# On the choice of contract type in vertical relations.

Christos Constantatos*

and

Ioannis N. Pinopoulos

*University of Macedonia, Thessaloniki, Greece

E-mail address: cconst@uom.gr

Very preliminary version

Please do not quote without permission

**Abstract**

How do firms within a vertical chain select the contract type through which trade will be conducted? We assume that an upstream and a downstream firm choose simultaneously and independently between two contract types: a linear contract and a two-part tariff contract. There are two equilibria over which the firms have divergent interests. The risk-dominance criterion selects the equilibrium with two-part (linear) tariff when the downstream firm has relatively high (low) bargaining power vis-à-vis the upstream one.The opposite holds true when firms bargain over the contract type instead of playing non-cooperatively. Our analysis can form the basis for empirical investigation.

*Keywords*: Vertical relations; strategic contracting, coordination games, risk dominance.

*JEL Classification codes:* L12; L22; L42; C72

*Corresponding address: Ioannis N. Pinopoulos, Department of Economics, University of Macedonia, 156 Egnatia Street, Thessaloniki, Greece. Phone: (+30) 2310-891-663. E-mail address: me0710@uom.gr

## 1. Introduction

Vertical relations are ubiquitous in real-world markets. Firmsthat are active in one stage of the vertical production chain trade with firms that operate at previous and/or later production stages. An important feature of vertically related markets is the contract type through which trading between firms is conducted. While a large number of studies in the theoretical literature on strategic vertical contracting assume predetermined contract types, there are some papers that assume that contract types are endogenous and therefore constitute a strategic decision for firms (Gal-Or, 1991; Rey & Stiglitz, 1995; Milliou & Petrakis, 2007;Milliou *et al.*, 2012, Milliou & Pavlou, 2013).

Gal-Or (1991), Rey & Stiglitz (1995) and Milliou & Pavlou (2013)consider the case where all the bargaining powerlies in the hands of upstream firms. In this setting, the choice of the contract types, as well as the choice of the exact terms of each contract, is made by the upstream suppliers.Milliou *et al.* (2012), acknowledging the observed fact of increased concentration in the downstream sector of many industries, consider the case whereupstream and downstream firms engage in bargaining over both the types and terms of the vertical contracts.[1]

In this paper, we maintain the assumption that once the contract type is chosen, firms bargain over the specific terms of the contract. However, we offer an alternative way of capturing the fact that both upstream and downstream firms participate in the selection of the contract type. Specifically, we assume that, instead of engaging in bargaining, up- and downstream firms simultaneously and independently choose between the contract types available.

In order to make our point as clear as possible, we consider a successive monopoly model where there are two types of contracts available: a simple *linear contract* that specifies only a per-unit price for the input and a *two-part tariff (non-linear) contract* consisting of a per-unit of input price and a fixed fee.[2]First, the upstream and the downstream firm simultaneously

[1]Milliou & Petrakis (2007) assume that upstream and downstream firms engage in Nash bargaining over the terms of the selected contract type, however, they also assume that the upstream firms are the ones that choose which contract will be enforced. This set of assumptions seems problematic since one might wonderwhy downstream firms have (at least some) bargaining power over the terms of a given contract but they do not have any power in the choice of the contract type.

[2]These two contract types are extensively used in the theoretical literature on vertical relations. For empirical evidence regarding the use of non-linear contracts see, e.g., Slade (1998), Berto Villa-Boas (2007), Bonnet & Dubois (2010) and Ferrari & Verboven (2012). For empirical evidence regarding the use of linear contracts see,

and independently choose the contract typethrough which trade will be conducted.If the two firms fail to coordinate their choices (one chooses a linear and the other chooses a two-part tariff) then both firms produce nothing and their payoffs are zero. Once the contract type is selected, the two firms engage in Nash bargaining over the contract terms.

The entire game has two subgame perfect Nash equilibria in pure strategies: one where both firms choose to trade through a linear contract and the other where both firms choose to trade through a two-part tariff contract. For any given distribution of bargaining power, it is shown that the upstream firm always prefers the equilibrium with a two-part tariff and the downstream firm always prefers the equilibrium with a linear contract. Since firms have divergent interests over equilibria, we resort to the risk-dominance criterion–originally proposed by Harsanyi & Selten (1988) –for equilibrium selection.[3]

According to the risk-dominancecriterion, the higher (lower) is the bargaining power of the upstream firm vis-à-vis the downstream one, the more likely is that the linear (two-part) tariff will be chosen. This finding seems counter-intuitive at first glance, since one anticipates that the firm with the higher bargaining power will be able to enforce the contract that it is more preferable to itself, i.e., when the upstream (downstream) firm has high enough bargaining power, one expects a two-part (linear) tariff to be enforced. However, the intuition for our result lies in the notion of risk dominance: when the upstream firm has high (low) enough bargaining power, a possible fail in coordinating actions implies much higher (lower) risk for the upstream firm compared to the downstream one, and therefore the linear (two-part tariff) contract will be chosen.

The above finding is reversed when firms bargain over the contract type. In particular, under bargaining over both the contract types and terms, the higher (lower) is the bargaining power of the upstream firm vis-à-vis the downstream one, the more likely is that the two-part (linear)tariff will be chosen. Thus, the contract type that will be eventually enforced within a vertical chain crucially depends on whether firms engage in bargaining or in a non-cooperative game regarding the contract type selection.

---

for example, Smith & Thanassoulis (2009), Crawford & Yurukoglu (2012), Grennan (2013, 2014), Gilbert (2015), Crawford *et al* (2015) and Ho & Lee (2017).

[3]As Cabrales *et al*. (2000) point out, there are several reasons (both theoretical and empirical) why risk dominance can be considered a good criterion for equilibrium selection. For more details on this issue see the discussion in Cabrales *et al*. (2000, pg 143-144) and the references therein.

## 2. The model

An upstream firm, denoted by*U*, produces an input which a downstream firm, denoted by *D*, use, in one-to-one-proportion in the production of a final good. For simplicity, and without loss of generality, we assume zero marginal production costs both upstream and downstream. Therefore, the downstream firm face no other cost than the cost of obtaining the input from the upstream supplier. Final-good demand is assumed to be linear, $p = 1 - Q$.

The timing of the three-stage game is as follows.

*Stage 1.*The upstream and the downstream firm simultaneously and independently choose the contract *type* through which trade will be conducted. We assume that there are two contract types available: asimple *linear contract* that specifies only a per-unit price for the input *w* and a *two-part tariff contract* consisting of a per-unit of input price *w* and a fixed fee *F*.If the two firms fail to coordinate their choices (one chooses a linear contract and the other chooses a two-part tariff) then both firms produce nothing and their payoffs are zero.

*Stage 2*. The upstream-downstream pair negotiates over the *terms* of the selected contract type. We consider Nash bargaining where the bargaining power of *U* and *D* in bilateral negotiations is given respectively by $\beta$ and $1-\beta$ with $\beta \in (0,1)$.

*Stage 3*. The downstream firm buys the input, produces the final good and serves consumers.

We solve the game backwards seeking subgame perfect Nash equilibria in pure strategies.Regarding notational issues, we will use *L* to denote the case of linear contracting and *T* to denote the case of two-part tariff contracts. Moreover, we denote gross profits of a firm as $\pi$ and net profits as$\Pi$. Although this distinction is redundant in the case of linear contracting where gross profits equal net profits, it is certainly not when two-part tariffs are used, in which case net profits are equal gross profits plus (minus) a fixed fee for the upstream (downstream) firm.

## 3. Equilibrium analysis

We start by solving the last stage of the game. Since the downstream firm is a monopolist in the final-good market, then it is straightforward that the equilibrium outcomes in the last-stage subgame, as functions of the input price*w*, are given by:

$$Q(w)=\frac{1-w}{2},\quad p(w)=\frac{1+w}{2},\quad \pi_D(w)=\frac{(1-w)^2}{4}. \tag{1}$$

Next, we solve the second stage of the gameby determining the equilibrium contract terms. We consider first the case of linear contracting. The upstream and the downstream firm set *w* to maximize the following generalized Nash product,

$$\max_{w}\Omega=[\Pi_U(w)]^{\beta}[\Pi_D(w)]^{1-\beta}, \tag{2}$$

where $\Pi_U(w)=\pi_U(w)=wQ(w)$ and $\Pi_D(w)=\pi_D(w)$. Solving the first-order condition of the maximization problem in (2),we obtain the equilibrium input price,

$$w^{L^*}=\frac{\beta}{2}. \tag{3}$$

Using (1), (3), we obtain the equilibrium downstream and upstream net profits underlinear contractingas:

$$\Pi_D^{L^*}=\pi_D^{L^*}=\frac{(2-\beta)^2}{16},\quad \Pi_U^{L^*}=\pi_U^{L^*}=\frac{\beta(2-\beta)}{8}. \tag{4}$$

We now turn to the case of a two-part tariff contract. The upstream and the downstream firm choose*w*and *F* to maximize the following generalized Nash product,

$$\max_{w,F}\Omega'=[\Pi_U(w)]^{\beta}[\Pi_D(w)]^{1-\beta}=[\pi_U(w)+F]^{\beta}[\pi_D(w)-F]^{1-\beta}, \tag{5}$$

Maximizing (5) with respect to $F$ we obtain:

$$F = \beta[\pi_D(w] - (1-\beta)[\pi_U(w)]\,. \tag{6}$$

Substituting (6) into (5), the generalized Nash product reduces to the following expression which is maximized with respect to*w*,

$$\max_w \pi_D(w) + \pi_U(w)\,. \tag{7}$$

As it is well-known in the literature, a two-part tariff contract is bilaterally efficient due to the existence of a fixed fee; the input price will be chosen as to maximize industry profits. This implies upstream marginal cost pricing and since in our model upstream marginal costs are normalized to zero then $w^{T^*} = 0$. Using (1), (6), we obtain the equilibrium downstream and upstream net profits under a two-part tariff contract as:

$$\Pi_D^{T^*} = \pi_D^{T^*} - F^{T^*} = \frac{1-\beta}{4}, \quad \Pi_U^{T^*} = \pi_U^{T^*} + F^{T^*} = \frac{\beta}{4}\,. \tag{8}$$

The entire game has two subgame perfect Nash equilibria in pure strategies (see Table 1): one where both firms choose to trade through a linear contract, i.e., (*L*,*L*), and the other where both firms choose to trade through a two-part tariff contract, i.e., (*T, T*). Comparing (4) and (8), it can be easily checked that $\Pi_U^{T^*} > \Pi_U^{L^*}$, which implies that the upstream firm always prefers the equilibrium with a two-part tariff and $\Pi_D^{T^*} < \Pi_D^{L^*}$, which implies that the downstream firm always prefers the equilibrium witha linear contract. In this type of coordination games, where players have divergent interests over different equilibria,[4] most standard criteria for equilibrium selection have no selective power (e.g., Pareto dominance) and therefore we resort to the risk dominance criterionfor equilibrium selection.

[4]See the game known as "Battle of the Sexes" (Luce & Raiffa, 1957).

| | | Upstream | |
|---|---|---|---|
| | | Two-part tariff (T) | Linear input price (L) |
| Downstream | Two-part tariff (T) | $\frac{1-\beta}{4}, \frac{\beta}{4}$ | 0,0 |
| | Linear input price (L) | 0,0 | $\frac{(2-\beta)^2}{16}, \frac{\beta(2-\beta)}{8}$ |

Table 1.

## 4.Risk dominance

The concept of risk dominancecaptures the intuitive idea that, when players do not know which of two equilibria should be played, they will measure the risk involved in playing each of these equilibria and they will coordinate expectations on the less risky one.[5]In other words, the risk-dominance criterion compares the product of deviation losses from each equilibrium and the equilibrium with the largest product is the one that risk dominates.

In our setting, the strategy pair (*T, T*) risk dominates (*L,L*) when the product of the deviation losses is highest for (*T, T*), or in other words, if the following inequality holds,

$$(0-\frac{1-\beta}{4})(0-\frac{\beta}{4}) > (0-\frac{(2-\beta)^2}{16})(0-\frac{\beta(2-\beta)}{8}). \quad (9)$$

Similarly, the strategy pair (*L,L*) risk dominates (*T, T*) when the above inequality is reversed.

**Proposition 1.***The equilibrium with a two-part tariff contract risk dominates the equilibrium with linear contracting whenever* $\beta < 0,76393$, *whereas the opposite holds true whenever* $\beta > 0,76393$.

***Proof***. After some straightforward calculations, the inequality in (9) can be written as $\beta(4-6\beta+\beta^2) > 0$. Since $\beta \in (0,1)$, the latter inequality holds whenever $\beta < 0,76393$. ■

[5]For a formal definition of risk dominancesee Harsanyi & Selten (1988). For an application of the risk-dominance criterion in other contexts (such as quality choice, endogenous price leadership and/or tax imposition)seeCabrales *et al*. (2000), van Damme & Hurkens (2004) and Kempf & Rota-Graziosi (2010) among others.

According to the criterion of risk dominance, the higher (lower) is the bargaining power of the upstream firm vis-à-vis the downstream firm, the more likely is that the linear contract (two-part tariff contract) will be chosen in equilibrium.This finding seems counter-intuitive at first glance, since one anticipates that the firm with the higher bargaining power will be able to enforce the contract that it is more preferable to itself, i.e., when the upstream (downstream) firm has high enough bargaining power, one expects a two-part (linear) tariff to be enforced. However, the intuition for our result lies in the notion of risk dominance: when the upstream firm has high (low) enough bargaining power, a possible fail in coordination of actions implies much higher (lower) risk for the upstream firm compared to the downstream firm, and thus the linear (two-part tariff) contract will be chosen.

Finally, one might wonder whether the above finding remains robust if firms bargain over the contract type instead of playing non-cooperatively.Following Milliou *et al*. (2012), we assume that with probability $\beta$ the contract is chosen by the upstream firm and with probability $1 - \beta$ the contract is chosen by the downstream firm. It is straightforward then that the higher (lower) is the bargaining power of the upstream firm vis-à-vis the downstream firm, the more likely is that the two-part tariff (linear) contract will be chosen in equilibrium. The latter finding is in stark contrast to the one obtained under the assumption of firms playing a non-cooperative game when selecting the contract type.

## 5. Concluding remarks

How do firms within a vertical chain select the contract type through which trade will be conducted? We assume that an upstream and a downstream firm choose simultaneously and independently between two contract types: a linear contract and a two-part tariff contract. There are two equilibria over which firms have divergent interests. The risk-dominance criterion selects the equilibrium with two-part (linear) tariff when the downstream firm has relatively high (low) bargaining power vis-à-vis the upstream one. The opposite holds true when firms bargain over the contract type.Thus, the contract type that will be eventually enforced within a chain crucially depends on whether firms engage in bargaining or in a non-cooperative game regarding the contract type selection.

It should be noted here that our finding is based upon the simplifying assumption of a successive monopoly model.Considering more competing vertical chains in order to check if and how our result is affected by both intra-brand and inter-brand competition comprises a

promising avenue for future research. Nevertheless, we believe that the present analysis is still useful for raising the question of how do firms within a vertical chain select the contract type through which trade will be conducted.

**References**


Berto Villas-Boas, S., 2007. Vertical relationships between manufacturers and retailers: inference with limited data. *The Review of Economic Studies*, 74(2), 625-652.

Bonnet, C., & Dubois, P., 2010. Inference on vertical contracts between manufacturers and retailers allowing for nonlinear pricing and resale price maintenance. *The RAND Journal of Economics*, 41(1), 139-164.

Cabrales, A., Garcia-Fontes, W., Motta, M., 2000. Risk dominance selects the leader: An experimental analysis.*International Journal of Industrial Organization*, 18(1), 137-162.

van Damme, E., Hurkens, S., 2004. Endogenous price leadership. *Games and Economic Behavior*, 47(2), 404-420.

Ferrari, S. & Verboven, F., 2012. Vertical control of a distribution network – an empirical analysis of magazines.*The RAND Journal of Economics*, 43(1), 26-50.

Gal-Or, E., 1991. Duopolistic vertical restraints.*European Economic Review*, 35(6), 1237-1253.

Gilbert, R. J. (2015). E-books: A tale of digital disruption. *Journal of Economic Perspectives*, 29(3), 165-84.

Crawford, G. S., & Yurukoglu, A. (2012). The welfare effects of bundling in multichannel television markets. *American Economic Review*, 102(2), 643-85.

Crawford, G. S., Lee, R. S., Whinston, M. D., & Yurukoglu, A. (2015). The welfare effects of vertical integration in multichannel television markets (No. w21832). National Bureau of Economic Research.

Grennan, M. (2013). Price discrimination and bargaining: Empirical evidence from medical devices. *American Economic Review*, 103(1), 145-77.

Grennan, M. (2014). Bargaining ability and competitive advantage: Empirical evidence from medical devices. *Management Science*, 60(12), 3011-3025.

Harsanyi, J., Selten, R., 1988. A General Theory of Equilibrium Selection in Games. The MIT Press, Cambridge, MA.

Ho, K., & Lee, R. S. (2017). Insurer competition in health care markets. *Econometrica*, 85(2), 379-417.

Kempf, H., Rota-Graziosi,G., 2010. Endogenizing leadership in tax competition. *Journal of Public Economics*, 94(9), 768-776.

Luce, R., Raiffa, H., 1957. Games and Decisions. Wiley, New York.

Milliou, C., Pavlou, A., 2013. Upstream mergers, downstream competition and R&D investments. *Journal of Economics and Management Strategy*, 22(4), 787-809.

Milliou, C., Petrakis, E., 2007. Upstream horizontal mergers, vertical contracts and bargaining. *International Journal of Industrial Organization*, 25(5), 965–987.

Milliou, C., Petrakis, E., Vettas, N., 2012. (In)efficient trading forms in competing vertical chains. Working paper, August 2012.

Rey, P., Stiglitz, J., 1995. The role of exclusive territories in producers' competition. *The RAND Journal of Economics*, 26(3), 431-451.

Slade, M.E., 1998. Strategic motives for vertical separation: evidence from retail gasoline markets.*Journal of Economics and Management Strategy*, 14(1), 84-113.

Smith, H., Thanassoulis, J., 2009. Bargaining between retailers and their suppliers. In A. Ezrachi and U. Bernitz, eds. *Private Labels, Brands and Competition Policy*, 45–70, Oxford, UK: Oxford University Press.