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TWO MODELS OF VIRTUAL TRANSFER PRICING MECHANISMS IN GLOBAL SUPPLY CHAIN

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ABSTRACT

Supply chain is a network of financial flow while contract is a primary way of recognizing and distributing profits between buyer and supplier in a supply chain. Virtual transfer pricing defined in this study is the mechanism of using contract bundles within a global supply chain to maximize profit. We propose two virtual transfer pricing models.

Key Words: Virtual Transfer Pricing; Contract Pricing; Profit Optimization; Global Supply Chain

1. INTRODUCTION

Profit shifting can be achieved through transfer pricing and contracts. Traditionally, multinational companies have used transfer pricing as a way to effectively manage exchange risk, minimize total transnational tax amount and optimize profits [22]. A transfer price is the cost of transferring product or service from one country to another country within a multinational corporation [1]. Transfer pricing is the most important concern of multinational companies (MNCs) [18] and is a major part of US foreign trade as well as world trade [11] [20]. Researchers develop many models to help industries to maximize their gains. Supply contracts can be a tool of sharing profits within a supply chain in one country [9]. Contract specifies financial details of transaction between buyer and supplier. Gramlich et al. (2004) identify that closely related firms such keiretsu group members strategically shift income from profitable members to unprofitable members to lower the overall tax of the group within one country [8].

Transfer pricing is allowed with the legitimate flows of product and services from one country and another country. However, due to significant impact of transferring price on after-tax income

of a company, the arbitrary manipulation of transferring price will be strictly penalized by tax authorities [22]. It has been observed that MNCs are turning to their suppliers to be intermediaries to transfer profits back to their home countries to minimize total transnational tax and manage exchange risk.

However, both two-party contracts and transfer pricing usually focus on partial profit maximization. In a global supply chain a manufacture often invests in another country using their own partner suppliers both in the home and foreign country. Very little research attention has been paid to how contracts can be used to have the same effect of transfer pricing, which is named virtual transfer pricing. This article presents two base models of allocating profits within supply chain through coordinating contracts with suppliers. The implications are significant for both government agencies and firms in a global supply chain.

2. LITERATURE REVIEW

Contract and bidding are two obvious ways of sharing profit. Bidding is used for selecting the most efficient bidder in terms of costs, quantity and order size. Contracts are widely used to allocate profit between manufacturer and supplier. Power plays a key role in the contract which mainly determines the extent of profit sharing between manufacturer and suppliers [7]. Manufacturer and buyers negotiate or even bid to decide an acceptable price with various incentives [13] [19]. Revenue sharing is implemented by using contracts [2] [24]. Supply profit sharing involves making use of contracts [9] and partnership that combines the strengths of collaborating entities [10].

A transfer price is the cost plus reasonable profits for transmitting product or service from one country to another country within the multinational corporation [1]. Villegas and Ouenniche (2008) summarize factors in previous transfer pricing studies, including income taxes, import tariffs, finished goods, intermediate products, primary trade, secondary trade, exchange rate risk, repatriation using tax credits, royalties, dividends, constrained transfer price, transfer price bonds by governments, exhaustible resources for intermediate products, NPV maximization objectives, transfer price penalty risk, not wholly owned subsidiaries, import and export transfer price, import and export trade quantities, import and export costs, and any levels of supply chains [23].

3. MODEL, PROPOSITIONS AND IMPLEMENTATIONS

In business situations, manufacturers expand from home country to a foreign country because of higher profit potential through larger sales or lower cost. When a manufacturer establishes a plant in a foreign country, it often asks its partner suppliers to invest into the foreign country as a way of securing the quality requirements of its product. Our model is based on the assumption that the manufacturer and its partner supplier(s) invest in both the home country and at lease one foreign country (Figure 1). A and B are different entities in form; in substance they may behave as one-linked entity (i.e., virtual organization). With the same supplier, virtual transferring profit is possible in that it may behave as partnering firm entity. In order to compare effects of global supply chain profit optimization with local supply chain profit optimization, a benchmark scenario is that the manufacturer deals with two different suppliers in two countries: supplier D

in country 1 while supplier E in country 0.

For the simplicity of presentation we first consider a scenario of one manufacture A and one supplier B in a home country 0, and a foreign country 1.

3.1 Negotiation Power Model

Figure 1: Supply Chain Structure for Company A and B in both countries

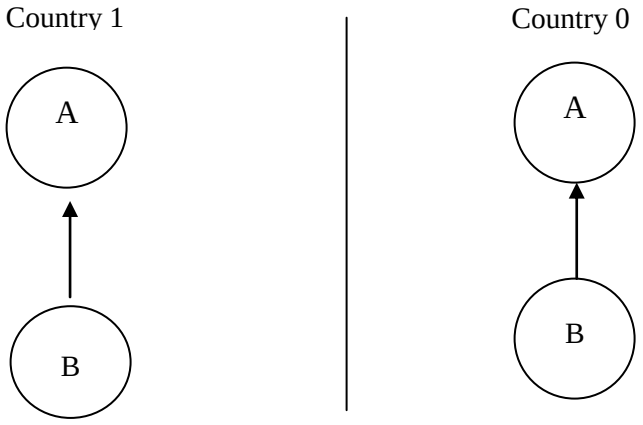


Table 1: parameters of the model

Parameter	Definition
R_i	Revenue function of manufacturer in country i = 0, 1
p_i	Contract price in country i = 0, 1
q_i	Sales quantity in country i = 0, 1
t_i	Company income tax rate in country i = 0, 1
c_j	Unit production cost of company j = A, B
λ	A's bargaining power
β	Exchange rate risk discounter from country 1 to country 0

A multinational company has to maximize global profit through different profit generating configurations, e.g., exchange rates, tax rates, tariffs, wage rates, sales price, risk factors, etc. The total profit of A and B in both country 0 and country 1 are Π_A and Π_B respectively. Assuming that the revenue function of R is continuously differentiable and convex, we can express the optimization problem facing company A as:

$$\Pi_A(q_0, q_1) = \max\left[\beta(1-t_1)\left(R_1(q_1) - (c_A + p_1)q_1\right) + (1-t_0)\left(R_0(q_0) - (c_A + p_0)q_0\right)\right] \quad (1)$$

Subject to $q_0 \geq 0$ and $q_1 \geq 0$.

Under the above stated assumptions on the revenue function, the optimality conditions for company A can be expressed as the following inequality [14] : determine $(q_1^*, q_0^*) \in R^+$, such

that

$$\left[\beta(1-t_1)(\frac{\partial R_1(q_1)}{\partial q_1}-c_A-p_1^*)\right]\times\left[q_1-q_1^*\right]+\left[(1-t_0)(\frac{\partial R_0(q_0)}{\partial q_0}-c_A-p_0^*)\right]\times\left[q_0-q_0^*\right]\geq 0 \quad (2)$$

Similarly, we can express the optimality problem facing company B (supplier) as:

$$\Pi_B(q_0,q_1)=\max\left[\beta(1-t_1)(p_1-c_B)q_1+(1-t_0)(p_0-c_B)q_0\right] \quad (3)$$

The optimality conditions for company B can be expressed as the following inequality (see also Nagurney and Ke (2001)): determine $(q_1^*, q_0^*) \in R^+$, such that

$$\left[\beta(1-t_1)(p_1^*-c_B)\right]\times\left[q_1-q_1^*\right]+\left[(1-t_0)(p_0^*-c_B)\right]\times\left[q_0-q_0^*\right]\geq 0 \quad (4)$$

If each company only maximizes its only profit independently, then the above profit functions show the incentive conflicts among the two companies. A wants to pay B a price p_0 and p_1 as low as possible and B wants both prices p_1 and p_0 as high as possible. However, since A and B negotiate the supply contracts in both countries, in practice, A pays B a low price p_1 in country 1 and a high price p_0 in country 0 and the difference of the prices works as the virtual transfer price to minimize its transnational tax. Indeed, B will then pay more transnational tax. Will this coordination relationship last long? In equilibrium, the product flows that manufacturer A receives from company B must be equal to those that company B transacts with manufacturer A in both foreign country 1 and home country 0. The contract and virtual transfer price must be agreed upon the negotiation between the two companies. Hence, the equilibrium product flows and price pattern must satisfy the sum of optimality conditions (2) and (4) in order to formalize the agreements between the two companies.

We now establish the following variational inequality:

$$\left[\beta(1-t_1)(\frac{\partial R_1(q_1^*)}{\partial q_1}-c_A-c_B)\right]\times\left[q_1-q_1^*\right]+\left[(1-t_0)(\frac{\partial R_0(q_0^*)}{\partial q_0}-c_A-c_B)\right]\times\left[q_0-q_0^*\right]\geq 0 \quad (5)$$

We now discuss how to recover the prices p_1^* and p_0^* from the solution of variational inequality (5). Note from (2), that if $q_1^*>0$, then p_1^* is precisely equal to $\frac{\partial R_1(q_1^*)}{\partial q_1}-c_A$ or, equivalently, to (cf. (4)) c_B. The price p_0^*, in turn (cf. also (2)), can be obtained by finding a $q_0^* > 0$, and then setting $p_0^*=\frac{\partial R_0(q_0^*)}{\partial q_0}-c_A$, or, equivalently (see (4)), to c_B. Notice that in equilibrium, or in the long run, p_0^* should be equal to p_1^* and virtual transfer price should be eliminated.

However, companies A and B may not have the same bargain power. In other words, according to Nash bargaining equilibrium, assume that A's bargaining power is λ, and B' bargaining power is 1-λ, the optimal contract is $\max(\Pi_A+\Pi_B)$, thus the profit function for companies A and B will be changed to:

$$\Pi_A(q_0,q_1)=\max\left[\lambda\beta(1-t_1)\left(R_1(q_1)-(c_A+p_1)q_1\right)+(1-t_0)\left(R_0(q_0)-(c_A+p_0)q_0\right)\right] \quad (6)$$

And

$$\Pi_B(q_0,q_1)=\max\left[(1-\gamma)\beta(1-t_1)(p_1-c_B)q_1+(1-t_0)(p_0-c_B)q_0\right] \quad (7)$$

The optimal contract is $\max_{p_0, p_1}(\Pi_A + \Pi_B)$, which is ,

$$\Pi_A + \Pi_B = (1-t_1)\beta\left[R_1(q_1)\lambda + \left((1-\lambda)p_1 - \lambda c_A - c_B\right)q_1\right] + (1-t_0)\left[R_0(q_0) - (c_A + c_B)q_0\right] \quad (8)$$

Therefore in this setup, Equation (8) suggests that firms A and B can both be better off if A pays a high price p_1 to firm B in country 1 and a lower price p_0 in country 0.

As a benchmark, now consider the scenario that A deals with two independent suppliers D and E at the two countries. Profits are Π_D and Π_E, A's total profit from both country is Π_A which is the same as (1). We have the following:

$$\Pi_D(q_0) = \max\left[(1-t_0)(p_0 - c_D)q_0\right] \quad (9)$$

$$\Pi_E(q_1) = \max\left[\beta(1-t_1)(p_1 - c_E)q_1\right] \quad (10)$$

In equilibrium, we have the following variational inequality established:

$$\left[\beta(1-t_1)\left(\frac{\partial R_1(q_1^*)}{\partial q_1} - c_A - c_D\right)\right] \times \left[q_1 - q_1^*\right] + \left[(1-t_0)\left(\frac{\partial R_0(q_0^*)}{\partial q_0} - c_A - c_E\right)\right] \times \left[q_0 - q_0^*\right] \geq 0 \quad (11)$$

Notice that p_0^* is not necessary to be the same as p_1^*.

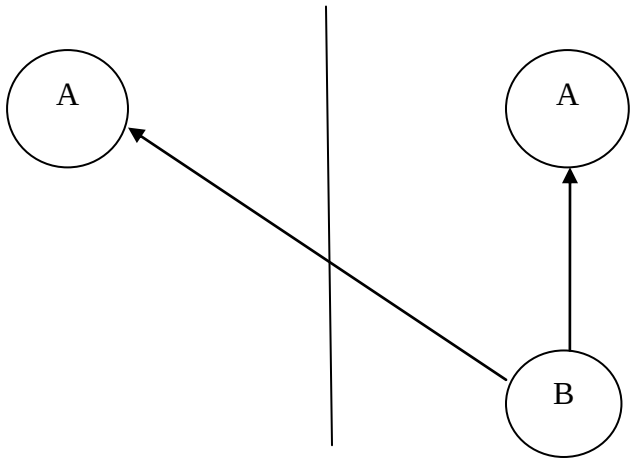
If A deals with B supplier only, which is a global company in both countries, A's total profit is Π_A'. B's total profit is Π_B'. We have the following conclusions:

Proposition 1: A global manufacturer A and its supplier B which co-exists with A in both countries can be both better off through virtual price transferring pricing: $\Pi_A' > \Pi_A$, $\Pi_B' > \Pi_D + \Pi_E$.

From analyzing the impact of parameters on company profits, we can get insights on what are the best strategies for each company, including the manufacturer, the supplier and the local company, to collaborate and how to manage the global supply chain.

3.2 Single Supplier Model

Figure 2: Supply Chain Structure for Company A in both countries and B in home country



In this model, we examine how A can transfer profit between two countries to avoid paying a high tax. The optimization problem facing company A will be the same as (1):

$$\Pi_A(q_0, q_1) = \max[\beta(1-t_1)(R_1(q_1)-(c_A+p_1)q_1)+(1-t_0)(R_0(q_0)-(c_A+p_0)q_0)] \quad (1)$$

Therefore, the optimality conditions for company A can be expressed as the following inequality (2): determine (q_1^*, q_0^*) $\in R^+$, such that

$$\left[\beta(1-t_1)(\frac{\partial R_1(q_1)}{\partial q_1}-c_A-p_1^*)\right]\times\left[q_1-q_1^*\right]+\left[(1-t_0)(\frac{\partial R_0(q_0)}{\partial q_0}-c_A-p_0^*)\right]\times\left[q_0-q_0^*\right]\geq 0 \quad (2)$$

However, the optimality problem facing company B (supplier) will become:

$$\prod_B(q_0,q_1) = \max[\beta(1-t_0)(p_1-c_B)q_1+(1-t_0)(p_0-c_B)q_0] \quad (12)$$

The optimality conditions for company B thus can be expressed as the following inequality (see also Nagurney and Ke (2001)): determine (q_1^*, q_0^*) $\in R^+$, such that

$$[\beta(1-t_0)(p_1^*-c_B)]\times[q_1-q_1^*]+[(1-t_0)(p_0^*-c_B)]\times[q_0-q_0^*]\geq 0 \quad (13)$$

Or $[\beta(p_1^*-c_B)]\times[q_1-q_1^*]+[(p_0^*-c_B)]\times[q_0-q_0^*]\geq 0$

Notice that when tax rate in country 1 (t_1) is higher than in country 0 (t_0), A can pay higher price (p_1^*) to B in country 1 and pay lower price (p_0^*) in country 0. So that A can transfer profit from country 1 to country 0 while lower the overall tax. This is similar to transfer pricing but does not use the way transfer pricing uses. So we call it a virtual transfer pricing.

4. CONCLUSIONS, DISCUSSIONS AND IMPLEMENTATIONS

This study proposes two profit maximization models through contract bundles in a global supply chain. The single supplier model is the model for the earlier stage of a global supply chain when suppliers are still in the home country of the buyer while the negotiation power model is for a mature and stable global supply chain with suppliers in both countries. In reality, most global supply chains are between these two extremes with some suppliers in the buyer's home country and some in other countries. Therefore, the two base models can be combined to be used in their profit maximization decisions.

This study has significant implications for tax authorities and companies. Tax authorities can use this model to identify possible manipulations of contract prices set by purchasing contracts. The models can help tax authorities to easily find the suspected suppliers among hundreds suppliers in a typical global supply chain. Firms in a global supply chain can use this model to largely increase their profits if they set their contract prices within the common region of the solutions of the models and the reasonable price range set by tax authorities. The models in this study can become reasonable balance tools for tax authorities and firms in global supply chains.

References available upon request from Kun Liao at LiaoK@cwu.edu