2+\beta))\gamma^2+(2+\beta)\gamma^4)^2}
\end{aligned}
$$

With respect to deviation (ii), U_2 always has incentives to deviate to interim observability. Therefore, the hybrid regime could not arise in equilibrium. ■

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