The impact of transfer prices on the production structure and location of firms. Preliminary Draft

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Abstract

In 1997, the OECD published guidelines to assess transfer prices, prescribing the application of the "arm's length principle" whereby transfer prices should equal the transaction prices with non-affiliated firms. While the two mostly used rules are the "Comparable Uncontrolled Price" and the "cost-plus" rules, arm's length transfer pricing has been translated mostly into marginal cost pricing in the existing literature. This paper proposes a two-country Dixit-Stiglitz model with iceberg transport costs and with two (endogenous) firm structures – multinationals and exporters – allowing us to translate the actual proposed rules into observable variables of a monopolistic competitive market. The firms that operate as exporters use an arm's length relationship with an independent foreign firm, generating double marginalization. Those operating under a multinational structure incur firm-specific distribution costs. In the presence of tax differences, the multinational structure offers the possibility of shifting profits to the low tax country. We study the choice of structure and location of firms under the alternative transfer pricing rules for different taxation and transport cost levels.

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1 Introduction

Transfer pricing between multinationals' affiliates is a widely observed phenomenon. By altering the prices of the goods transferred between affiliates, multinational firms are able to move a significant share of their revenues to low tax countries, thus avoiding profit taxes in high tax countries. As a response to transfer pricing behaviors, tax authorities exert audit, negotiation and litigation with multinationals in order to recover tax revenues. This situation is costly for both firms and tax authorities because it creates business uncertainty and because government' coordination failure lead to inefficient (effective) tax levels.

In 1997, the OECD published guidelines for transfer pricing that prescribe a set of rules to assess transfer prices in conjunction to documentation and agreement procedures. The prescribed rules apply the "arm's length principle" whereby transfer prices should reflect the transaction prices with (existing or potential) non-affiliated firms. The two mostly used rules are the "Comparable Uncontrolled Price" and the "cost-plus" rules.

The pervasive evidence on transfer pricing manipulation has led to the development of a theoretical literature focusing on the firms' incentives to manipulate transfer prices, on the one hand, and on (competing) governments' motivation to regulate their use. The early contributions have identified a tendency for a run to the top on transfer pricing regulations on behalf of competing governments facing immobile multinationals (Mansori and Weichenrieder, 1999, and Raimondos-Møller and Sharf, 2002). This run to the top result was later challenged by, e.g., Kind et al. (2004), Peralta et al. (2006), Bucovetsky and Haufler (2005), who model competing governments facing mobile multinationals.[1] Nielsen et al. (2003, 2005) and Schjelderup and Weichenrieder (1999) focus on the use of transfer prices as a profit shifting and/or incentive device in different product market and tax system contexts, and multinational organizational forms, without modeling competing governments.

While the literature has dealt with many important points regarding transfer pricing policy from the viewpoint of both multinationals and governments, at least two aspects have been, too date, largely disregarded. The first is the actual implementation of the arm's length principle as put forward by the OECD (1997). The arm's length principle is usually translated into marginal cost pricing (Kind et al., 2004, 2005, Peralta et al., 2006, Nielsen et al., 2005). This simplification assumption is mainly due to the absence of a benchmark arms' length price in models that usually treat the multinational firm as a monopolist. This takes us to the second missing element in the literature, namely, the

[1] Other references modeling competing governments include Elitzur and Mintz (1996) and Kind et al. (2005), who recognize the use of transfer pricing as a means to give the appropriate incentives to subsidiaries, and Haufler and Schjelderup (2000).

absence of competition in the markets where the multinationals operate. The exceptions here are Nielsen et al. (2003, 2005), who focus on the use of transfer prices as incentive devices under oligopolistic competition. To the best of our knowledge, no paper has used a monopolistic competition setting, which has, nonetheless, proved useful in explaining many features of international trade (REFERENCES ON ECONOMIC GEOGRAPHY). In this paper, we tackle these two caveats simultaneously, i.e., we take the OECD (1997) guidelines seriously by translating the actual proposed rules into observable variables of a monopolistic competitive market.

In this paper, we develop a two-country Dixit-Stiglitz model with iceberg transport costs and with an *arm's length* production issue (see Barba Navaretti and Venables 2003, Grossman Helpman). In the absence of tax incentives, the firms that choose an exporter structure must use an foreign independent firm to adapt and market their exported goods. They form an arm's length relationship that generates double marginalization and thus production inefficiencies. The firms that choose a multinational structure avoid those inefficiencies but incur firm-specific costs (e.g. to distribute and adapt products). So firms trade off between the inefficiencies in the exporter and multinational structures. In the presence of tax differences, the multinational structure offers an additional fiscal incentive as firms can then cash to the affiliate in the low tax country.

In our model, cash transfers are constrained to the transfer prices authorized by tax authorities. In that sense, our paper differs from Kind et al. (2004, 2005), Nielsen et al. (2005), Peralta et al. (2006), and Swenson (2001), who model the optimal transfer price set by firms who face a (usually convex) concealment cost when they deviate from the prescribed arms length (supposed equal to the marginal cost) price.

This paper contributes to the literature in the following ways. First, it is the first study of OECD transfer pricing recommendations in a full-fledge model where firms interact in the product market and choose their production structure and location. Second, it is the first study that takes into consideration the transport costs and that studies the firms' optimal choice about the fiscal imputation of this cost. Should the affiliate or the production unit bear this cost? Should the exporting firm or the local distributor bear this cost? This aspect has been neglected in most of the literature about transfer pricing. Third, it is the first study that applies the OECD transfer pricing rules in the context of an industry. This implies two things. On the one hand, we take into account some actual imperfections of the OECD rules. For instance, when a tax authority applies the Comparable Uncontrolled Price rule to tax a multinational, the tax authority observes the price quoted by another firm that sells locally and that is similar but not exactly the same as the multinational under consideration. Also, when the tax authority applies the Cost Plus rule, the it considers some measure of average mark-up of the competing firms selling in the local market. This measure corresponds imperfectly to the true cost of serving the export market that the multinationals under tax consideration have. On the other hand, we also take into account the industry effect of tax on product market prices and profitability of firms. This is important because the economic rationales of OECD transfer pricing is based on the assumption of perfect competition, which is neither the case of the monopolies that are often studied in the literature about transfer pricing, nor it is the case of real life examples where multinationals face locale and foreign competitors that sell imperfect substitutes (e.g. Barba Navaretti and Venables 2003). In this paper we make use of the Dixit-Stiglitz model of monopolistic competition with imperfect substitutes and take advantage of its analytical simplicity to analyze the effects of the transfer pricing at the industry level.

We offer several interesting and novel results. First, we show that firms are indifferent to the fiscal imputation of the transport cost. We show that this occurs because the marginal cost of exporters and the 'true marginal cost' of multinationals are not affected by the imputation of the transport costs. Second, we show that the two OECD rules of Comparable Uncontrolled Prices and Cost Plus pricing are equivalent. This is true when the tax authorities use the price of a similar firm selling locally as the Comparable Uncontrolled Price and when they use the average of the mark-ups of firms selling locally as the Cost Plus mark-up. Therefore, the OECD transfer pricing rules can be studied under the same umbrella. Third, we show that when products become perfect substitute the OEDC rules leads to the perfect audit case where tax authorities are able to perfectly observe and verify the true cost of imported and exported goods.

Fourth, we study the incentives to adopt an exporter or multinational structure at given location of exporter and multinational production units. We compare the OECD transfer pricing rules to the perfect audit case and to the no audit case. As expected, firms have higher incentives to become multinational in the no audit case than in the perfect audit case because they are able to freely use transfer prices. The OECD rules yields different outcome according to the location of the firms' production units. As one expects, we show that more firms choose a multinational structure in the high tax country than in the low tax country. Incentive for tax avoidance are here quite clear. We also show that the incentives to choose a multinational structure in the low tax country are higher than under perfect audit and no audit by tax authorities. The number of firms choosing a multinational structure in the low tax country is shown to lie between the numbers under perfect audit and no audit by the tax authorities. In contrast, the incentives to choose a multinational structure in the high tax country are not ranked in the same way. Indeed, it is shown that such incentives are always lower under the OECD rules than under the perfect audit and no audit case. This is because the Comparable Uncontrolled Price and the average market do not only take into consideration the cost of producing and shipping goods but also the mark-ups of exporters. This drives the OECD transfer prices up and hinders the multinationals that wish to shift cash to the low tax country.

Finally, we study the structure and location incentives of firms by allowing firms to choose their production and production unit location at the same time as their exporting or multinational structures. We show that industry structure and location varies a lot according to the values of tax and transport costs. (...To be completed later.)

The paper is organized as follows.... All proofs are relegated to the appendix.

2 The model

2.1 Preferences

We consider an economy with two countries, labeled $i = 1, 2$. Variables associated with each country will be subscripted accordingly. There is a unit mass of consumers in each country i, all of which have identical CES preferences given by:

$$U_i = z^{1-\mu}\left(\int_{\Omega_i} q_{ii}(v)^{\frac{\sigma-1}{\sigma}}\mathrm{d}v + \int_{\Omega_j} q_{ji}(v)^{\frac{\sigma-1}{\sigma}}\mathrm{d}v\right)^{\frac{\mu\sigma}{\sigma-1}} \qquad j \neq i, \tag{1}$$

where Ω_i denotes the set of varieties (indexed by v) produced in country i, with measure n_i, and z is a numéraire good. The parameters σ and μ respectively correspond to the elasticity of substitution between the varieties and to the expenditure share of the differentiated products in the economy. In what follows, we normalize the total mass of varieties: $n_i + n_j \equiv 1$. Consumers purchase the differentiated goods subject to their budget constraint

$$\int_{\Omega_i} p_{ii}(v)\mathrm{d}v + \int_{\Omega_j} q_{ji}(v)\mathrm{d}v = I_i, \quad j \neq i$$

where I_i is the income in country i. We suppose that labor is mobile across sectors. The numéraire good (say, food) is produced under a constant unit returns to scale using labor only and is traded at no cost. Factor price equalization implies the same wage in both country. Furthermore, we sterilize possible expenditure asymmetries[2] to focus on the location-structure issue. To this purpose we assume that profits are either uniformly distributed across consumers and countries or that they are distributed to absentee owners. In this case, countries have identical incomes, which we normalize to one: $w_i \equiv 1$. Hence, when consumers maximize their utility subject to their budget constraints, they display the following demand functions:

$$q_{ji}(v) = \frac{p_{ji}(v)^{-\sigma}}{\mathbb{P}_i^{1-\sigma}}\mu \tag{2}$$

[2] Expenditure asymmetries can lead to home market effect and endogenous core-periphery structure as discussed in economic geography (see Balwin et al. 2003). We do not discuss such properties in the present paper.

where

$$\mathbb{P}_i^{1-\sigma} \equiv \int_{\Omega_i} p_{ii}(v)^{1-\sigma}\mathrm{d}v + \int_{\Omega_j} p_{ji}(v)^{1-\sigma}\mathrm{d}v \tag{3}$$

stands for the CES price index in country $i = 1, 2$.

2.2 Technology, transport costs and taxes

Labor is the only factor of production. Each firm produces and sell one variety v under monopolistic competition. So, we can label each firm by the address of its variety, v. Each firm faces a constant marginal cost which we also normalize to 1 without loss of generality. Each variety can be traded across the two countries. We denote by $\tau > 1$ the iceberg or *ad-valorem* transport cost, i.e., for one unit of any variety to arrive at its destination the firm has to ship τ units of it. Such an assumption is standard in Dixit-Stiglitz models (e.g. Krugman 1991, Barba Naverretti and Venables 2003, etc.). Firms have two choices concerning their access to export markets:

1. they can sell the good to a local independent firm, who then assembles, adapts, markets and distributes the good independently to consumers (*exporter structure*);

2. they can sell it to a fully controlled foreign affiliate, incurring a firm-specific per-unit distribution cost (*multinational structure*).

This set-up allows us to capture the *arm's length principle* rationales that is at the core of the OECD transfer pricing recommendations.[3] The local independent firm is able to sell the traded good with an additional mark-up. The firm must then balance the cost of independent distribution to its firm-specific distribution cost. For simplicity and without loss of generality, we refer to the local independent firm as the *independent distributor*. The fact that foreign units and local independent firms also assembles, adapts and markets is not central to our analysis. In what follows, variables pertaining to exporters will be superscripted with x, while those of multinationals do not carry any superscript. We denote by r_i^x and r_i respectively the (external and internal) transfer prices of exporters and of multinationals, respectively. We respectively denote by m_i and x_i the mass of exporters and multinationals that have their production units in country i. The mass of firms producing in country i is equal to $n_i = m_i + x_i$ whereas the total mass of firms is given by $m_1 + x_1 + m_2 + x_2 = 1$.

In this paper we pay some attention to the optimal imputation of transportation costs. We naturally assume that transportation costs are incurred independently of whether the

[3] We do not model the 'proximity-concentration' trade-off highlighted in the international trade literature, where firms incur additional fixed costs for doing FDI in order to save on (variable) transport costs by producing locally (see, e.g., Markusen, 2002; Navaretti and Venables, 2004).

firm in an exporter or a multinational, the question being which firm unit will bear that cost. Firms are thus free to split their transport costs across the multinational units or across the exporter and independent distributor. In what follows, we denote by τ_{ii} the part of transport costs borne by the upstream unit (either multinational or exporter) in country i where the goods originate, and by τ_{ij} the part of transport costs borne by the downstream unit (either multinational or independent distributor) in country $j \neq i$ where the good is consumed. By definition of iceberg or *ad-valorem* transport cost, we have that $\tau_{ii}\tau_{ij} = \tau$, since the whole amount of costs must be borne by the upstream and downstream units, and that $\tau_{ii}, \tau_{ij} > 1$ because we rule out hidden cross-subsidization using the transport costs split.

INSERT FIGURE 1 HERE

Figure 1 illustrates how the value of production changes exported goods move from the domestic production unit to the foreign unit and then to the product market. Goods have decreasing *accounting values* of $\tau_{ii}\tau_{ij}r_iq_{ij}$, $\tau_{ij}r_iq_{ij}$ and finally r_iq_{ij}. The sales by the foreign unit naturally have an economic value of $p_{ij}q_{ij}$. In this business chain, $\tau_{ij}r_i$ represents *the transfer price gross of transport costs* since this embeds both the tranfer price and the cost borne by the foreign unit.

All firms pay corporate profits taxes at a rate t_i on profits made in country $i = 1, 2$. Let $\theta_i \equiv 1 - t_i$ denote the 'after-tax rate of profit' country i where a gross profit of one dollar yields a net profit of θ_i dollars that can be distributed to shareholders. In what follows we assume, without loss of generality, that country 1 is the high-tax country: $\theta_1 < \theta_2$ (i.e., $t_1 > t_2$).

We now turn to the study of the exporter structure.

3 Exporter structures

In this section we derive the profit of a firm that chooses to export through an independent distributor. The *net profit* of an exporter established in country i is given by

$$\Pi_i^x(v) = \pi_{ii}^x(v) + \pi_{ij}^x(v),$$

where

$$\pi_{ii}^x(v) = \theta_i \left[p_{ii}^x(v) - 1\right] q_{ii}\big(p_{ii}^x(v)\big) \qquad \text{and} \qquad \pi_{ij}^x(v) = \theta_i \left[r_i^x(v) - \tau_{ii}\right] \tau_{ij} q_{ij}\big(p_{ij}^x(v)\big)$$

denote the net operating profits the exporter makes in its domestic and export markets, after taxation in its domestic country. In the foregoing expression, $r_i^x(v)$ denotes the (external) transfer price at which the exporter of variety v sells to its independent distributor.

We first derive the domestic profit of the exporter. Under Dixit-Stiglitz preferences, the firm applies a constant mark-up on the unit production costs. This gives

$$p_{ii}^{x}(v) = p_{ii}^{x} \equiv \frac{\sigma}{\sigma - 1}. \tag{4}$$

Because this price is a constant for all varieties, we may drop the reference to the firm's variety v. The domestic net profits are then given by

$$\pi_{ii}^{x} = \theta_i \mathbb{P}_i^{\sigma-1} K, \tag{5}$$

where $K \equiv \frac{\mu}{\sigma-1}\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma} > 0$ is a constant term.

Turning to profits in the export market, since the exporting firm does not have nexus in that market it must rely on an independent distributor to sell its product. This *arm's length relationship* is not efficient because there is not possibility to write complete contracts between the two firms (Hart and Moore, Antras, etc...PUT REFERENCES). A convenient way to tackle this issue is to assume that the independent distributor has the right to manage over his firm and that he/she negotiates the price at which he/she buys the goods from the exporter. Hence, the price-setting problem of an exporter v located in country i involves three stages: first, the exporter and the independent distributor negotiate a (external) transfer price $r_i^x(v)$ for the good; second, the independent distributor sets a price $p_{ij}^x(v)$ in its local product market; and finally, the local product market clears such that local consumer demand is equal to the distributor's supply.[4] The share of iceberg costs borne by the independent distributor and the exporter are denoted by $\tau_{ij}^d(v)$ and $\tau_{ii}^x(v) = \tau/\tau_{ij}^d(v)$.

We now solve this price-setting problem backwards. For the sake of clarity let us drop the reference to the variety v, the subsequent results applying to any variety v. The product market outcome in the last stage has already been presented in Section 2.1. In the second stage, the independent distributor in country j maximizes his net profits

$$\Pi_j^d = \theta_j \left[p_{ij}^x - \tau_{ij}^d r_i^x\right] q_{ij}\left(p_{ij}^x\right), \tag{6}$$

taking the transfer price gross of transport costs, i.e. $\tau_{ij}^d r_i^x$, as given. This yields the consumer price

$$p_{ij}^x = \frac{\sigma}{\sigma - 1}\tau_{ij}^d r_i^x, \tag{7}$$

where the distributor's profit is given by

$$\Pi_j^d = \theta_j \mathbb{P}_j^{\sigma-1}\left(r_i^x \tau_{ij}^d\right)^{1-\sigma} K. \tag{8}$$

[4] Our result would not be qualitatively very different with other models of arm's length relationship provided that they yield the same 'double marginalization' inefficiency. Note also that, in our set-up, it is never optimal for the exporter to restrict its supply to the independent distributor. The latter always want to sell less goods than what is desired by the exporter.

and the exporter's profit by

$$\pi_{ij}^{x} = \theta_i K(\sigma - 1)\mathbb{P}_j^{\sigma-1} \left(r_i^x \tau_{ij}^d - \tau\right) \left(r_i^x \tau_{ij}^d\right)^{-\sigma}. \tag{9}$$

From those two expressions, one can note that the independent distributor and the exporter are concerned only with the transfer price gross of transport costs, $\tau_{ij}^d r_i^x$.

In the first stage, the exporter and the distributor bargain over the transfer price r_i^x and the trade cost sharing $(\tau_{ii}^x, \tau_{ij}^d)$, anticipating the distributor's sales decisions. Relationships between exporters and distributors are many times very specific. It is often costly for them to break their long term relationship. For instance, independent distributors make irreversible investments in advertizing, marketing, learning and distribution channels. Exporters may sink similar investment on behalf of their distributors. Also, the specific relationship is often be written in and enforced by exclusivity contracts that specify large costs in the case of separation. For simplicity, we here assume that firms are not able to earn anything outside an established relationship. In particular, if firms chose an export structure, they cannot revert back to a multinational structure. Similarly, if an independent distributor invested in the distribution for an exporter, he/she cannot earn anything when he/she quits the exporter. As a result, both firms have zero fall-back position.

We assume a Nash bargaining process, where $0 < \alpha < 1$ stands for the distributor's bargaining power. The transfer price is then a solution to

$$\max_{r_i^x, \tau_{ij}^d, \tau_{ii}^x} \quad \left[\Pi_j^d\right]^{\alpha} \left[\pi_{ij}^x\right]^{1-\alpha},$$

where the price indices $\mathbb{P}_i, i \in \{1, 2\}$, are taken as given. Given our earlier observation we can write this program as a function of the transfer price gross of transport costs, $\tau_{ij}^d r_i^x$. This implies that the shares of transport cost borne by each firm has no implication in the bargained solution. This gives us our first result: *exporters are indifferent to the imputation of the transport cost.*

We now turn to discuss the value of the (external) transfer price in the exporter configuration. The unique solution of the above program is computed as

$$\tau_{ii}^x \tau_{ij}^d = \beta\tau \quad \text{where} \quad \beta \equiv \frac{\sigma - \alpha}{\sigma - 1} \tag{10}$$

The transfer price and the market price are then equal to:

$$r_i^x = \beta\tau_{ii}^x \qquad \text{and} \qquad p_{ij}^x = \frac{\sigma}{\sigma - 1}\beta\tau. \tag{11}$$

Because, this derivation can be replicated for any exporter v located country $i \in \{1, 2\}$, these (external) transfers prices and product prices are the same in any country.

The parameter β is a measure of the inefficiency of the *arm's length relationship* in the exporter structure. It measures the mark-up over the marginal cost τ that exporters include in their (external) transfer prices. There is obviously a *double marginalization* issue as each exporter and independent distributor does not internalize the impact of his/her pricing decisions on the other's profit. This issue becomes less severe as the bargaining power of the distributor increases. Indeed, transfer prices gross of transport costs are equal to the cost of serving the export market τ when independent distributors get the full bargaining power ($\alpha = 1$). In this case, the independent suppliers decide on both (external) transfer price and consumer price.

Using expressions (11), the exporter's net profit can be decomposed into domestic and foreign parts as follows:

$$\pi_{ii}^{x} = \theta_i \mathbb{P}_i^{\sigma-1} K \qquad \text{and} \qquad \pi_{ij}^{x} = \theta_i \mathbb{P}_j^{\sigma-1} K \tau^{1-\sigma} \gamma, \tag{12}$$

where

$$\gamma \equiv \beta^{-\sigma}(\beta - 1)(\sigma - 1)$$

The parameter $\gamma \in (0, 1/e)$ captures the disadvantage of serving the foreign market through an independent distributor. It rises with larger σ and smaller α.

We summarize the above two results in the following proposition.

Proposition 1 *Exporting firms are indifferent to the imputation of transport costs. Exporters incur a cost because of the inefficiency of their* arm's length relationship *with independent suppliers.*

The first result is novel but specific to the Dixit-Stiglitz model with iceberg transport cost. It will ease subsequent discussion and raises any ambiguity about whether imputation of transport cost has any impact on the choice of structure or location of firms. The second result is not novel but not specific to the model. It is many times discussed in the literatur. We now turn to the analysis of multinational firms.

4 Multinational structures

Multinational firms are able to shift cash between their units using (internal) transfer prices. This feature is particularly advantageous when some units are located in countries with different tax rates. We here describe the multinational structure and discuss the decision about the imputation of transport cost. We then study the multinational pricing decision under the two benchmark cases of perfect audit and no audit by the tax authorities. The OECD transfer pricing rules are studied in the following section.

By integrating their upstream and downstream activities across countries, multinational firms are able to avoid the inefficiencies of arm's length relationship. However, each firm has a cost for accessing foreign markets. Most of the time, such costs similar to the cost of independent distributor, i.e. advertizing, marketing, learning, expertise, retail networks, distribution channels, etc. Yet, in contrast to exporting firms, those costs do not create any arm's length inefficiency and any price distortion in the product market. This implies that such cost are invariant to output level. Furthermore, because of the cultural, institutional and economic differences between countries and because of technology differences between firms, such a cost vary a lot across multinationals. To reflect those two ideas we assume that each multinational v incurs a cost that is proportional to its profits from foreign sales.[5] Hence, each multinational v is endowed with a *firm-specific distribution efficiency* parameter $\varphi_i(v) \in [0,1]$ such that a share of $1-\varphi_i(v)$ of each unit of profit that is made in the foreign market is dampened in the multinational internal distribution.

In this section we focus on a multinational v producing in country i. As before, we drop the reference to v, our results applying to any variety v produced by other multinationals. Remember that variables pertaining to multinational carry no superscripts. The multinational sets its domestic and foreign product prices (p_{ii},p_{ij}), its (internal) transfer price r_i and its domestic and foreign imputation of transport costs (τ_{ii},τ_{ij}) where $\tau_{ii}\tau_{ij}=\tau$. In the iceberg transport cost setting, a sale value of $p_{ij}q_{ij}$ dollar in the foreign product market requires to supply the foreign affiliate with a value of $\tau_{ij}p_{ij}q_{ij}$ dollars and to produce domestically for a value of $\tau_{ii}\tau_{ij}p_{ij}q_{ij}$. Internal shipment have a value equal to $r_i * \tau_{ij}p_{ij}q_{ij}$ dollar. All those values are deflated by the firm-specific distribution parameter φ_i. [Here is the real twist : φ_i deflate profits in the same way in both countries...! We should try to polish our explanation...] Therefore, the corporate profit includes three terms: the profit from domestic sales taxed at the domestic tax rate

$$\pi_{ii} \equiv \theta_i \ \left(p_{ii}-1\right) q_{ii} \tag{13}$$

the profit of the foreign affiliate, taxed at the foreign tax rate,

$$\theta_j \ \left(p_{ij}q_{ij} - r_i \ \tau_{ij}q_{ij}\right) \ \varphi_i \tag{14}$$

and the profit or loss from domestic sales to the foreign affiliate, taxed at the domestic tax rate,

$$\theta_i \ \left(r_i \ \tau_{ij}q_{ij} - \tau_{ii}\tau_{ij}q_{ij}\right) \ \varphi_i \tag{15}$$

[5] The alternate assumption is to assume firm-specific fixed costs. This assumption introduces an additional but cumbersome trade-off between arm's length inefficiencies and economies of scale in the internal distribution of multinationals. It is not surprising that such a specification presents some serious difficulties, in particular in the study of the structure and location equilibrium of Section 5. Numerical simulations show that our main results are robust to this specification. (SIMULATIONS A FAIRE)

The two last expressions can be added to give the net profits from the foreign sales

$$\pi_{ij} \equiv \theta_j \left(p_{ij} - R_i\right) \varphi_i q_{ij} \tag{16}$$

In those expressions the demands (q_{ii}, q_{ij}) are functions of the consumer prices (p_{ii}, p_{ij}) and price indices $(\mathbb{P}_i, \mathbb{P}_j)$ and are given in Section 2.1. Also the variable R is given by

$$R_i \equiv \tau_{ij} r_i - \frac{\theta_i}{\theta_j} \left(\tau_{ij} r_i - \tau\right) \tag{17}$$

which represents the multinational's *true marginal cost of serving the foreign market*. Note that, as in the analysis of the exporter structure, the multinational is concerned only with the (internal) transfer price gross of transport costs, $\tau_{ij} r_i$. There is however a difference with the exporter structure. Here, the multinational may not have the ability to freely set its transfer prices r_i because of the tax authorities. So, the imputation of transport cost is *a priori* ambiguous and dependent of the transfer pricing rule.

The *true marginal cost of serving the foreign market* depends on the (internal) transfer price that the multinational charges to its affiliate and on tax rates.[6] Since the multinational makes its decision according to the value of this true marginal cost, the multinational's production incentives are close linked to this variable. In the absence of tax differences $(\theta_i = \theta_j)$, R_i is equal to the technological cost of serving the foreign market, τ, and the multinational supplies according to its technological trade-off. This is however not true when tax rates differ. Consider a multinational that produces in the high tax country $i = 1$ $(\theta_1 < \theta_2)$ and that is imposed a transfer price higher than its technological marginal cost of serving the foreign market $(\tau_{12} r_1 > \tau)$. Then the true marginal cost of serving the foreign market, R_1, is larger than the technological cost of serving this market, τ, which entices the multinational to under-produce compared to the case without tax differences. The reason is simple. When the transfer price is large enough, the multinational is harmed as it must transfer cash from foreign affiliate into the high tax country. The multinational minimizes this loss by under-producing. The opposite argument holds when the transfer price is low enough.

We now investigate the pricing decision under the various transfer price rules. We first look at the situations where tax authorities can perfectly audit the costs of multinationals and where they cannot. We then analyze the OECD rules.

4.1 Perfect audit

Suppose that tax authorities are able to acquire perfect information about the true production costs of the multinationals and are able to constrain them to sell their output at

[6] For incentive related aspects of transfer pricing see, e.g., Elitzur and Mintz (1996) and Schjelderup and Søgard (1997).

those costs to their affiliates. This means that the tax authorities impose the constraint, $r_i = \tau_{ii}$. Under this rule, the true marginal cost R_i is equal to τ. Because this is a constant, *the multinational is indifferent to the imputation of its transport cost* (τ_{ii}, τ_{ij}). The multinational located in country i chooses p_{ii} and p_{ij} so as to maximize its profit, given by

$$\Pi_i = \theta_i(p_{ii} - 1)q_{ii} + \theta_j(p_{ij} - \tau)q_{ij}\varphi_i$$

It is readily verified that prices are given by

$$p_{ii} = \frac{\sigma}{\sigma - 1} \quad \text{and} \quad p_{ij} = \frac{\sigma}{\sigma - 1}\tau$$

which are again independent of the imputation of transport costs. Its profits from the domestic and foreign sales are given by

$$\pi_{ii}^o = \theta_i K \mathbb{P}_i^{\sigma-1} \qquad \text{and} \qquad \pi_{ij}^o = \theta_j K \mathbb{P}_j^{\sigma-1}\tau^{1-\sigma}\varphi_i. \tag{18}$$

where we use the o superscript for the perfect audit case.

4.2 No audit

Suppose now that tax authorities are not able to acquire information about the multinationals' costs. They are thus not allowed to impose any estimate of the transfer price. Fully unconstrained multinationals are however willing to declare losses, thus claiming a subsidy in the high tax country 1. Yet, (in the long run) no tax authority will subsidize multinationals if they declare (permanent) losses. Hence, the multinational finds the best prices (p_{ii}, p_{ij}) and transfer price r_i that maximize its total profit $\Pi_i = \pi_{ii} + \pi_{ij}$ subject to the non-negativity of its declared profits in the high tax country 1 : either $(13) + (15) \geq 0$ if it produces in country 1 or $(14) \geq 0$ if it produces in country 2.

The solution of this program is intuitive, a formal proof being given in the Appendix A. The multinational shifts all the profits generated in the high tax country to the low tax country by setting a transfer price r_i equal to the market price p_{ij}. In this way all profits are taxed at the lowest rate and there is no price and output distortion due to the tax differences. So,

$$p_{ii} = \frac{\sigma}{\sigma - 1} \quad \text{and} \quad p_{ij} = \frac{\sigma}{\sigma - 1}\tau$$

Since prices are independent of (τ_{ii}, τ_{ij}), *the multinational is indifferent to the imputation of its transport cost* in this setting.

Using our convention that tax is lower in country 2, the net profits in each market are simply given by

$$\pi_{ii}^* = \theta_2 \mathbb{P}_i^{\sigma-1} K \quad \text{and} \quad \pi_{ij}^* = \theta_2 \mathbb{P}_i^{\sigma-1}\tau^{1-\sigma}\varphi_i K \tag{19}$$

where the superscript * stands for the no audit case.

The two benchmark cases of perfect audit and no audit are hardly realistic as they assume either a too myopic or a too sophisticated behavior on behalf of tax authorities. Tax authorities do realize that firms can use transfer prices to shift profits. Multiple taxation conventions are available to them to constrain multinationals' pricing decisions. In what follows, we study in more detail two transfer pricing rules that are the most widely used by tax authorities around the world (Ernst&Young, 2002, Fig. 1). In both cases, we assume that firms take the transfer pricing rule as given, since it is imposed and enforced by the competent tax authorities. We begin with the Comparable Uncontrolled Price.

4.3 Comparable Uncontrolled Price

A widely used rule of transfer pricing recommended by the OECD is the *Comparable Uncontrolled Price* (henceforth, CUP). Under CUP, the tax authority constrains the firms to set a transfer price equivalent to the price of a comparable uncontrolled transaction with an independent firm (the so-called *arm's length principle*). According to the OECD (2001 Chap II-2.11), "the CUP method is a particularly reliable method where an independent entreprise sells the same product as is sold between two associated enterprise". However, comparability is not an easy matter. The OECD recommendations indeed recognizes that much care should be taken for the accounting of transport cost and product differentiation (OECD 2001 Chap II-2.15-2.19) .

Since varieties are symmetric in our model, a valid basis for doing so is given by the relationship between the exporter in country i and the independent distributor in country j. The tax authority observes the total cost borne by the independent distributor for each unit it sells, which, by (6) and (10), is equal to $\tau_{ij}^d r_i^x = \beta\tau$. This cost includes the (external) transfer price from the exporter, r_i^x, and the transport cost the independent distributor bears, $\left(\tau_{ij}^d - 1\right) r_i^x$. It is this cost that the tax authority imposes on the multinational's affiliate. Hence, under the CUP rule, the transfer prices of multinationals producing in the high tax country i are restricted such that

$$r_i \tau_{ij} = r_i^x \tau_{ij}^d = \beta\tau \qquad \Longleftrightarrow \qquad r_i = \beta\tau_{ii}.$$

As for the case of no audit, multinationals may end up declaring losses, thus claiming a subsidy from the tax authority. Again, (in the long run) no tax authority is willing to subsidize multinationals that declare (permanent) losses in their foreign market when $p_{ij} \leq r_i\tau_{ij}$.[7]

[7] Note that, because $r_i\tau_{ij} = \beta\tau > \tau$, multinationals are constraind to declare a positive profit in their production country.

Suppose first that multinationals do not declare losses in their foreign market: $p_{ij} > r_i \tau_{ij}$. The production incentive in that market is then given by the true marginal cost of serving that market, which simplifies here as

$$R_i = \tau \left[\beta - \frac{\theta_i}{\theta_j} (\beta - 1) \right]$$

and which gives the optimal product prices

$$p_{ii} = \frac{\sigma}{\sigma - 1} \quad \text{and} \quad p_{ij} = \frac{\sigma}{\sigma - 1} R_i \tag{20}$$

Those firms do not declare losses when $p_{ij} > r_i \tau_{ij}$ which is equivalent to $\frac{\sigma}{\sigma - 1} R_i > \beta \tau$ or $\frac{\theta_j}{\theta_i} > \widehat{\theta}$ where

$$\widehat{\theta} \equiv \frac{\sigma (\beta - 1)}{\beta} = \frac{\sigma - \sigma \alpha}{\sigma - \alpha} \in (0, 1).$$

This inequality is always satisfied for multinationals producing in country $i = 1$ because $\theta_2 / \theta_1 > 1$. It is satisfied for multinationals producing in the low tax country 2 only if $\theta_1 / \theta_2 > \widehat{\theta}$.

We can make three observations from those prices. First, the production incentives for the foreign market do not depend on the imputation of transport cost (τ_{ii}, τ_{ij}). So, *under CUP, the multinational is indifferent to the imputation of transport costs.* Second, *the CUP transfer price reflects the inefficiency existing in the arm's length relationship*, since the latter is used as a point of comparison. Larger inefficiencies β imply higher transfer price r_i. This upward bias on transfer price is profitable for the multinationals that produce in the low tax country 2 and that want to shift cash into that country. It is however not profitable for multinationals producing in the high tax country 1 as the CUP transfer price forces them to shift cash into the high tax country 1. The latter multinationals minimize the loss by reducing their production for the foreign market. This is consistent with their true marginal cost of serving the foreign market R_1 which is larger than τ. One can readily show that $R_1 \geq \tau \geq R_2$. By the same argument, one will verify that multinationals that produce in the low tax country maximize their profits by increasing their production for the foreign market. This gives us our third observation: *the CUP transfer prices yield under-production (resp. over-production) by the multinationals headquarted in the high (reps. low) tax country.*

The operating profits generated in each market are given by

$$\pi_{ii}^c = \theta_i K \mathbb{P}_i^{\sigma - 1} \qquad \text{and} \qquad \pi_{ij}^c = \theta_j K \mathbb{P}_j^{\sigma - 1} R_i^{1 - \sigma} \varphi_i \quad \text{if } \theta_j / \theta_i > \widehat{\theta} \tag{21}$$

where we use the superscript c to refer to the CUP transfer price rule.

Suppose now that the CUP transfer price entices multinationals to declare losses in their foreign market. This can happen to multinationals producing in the low tax country

2 when $\theta_1/\theta_2 < \widehat{\theta}$. As stated earlier, the tax authorities detect such permanent losses and react by asking multinationals to reduce their transfer prices. Country 1's tax authority requires foreign multinationals to reduce the transfer prices down to the level where the permanent losses in its market vanish. As a consequence, it must be that $p_{21} = r_2\tau_{21} = \beta\tau$. Because the latter price is independent of the imputation of transport cost (τ_{22}, τ_{21}), depends on β and is smaller than $\tau\sigma/(\sigma-1)$, we can again conclude that multinationals are indifferent to the imputation of transport costs, and that the CUP transfer price reflects the inefficiency existing in the arm's length relationship, yielding over-production. Using this price, a multinational v producing in the low tax country 2 then gets a foreign profit equal to

$$\widetilde{\pi}^c_{21}(v) = \theta_2 K\gamma \left(\frac{\sigma}{\sigma-1}\right)^{\sigma} \tau^{1-\sigma}\mathbb{P}_1^{\sigma-1}\varphi_2(v) \quad \text{if } \theta_1/\theta_2 < \widehat{\theta}$$

4.4 Cost Plus

The second transfer pricing rule is the *Cost Plus* transfer pricing rule, whereby the transfer price is computed by applying an 'appropriate' margin to the cost of multinationals. The OECD indeed recommends that "an appropriate mark-up is [..] added to [the multinational's] cost, to make an appropriate profit in the light of functions perfomed and the market conditions" (see OECD (2001) Chap. II-11). The mark-up itself is estimated from the market conditions of the industry. It must be noted at the outset that the low tax country always wins from multinationals' tax avoidance. This country therefore imposes no restriction on transfer pricing by multinationals. So, we just need to study the behavior of the tax authority in the high tax country.

To reduce tax shifting by multinationals, the tax authority of the high tax country 1 can impose the Cost Plus rule. Let us first consider a multinational that produces in this country and that wants to shift cash in the low tax country 2 through low transfer prices r_1. Under the Cost Plus rule, the tax authority computes an 'appropriate' margin η_1 (defined below) and is allowed to use this figure as a *downward* constraint on the mark-up of the domestic multinational. As the domestic cost gross of domestic transport cost is equal to τ_{11}, the constraint is defined as

$$\eta_1 \leq \frac{r_1 - \tau_{11}}{\tau_{11}}$$

The existence of this constraint prevents firms from shifting too much profit by transferring the good at too low a price.

Let us now consider a multinational that produces in country 2 and that wants to shift cash to its production unit located in the low tax country 2 through a high transfer price. The tax authority computes another 'appropriate' margin η_2 (also defined below) and is allowed to apply this number as an *upward* constraint on the mark-up on the foreign multinational. As the cost gross of local transport cost of the foreign multinational is equal to τ_{22}, the constraint is defined as

$$\frac{r_2 - \tau_{22}}{\tau_{22}} \leq \eta_2.$$

The OECD recommendations state that the appropriate margin must reflect the market condition where the firm sells. The underlying idea is that multinationals may charge prices in excess of cost, but the magnitude of their margins is limited by competitive conditions in the market. We now make explicit the tax authority's computation about 'appropriate' margins. The tax authority can assess such margins in several ways according to the information at its disposal and its ability to manipulate complex data. In many cases, the tax authority asks for a (short) industry survey in the country where the multinational produces and gets a rough estimate of the mark-ups in that industry (see OEDC (2001), Chap II-2.46 [je n'ai pas trouvé de règle bien établie par l'OCDE pour le calcul du mark-up approprié..., Pierre]). It then considers some average value of those mark-ups. (See OECD notes [retrouver les explications dans la brochure OECD]). In this paper we follow this approach by assuming that the tax authority is able to get information about the 'appropriate' margin defined as

$$\eta_i \equiv \frac{m_i}{m_i + x_i} \frac{r_i - \tau_{ii}}{\tau_{ii}} + \frac{x_i}{m_i + x_i} \frac{r_i^x - \tau_{ii}^x}{\tau_{ii}^x}$$

In this formula, the mark-ups of the multinationals and exporters that produces in the country i are weighted by the share of such producers in the country. This represents the mark-ups of producers as recommended by the OECD; it indeed does not include any additional mark-ups of independent distributors.

As for the case of no audit and CUP, multinationals may end up declaring losses, thus claiming a subsidy from the tax authority. Again, no tax authority is willing to subsidize multinationals that declare losses in their foreign market; that is, multinationals are constrained to set their foreign prices p_{ij} above their foreign cost $r_i \tau_{ij}$.

Let us suppose for a moment that no multinationals declare losses and let us compute the equilibrium margins (η_1, η_2). Then, multinationals exploit as much as possible tax differentials and they set their transfer prices so that the above constraints on 'appropriate' margins bind. Therefore, the 'appropriate' margins are defined as functions of the multinationals' transfer prices which are themselves constrained by the 'appropriate' margins. The 'appropriate' margins and the transfer prices thus feedback on each other and move until an equilibrium occurs. Replacing $(r_i - \tau_{ii}) / \tau_{ii}$ by η_i in the previous definition and using the exporter prices (11) we successively get

$$\eta_i = \frac{m_i}{m_i + x_i}\eta_i + \frac{x_i}{m_i + x_i}\frac{1}{\tau_{ij}^d}\frac{r_i^x \tau_{ij}^d - \tau}{\tau_{ii}^x}$$
$$= \frac{m_i}{m_i + x_i}\eta_i + \frac{x_i}{m_i + x_i}(\beta - 1), \qquad i = 1, 2,$$

which reduces to $\eta_i = \beta - 1$. Hence, the Cost Plus rule constrains firms to set a transfer price given by

$$r_i = \beta \tau_{ii}$$

Hence, *multinationals are imposed the same constraint under CUP and Cost Plus transfer pricing*. The two main results pertaining to CUP apply to Cost Plus: multinationals are indifferent to the imputation of transport costs and transfer prices reflect the inefficiency existing in the arm's length relationship of the exporter structure. The corporate profits are thus the same. This conclusion is valid under Dixit-Stiglitz preferences and iceberg transport cost and for the above definition of the 'appropriate' margin. Any deviation from these assumptions gives no guaranty of such an equivalence.

Yet as under the CUP transfer pricing rule, the declared profits can become negative. Because prices are the same as under CUP, we readily conclude that multinationals producing in the high tax country 1 never declare negative profits. By contrast, those producing in the low tax country 2 might declare negative profits if $\theta_1/\theta_2 < \widehat{\theta}$. The tax authority does not impose a floor on product prices so that $p_{21} \geq r_2\tau_{21}$. We show in the Appendix A that CUP and Cost Plus are also equivalent when $\theta_1/\theta_2 < \widehat{\theta}$.

We summarize the result of the last four sub-sections in the following proposition.

Proposition 2 (imputation of transport cost and CUP-Cost Plus equivalence)
(i) Multinationals are indifferent to the imputation of transport costs under perfect audit, no audit, CUP and Cost Plus transfer pricing rules.
(ii) Production incentives and profits are the same under CUP and Cost Plus transfer pricing. In particular, those transfer prices reflect the inefficiency existing in the arm's length relationship. Multinationals under-produce for their export markets in the high tax country and over-produce in the low tax country.

The proposition gives a very simple answer to the question about the impact of taxes on firms' imputation of transport costs. Tax rates do not matter for the imputation of transport costs. The proposition also gives a very simple answer to the question about the difference between CUP and Cost Plus. There is no difference. This implies that in the subsequent section we do no longer need to raise the question about the imputation of transport cost and we can merge the analysis of CUP and Cost Plus under the same umbrella.

The inefficiency with CUP and Cost Plus transfer prices is related to the additional mark-up that is present in the exporter arm's length relationship. The transfer prices are then not equal to the technological cost of serving foreign markets. Nevertheless, this inefficiency vanishes as soon as products become better substitute. Indeed, the parameter β decreases as the elasticity of substitution σ rises; it becomes equal to one when $\sigma \to \infty$. This gives the following corollary.

Proposition 3 (competitive limit) *When product substitutability becomes very strong ($\sigma \to \infty$), the cost-plus and CUP rules yield the same transfer prices as under perfect audit.*

This result may be seen as a rationale for the use of these rules by the OECD. However, it also carries two cautionary messages. Firstly, the rules only converge to the perfect audit case in the limit of a perfectly competitive industry; it yields quite different results otherwise. Secondly, transfer prices tend to the same value, and profits tend to zero (for every structure and transfer pricing rule), when products become arbitrarily close to being perfect substitutes. Nevertheless, such small profits under different structures can still be ranked, so that firms may not choose the same structure for the different transfer pricing rules at this competitive limit. We will turn to this issue in the next section.

5 Choice of production structure

In this section, we consider the firms' choices of production structure at a given location. Firms can choose to export their goods using local independent distributors or they can choose to become multinational by integrating the local distribution. The incentives to become multinational are grounded on tax consideration and on the inefficiencies that the arm's length relationship creates in the exporter structure. This section abides by the existing literature on transfer pricing that usually analyze firms at fixed location.

In this section, each country is endowed with a set of heterogenous firms. Those firms are endowed with firm-specific efficiency parameters $\varphi_i(v)$ that are distributed according to the cumulative distribution $F_i : [0, 1] \to [0, 1]$ where $F_i' > 0$. To distinguish the effect of transfer price rules from countries' industrial composition, we sterilize composition effects by assuming that each country gets the same mass and the same distribution of firms. That is, $F(\varphi) \equiv F_i(\varphi)$, $i \in \{1, 2\}$ and $\sum_i F_i(1)/2 = F(1) = 1$.

In each country i, a firm v endowed with firm-specific efficiency parameter $\varphi_i(v)$ chooses the multinational structure if this yields higher profit than the exporter structure. That is, if

$$\Pi_i(v) \equiv \pi_{ii} + \pi_{ij}(v) \;\; \geq \;\; \Pi_i^x \equiv \pi_{ii}^x + \pi_{ij}^x$$

In this condition, the multinational's profit on foreign sales $\pi_{ij}(v)$ depends on its parameter $\varphi_i(v)$ and must then be index by v. The exporter's profits in the domestic and foreign markets are given in Section 3 by expression (12) and the multinational's profits are given in Section 4 by either expressions (18), (19) or (21) according to the transfer pricing rule. We begin with the choice of production structure in the perfect audit and no audit benchmark cases. We derive the structure of firms under the OECD rules and finally compare those cases with each other.

5.1 Perfect audit

When the tax authorities are able to perfectly audit multinationals, they can apply a transfer price that is equal to the technological cost of shipped goods, τ. Each firm then compares its profits as a multinational (18) with its profits as an exporter (12). Simple computations show that a firm v producing in country i chooses the multinational structure if its firm-specific efficiency parameter $\varphi_i(v)$ is larger than the threshold

$$\varphi_i^o \equiv \frac{\theta_i}{\theta_j}\gamma$$

Otherwise, it chooses the exporter structure. Country i therefore hosts a mass of exporters, $F(\varphi_i^o)$, and a mass of multinationals, $(1 - F(\varphi_1^o))$. Two observations are worth noting. First, although tax authorities are able to impose the 'right' transfer price, they do not affect the inefficiencies that are present in the arm's length relationship of exporters. Stronger inefficiencies imply a smaller parameter γ, reduce the thresholds φ_i^o and imply fewer exporters in both countries. Second, given that $\theta_1 < \theta_2$, it is clear that $0 < \varphi_1^o < \gamma < \varphi_2^o$. The mass of multinationals in the high tax country $(1 - F(\varphi_1^o))$ is therefore larger than the mass of multinationals in the low tax country, $(1 - F(\varphi_2^o))$. This is explained by the fact that, compared to exporters, multinationals must pay higher taxes on the profits made in the high tax country 1. By contrast, exporters are able to repatriate a share of those profits through the mark-ups that they negotiated with independent distributors. Then, it naturally comes that *firms producing in the low tax country* 2 *have smaller incentives to adopt a multinational structure.* In contrast, firms producing in the high tax country 1 prefer the multinational structure because all their profits generated in the low tax country can be taxed there. Note that it is possible that no firms choose the multinational structure in the low tax country if tax differences are large enough ($\varphi_2^o > 1$).

5.2 No audit

Suppose now that tax authorities are not able to acquire information about multinationals' costs and do not impose any transfer price. Multinationals are then free to shift all their profits to the low tax country 2 and are thus taxed at the lowest tax rate.

The trade-off between exporter and multinational structures is obvious for the firms producing in the low tax country 2. Since multinationals and exporters are taxed at the same rate there, taxation is irrelevant to their structure choice. Their choice is only driven by the trade-off between the inefficiencies in the arm's length relationship of the exporter structure and the firm-specific distribution inefficiency of the multinational structure. A simple comparison between expressions (12) and (19) indeed yields that a firm v producing in country $i = 2$ chooses the multinational structure if and only if its firm-specific efficiency parameter $\varphi_2(v)$ is larger than the threshold

$$\varphi_2^* \equiv \gamma$$

The firms producing in the high tax country 1 face a slightly different trade-off between exporter and multinational structures because their profits on each market are taxed in a different way. A comparison between expressions (12) and (19) yields that a firm v producing in country $i = 1$ chooses the multinational structure if and only if its firm-specific efficiency parameter $\varphi_1(v)$ is larger than the threshold

$$\varphi_1^* \equiv \frac{\theta_1}{\theta_2}\gamma - \left(1 - \frac{\theta_1}{\theta_2}\right)\left(\frac{\mathbb{P}_1}{\mathbb{P}_2}\right)^{\sigma-1} \tau^{\sigma-1}$$

Since $\theta_1 < \theta_2$, one can check that $\varphi_1^* < \varphi_2^*$. As a result, *firms producing in the high tax country* 2 *also have smaller incentives to adopt a multinational structure.* The mass of multinationals producing in the high tax country $(1 - F(\varphi_1^*))$ is then larger than the mass of multinationals in the low tax country $(1 - F(\varphi_2^*))$. The multinationals producing in the high tax country 1 are able to avoid the tax that the exporter must pay on its domestic sales and on the domestic share of foreign sales. In contrast, the multinationals producing in the low tax country 2 do not avoid any tax paid by the exporters. They only avoid the inefficiency in the arm's length relationship of the exporter structure. Their incentives to form a multinational is therefore weaker.

We now turn to the impact of the OECD transfer pricing rules on firms' structure.

5.3 CUP and Cost Plus

Because firms have the same behavior in the product market under CUP or Cost-Plus transfer pricing rules, we are allowed to restrict our attention to the CUP transfer price. In this case tax authorities impose the transfer price $r_i = \beta\tau_{ii}$ to multinationals. Firms chooses to become multinational if this structure yields more profit than the exporter structure. Comparing expression (12) to (21), we readily conclude that a firm v producing in country i chooses the multinational structure if and only if its firm-specific efficiency parameter $\varphi_i(v)$ is larger than the threshold

$$\varphi_i^c \equiv \gamma \frac{\theta_i}{\theta_j} \left(\frac{R_i}{\tau} \right)^{\sigma-1} = \gamma \frac{\theta_i}{\theta_j} \left[\beta - \frac{\theta_i}{\theta_j} (\beta - 1) \right]^{\sigma-1} \tag{22}$$

which is affected by the tax differences and by the efficiency in the arm's length relationship of exporters.

The above condition is however not valid for all economic parameters. Indeed, under the CUP (and Cost Plus) rule, there exist parameter constellations for which multinationals producing in the low tax country 2 get a permanent loss in their foreign market 1 (profits declared in region 2, as given by (14), are negative). This is because the cost borne by the affiliate, $r_2\tau_{21}$ can be higher than multinationals' product prices, p_{21}, which happens if[8]

$$r_2\tau_{21} \equiv \beta\tau > p_{21} \equiv \frac{\sigma}{\sigma - 1} R_2 \quad \Longleftrightarrow \quad \frac{\theta_1}{\theta_2} < \frac{\sigma(\beta - 1)}{\beta} = \frac{\sigma - \sigma\alpha}{\sigma - \alpha} \in (0, 1) \tag{23}$$

and which is true for large enough tax differences. As stated earlier, the tax authorities are able to detect such permanent losses and are likely to react by asking multinationals to reduce their transfer prices. We assume that country 1's tax authority asks foreign multinationals to reduce the transfer prices down to the level where the permanent losses in its market vanish ($r_2\tau_{21} = p_{21}$). A multinational v then gets a corporate profit equal to

$$\widetilde{\Pi}_{21}(v) = \theta_2 K \gamma \left(\frac{\sigma}{\sigma - 1} \right)^{\sigma} \tau^{1-\sigma} \mathbb{P}_1^{\sigma-1} \varphi_2(v)$$

This profit is equal to the profit under the exporter structure (12) if $\varphi_2(v)$ is equal to

$$\widetilde{\varphi}_2^c \equiv \left(\frac{\sigma - 1}{\sigma} \right)^{\sigma}$$

Collecting the above results we can state that a firm v producing in country 2 chooses the multinational structure if and only if its firm-specific efficiency parameter $\varphi_2(v)$ is larger than φ_2^c when $\theta_1/\theta_2 > \frac{\sigma-\sigma\alpha}{\sigma-\alpha}$ and larger than $\widetilde{\varphi}_2^c$ otherwise.

We now in a position to compare the firms' structures in both countries. Some lines of computation allows us to get the following ranking: $\varphi_1^c < \gamma < \varphi_2^c \leq \widetilde{\varphi}_2^c$. As a consequence, *firms producing in the low tax country 2 have low incentives to adopt a multinational structure*. The mass of multinationals in the high tax country, $(1 - F(\varphi_1^c))$, is smaller than the mass of multinationals in the low tax country, $(1 - F(\varphi_2^c))$. This conclusion is congruent to the two benchmark cases.

It is instructive to compare this firms' structure with the perfect audit case by rewriting expression (22) as $\varphi_i^c = \varphi_i^o * (R_i/\tau)^{\sigma-1}$. The incentives to form a multinational

[8] It is a straightforward exercise to show that the headquarter's declared profit is never negative for any transfer pricing rule, nor is the affiliate's for other transfer pricing rules.

are thus similar to the perfect audit case except for a correction about the true marginal cost of serving the foreign market R_i. On the one hand, this true marginal cost is larger than τ for multinationals producing in the high tax country 1, which implies that $\varphi_1^c > \varphi_1^o$. Therefore, *the firms producing in the high tax country* 1 *have less incentives to choose a multinational structure than under perfect audit*. This is because the CUP transfer price is too large and imposes cash transfers into the high tax country 1. Although multinationals minimize this loss by reducing their output, they still incur a fall in their profits, which makes them worse off than under perfect audit. Conversely, for multinationals producing in the low tax country 2, we have that $R_2 < \tau$, which implies that $\varphi_2^c < \varphi_2^o$. Hence, *the firms producing in the low tax country* 2 *have more incentives to choose a multinational structure than under perfect audit*. The too large CUP transfer price permits cash transfers to the low tax country 1, which is beneficial to multinationals. To sum up, CUP and Cost Plus transfer pricing rules allows tax authorities to reduce the profit shifting activities through the use of transfer prices. Yet, the rules are imperfect. In particular, they give too weak incentives to form a multinational in the high tax country and too strong incentives in the low tax country.

INSERT FIGURE 2 HERE

We can get an overall picture of the production structure of firms by inspecting Figure 2. This figure shows the loci of the above thresholds under perfect audit (o), no audit ($*$), CUP and Cost Plus transfer price rules (c). In each case, the mass of exporters $F(\varphi)$ is related to the vertical distance from the x-axis to φ whereas the mass of multinationals $(1 - F(\varphi))$ is related to the vertical distance from φ to the top of the figure. Using the above results and some additional lines of computations, it is possible to show the following ranking (see Appendix)

$$\varphi_1^* < \varphi_1^o < \varphi_1^c < \varphi_2^* < \varphi_2^c < \varphi_2^o$$

One can also show that the thresholds $(\varphi_1^*, \varphi_1^o, \varphi_1^c)$ are increasing functions of the tax difference θ_1/θ_2, whereas the thresholds $(\varphi_2^c, \varphi_2^o)$ are decreasing functions of θ_1/θ_2. It must be noticed that all the thresholds tend to γ when the tax difference vanishes ($\theta_1/\theta_2 \to 1$). So, when tax differences are very small, the structure of firms reflects the trade-off between the inefficiency in the arm's length relationship of exporters and the firm-specific distribution inefficiency of multinationals. When tax differences increase (lower θ_1/θ_2), the firms producing in the high tax country 1 have more incentives to choose the multinational structure whereas those producing in the low tax country 2 have more incentives to use the exporter structure. Those incentives diverge more when tax differences rise

We summarize those results in the following proposition.

Proposition 4 *The incentives to choose a multinational structure are always larger in the high tax country ($\varphi_1^k < \varphi_2^k$, $k = o, *, c$). In the high tax country, they are always* *lower under CUP and Cost Plus than under perfect audit and no audit ($\varphi_1^* < \varphi_1^o < \varphi_1^c$). In the low tax country, they lie between the incentives under perfect audit and no audit ($\varphi_2^* < \varphi_2^c < \varphi_2^o$). Those incentives diverge more when tax differences rise (lower θ_1/θ_2).*

Note that this result applies at the competitive limit when products become close to perfect substitutes (i.e., $\sigma \to \infty$). Despite the equivalence of transfer prices obtained in Proposition 3, the profits realized by the firms under the different rules are not equivalent, and the firm is thus not indifferent as to its structure. We highlight this result in the following proposition. The next section builds on this result and introduces location choice at the competitive limit.

Proposition 5 (competitive limit) *When product substitutability becomes very strong ($\sigma \to \infty$), the number of firms opting for a multinational structure under CUP and Cost Plus does not converge to the full audit case. The ranking between the different transfer-pricing rules obtained in Proposition 4 applies.*

6 Choice of production structure and location

In the previous section we have studied how firms choose their structure at a given production unit location and tax system. In this section we analyze the equilibrium when firms choose both their structure and location. As before we review the two benchmark cases of perfect audit, no audit and the case of transfer pricing under CUP and Cost Plus. For the sake of clarity we focus on the competitive limit where products are close substitutes.

In this section, (most) firms endogenously choose a country for their production site. In order to rule out undefined transfer pricing rules under CUP and Cost-Plus,[9] we assume that each country i host a mass $\varepsilon/2 > 0$ of immobile exporters ($\varepsilon \to 0$). The remaining firms are perfectly mobile and are distributed according the firm-specific distribution efficiency parameters φ. This paremeter is drawn from the same global, cumulative probability distribution $F_\varepsilon(\varphi) : [0, 1] \to [\varepsilon, 1]$, $F'_\varepsilon > 0$. For simplicity we assume that this distribution is uniform. So, the mass of firms with $\varphi \leq \widetilde{\varphi}$ is given by $\lim_{\varepsilon \to 0} F_\varepsilon(\widetilde{\varphi})$ which is simply equal to $\widetilde{\varphi}$.

[9] The location and production structure equilibrium may be undefined under the CUP and Cost-Plus rules when a country $i \in \{1, 2\}$ ends up with no exporting firms ($x_i = 0$). There is therefore no independent distributors on which tax authorities can base their computation of the CUP transfer prices r_i. The markup constraint under Cost-Plus ends up to be slack. Such situations are however neither appealing nor realistic as they would stem from the assumption of perfect mobility for all firms and as there usually always exists some exporters in any countries.

For the sake of clarity, let $\mathbb{P} \equiv (\mathbb{P}_1/\mathbb{P}_2)^{\sigma-1}$ measures the *competitive attractiveness of country* 1 relative to country 2. A higher $\mathbb{P}$ implies that prices are larger in country 1 so that competition is weaker there and firms are enticed to locate in that country. The structure-location equilibrium is determined in two steps. On the one hand, the competitive attractiveness $\mathbb{P}$ determines the values of profits and thus the location and structure of firms so that

$$m_i(\mathbb{P}) = \#\{v : \ \Pi_i^m(v,\mathbb{P}) \geq \max_j[\Pi_j^m(v,\mathbb{P}), \Pi_j^x(v,\mathbb{P})]\}$$
$$x_i(\mathbb{P}) = \#\{v : \ \Pi_i^x(v,\mathbb{P}) \geq \max_j[\Pi_j^m(v,\mathbb{P}), \Pi_j^x(v,\mathbb{P})]\}$$

$i = 1, 2$. The location and structure of firms is derived for each transfer pricing case. On the other hand, the competitive attractiveness $\mathbb{P}$ is determined by the ratio of price indices $(\mathbb{P}_1/\mathbb{P}_2)^{\sigma-1}$ that are given by (3) and that reflects product market conditions. Hence, the product market equilibrium implies that

$$\mathbb{G}(m_1, x_1, m_2, x_2) \equiv \frac{m_2 + x_2 + R_1^{1-\sigma} m_1 + \phi\beta^{1-\sigma} x_1}{m_1 + x_1 + R_2^{1-\sigma} m_2 + \phi\beta^{1-\sigma} x_2}$$

The structure-location equilibrium is then defined as the fixed point $\mathbb{P} = \mathbb{G}[m_1(\mathbb{P}), n_1(\mathbb{P}), m_2(\mathbb{P}), n_2(\mathbb{P})]$.

The set of structure and location equilibria is quite rich. To focus on the issue of taxation and arm's length relationship, we limit our attention to the competitive limit. The following conjecture holds about the structure and location of firms under perfect competition: because perfect competition pushes profits down to zero for any structure and location of firms, the tax on profits θ_i should have no impact on how firms structure and locate their production. The firms' structure and location would thus be indeterminate. In our model, the competitive limit obtains when products become perfect substitute $\sigma \to \infty$. Yet, at this limit, the structure and location of firms in not indeterminate as firms inherit the structure and location configuration of the case where products are still slightly differentiated, allowing them to make slightly positive profits. The following proposition establishes the properties of this competitive limit.

Proposition 6 *When products are close to perfect substitutes ($\sigma \to \infty$), the equilibrium implies only two configurations of location and structure: either with multinationals in both countries and exporters in the low tax country ($m_1, m_2, x_2 > 0 = x_1$) or with multinationals in the high tax country and exporters in the low tax country ($m_1, x_2 > 0 = x_1 = m_2$). For any $\theta \in (0, 1)$, the number of firms are ranked as it follows:*

$$m_1^* > m_1^o = m_1^c, \quad m_2^* > m_2^o > m_2^c \quad \text{and} \quad x_2^* < x_2^c \leq x_2^o$$

Figure 3 depicts the location and structure of firms as a function of the tax difference θ_1/θ_2. In this figure, the curves denoted by $*$ and o refer to cases of no audit and perfect audit whereas the curves denoted by c refer to the cases of CUP and Cost-Plus. The number of multinationals in the high tax country m_1 reads from the top to the highest curve whereas the number of exporters in the low tax country x_2 reads from the bottom to the lowest curve. The number of multinationals in the low tax country m_2 is given by the distance between the highest and the lowest curves. The highest and lowest curves of each case converge to the same points 1/2 and γ_∞ when $\theta_1/\theta_2 \to 1$. So, as expected, the location and structure of firms converge as tax differences vanish. It is worth noting several intersting properties.

First, *in equilibrium, there exist no exporters in the high tax country* 1. Indeed, because exporters are unable to avoid taxation, they prefer to locate in the low tax country 2. Therefore, exporters crowd out in the low tax country 2 the multinational firms that have the best distribution efficiency parameters. Better efficiency in distribution then compensate for higher taxes in the high tax country 1.

Second, *under no audit, the structure and location of firms do not depend on the tax difference and each country hosts the same number of firms.* The former observation obtains because multinationals use transfer prices to pay all their taxes in the low tax country; they therefore not affected by the tax difference between the two countries. The second observation stems from the fact that, at the competitive limit, exported goods are not very competitive compared to locally produced goods: the latter are alike and less expensive because they do not bear any transport cost. Firms then mainly concentrate on their local market. Since consumers' demand is evenly spread across markets in this model, the distribution of firms is also evenly spread.

Third, *in the cases of perfect audit, CUP and Cost-Plus, the number of firms in the high tax country* 1 *decreases as tax differences increase* (lower θ). This property is caused by the transfer prices that are imposed by high tax country 1 and that reduce the after-tax profitability of firms producing there. Those transfer prices entice firms to leave the high tax country 1 so that competition gets weaker there and so that remaining firms are able to sell more. In equilibrium, the larger sales compensate for the higher tax which implies that the number of firms must smaller in the high tax country 1.

Fourth, *in the cases of perfect audit, CUP and Cost-Plus, the number of multinationals in the low tax country falls to zero for very large tax differences.* Indeed, firms producing in the low tax country 2 have smaller incentives to adopt a multinational structure than under no audit (see $\varphi_2^* < \varphi_2^c < \varphi_2^o$ in Section 5.1 and 5.3). So, many such firms can repatriate more cash through the prices charged to independent distributors than through the constrained transfer prices charged to their own affiliates. This effect is obviously more intense in the case of perfect audit. Hence, large tax differentials can make the multinational structure so unattractive that firms never choose when they choose to produce in the low tax country 2. As a result, one observes multinationals' production only in the high tax country 1.

Note that this last property strongly contrasts to the common intuition saying that multinationals evade taxation by locating in low tax countries. In this model, the force inducing firms to locate in the low tax country is stronger for firms choosing the exporter structure than those choosing the multinational structure and having better distributional efficiency.

Finally, there exits *fewer exporters under CUP and Cost-Plus than under perfect audit.* This follows our previous remark. Transfer prices are higher under CUP and Cost-Plus. Then, firms producing in the low tax country 2 can repatriate more cash through the constrained transfer prices (see $\varphi_2^c < \varphi_2^o$ in Section 5.1 and 5.3.). The multinational structure is less unattractive under CUP and Cost-Plus.

7 Conclusion

One may wonder why the OECD provides guidelines that yield such unexpected results. One possible answer is provided by the results of Proposition 3. Indeed, were markets competitive, the CUP principle would take an efficient market prices as the benchmark for constraining multinationals' transfer prices. Yet, prices are inefficient and the 'appropriate margin' is too high because of double marginalization. This finding calls once more to our attention the well-known fact that the properties of a given policy may dramatically change when one considers non-competitive markets. This should be taken into account in policy design.

[To be completed]

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Appendix A: Structure Equilibrium #at# fixed location

7.1 #Proof of Proposition 2#

#Prices and Imputation of Transport Costs under No Audit# #We here derive the optimal product and transfer prices under No Audit. We also show that multinationals are indifferent to the choice of the imputation of transport costs. Under no audit, the program of the multinational firm in i writes as#

$$\max_{\tau_{ii},p_{ii},p_{ij},r_i} \quad \theta_i\left((p_{ii}-1)q_{ii}+(r_i-\tau_{ii})\varphi_i\frac{\tau}{\tau_{ii}}q_{ij}\right)+\theta_j\left(p_{ij}-r_i\frac{\tau}{\tau_{ii}}\right)\varphi_i q_{ij}$$

$$s.t. \quad (p_{ii}-1)q_{ii}+(r_i-\tau_{ii})\varphi_i\frac{\tau}{\tau_{ii}}q_{ij}\geq 0 \tag{24}$$

$$\left(p_{ij}-r_i\frac{\tau}{\tau_{ii}}\right)\varphi_i q_{ij}\geq 0 \tag{25}$$

#where the constraints impose non-negative declared profits in country i and j, respectively.# The first order condition for the choice of r_i is

$$(\theta_i-\theta_j)\varphi_i\frac{\tau}{\tau_{ii}}q_{ij}$$

#which is positive iff $\theta_i \geq \theta_j$. The optimal transfer price is always a corner solution. In particular, when $i=1$ so that $\theta_1-\theta_2<0$,# (24) binds, and we have $r_1^*=\tau_{11}-\frac{(p_{11}-1)q_{11}}{\varphi_1 q_{12}}\frac{\tau_{11}}{\tau}=\tau_{11}\frac{\varphi_1 q_{12}\tau-(p_{11}-1)q_{11}}{\varphi_1 q_{12}\tau}$. Using r_1^* in the firm's objective function, and simplifying, one obtains

$$\max_{p_{11},p_{12}} \quad \theta_2\left(p_{12}-r_1^*\tau_{12}\right)\varphi_1 q_{12}=\theta_2\left((p_{11}-1)q_{11}+(p_{12}-\tau)\varphi_1 q_{12}\right),$$

from which it is clear #that the firm's profit is independent of imputation of transport cost τ_{11}.The multinational then set the following prices#

$$p_{11}^{*} = \frac{\sigma}{\sigma - 1} \quad \text{and} \quad p_{12}^{*} = \frac{\sigma}{\sigma - 1}\tau \tag{26}$$

#When $i = 2$ so that $\theta_2 - \theta_1 > 0$,# (25) binds, and we have $r_2^* = p_{22}\tau_{22}/\tau$, hence the firm's problem becomes

$$\max_{p_{22},p_{21}} \quad \theta_2 \left(p_{22} - 1\right) q_{22} + \left(r_2^* - \tau_{22}\right) \tau_{21}\varphi_2 q_{21} = \theta_2 \left((p_{22} - 1)q_{22} + (p_{21} - \tau)\varphi_2 q_{21}\right),$$

from which it is clear that the firm is also indifferent #to imputation of transport cost τ_{22}. The firms also sets the prices given in (26).#

#Equivalence of Cost Plus and CUP transfer pricing# #We here show that transfer prices under Cost Plus are equal to those under CUP. We also show that multinationals are indifferent to the choice of the imputation of transport costs.

First, let us discuss the export market decision of a multinational that produces in country 1. The firm maximizes its profit from foreign sales

$$\max\left[\theta_2 \left(p_{12}q_{12} - r_1\tau_{12}q_{12}\right)\varphi_1 + \theta_1 \left(r_1\tau_{12}q_{12} - \tau_{11}\tau_{12}q_{12}\right)\varphi_1\right]$$
$$\text{s.t. } \frac{r_1 - \tau_{11}}{\tau_{11}} \geq \eta_1 \text{ and } p_{12} \geq r_1\tau_{12}$$

where $q_{12} \equiv \mu p_{12}^{-\sigma}/\mathbb{P}_2^{1-\sigma}$ and where the firm takes the markup η_1 and the price index $\mathbb{P}_2$ as constants. The first inequality represents the markup constraint under Cost-Plus and the second inequality constrains the firm to declare non-negative profits in the export country. Because this first constraint can be written as $r_1\tau_{12} - \tau = \tau\eta_1$, the firm's program can be written only in terms of the variables $(p_{12}, r_1\tau_{12})$. So, the imputation of transport cost τ_{12} has no impact on the firm's decision. Also, because the marginal (unconstrained) profit of increasing r_1

$$\tau_{12}\left(\theta_1 - \theta_2\right) q_{12}\varphi_1$$

is negative, the firm sets the minimum admissible r_1, i.e., so that the markup constraint binds: $\left(r_1 - \tau_{11}\right)/\tau_{11} = \eta_1$.

In equilibrium the 'appropriate' margin is given by

$$\eta_1 \equiv \frac{m_1}{m_1 + x_1}\frac{r_1 - \tau_{11}}{\tau_{11}} + \frac{x_1}{m_1 + x_1}\frac{r_1^x - \tau_{11}^x}{\tau_{11}^x}$$

After some simplification the binding markup constraint $\left(r_1 - \tau_{11}\right)/\tau_{11} = \eta_1$ becomes is equivalent to the constraint

$$r_1\tau_{12} = \beta\tau \tag{27}$$

which is exactly the condition under CUP.

Second, we discuss the export market decision of a multinational that produces in country 2. The firm maximizes its profit from foreign sales

$$\max\left[\theta_1\left(p_{21}q_{21}-r_2\tau_{21}q_{21}\right)\varphi_2+\theta_2\left(r_2\tau_{21}q_{21}-\tau_{22}\tau_{21}q_{21}\right)\varphi_2\right]$$
$$\text{s.t. } \frac{r_2-\tau_{22}}{\tau_{22}}\geq\eta_2 \text{ and } p_{21}\geq r_2\tau_{21}$$

where $q_{21}\equiv\mu p_{21}^{-\sigma}/\mathbb{P}_1^{1-\sigma}$ and where the firm takes the markup η_2 and the price index $\mathbb{P}_1$ as constants. For the sake of convenience we transform the first inequality as $r_2\tau_{21}-\tau-\tau\eta_2\geq 0$. As before, the firm's program depends only on the variables $(p_{21}, r_2\tau_{21})$ so that the imputation of transport cost τ_{21} has no impact on the firm's decision.

Denoting the Lagrange multipliers of each constraint by λ and ϑ, $(\lambda\geq 0, \vartheta\geq 0)$. The first order condition with respect to p_{21} and $r_2\tau_{21}$ are equal to

$$\theta_1\varphi_2 p_{21}^{-\sigma-1}\frac{1}{\sigma-1}\left(p_{21}-R_2\frac{\sigma}{\sigma-1}\right)+\vartheta=0$$
$$\theta_1\varphi_2 p_{21}^{-\sigma}\left(\frac{\theta_2}{\theta_1}-1\right)-\lambda-\vartheta=0$$

where R_2 is given by (17). There are two cases to discuss.

First, suppose $\lambda>0=\vartheta$ which implies that $\frac{r_2-\tau_{22}}{\tau_{22}}=\eta_2$ and $p_{21}>r_2\tau_{21}$. The first order condition implies that $p_{21}=R_2\frac{\sigma}{\sigma-1}$. By the same argument as for expression (27), at the equilibrium, the markup (binding) constraint becomes $r_2\tau_{21}=\beta\tau$. This solution is equivalent than the condition under CUP transfer pricing when $\theta_1/\theta_2>\widehat{\theta}$

Second, suppose $\lambda>0$ and $\vartheta>0$ which implies that $\frac{r_2-\tau_{22}}{\tau_{22}}=\eta_2$ and $p_{21}=r_2\tau_{21}$. The first order condition implies that $p_{21}>R_2\frac{\sigma}{\sigma-1}$. By the same argument as for expression (27), in equilibrium, the markup (binding) constraint becomes $r_2\tau_{21}=\beta\tau$. Therefore, we get that $p_{21}=r_2\tau_{21}=\beta\tau$, which is the same condition as for CUP when $\theta_1/\theta_2\leq\widehat{\theta}$.#

7.2 #Proof of Proposition 4#

Let $\theta\equiv\theta_1/\theta_2<1$. We may rewrite the relevant thresholds as $\varphi_1^o=\gamma\theta$, $\varphi_2^o=\gamma\theta^{-1}$, $\varphi_1^*=\gamma\theta-(1-\theta)\left(\mathbb{P}_1/\mathbb{P}_2\right)^{\sigma-1}\tau^{\sigma-1}$, $\varphi_2^*=\gamma$, $\varphi_1^c=\gamma\theta\left(\beta-\theta(\beta-1)\right)^{\sigma-1}$, and $\varphi_2^c=\gamma\theta^{-1}\left(\beta-\theta^{-1}(\beta-1)\right)^{\sigma-1}$.

(i) We start by deriving how each threshold varies with θ. It is immediate that $\frac{d\varphi_1^o}{d\theta}>0$, $\frac{d\varphi_2^o}{d\theta}<0$. Let us now show that $\frac{d\varphi_1^*}{d\theta}>0$, $\frac{d\varphi_1^c}{d\theta}>0$, $\frac{d\varphi_2^c}{d\theta}<0$. Firstly,

$$\frac{d\varphi_1^*}{d\theta}=\gamma+\left(\frac{\mathbb{P}_1}{\mathbb{P}_2}\right)^{\sigma-1}\tau^{\sigma-1}>0$$

As regards the CUP and cost-plus cases, after some straightforward simplifications, we get

$$\frac{d\varphi_1^c}{d\theta} = \gamma \left[\beta - \theta(\beta - 1)\right]^{\sigma-2} \left[\beta - \theta\sigma(\beta - 1)\right]$$

Observe that, since $\theta < 1$, we have $\beta - \theta(\beta - 1) > \beta - (\beta - 1) = 1 > 0$ and $\beta - \theta\sigma(\beta - 1) > \beta - \sigma(\beta - 1) = \alpha > 0$, therefore, φ_1^c is increasing in θ. Turning to country 2, it is straightforward that

$$\frac{d\varphi_2^c}{d\theta} = \frac{d\varphi_2^c}{d\theta^{-1}} \frac{d\theta^{-1}}{d\theta} = -\gamma\theta^{-2} \left[\beta - \theta^{-1}(\beta - 1)\right]^{\sigma-2} \left[\beta - \theta^{-1}\sigma(\beta - 1)\right]$$

which is negative over the relevant range since $\theta^{-1} < \beta/(\sigma(\beta - 1)) < \beta/(\beta - 1)$. Therefore, φ_2^c is decreasing in θ.

(ii) Using the above derivatives and the fact that $0 \leq \theta \leq 1$ and that the relevant range of θ^{-1} for φ_2^c is $1 \leq \theta^{-1} \leq \frac{\beta}{(\beta-1)\sigma}$, it is straightforward to establish

$$0 \leq \varphi_1^o \leq \gamma, \quad \varphi_2^o \geq \gamma$$
$$-\left(\frac{\mathbb{P}_1}{\mathbb{P}_2}\right)^{\sigma-1} \tau^{\sigma-1} \leq \varphi_1^* \leq \gamma, \quad \varphi_2^* = \gamma$$
$$0 \leq \varphi_1^c \leq \gamma, \quad \gamma \leq \varphi_2^c \leq \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma}, \quad \widetilde{\varphi}_2^c = \gamma$$

(iii) From the above, it is straightforward that $\varphi_1^k < \varphi_2^k$ for $k = o, *, c$.

(iv) We now show that $\varphi_1^* < \varphi_1^o < \varphi_1^c$. It is straightforward that

$$\varphi_1^* = \varphi_1^o - (1 - \theta) \left(\frac{\mathbb{P}_1}{\mathbb{P}_2}\right)^{\sigma-1} \tau^{\sigma-1} < \varphi_1^o$$

Now note that

$$\beta - \theta(\beta - 1) - 1 = (\beta - 1)(1 - \theta) > 0,$$

which, since $\sigma > 1$, implies that

$$\varphi_1^c = \theta\gamma \left[\beta - \theta(\beta - 1)\right]^{\sigma-1} > \theta\gamma = \varphi_1^o.$$

(v) Finally, we show that $\varphi_2^* < \tilde{\varphi}_2^c < \varphi_2^o$. The fact that $\varphi_2^* < \tilde{\varphi}_2^c$ comes from the ranges derived in *(ii)* above. Observe that

$$\varphi_2^c = \varphi_2^o \left[\beta - \theta^{-1}(\beta - 1)\right]^{\sigma-1} < \varphi_2^o,$$

because

$$\beta - \theta^{-1}(\beta - 1) - 1 = (\beta - 1)\left(1 - \theta^{-1}\right) < 0$$

7.3 #Proof of Proposition 5#

Straightforward algebra allows us to compute the limits of the thresholds obtained in Proposition 4 when $\sigma \to \infty$. First of all, notice that $\gamma \to \gamma_\infty = (1-\alpha)e^{-(1-\alpha)}$. It is then immediate that $\varphi^c_{1\infty} = (1-\alpha)\theta e^{-(1-\alpha)\theta}$, $\varphi^c_{2\infty} = (1-\alpha)\theta^{-1}e^{-(1-\alpha)\theta^{-1}}$ (if $\theta \geq (1-\alpha)$), $\tilde{\varphi}^c_{2\infty} = e^{-1}$ (if $\theta < (1-\alpha)$), $\varphi^o_{1\infty} = \theta(1-\alpha)e^{-(1-\alpha)}$, $\varphi^o_{2\infty} = \theta^{-1}(1-\alpha)e^{-(1-\alpha)}$, $\varphi^*_{1\infty} = -\infty$, and $\varphi^*_{2\infty} = (1-\alpha)e^{-(1-\alpha)}$. To see why $\varphi^*_{1\infty} = -\infty$, it suffices to use the fact that at the competitive limit

$$\frac{\mathbf{P}_1^{\sigma-1}}{\mathbf{P}_2^{\sigma-1}} \to \frac{m_2+x_2}{m_1+x_1} = 1$$

is finite, and $\tau^{\sigma-1} \to \infty$. Finally, notice that, indeed ($\varphi^k_{1\infty} < \varphi^k_{2\infty}$, $k = o, *, c$), $\varphi^*_{1\infty} < \varphi^o_{1\infty} < \varphi^c_{1\infty}$), and $\varphi^*_{2\infty} < \varphi^c_{2\infty} < \varphi^o_{2\infty}$.

8 Appendix B: Structure and Location Equilibrium

#New proof#

8.1 Structure and location equilibrium under no audit

We here determine the production and location of firms under no audit. For the sake of clarity, we drop the superscript * that refers to no audit setting when this does not give rise to any confusion.

1. We first determine the structure of each firm v with specific distribution cost $\varphi_i(v)$. This is shown in the first panel of Figure 4, which maps the chosen structure $('m_1','x_1','m_2','x_2')$ as a function of φ and $\mathbb{P}$. In this figure, $\mathbb{P}_a \equiv 1$ solves the condition $\Pi^m_1 = \Pi^m_2$ and $\mathbb{P}_b \equiv (1-\gamma\phi\theta)/(\theta-\gamma\phi) > 1/\theta$ solves the condition $\Pi^x_1 = \Pi^x_2$. Also $\varphi_{12}(\mathbb{P}) = [1-\mathbb{P}(1-\gamma\phi)]/\phi$ solves the conditions $\Pi^m_1 = \Pi^x_2$ and $\varphi_2 = \gamma$ solves the condition $\Pi^m_2 = \Pi^x_2$.

2. We secondly determine the fixed point of the system. The correspondence G is here defined as
$$\mathbb{G}(m_1, x_1, m_2, x_2) \equiv \frac{m_2+x_2+\phi m_1+\phi\beta^{1-\sigma}x_1}{m_1+x_1+\phi m_2+\phi\beta^{1-\sigma}x_2}$$
One can readily check that the graph of $\mathbb{G}$ looks as in the second panel of Figure 4. It is a upper hemicontinuous correspondence, which implies that an equilibrium exists. Furthermore, because the graph of $\mathbb{G}$ is strictly decreasing on the interval $[1, \mathbb{P}_b]$, the equilibrium is unique. More formally, let the graph of G be defined as $\Gamma(\mathbb{P}) = G[m_1(\mathbb{P}), x_1(\mathbb{P}), m_2(\mathbb{P}), x_2(\mathbb{P})]$. One can check that $\mathbb{P}_1 < \mathbb{P}_2 \Rightarrow \Gamma(\mathbb{P}_1) > \Gamma(\mathbb{P}_2)$. Then, suppose that $\mathbb{P}^*_1$ and $\mathbb{P}^*_2$, $\mathbb{P}^*_1 < \mathbb{P}^*_2$, are two solutions of $\mathbb{P} = \Gamma(\mathbb{P})$. Since

$\mathbb{P}_1^* < \mathbb{P}_2^*$, it must be that $\Gamma(\mathbb{P}_1^*) < \Gamma(\mathbb{P}_2^*)$, a contradiction. Therefore, the solution is unique: $\mathbb{P}_1^* = \mathbb{P}_2^*$.

3 We thirdly establish for equilibrium conditions for the different possible configurations of structure and location at the competitive limit.

Lemma 7 *At the competitive limit ($\sigma \to \infty$), the equilibrium has the configuration '$m_1 m_2 x_2$' where $m_1 = 1/2$, $x_2 = \gamma_\infty$ and $m_2 = 1/2 - \gamma_\infty$ where $\gamma_\infty \equiv (1-\alpha)e^{-(1-\alpha)}$.*

In the competitive limit we have that

$$\phi \to 0, \quad \beta \to 1, \quad \beta^{1-\sigma} \to \beta_\infty^{1-\sigma} \equiv e^{-(1-\alpha)}, \quad \gamma \to \gamma_\infty \equiv (1-\alpha)e^{-(1-\alpha)}$$

$$\varphi_{2\infty} = \gamma_\infty$$

The left panel of Figure 4 is valid. Inspection of this figure reveals that there can exist only six configurations: 'm_2x_2','$m_1m_2x_2$','m_1x_2','$m_1x_1x_2$','m_1x_1','m_1'. Note that at the competitive limit the border $\varphi_{12}(\mathbb{P})$ is nearly vertical. As a result, there exists no equilibrium configuration with $x_1 > 0$. Indeed, a firm producing in country 1 always has a larger profit by using the multinational structure to export its cash. So $x_1 = 0$ and the configurations '$m_1x_1x_2$' and 'm_1x_1' are not possible. Also, note that

$$\mathbb{G}(m_1, x_1, m_2, x_2) \equiv \frac{m_2 + x_2}{m_1}$$

and $\mathbb{P}_{a\infty} = 1$ and $\mathbb{P}_{b\infty} = 1/\theta$ at the competitive limit.

3.i An equilibrium 'x_2m_2' where $x_2 > 0$ and $m_2 > 0 = x_1 = m_1$ implies that $\mathbb{P} = \mathbb{G}[0, 0, m_2, x_2]$ and $\mathbb{P} < \mathbb{P}_{a\infty} = 1$ which is not possible because gives $\mathbb{G}[0, 0, m_2, x_2] = 1/0$.

3.ii An equilibrium '$m_1m_2x_2$' with $m_1 > 0, m_2 > 0$ and $x_2 > 0 = x_1$ implies that $\mathbb{P}_{a\infty} = \mathbb{G}[m_1, 0, m_2, x_2]$ where $x_2 = \varphi_{2\infty}$ and $m_1 + m_2 = 1 - \varphi_{2\infty}$. This gives

$$1 = \frac{m_2 + x_2}{m_1}$$

so that

$$m_1 = 1/2, \quad x_2 = \varphi_{2\infty} \quad \text{and} \quad m_2 = 1/2 - \varphi_{2\infty}$$

This configuration is an equilibrium if $m_2 > 0 \iff 1/2 > \gamma_\infty$ which is true because $\max \gamma_\infty = e^{-1} = 0.36$.

3.iii An equilibrium 'm_1x_2' with $m_1 > 0$ and $x_2 > 0 = x_1 = m_2$ implies that $x_2 = \varphi_{12}(\mathbb{P})$ and $m_1 = 1 - x_2$. Since $\varphi_{12}(\mathbb{P})$ is nearly vertical at the competitive limit, it must be that $\mathbb{P} = \mathbb{P}_{a\infty} = 1$. So, the equilibrium condition $\mathbb{P} = \mathbb{G}[m_1, 0, 0, x_2]$ is equivalent to

$$1 = \frac{x_2}{m_1}$$

so that

$$m_1 = x_2 = 1/2$$

This configuration is an equilibrium if $x_2 < \varphi_{2\infty} \iff 1/2 < \gamma_\infty$ which is never true because $\max \gamma_\infty = e^{-1} = 0.36$.

3.iv There is no equilibrium 'm_1' with $m_1 > x_1 = m_2 = x_2 = 0$ as this requires $\mathbb{G}[m_1, x_1, 0, 0] = \mathbb{P}$ where $\mathbb{P} > 1$, which is impossible since $\mathbb{G}[m_1, x_1, 0, 0] = \frac{0}{m_1} = 0$.

8.2 Structure and location equilibrium under perfect audit

We here determine the production and location of firms under perfect audit. For the sake of clarity, we drop the superscript ^{o} that refers to perfect audit setting when this does not give rise to confusion.

1 We first determine the structure of each firm v with specific distribution cost $\varphi_i(v)$. This is shown in as in the first panel of Figure 5, which maps the chosen structure $('m_1','x_1','m_2','x_2')$ as a function of φ and $\mathbb{P}$. Let $\mathbb{P}_a \equiv 1/\theta$ solves the condition $\Pi_1^m = \Pi_2^m$ and let $\mathbb{P}_b \equiv (1 - \gamma\phi\theta)/(\theta - \gamma\phi) > 1/\theta$ solve $\Pi_1^x = \Pi_2^x$; a positive attractiveness index $\mathbb{P}_b$ requires that $\theta > \gamma\phi$. Let also $\varphi_1 = \gamma\theta$ and $\varphi_2 = \gamma/\theta$ solve the condition $\Pi_1^m = \Pi_1^x$ and $\Pi_2^m = \Pi_2^x$.

2 As before, one can readily check that $\mathbb{G}$ is a upper hemicontinuous correspondence on the interval, which implies that an equilibrium exists. Furthermore, because the graph of $\mathbb{G}$ is strictly decreasing (see second panel of Figure 5), the equilibrium is unique.

3 We thirdly establish for equilibrium conditions for the different possible configurations of structure and location at the competitive limit.

Lemma 8 *At the competitive limit ($\sigma \to \infty$), the equilibrium has the configuration '$m_1m_2x_2$' if $\theta > \gamma_\infty/(1-\gamma_\infty)$ and the configuration 'm_1x_2' otherwise. In both cases, $m_1 = \theta/(1+\theta)$ and $m_2 + x_2 = 1/(1+\theta)$. In the first case, $m_2 = 1/(1+\theta) - \gamma_\infty$ where $\gamma_\infty = (1-\alpha)e^{-(1-\alpha)}$.*

In the competitive limit we have that

$$\phi \to 0, \quad \beta \to 1, \quad \beta^{1-\sigma} \to \beta_\infty^{1-\sigma} \equiv e^{-(1-\alpha)}, \quad \gamma \to \gamma_\infty \equiv (1-\alpha)e^{-(1-\alpha)}$$
$$\varphi_{1\infty} = \gamma_\infty \theta \quad \text{and} \quad \varphi_{2\infty} = \gamma_\infty/\theta$$

The left panel of Figure 5 is valid. Inspection of this figure reveals that there can exist only five configurations: 'm_2x_2','$m_1m_2x_2$','m_1x_2','$m_1x_1x_2$','m_1x_1'. Also, note that

$$\mathbb{G}(m_1, x_1, m_2, x_2) \equiv \frac{m_2 + x_2}{m_1 + x_1}$$

and $\mathbb{P}_{a\infty} = 1/\theta$ and $\mathbb{P}_{b\infty} = 1/\theta$ at the competitive limit.

3.i An equilibrium 'm_2x_2' with $x_1 = m_1 = 0 < m_2, x_2$ never occurs because the condition $\mathbb{P}_{a\infty} = \mathbb{G}[0, 0, m_2, x_2]$ where x_2=$\varphi_{2\infty}$ and $m_2 = 1 - \varphi_{2\infty}$. This requires that

$$\frac{1}{\theta} = \frac{1}{0}$$

which is impossible.

3.ii Then, an equilibrium '$m_1m_2x_2$' with $x_1 = 0 < m_1, m_2, x_2$ occurs if $\mathbb{P}_b = \mathbb{G}[m_1, 0, m_2, x_2]$ where x_2=$\varphi_{2\infty}$ and m_1+$m_2 = 1 - \varphi_{2\infty}$. This requires that

$$\frac{1}{\theta} = \frac{m_2 + x_2}{m_1}$$

so that

$$m_1 = \frac{\theta}{1+\theta}, \; x_2{=}\varphi_{2\infty} \text{ and } m_2 = \frac{1}{1+\theta} - \varphi_{2\infty}$$

This solution is valid provided that $x_2 < 1 \iff \theta > \gamma_\infty$ and that $m_2 > 0 \iff \theta > \gamma_\infty/(1+\gamma_\infty)$. The second condition being more restrictive, an equilibrium '$m_1m_2x_2$' exists if $\theta > \gamma_\infty/(1+\gamma_\infty)$.

3.iii An equilibrium 'm_1x_2' with $x_1 = m_2 = 0 < m_1, x_2$ occurs if $\mathbb{P} = \mathbb{G}[m_1, 0, 0, x_2]$ where $x_2 \in (\varphi_{1\infty}, \varphi_{2\infty}]$ and $m_1 = 1 - x_2$ and where $\mathbb{P} \in [\mathbb{P}_{a\infty}, \mathbb{P}_{b\infty}]$. This gives

$$\frac{1}{\theta} = \frac{x_2}{m_1}$$

so that

$$m_1 = \frac{\theta}{1+\theta} \text{ and } x_2{=}\frac{1}{1+\theta}$$

This solution is valid if $x_2 > \varphi_{1\infty} \iff 1/\gamma_\infty > \theta(1+\theta)$ and if $x_2 \leq \varphi_{2\infty}$ which is true either if $\varphi_{2\infty} > 1 \iff \theta < \gamma_\infty$ or else if $\theta < \gamma_\infty/(1+\gamma_\infty)$. The last condition being less restrictive, an equilibrium 'm_1x_2' exists if $\theta < \gamma_\infty$ and $\gamma_\infty < 1/\left[\theta(1+\theta)\right]$.

3.iv An equilibrium '$m_1x_1x_2$' with $m_2 = 0 < m_1, x_1, x_2$ occurs if $\mathbb{P}_{b\infty} = \mathbb{G}[m_1, x_1, 0, x_2]$ where $m_1 = 1 - \varphi_{1\infty}$ and $x_1 + x_2 = \varphi_{1\infty}$. This gives

$$\frac{1}{\theta} = \frac{x_2}{m_1 + x_1}$$

so that

$$m_1 = 1 - \varphi_{1\infty}, \quad x_1 = \frac{\theta}{1+\theta} - (1 - \varphi_{1\infty}) \text{ and } x_2 = \frac{1}{1+\theta}$$

This solution is valid if and only if $x_1 > 0$. This requires that $\varphi_{1\infty} > \frac{1}{1+\theta} = x_2 \iff 1/\gamma_\infty < \theta(1+\theta)$. Because $\max 1/\gamma_\infty = e = 2.73$, the last condition is never satisfied. So, there is no equilibrium '$m_1x_1x_2$'.

3.v An equilibrium 'm_1x_1' with $m_2 = x_2 = 0 < m_1, x_1$ occurs if $\mathbb{P} = \mathbb{G}[m_1, x_1, 0, 0]$ which requires

$$\frac{1}{\theta} = \frac{0}{m_1 + x_1}$$

which is impossible.

8.3 Structure and location equilibrium under CUP and Cost Plus

We here determine the production and location of firms under CUP and Cost Plus. For the sake of clarity, we drop the superscript ^{c} that refers to this setting.

1 We first determine the structure of each firm v with specific distribution cost $\varphi_i(v)$. At given attractivity index $\mathbb{P}$ the location and structure of firms is given by the first panel of Figure 5. Some notation proves useful.

1.i Let us define $M_1 \equiv R_1^{1-\sigma}/\phi = (\beta + \theta(1-\beta))^{1-\sigma}$ and

$$M_2 = \begin{cases} R_2^{1-\sigma}/\phi = (\beta + \theta^{-1}(1-\beta))^{1-\sigma} & \text{if } \theta \geq \sigma\frac{1-\alpha}{\sigma-\alpha} \\ \widetilde{M}_2 = \gamma\theta^{-1}\left(\frac{\sigma}{\sigma-1}\right)^{\sigma} & \text{otherwise} \end{cases}$$

Using those definitions, the export profit of a multinational producing in country 1 and 2 are respectively equal to $\pi_{12} = K\theta_2\mathbb{P}_2^{1-\sigma}\phi M_1\varphi(v)$ and $\pi_{21} = K\theta_1\mathbb{P}_1^{1-\sigma}\phi M_2\varphi(v)$. We also have $M_1 < 1 < M_2$.

1.ii Let φ_1 solve the condition $\Pi_1^m = \Pi_1^x$. So, $\Pi_1^m > \Pi_1^x$ for any $\varphi(v) > \varphi_1 \equiv \gamma\theta/M_1 \in [0, \gamma]$. Third, let

$$\varphi_2 = \gamma/(\theta M_2) = \begin{cases} \frac{\gamma}{\theta(\beta+\theta^{-1}(1-\beta))^{1-\sigma}} & \text{if } \theta \geq \sigma\frac{1-\alpha}{\sigma-1} \\ \widetilde{\varphi}_2^c \equiv \left(\frac{\sigma}{\sigma-1}\right)^{-\sigma} & \text{otherwise} \end{cases}$$

solve the condition $\Pi_2^m = \Pi_2^x$. It can be shown that $\gamma < \varphi_2 < \left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}$. So, $\Pi_2^m > \Pi_2^x$ for any $\varphi(v) > \varphi_2$. Fourth, for any $\mathbb{P} > \frac{1}{\theta}$, let

$$\varphi_{m1m2}(\mathbb{P}) = \frac{1}{\phi}\frac{\theta\mathbb{P} - 1}{\theta M_2\mathbb{P} - M_1}$$

solve the equality $\Pi_1^m = \Pi_2^m$. This is an increasing function of $\mathbb{P}$. If $\mathbb{P} > \frac{1}{\theta}$, we get that $\Pi_1^m > \Pi_2^m$ if $\varphi(v) < \varphi_{m1m2}(\mathbb{P})$ whereas $\Pi_1^m < \Pi_2^m$ for all $\varphi(v)$ if $\mathbb{P} < 1/\theta$.

1.iii Let

$$\mathbb{P}_b \equiv \frac{1 - \gamma\phi\theta}{\theta - \gamma\phi}$$

solve $\Pi_1^x = \Pi_2^x$. We get that, if $\theta \geq \gamma\phi$, $\Pi_1^x > \Pi_2^x$ iff $\mathbb{P} > \mathbb{P}_b$ whereas $\Pi_1^x < \Pi_2^x$ for any $\mathbb{P}$ if $\theta < \gamma\phi$.

1.iv Let

$$\varphi_{m1x2}(\mathbb{P}) = \frac{1 + (\gamma\phi - \theta)\mathbb{P}}{\phi M_1}$$

solve $\Pi_1^m = \Pi_2^x$. This function decreases iff $\theta > \gamma\phi$. Therefore, we get that $\Pi_1^m > \Pi_2^x$ iff $\varphi(v) > \varphi_{m1x2}(\mathbb{P})$.

1.v For all $\theta < \gamma\phi$, let

$$\mathbb{P}_a \equiv \frac{1}{\theta}\frac{M_2\theta - M_1\gamma\phi}{M_2(\theta - \gamma\phi)}$$

solve the condition $\Pi_1^m = \Pi_2^m = \Pi_2^x$; that is, it solves $\varphi_{m1m2}(\mathbb{P}) = \varphi_2$. If $\theta < \gamma\phi$, there is not intersection of $(\Pi_1^m, \Pi_2^m, \Pi_2^x)$. Finally,

$$\mathbb{P}_c \equiv \frac{1}{\theta}\frac{1 - M_1\phi}{1 - M_2\phi}$$

solve $\varphi_{m1m2}(\mathbb{P}) = 1$. This solution exists only if $\phi < 1/M_2$. Those variables are used to build the first panel of Figure 6.

2 The second panel of Figure 6 displays the graph of $\mathbb{G}$ when $\theta > \gamma\phi$. As before, one can readily check that $\mathbb{G}$ is a upper hemicontinuous correspondence on the interval, which implies that an equilibrium exists. Furthermore, because the graph of $\mathbb{G}$ is strictly decreasing (see second panel of Figure 6), the equilibrium is unique.

3 We thirdly establish for equilibrium conditions for the different possible configurations of structure and location at the competitive limit where $\sigma \to \infty$.

Lemma 9 *At the competitive limit ($\sigma \to \infty$), the equilibrium has the configuration '$m_1m_2x_2$' if $\theta > 1-\alpha$ and the configuration 'm_1x_2' otherwise. In both cases, $m_1 = \theta/(1+\theta)$ and $m_2 + x_2 = 1/(1+\theta)$. In the first case, $m_2 = 1/(1+\theta) - \frac{1-\alpha}{\theta}e^{-\frac{1-\alpha}{\theta}}$.*

3.i In the competitive limit, we successively get

$$\phi \to 0, \quad \beta \to 1, \quad \beta^{1-\sigma} \to \beta_\infty^{1-\sigma} \equiv e^{-(1-\alpha)}, \quad \gamma \to \gamma_\infty \equiv (1-\alpha)e^{-(1-\alpha)}$$

$$M_{1\infty} = e^{-(1-\alpha)(1-\theta)}$$
$$M_{2\infty} = \begin{cases} e^{(1-\alpha)\frac{1-\theta}{\theta}} & \text{if } \theta \geq 1-\alpha \\ \frac{1-\alpha}{\theta}e^{\alpha} & \text{otherwise} \end{cases}$$

whereas

$$\varphi_{1\infty} \equiv (1-\alpha)\,\theta e^{-(1-\alpha)\theta}$$
$$\varphi_{2\infty} = \begin{cases} \frac{1-\alpha}{\theta}e^{-\frac{1-\alpha}{\theta}} < 1 & \text{if } \theta \geq 1-\alpha \\ e^{-1} < 1 & \text{otherwise} \end{cases}$$

As a result, one can check that $\theta > \gamma_\infty \phi_\infty = 0$, so that the left panel of Figure 5 is valid. Inspection of this figure reveals that there can exist only five configurations: 'm_2x_2','$m_1m_2x_2$','m_1x_2','$m_1x_1x_2$','m_1x_1'. Also, note that

$$\mathbb{G}(m_1, x_1, m_2, x_2) \equiv \frac{m_2 + x_2}{m_1 + x_1}$$

and $\mathbb{P}_{a\infty} = 1/\theta$ and $\mathbb{P}_{b\infty} = 1/\theta$ at the competitive limit.

3.i An equilibrium 'm_2x_2' with $x_1 = m_1 = 0 < m_2, x_2$ never occurs because the condition $\mathbb{P}_{a\infty} = \mathbb{G}[0, 0, m_2, x_2]$ where $x_2{=}\varphi_{2\infty}$ and $m_2 = 1 - \varphi_{2\infty}$. This requires that

$$\frac{1}{\theta} = \frac{1}{0}$$

which is never true.

3.ii Then, an equilibrium '$m_1m_2x_2$' with $x_1 = 0 < m_1, m_2, x_2$ occurs if $\mathbb{P}_{b\infty} = \mathbb{G}[m_1, 0, m_2, x_2]$ where $x_2{=}\varphi_{2\infty}$ and $m_1{+}m_2 = 1 - \varphi_2$. This requires that

$$\frac{1}{\theta} = \frac{m_2 + x_2}{m_1}$$

so that

$$m_1 = \frac{\theta}{1+\theta}, \quad x_2{=}\varphi_{2\infty} \text{ and } m_2 = \frac{1}{1+\theta} - \varphi_{2\infty}$$

This solution is valid provided that $m_2 > 0$. One readily check that $m_2 \leq 0$ if and only if $\theta \geq 1 - \alpha$. So, an equilibrium '$m_1m_2x_2$' exists if $\theta < 1 - \alpha$.

3.iii An equilibrium 'm_1x_2' with $x_1 = m_2 = 0 < m_1, x_2$ occurs if $\mathbb{P} = \mathbb{G}[m_1, 0, 0, x_2]$ where $x_2 \in (\varphi_{1\infty}, \varphi_{2\infty}]$ and $m_1 = 1 - x_2$ and where $\mathbb{P} \in [\mathbb{P}_{a\infty}, \mathbb{P}_{b\infty}]$. This gives

$$\frac{1}{\theta} = \frac{x_2}{m_1}$$

so that

$$m_1 = \frac{\theta}{1+\theta} \text{ and } x_2 = \frac{1}{1+\theta}$$

This solution is valid if $x_2 > \varphi_{1\infty}$, which is always true, and if $x_2 \leq \varphi_{2\infty}$ which is true if and only if $\theta \geq 1 - \alpha$. So, an equilibrium 'm_1x_2' exists if $\theta \geq 1 - \alpha$.

3.iv An equilibrium '$m_1x_1x_2$' with $m_2 = 0 < m_1, x_1, x_2$ occurs if $\mathbb{P}_{b\infty} = \mathbb{G}[m_1, x_1, 0, x_2]$ where $m_1 = 1 - \varphi_{1\infty}$ and $x_1 + x_2 = \varphi_{1\infty}$. This gives

$$\frac{1}{\theta} = \frac{x_2}{m_1 + x_1}$$

so that

$$m_1 = 1 - \varphi_{1\infty}, \quad x_1 = \frac{\theta}{1+\theta} - (1 - \varphi_{1\infty}) \text{ and } x_2 = \frac{1}{1+\theta}$$

This solution is valid if and only if $x_1 > 0$. This requires that $\varphi_{1\infty} > \frac{1}{1+\theta} = x_2$, which is never satisfied. There is no equilibrium '$m_1x_1x_2$'.

3.v An equilibrium 'm_1x_1' with $m_2 = x_2 = 0 < m_1, x_1$ occurs if $\mathbb{P} = \mathbb{G}[m_1, x_1, 0, 0]$ which requires

$$\frac{1}{\theta} = \frac{0}{m_1 + x_1}$$

which is impossible.

	Domestic Production Unit		Foreign Border		Foreign Unit		Foreign Consumer
Number of exported goods	$\tau_{ii}\ \tau_{ij}\ q_{ij}$	→	$\tau_{ij}\ q_{ij}$	→	q_{ij}	→	q_{ij}
Value of exported goods	$\tau_{ii}\ r_i\ \tau_{ij}\ q_{ij}$	→	$r_i\ \tau_{ij}\ q_{ij}$	→	$r_i\ q_{ij}$	→	$p_{ij}\ q_{ij}$

Figure 1: Splitting of Transport Costs and Value of Production under Iceberg Transport Cost

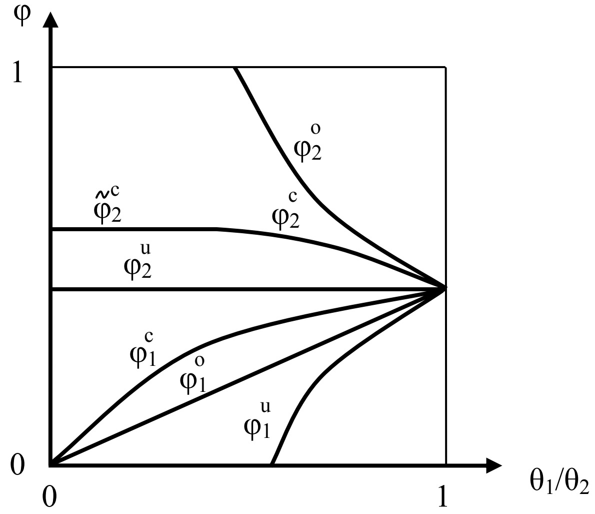

Figure 2: Choice of Production Structure

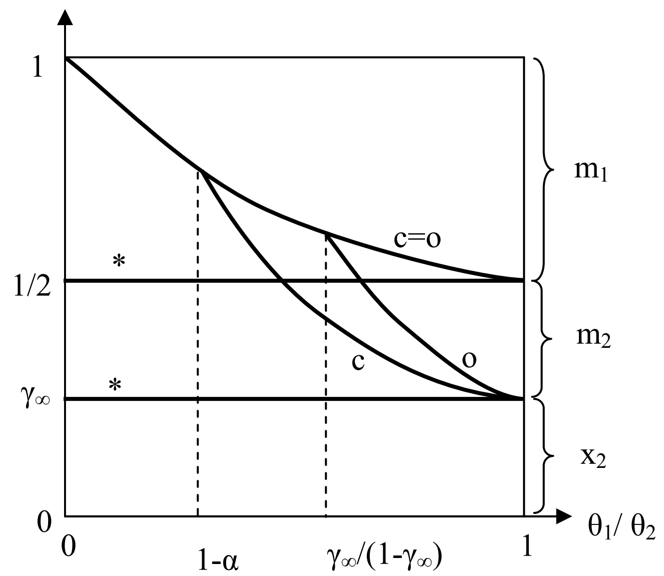

Figure 3 : Structure and Location of Firms at the Competitive Limit

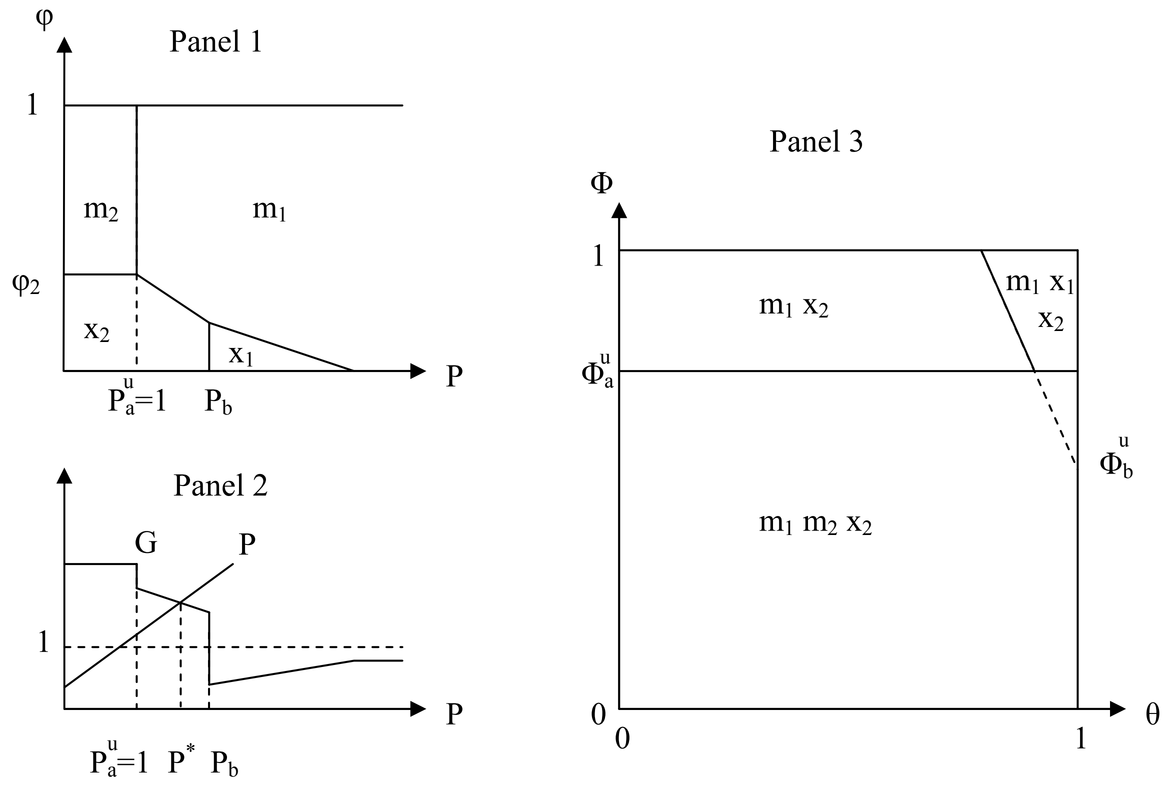

Figure 4 : Structure and Location of Firms under No Audit

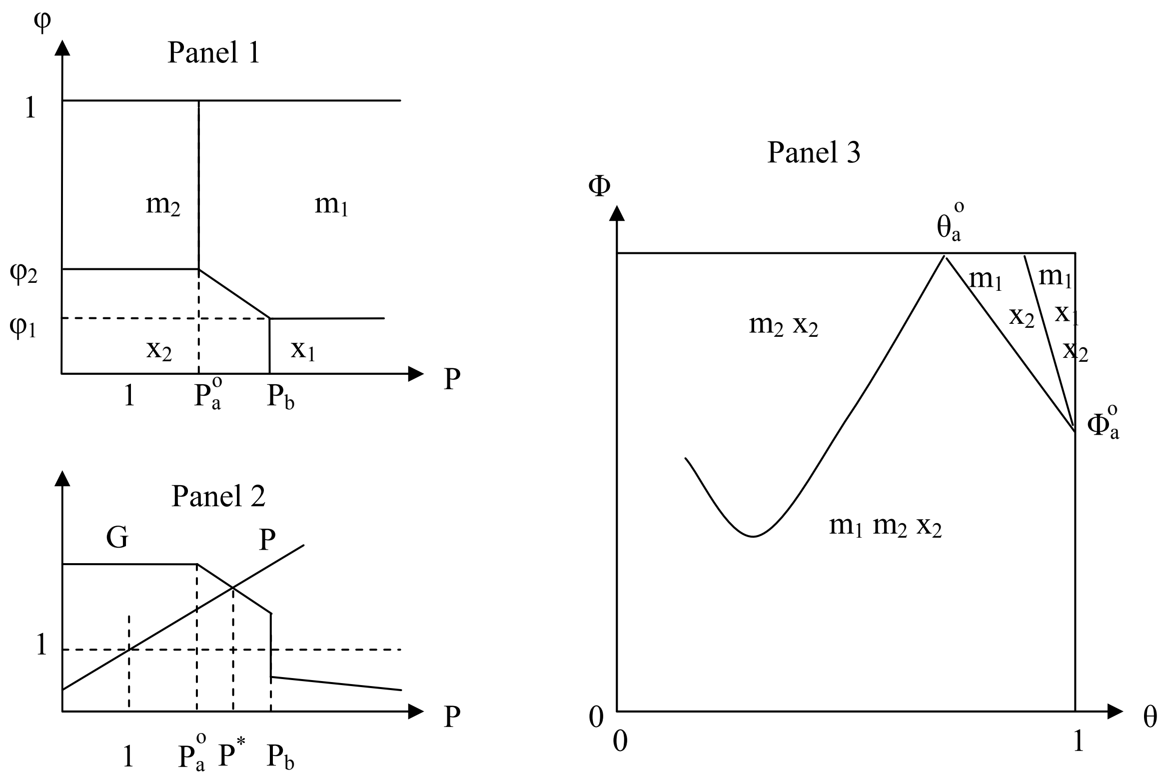

Figure 5 : Structure and Location of Firms under Perfect Audit

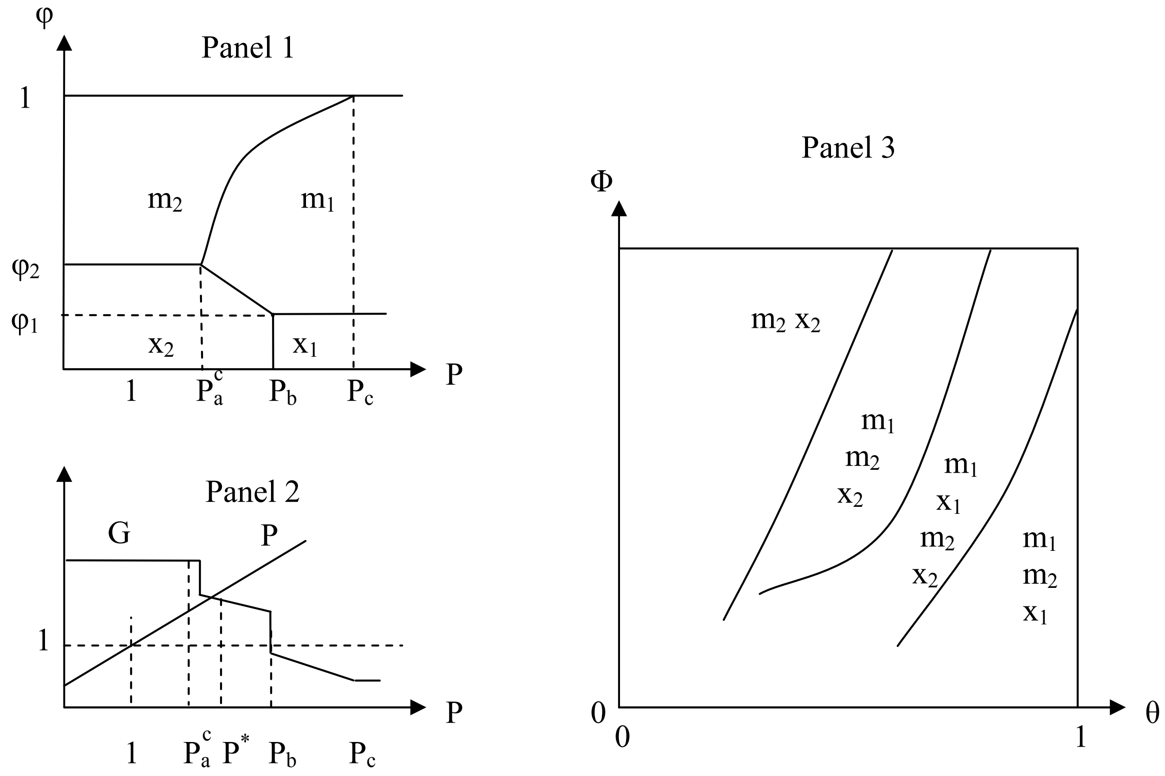

Figure 6 : Structure and Location of Firms under CUP and Cost Plus (case θ>γΦ)