TABLE OF CONTENTS

ABSTRACT

This work aims to shed a light on how multinational enterprises set the transfer pricing, exploiting corporate tax differentials between their domestic and abroad branches. It is a practice implemented by multinationals with the aim to lower their tax burden. We develop a model characterized by a multinational enterprise that splits its value chain into two main activities, carried out by two divisions (parent and subsidiary) located into two different states. The key feature is that, since the corporate tax rate is assumed to be lower abroad in the subsidiary's country, MNEs would like to shift profits there. The State of the domestic country will therefore intervene with some random controls and penalties on those multinational firms who unfairly abused of the transfer pricing practice. In contrast with the main existing literature, in order to capture the dynamics behind the negotiation of the transfer pricing, a game theoretic approach between the managers of the two divisions is implemented, and the bargaining activity follows the rule of the "trust game". We simulate the model in C programming, simulating an economy composed by several MNEs and one State, according to an agent based approach. The model simulations suggest that an optimal level of regulation for the State exists, and according to this level, we show the implications on the transfer pricing level and both parent and subsidiary profits.

ABSTRACT

(IT)

Questo lavoro ha come obbiettivo quello di fare chiarezza su come le multinazionali decidono il loro transfer pricing, sfruttando la differenza di tassazione tra la divisione domestica e estera. Si tratta di una pratica utilizzata dalle multinazionali con l'obiettivo di abbassare il loro carico fiscale. Sviluppiamo un modello caratterizzato da una multinazionale che sviluppa la sua catena produttiva in due principali attività, portate avanti da due divisioni locate in due stati differenti. La caratteristica chiave è che, dato che assumiamo che la tassazione estera sia minore, le multinazionali vorranno portare i propri profitti all'estero. Lo stato del paese domestico, perciò, interverrà con dei controlli casuali e imponendo delle multe su quelle multinazionali che hanno abusato della pratica del transfer pricing. Rispetto alla letteratura esistente, per catturare la dinamica del transfer pricing negoziato, viene utilizzato un approccio che sfrutta la teoria dei giochi tra i managers delle due divisioni, e l'attività di negoziazione segue le regole del "trust game". Simuliamo il modello con una programmazione in C, simulando un'economia composta da diverse multinazionali e uno Stato, seguendo un approccio basato sugli agenti. Le simulazioni del modello suggeriscono l'esistenza di un livello di regolamentazione ottimale dello stato, e in base a quello dimostriamo le implicazioni sui profitti delle due divisioni della multinazionale e sul livello di transfer pricing.

INTRODUCTION

The aim of this work is to understand, on one hand, how multinational enterprises can gain from the lack of international coordination in terms of corporate tax rate, and on the other hand, how a State can intervene in order to limit the tax manipulation practices of MNEs. Multinationals, in fact, have their supply chains widespread across more countries, and since these countries show different level of taxation, MNEs can choose where to show taxable profits, with the goal of minimizing the amount of tax burden. In order to do so, multinationals implement the *Transfer Pricing* mechanism, which refers to the price given to an intermediate product exchanged within two divisions of the same multinational. Taking into account that more than 65% of trade in goods is explained by trade in intermediate product, the impact of the strategic pricing of these intermediate goods can strongly influence multinational overall profits on one side, and the State tax revenue and consumer surplus on the other. This work can be useful for students, managers and policy makers that aim to understand the dynamic behind the transfer pricing mechanism, and its effects on several strategic variables with a multi-level analysis, from the micro to the macroeconomic point of view. This thesis is inspired by the main literature on the economic approach of transfer pricing. Starting from the *Hirsleifer* contribution "On the economics of transfer pricing", the author suggests two main kind of transfer pricing system: centralized and decentralized (or negotiated). The centralized approach happens when the head quarter of the multinational sets the transfer pricing regardless to managers preferences, and is then studied in depth in the works of *Horst* (1971) and *Kant* (1987). The decentralized or negotiated transfer pricing system, that is the most used in MNEs practice because happens when the decision making is up to the agreement of division managers, is generally studied as a bargaining game. Models of the latter kind are proposed by the economists *Stoughton* (1992) and *Vaysman* (1998) and in particular, this work is mainly inspired by both these two papers. The model proposed in this thesis focuses on the profit split transfer pricing method, in which several MNEs composed by two divisions (Parent and foreign Subsidiary) located into two different states, have the possibility to shift profits abroad where the tax rate is lower, covering a risk of penalty that is imposed randomly by the State. In order to capture the dynamic behind the mechanism of setting the negotiated transfer pricing, the model implements the trust game approach, that is a particular kind of sequential and non-cooperative game, with some assumption of asymmetric information among agents. The game is carried out through the assumption that the foreign subsidiary can be partially owned by the parent company, and the exchange of equity shares is used as a proxy for the Trust game (or "investment game"). Since the latest developments of this research field are the computational analysis implemented through the simulations of different game theoretical approaches, this work attempts to simulate an economy composed by several MNEs, whose profits are a function of the negotiated transfer pricing level, which is in turn a function of the State regulation level.

After a brief literature review of the main economic approaches on transfer pricing contributions present in the first chapter, the second chapter of this work deals with the construction of the model that will be in the end simulated and analysed in the chapter III. The simulations of the model suggest that the State is not able to fully neutralize the MNEs attempts to manipulate taxes, and this result is consistent across several level of State intervention. Moreover, from a microeconomic point of view, only when a State regulation exists the bargaining game between managers is cooperative, therefore in this case a negotiated transfer pricing system would be more effective than a centralized one.

CHAPTER I:

"LITERATURE REVIEW"

I.1 THE ROLE OF TRANSFER PRICING

Thanks to globalization and new technologies, always more firms can afford to extend their business activities and supply chains among different countries. From a macroeconomic point of view, the increase of international trade would lead to an overall increasing of economic market welfare, however some negative backlash of this could arise. In fact, multinational enterprises (MNEs from now on) which can be defined as a firm with at least two plants, in at least two locations, are the big players of international trade, and they have a lot of economic power. Tax planning is becoming more and more important in the long term strategy of these companies, and this often translates into activities of tax manipulation that lead to a loss of welfare for both State and citizens. The goal of MNEs' international tax management is to increase corporation-wide profits by reducing the total amount of taxes paid. This can be afforded through the mismatch of international corporate tax rate. In fact, it is an opportunity for businesses to exploit differences between corporate tax rates among countries in which they operate, because in this way they can show income and profits where the tax rate is lower. This is possible thanks to the practice of transfer pricing. It is a system that MNEs employ when they are supposed to price a good (intermediate) that is traded within two divisions of the same company. The aim of MNEs, in this field, is to find the optimal transfer pricing, that is the price that leads both division managers, who act in their own self-interest and are rewarded according to each divisional profits, to make decisions that are in the firm's best interest. In economics terms, this can be viewed as a pareto efficient solution. In fact, the goal is to find a level of transfer pricing that leads to an improvement of both division and overall firm profits.

In order to do so, several conditions have to be respected. For instance, Business International Corporation (1965) provides seven requirements for a transfer pricing system to work:

1) the producing unit should make a fair profit;

2) the purchasing unit should be able to market competitively priced products;

3) top management should be able to compare the performance of the various producing and purchasing units;

4) purchasing and producing units should be satisfied with the transfer pricing system so that top management would not spend too much time in mediation to settle disputes;

5) the transfer prices should be acceptable to tax authorities;

6) the transfer prices should be acceptable to customs officials;

7) control via transfer pricing should be exercised over foreign subsidiaries so that the subsidiaries would be able to meet their profit requirements.

In order to assess the impact on the global economy of the phenomenon of transfer pricing, it is enough to understand that the market is dominated by the trade in intermediate goods. In fact, the share of intermediate goods on the total manufactured consumed goods traded is more than 65% in 2005, against the 10% of the 1925.[1] Therefore, the pricing of these intermediate goods, especially when traded within the same company, matters a lot in terms of overall profits, consumer and producer surplus for the global economy.

The international lack of coordination among countries makes all this possible, and it represents a twofold phenomenon: on one side, as already said, it is an opportunity for the strategic behaviour of MNEs in setting transfer pricing, which translates into a gain in terms of higher profits; on the other side, there is a loss of surplus for the State. In general, it has to be point out that states compete for attracting capital as much as possible, and since there is the free movement of capital flows almost all over the world, then States compete in a race to the bottom. In fact, each state acts in its own interest because knows that if its tax rate is lower than the one proposed by the other states, then it will attract much more foreign direct investments and

[1] See Vertical Production Network in Multinational Firms, REStat, 2005 Hanson, Mataloni and Slaughter (2005).

capital. If we suppose that more states will agree on a single common tax rate, then other closed countries will have an increasing return if they offer a lower tax rate and are not obliged to follow that common tax rate. This explains why there is free riding in international cooperation on tax rates, and this can be viewed as the presence of tax heavens also within the same economic area. Rugman and Aliber argue that global welfare is reduced since transfer pricing worsens the global allocation of resources. To sum up, the international coordination problem can be studied as a non cooperative game, and the tax competition is much larger than the tax cooperation.

However, some attempts to international cooperation have been proposed by supranational organization, such as the OECD, which represents the highest way of international coordination. In 2010, OECD proposed the guidelines on transfer pricing methods, providing five common transfer pricing methods that are accepted by nearly all tax authorities, updating these guidelines in 2017. The five transfer pricing methods are divided in “traditional transaction methods”, which rely on actual and similar market transactions, and “transactional profit methods”, which rely on divisional profits. Traditional methods are three, respectively the *Comparable Uncontrolled Price method* (CUP), the *Resale Price Method* and the *Cost Plus Method*. Instead, the transactional profit methods are the *Transactional Net Margin Method* (TNMM) and the *Profit Split Method* (PSM). The latter methods are less precise but more applied than the former ones, and are the ones that give the MNEs more opportunity of gain. Indeed, traditional methods are precise because they compute the transfer pricing according to real and actual prices, in similar circumstances. For instance, according to OECD guidelines, the CUP is "*the price charged for property or services transferred in a controlled transaction to the price charged for property or services transferred in a comparable uncontrolled transaction in comparable circumstances*". On the other hand, profit methods are harder to evaluate because they have to be assessed according to the situation of each firm, and instead of the comparative analysis, it is needed a functional analysis. Especially in the latest years, with the increasing digitalization of the economy, profit split method is becoming more and more popular. The PSM, like any other transfer pricing method, should be chosen as the most appropriate method only after the accurate delineation of the transaction including the functional analysis. Given the high degree of subjectivity in the mechanism for profit allocation among divisions, when this allocation is unfair or strategic, then companies may be exposed to risks of penalty or litigation. In order to avoid these tax problems, OECD gives the possibility to firms and tax authorities to subscribe an "APA". It stands for *Advanced Price Arrangement* and it is s an arrangement that determines, in advance of controlled transactions, an appropriate set of criteria for the determination of the transfer pricing for those transactions over a fixed period of time. Another important step forward on the international cooperation is the *EU Joint Transfer Pricing Forum* on October 2018, where the European commission proposes a coordinated approach to transfer pricing controls. The aim is to "Think international – act international – audit international" proposing a coordinated approach to transfer pricing controls and contributing to a better functioning of the internal market on two sides: first, through a transparent and efficient tool for national tax administrations to facilitate the allocation of taxing rights; second, preventing the occurrence of double taxation and double non taxation.

I.2 ECONOMIC APPROACH ON TRANSFER PRICING

The problem of the optimal transfer pricing system can be studied in economic terms, through an optimization problem. The first economic approach on the transfer pricing mechanism is provided by *Hirshleifer* (1956): in his paper "On the economics of transfer pricing", he develops an optimization model which aims to find the single joint output according to the optimal transfer pricing level. He takes into account a firm with two divisions, a manufacturing and distribution one, which exchange a commodity, called "intermediate good". The main starting point is that there could be two different ways of setting the transfer pricing: Exogenous and endogenous systems. The exogenous transfer pricing refers to the market based one, where the multinational company just set the transfer pricing as high as the market price of the internally traded good. The endogenous transfer pricing, rather, occurs when is the firm who is in charge to set the transfer pricing, and this can happen in two ways: centralized or decentralized system. In centralized systems, the transfer pricing level is decided by the board of directors or the CEO of the multinational, without care about the managers of each division. In the decentralized transfer pricing mechanism, the task of setting it is up to the managers, that will agree on an optimal level through the process of bargaining, which is usually studied with the game theoretic approach. In particular, Hirshleifer focuses on the market based method:

The centralized approach is desirable when the intermediate good is produced in a perfect competitive market, where no single producer can influence the market price. Rather, when market is not perfectly competitive, then the transfer pricing should be equal to the marginal cost. Going more in depth, when a firm wants to set the transfer pricing for the best joint level of output, some assumptions have to be considered: Hirshleifer considers the technological independence and demand independence as very strong assumptions. In fact, with technological independence the costs of each divisions are independent on the cost of the other division. Demand independence means that an additional external sale for each division would not reduce the external demand for the other division.

According to the mix of different assumptions, there are several transfer pricing setting rule:

The most general solution is to set the transfer pricing equal to the marginal cost of the seller division. This could happen first, when no intermediate market exists, and there is a strong technological dependence between manufacturing and distribution divisions, then the optimal condition is the previously cited. Moreover, when the intermediate market exists and it is imperfectly competitive, then set transfer pricing as the marginal cost of selling division, as before. On the other hand, when the intermediate market is perfectly competitive, transfer pricing should be equal to the market price, and this finding is the same when we assume technological independence and demand dependence within the firm.

Even *Horst* (1971), supports the idea of exogenous transfer pricing. In particular, he finds that a MNE would set the optimal transfer pricing as highest or lowest possible, according to the government rules and the tariffs schedule imposed on international trade. In fact, if tax differential between countries is larger than the tariff, then multinationals can exploit this difference to increase the transfer pricing through an over invoicing of within trade bills. This dynamic is explained also by *Kant* (1987). In fact, the intervention of the state is employed in his model of endogenous transfer pricing. The author states that the strategic transfer pricing setting is a mechanism similar to that between wage and price guideposts and wage and price controls. Although transfer price guidelines exist, for instance the ones proposed by OECD, there is no control on transfer price, and this is a great opportunity for MNEs to manipulate taxes. In his paper, in which he constructs a model where a multinational firm produces and sells a final good into two countries, the author proposes a mechanism of endogenous and centralized transfer pricing, adding an important innovation on the model: the effects of uncertain regulation. In the Kant model there is the State who intervenes with some penalty imposed to firms that employ an unfair transfer pricing. Wider the difference between the transfer pricing and the "arm's length principle" (market price), higher would be the probability to be fined by the State.

The overall profit function is given by the following formula:

$$\pi = \pi_1 T_1 + \pi_2 T_2$$

Where i is the country index, firm in country 1 is the parent who exports in country 2 where is located the affiliate firm, $T_i = (1 - t_i)$ and t_i is the corporate tax rate in country i. The model assumes that tax rate is larger in country 2, so that $t_2 > t_1$, and are also considered the tariffs on imports, which are represented by τ. At this point, the multinational company is interested to keep profits in country 1 because tax rate is lower than the one in country 2, and in order to do so, would like to underinvoice his bills. Without any State control and intervention, MNE would lower his transfer pricing as low as possible. However, this is true only when the transfer pricing is greater than the arm's length price p^* (market price based) so that the probability of penalty is zero. When the transfer pricing starts to be lower than the ALP price $(p < p^*)$, alpha is positive and so a probability of being fined exists, and this probability is equal to one (surely fined) when the transfer price is unfairly set lower than a critical value imposed by the author(p_c).

At this point, the objective function is

$$\emptyset = \pi - \alpha \mathfrak{z}(p - p^*)$$

Where $\mathfrak{z}$ represents the penalty, α is the probability to get caught by the State, p is the transfer pricing and p^* the ALP.

The innovative finding respect to the basic model of Hirshleifer is that the transfer pricing in this case has not to be necessarily equal to the marginal cost of the intermediate product, but can be lower in case of under invoicing, and greater in case of over invoicing. Moreover, when the State increases controls, through an increase of the probability of being fined, then the transfer pricing starts to increase and the consumer surplus too, against a lower producer surplus.

On the other hand of the market pricing method or endogenous and centralized, there is a field of literature based on the idea that transfer pricing should be set endogenously and in a decentralized way, namely through the process of bargaining among division managers. This kind of technique is employed by the majority of multinational entreprises. An important contribution is given by the model proposed by *Stoughton* (1992), in which he attempts to understand how multinational choose transfer pricing in presence of differential corporate tax rates and asymmetric information between MNE branches. In fact, the author assumes a situation of information asymmetry between a parent company and its foreign subsidiary, where the latter is partially owned by the parent. Moreover, the subsidiary is in charge of producing the intermediate good, for which does not exist a market for similar goods, while the parent is in charge to finish the intermediate good and to sell it in the final market. With these starting conditions, there is not any market based signal so the only affordable way to set transfer pricing is through bargaining of parent and subsidiary, and the expected profit function of parent company is the following:

$$(1-\tau_p)(R(q(\hat{\theta}))-t(\hat{\theta}))+(1-\tau_s)\alpha(t(\hat{\theta})-C(q(\hat{\theta}),\theta))$$

Where τp and τs are the tax rates for the home country (parent) and for the host country (subsidiary). In general, these two tax rates are not the same, R(q) is the function of total revenues, t(θ) is the transfer pricing function, α is the share of P on S and C(q) is the function of total costs. It is straightforward to see that, if one does not take into account the term alpha, the left part of the equation represents the profit function of the subsidiary.

If α =0, so that P does not own S, then the Profit function of parent would be represented just for the left part of the equation, before the plus. On the other hand, in α =1, P would own totally its subsidiary, and the total profit would be equal to the sum of P profits and S profits.

At this point the author starts the bargaining with asymmetric information between the managers of respectively P and S, once when the bargaining is controlled by the parent, once when this is controlled by the subsidiary. Thus, when parent has more bargaining power will try to rise his fraction of the subsidiary "α ->1", in order to take back the money that initially transferred to S through the increase in transfer pricing. When this situation is reversed and S controls the bargaining, RSW mechanism occurs[2], and the results are the opposite: parent owns a smaller fraction of the subsidiary. The result seems to bring to a non cooperative solution of the bargaining game, as suggested by Myerson (1983).

Following this logic, a very important contribution on endogenous transfer pricing is given by *Vaysman* (1998), who proposes a model of dynamic and negotiated transfer pricing. This paper considers a firm consisting of headquarters (HQ) and two divisions, producing and marketing. The producing division provides an intermediate good which will be the input of the marketing division, who is in charge to transform and sell it into the final market. Also in this model, there is not market for the intermediate good, so that market based model cannot be applied and the producing division has to bargain with the marketing division. Each division

[2] RSW: Rotshild, Stiglitz, Wilson

manager is rewarded according to a linear function of the division profits, of the form:

$$Manager\ i\ reward = [a_i + \beta_i \Pi_i]$$

where Π_i denotes the divisional profits of manager I, alpha is an exogenous reward independent of the divisional profits, and beta represents the linear coefficient of the proportional rewarding system. Suppose T is the transfer pricing and C (q,z1), R (q,z2) are respectively the cost and revenues realized for each division which are functions of the output and of a personal productive parameter zi, then divisional profits are given by the following equations:

$$\Pi_1 = T - C(q, z1) \qquad \Pi_2 = R(q, z1) - T$$

According to the previous information, the model starts with the bargaining activity between managers, and the final transfer pricing could be centralized or decentralized. In particular, the bargaining is structured as follows:

1. Manager i learns private information hi.

2. Managers sign contracts specifying compensation menus. In addition, the head quarter (HQ for sake of simplicity) commits to the transfer price it will impose in case of intervention (in case of intervention, the managers are obligated to follow HQ's instructions and the model shifts from endogenous to exogenous).

3. At time 0, managers simultaneously select compensation parameters. These become public.

4. Managers negotiate whether the product is produced and transferred and the transfer price T. Each manager is free to withdraw from negotiations and appeal to HQ to intervene. HQ can then impose a transfer price.

5. If managers do not reach an agreement by some terminal time, HQ intervenes and imposes a transfer price.

6. If managers agree not to produce and transfer the product, the interaction is over. If the product is to be produced, managers select their divisional productivity parameters zi to maximize individual welfare.

7. Production, transfer, and sale take place. The accounting system records the realized cash flows and computes divisional profits as cash flows adjusted by the transfer price. HQ settles the contract with each manager

The main finding of this kind of bargaining model is that through personal compensation schemes, overall firm profits reach their upper bound limit, so the result is quite desirable. However, the manufacturing manager would like to show all his information before bargaining begins, negotiations are of the form where the marketing manager makes all offers, and the manufacturing manager can only accept or reject them.

Different stages of a similar game are proposed in the *R.Gox* (2000) model of strategic transfer pricing. In his model, he proposes a two stage game of negotiated transfer pricing with a duopolistic price competition on the final market. Also in Gox model, asymmetric information is assumed, and the game structure is the following:

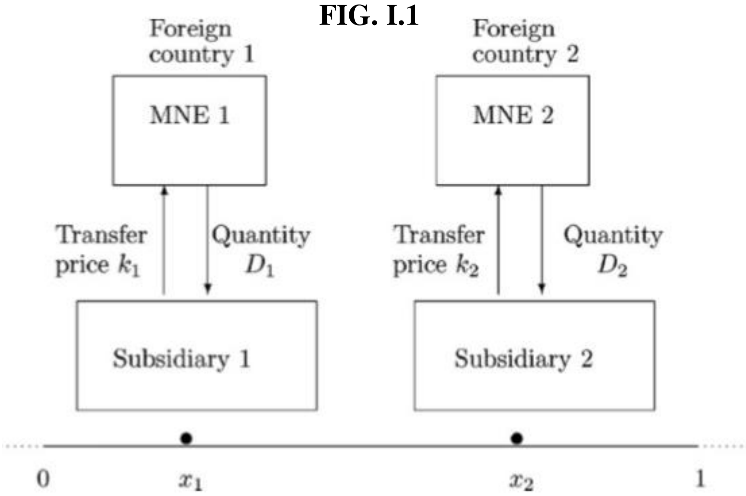
First, the two headquarters simultaneously choose their transfer prices. Since asymmetric information exists, the result of the first stage of the game is uncertain. Each agent can only observe the transfer price of his own firm, not the transfer price of the competitor, when deciding on his pricing strategy.

Nevertheless, each firm can still be influenced on the pricing strategy of its own manager by deviating from the intermediate product's marginal cost. The equilibrium strategies are based on rational conjecture and both managers, who are divisional profit maximisers, simultaneously play. As in the traditional Hirshleifer model, the optimal transfer price equals the marginal cost of the intermediate product. The innovation respect to the Hirshleifer model is that, when proposed transfer pricing are observable and asymmetric information disappear from the model, strategic transfer pricing is above the marginal cost of the intermediate good.

After the 2000s, the focus on transfer pricing literature has been shifted to understand the implication of different sort of transfer pricing methods on the global supply chain of multinational firms, applying game theoretical models and simulating them through computational analysis. Multinational firms, in fact, have been implementing the *vertical specialization* process: it is the activity of splitting the value chain across more than 2 borders with the aim to buy (import) the cheapest possible inputs and obtain the lowest possible production cost, producing the final product in the domestic market and then sell (export) it abroad, without any care about customer surplus. It is also known as “foreign outsourcing”. The impact of different TP methods on the vertical integration of multinational has been studied by *Rosenthal* (2008), with a game theoretic approach. The author develops a “cooperative game”, which is a form of bargaining between managers that would lead to a cooperative equilibrium, that provides transfer prices for the intermediate products in the supply chain. This model is applied both when the market prices for these products are known and also when their valuations differ. According to different transfer pricing system, also the supply chain could be modified, shifting some key activities into countries that are more convenient. In this context, *R. Hammami and Frein* (2014) develop a mathematical optimization model for the redesign of supply chains in the global economy, taking into account two transfer pricing methods, and the asymmetric information between the firm and the tax authorities. On one hand, the first method is employed imposing acceptable bounds on the values of transfer prices ,and this assumes that exists a market for comparable intermediate market, and so transfer pricing can be found through a market based approach and lower and upper bound can be determined. On the other hand, when the market for similar intermediate goods does not exist, the authors employ the "profit split" method introduced with the OECD guidelines. Thanks to this methods, firms can split their profits on the base of the contribution on value added of each division. It is straightforward to see that this is the case in which MNEs are more likely to cheat and to set a strategic transfer pricing. In fact, with the profit split methods, asymmetric information arises between the company and tax authorities, and MNEs can gain from this unless tax authorities check all the activities of each MNE, but this takes time to happen. Authors, show up the trade off that exists between increasing profits and respecting the transfer pricing regulation. If a MNE wants to increase profits, then can employ the profit split method to shift all profits to lower tax rate countries, but this means a manipulation of taxes and this does not respect the regulation on transfer pricing. According to their simulations of the model, transfer pricing manipulation leads anyway to an increase of profits, but profit split method is less efficient than setting upper and lower bounds. Other simulation have been proposed by *Lu Gao and Zhao* (2015). With and Experiment in matlab to maximize expected profits of the firm, authors add a second tariffs respect to the Kant model, which means that when the selling division sells the intermediate good pays a tariff, and then the final good is re sold in the selling division country the firm pays another one. After a sensitivity analysis on some parameters such as the increasing of foreign tax rate, authors found that division managers should be careful on tax rate fluctuations, because a decrease in tax rate might lead to the other division's revenue loss or cost increase.

The relationship between corporate tax rate, transfer pricing systems and geographical location of divisions seems to be of strategically importance for MNEs. *Yao* (2013) proposes a model in which two different MNEs set up a subsidiary in a common host country, and then compete in a duopolistic way on the selling price of final market with a homogeneous final good. The topology of the market is given by figure I.1, in which the horizontal axis represents the final market, and consumers are uniformly distributed between the interval [0;1] and are supposed to buy the cheapest product between subsidiary 1 or 2.

FIG. I.1



The decision making mechanism is decentralized, means that the headquarters of each MNE (1 and 2) is in charge to choose both the location of the subsidiary and the level of transfer price. After this step, the subsidiary has the power to set the selling price of the final good. In order to assess the impact of different transfer pricing on MNEs location, the author implements a three-stage game solved with the "backward induction". The main finding is that the introduction of the Arm's Length principle (OECD 2010) decreases overall firm profits, and thus does not increase tax revenue, in contrast to what expected from the tax authorities.

I.3 GAME THEORETIC APPROACH

According with the majority of the models presented, the game theoretical approach seems to be effective for capturing the bargaining mechanism around the transfer pricing. Going more in depth, there is a field of game theory that provides several "bargaining games". These are games in which two or more agents are supposed to bargain on some economic good to reach a common final agreement. Taking as a benchmark the famous prisoner dilemma proposed by J. Nash, there are several different games applied for the bargaining activity. For instance, the *Ultimatum Game* (UG) introduced by *W. Güth, R.Schmittberger and B.Schwarze* (1982), is a sequential game in which there are two agents: the proposer and the responder. The proposer divides a sum of money between himself and the responder, offering an amount to the responder. Then, if the responder accepts, the proposer would get the initial endowment less the amount proposed and given to the responder, while the latter would get the sum given by the proposer. In case the responder does not accept, both proposer and responder take zero. The theoretical prediction, also called Sub Perfect Nash Equilibrium (SPNE), is that proposer offers smallest possible amount to the responder. *Forsythe et al.* (1994) introduce the *Dictator Game*, in which a proposer divides a sum of money between himself and the responder. It is different from the ultimatum game because in the dictator game, the responder has no power and can just take the money offered by the proposer. It is a game used to capture the altruism of people, for example to explain the charity. The SPNE of the dictator game is that the proposer gives zero to the responder. The non cooperative equilibrium is also theoretically found in the *trust game* (also called "the investment game") proposed by *Berg et al.* (1995). It is a two stage sequential game in which there are two agents: an investor and a trustee. The investor (player 1) starts the game and has to decide to trust or not the trustee (player 2). In case of trust, investor gives money to trustee. If this happens, then trustee receives a multiple of that amount, and can play two different strategies: reciprocate or not reciprocate. In case trustee reciprocates, then an amount of money is returned to player 1. On the contrary, player 2 keeps all the money and does not give back anything to player 1. It is a sort of theoretic game employed to study the trustworthiness and the reciprocity of agents. The theoretical prediction SNPE is to not cooperate (no trust and no reciprocity). Even if this is the theoretical prediction, the next chapter attempts to create a model in which different transfer pricing system are employed.

CHAPTER II:

"THE MODEL"

This chapter deals with a model of profit split method in a multinational enterprise whose supply chain is carried out by two divisions, into two different locations, with two different corporate tax rate.

First, the model is developed as a single multinational who sets the transfer pricing endogenously with a centralized approach;

Then, the model shows the game theoretic approach of bargaining between managers in order to set the negotiated transfer pricing. The trust game approach is employed to study the dynamics of the decentralized system of transfer pricing.

In the end, an improvement of the decentralized model with the State regulation is provided, simulating a market composed by several MNEs.

II.1 CENTRALIZED TRANSFER PRICING APPROACH

There is a Multinational company *M* that wants to increase profits shifting them to lower- tax country, and *M* has two divisions:

P=Parent (buying division, distribution division);

S=Subsidiary (selling division, manufacturing division);

Parent company operates in the domestic market, while the subsidiary is located in the foreign market. *M* produces a final good *Q*, and the value chain is split into two sequential steps:

1) **Subsidiary (S)** buys raw materials at cost *C*, produces an intermediate good *Qs* that is sold to the parent *P* at the transfer pricing *TR*.
2) **Parent (P)** buys the intermediate good from Subsidiary at *TR*, transforms it and sells *Qp* in the final market at a given market price ***P*.**

For sake of simplicity, the model assumes that production costs and final price are exogenously given by the market, the quantity of intermediate good produced is the same of the final good (Qs=Qp), no transaction costs or tariffs exist and the exchange rate between P and S currencies is equal to 1.[3]

The gross profits of the two divisions are shown in the table II.1:

[3] These assumption are consistent with the work of Kant, Vaysman and Stoughton.

TAB II.1

UNITARY PROFIT FORMATION

	Subsidiary **(Selling Division)**	**Parent** **(Buying division)**
Revenues	TR	P
Costs	-C	-TR
Profits	π**S**	π**P**

Equation 1 shows the total gross profit of M in time 0:

$$\pi_{m,0} = \pi_{p,0} \ + \pi_{s,0} = Q_p(P - TR) + Q_s(TR - C)$$

In order to get the net profits equation, suppose that different corporate tax rates exist between parent's country and subsidiary's one. The tax rates are a percentage on gross profits and are represented by $t_p$for parent and t_s for the subsidiary. Now assume that $TP = (1 - t_p)$ and $TS = (1 - t_s)$, then we get the equation for the net MNE's profit:

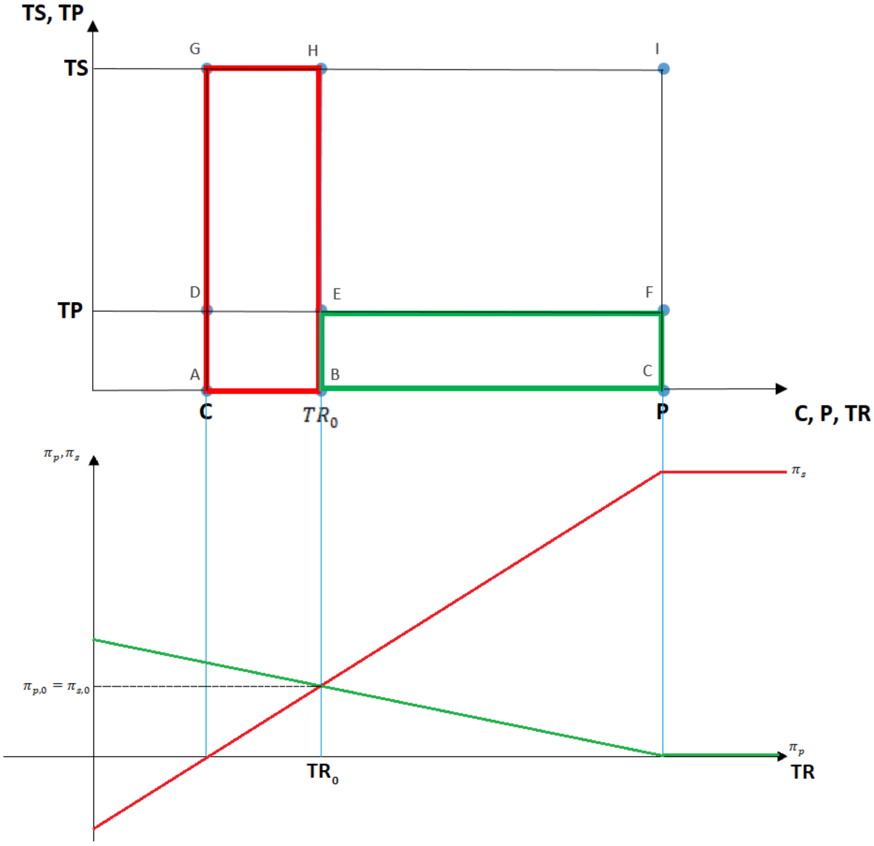
$$\pi_{m,0} = \pi_{p,0}\, TP \ + \pi_{s,0}\, TS$$

In contrast to the model of Kant, we suppose that the parent's country has the higher tax rate, meaning that $TP < TS$.

In this part of the model, in which we assume the centralized approach and the absence of the State intervention on unfair transfer pricing systems, the strategic decision of the headquarter is straightforward. In order to bear a lower of tax burden and to gain more profits, the centralized decision could be to show profits where tax rate is lower. In particular, in order to shift profits to the subsidiary accounting system, the headquarter wants to increase overall profits by moving upward the Transfer Price. [4] To capture the mechanism of the effect of a variation of transfer pricing, it is useful to see the following graphical representation (Fig. II.1):

[4] In this case, we assume that TS>TP, so it is convenient to shift profits to S.

Fig. II.1: The box of potential profits and demand supply of TR equilibrium



The first graph represents the starting situation of a MNE, where according to the initial transfer pricing TR_0, the profit is splitted as follows:

The red rectangle **AGHB** represents the unitary net profit of subsidiary, given by the equation: $\pi_{s,0} = TS(TR_0 - C)$

The green rectangle **BEFC** is the unitary net profit of parent, whose equation is: $\pi_{p,0} = TP(P - TR_0)$. Note that the areas can be viewed also as total divisional profits, because we suppose that the *Qs*=*Qp*, so the result would be the same but in a larger scale. At this point, the total profit for the MNE is given by the sum of the areas of the two rectangles. The rectangle **AGIC** represents the "*box of the potential profits*". In fact, if transfer pricing is centrally established and there is not a control from tax authorities, then MNE can gain potential profits just shifting as right as possible the transfer pricing.

Looking at the graph below the box of potential profits, S profits represented by the red curve, are negative until TR is at least equal to the production cost. On the other hand, when TR>P, then the profits of buying division are 0. However, the two profits start on equilibrium whit the initial transfer pricing level TR_0 and equal division profits $\pi_{p,0} = \pi_{s,0}$. It is a way to design the transfer pricing demand and supply curves. In fact, the slope of the subsidiary's profit is positive and steeper, this means that subsidiary has a positive relation between transfer pricing and divisional profits, so the *supply curve of TR* is given by:

$$TR_0 = C + \frac{\pi_{s,0}}{TS\,Q_s}$$

On the other hand, the parent has a negative relation between transfer pricing and profits, thus the *demand curve of TR* is:

$$TR_0 = P - \frac{\pi_{p,0}}{TP\ Q_p}$$

Since $TS > TP$, the slope of S profit function is steeper than P profit function.

An interpretation of the demand/supply graph can be that, if Parent company wants higher profits, then transfer pricing has to decrease, on the contrary, when S wants to gain more profits, then TR has to increase. However, since transfer pricing level is now centralized, according to the first graph of the “box of potential profits”, it would be enough to shift TR right in order to increase overall MNE’s profits. This mechanism is shown in the graphs II.2 below. It is visible that, the area of S profits is now larger than before, and it is represented by the rectangle **AGH_1B_1**, while the P profit area is decreased and is now given by the area **B_1E_1FC**. Even if the P profits have decreased, now the overall MNE profits are larger than before, and this positive variation is captured in the area **EHH_1E_1**. This effect can be also seen from the point of view of transfer pricing demand and supply scheme. In fact, in the figure II.2 below, a shift to right of transfer pricing leads to an increase of S profits against a decrease of P profits. However, the positive variation of S profits is much larger than the negative variation of P profits, and this means that S profit increase over compensate the P loss.

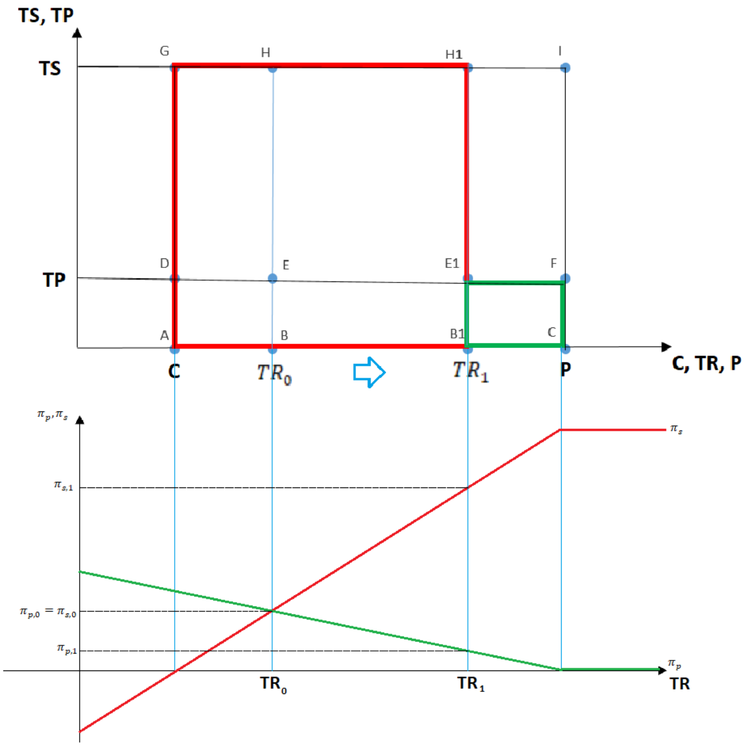
As one can see from the fig.II.2 below, when the transfer pricing increases, the overall profit for multinational increase too. Thus the following condition is always verified:

$$\pi M_1 > \pi M_0$$

Overall profit Increased by: $(TR_1 - TR_0)(TS - TP)$

The larger the increase of transfer pricing or the corporate tax differential between P and S countries, greater is the possibility of gain through an effective transfer pricing system. This is due to the fact that each unit of gross profit shown in the lower tax country, would be taxed less and so on each product sold, the company gains more margin.

Fig. II.2: The box of potential profits and demand supply of TR after a TR positive shock



In theory, according to these assumptions, there is a negative impact on parent profits that is compensated by the larger increasing profits for subsidiary. The prediction of the model suggests that, for each country in where $TS > TP$, the MNE has incentive to show up all profits in S country, rising the transfer pricing as high as possible. These results are mathematically consistent with the analysis of partial derivative of profits respect to transfer pricing. A summary of the impact of a centralized variation on transfer pricing into some concluding observations is provided in the next section.

<u>Impact of TR variation on MNE profits</u>

In order to capture the effect of an increase in transfer pricing to overall profits, we take the first derivative of πM_0 respect to TR_0:

$$\pi M_0 = \pi_{p,0}\ TP + \pi_{s,0}\ TS = Q_p\ TP\ (P - TR_0) + Q_S\ TS\ (TR_0 - C)$$

$$\frac{\partial \boldsymbol{\pi}_{M,0}}{\partial TR_0} = -Q_p TP + Q_s TS$$

$$\frac{\partial \boldsymbol{\pi}_{M,\mathbf{0}}}{\partial TR_0} = TS - TP$$

We assume that corporate tax in the subsidiary country (*ts*) is lower than the parent one (*tp*), and *TS=(1-ts); TP=(1-tp)*. Since TS>TP we obtain:

TS-TP>0

$$\frac{\partial \boldsymbol{\pi}_{p,0}}{\partial \boldsymbol{TR_0}} > 0$$

1st observation: An increase in TR would have a positive impact on overall profits, equal to the difference between corporate taxes.

<u>Impact of TR variation on P and S profits</u>

Even if the overall impact is positive, it is interesting to see how the effects of a TR increase are distributed between P and S.

- Effects on P

$$\pi_{p,0} = Q_p \, TP \, (P - TR_0)$$

$$\frac{\partial \pi_{p,0}}{\partial TR_0} = -Q_p TP < 0$$

- Effects on S

$$\pi_{s,0} = Q_s \, TS \, (TR_0 - C)$$

$$\frac{\partial \pi_{s,0}}{\partial TR_0} = Q_s TS > 0$$

2nd observation: An increase in TR would have, on one hand, a negative impact on parent's profit and on the other hand a positive and larger impact on the subsidiary's profit.

TAB II.2:IMPACT OF A POSITIVE TR SHOCK

	TR system: centralized
π_M	+
π_p	-
π_s	+

Even though this theoretical model seems to work very well for a potential MNE's strategy, some limits exist. In fact, with the centralized approach, the role of both division managers is nullified, while in reality they play a key role in setting the transfer pricing level. Moreover, the absence of any tax regulation and tax authority is assumed, and it is a very strong assumption. We will try to "remove" these two assumptions in the following two sections.

II.2 NEGOTIATED TRANSFER PRICING APPROACH

The negotiated transfer pricing is one of the most suitable systems for MNEs because it derives from an agreement of the managers, who usually are rewarded according to their division profits, and thus an optimal agreement is expected in confront to the centralized approach. In order to capture the dynamics behind the bargaining of the two managers, in this model I use the game theory, in particular the “trust game” proposed by Berg et al. (1995) and also called “the investment game”. It is a two stage sequential game in which there are two agents: an investor and a trustee. The investor (player 1) starts the game and has to decide to trust or not the trustee (player 2). In case of trust, investor gives money to trustee. If this happens, then trustee receives a multiple of that amount, and can play two different strategies: reciprocate or not reciprocate. In case trustee reciprocates, then an amount of money is returned to player 1. On the contrary, player 2 keeps all the money and does not give back anything to player 1. It is a sort of theoretic game employed to study the trustworthiness and the reciprocity of agents. The theoretical prediction or Sub Perfect Nash Equilibrium (SPNE) is to not cooperate (no trust and no reciprocity).

In this model it is implemented a modified trust game approach, that is characterized by the following structure of the game:

First, the head quarter gives the possibility to set the transfer pricing to the managers P and S, as they prefer. Then the game starts between P and S, and the decision making mechanism is explained in the following section.

Structure of the game and payoffs

Since the trust game is a sequential game, the timing and structure of the game is of a critical importance in order to get the equilibrium. The arrangement of the moves of the agents P (investor) and S (trustee) is the following:

1) P decides whether or not to shift a share of its profits to S, measured by the increase of transfer pricing;

2) At the same time, P proposes to S a participation on S profits;

3) S automatically receives the portion of P profits, then can decide whether to reciprocate or not, according to the participation proposed by P.

4) In case S reciprocates, then an amount of S profits is transferred to P and the game stops. If S does not reciprocate, then no money returns to parent and the game stops.

As one can see, the model does not take into account the reward system of managers, and this is due to the fact that the aim of the model is to understand how the behaviour of both P and S influences the transfer pricing level. Moreover, two levels of asymmetric information are present. On one hand, there is asymmetric information between headquarter of the MNE and the two divisions. The model assumes that only the manager of parent company learns some information about headquarter. On the other, there is asymmetric information between P and S. In fact, in the model, P does not know about the production costs of S, and this would lead to a mismatch between the participation on profits bid and ask. Let us plunge into the payoff function of the agents.

Player P: Payoff function and strategic decision

Parent knows that the head quarter is willing to increase the TR because of the condition TS>TP. Thus, P divisional profits will definitely go down because parent company is located in the country with the higher tax rate and $\frac{\partial \pi_p}{\partial TR}<0$. At this point, P starts to bargain with the division manager of the selling (manufacturing) division S. In order to start the bargaining, P proposes to shift part of his profits to S through an *over voicing* of S bills, that means an increase of intermediate product price, the transfer pricing, according to this equation:

$$(P - TR_1) = (P - TR_0)\,\gamma$$

$$\gamma = \frac{(P - TR_1)}{(P - TR_0)}$$

Where γ is the share of π_p that P would keep, shifting the portion $(1-\gamma)$ to S. As one can see, if TR_1 increases, γ decreases, thus P shows more trustworthiness.

At this point the payoff of P in time 0 is: Notation:

$\pi_{i,t,g}$*: profit of subject i, at time t, with strategy g*

$i = M, P, S$*: Multinational, Parent, Subsidiary*

t=0,…,T

g=: t, nt, ,r, nr= trust, no trust, reciprocate, no reciprocate

$$\pi_{p,0} = Q_p TP(P - TR_0)$$

After P trusts S, he gets the payoff in time 1:

$$\pi_{p,1,t} = Q_p TP(P - TR_1)$$

$$\pi_{p,1,t} = Q_p TP[\gamma(P - TR_0)]$$

This payoff function is consistent with the relationship $\frac{\partial \pi_p}{\partial TR}$<0 because if transfer pricing increases, then $TR_1 > TR_0$, γ would go down and $\pi_p$too.

Then, P proposes a participation on S profits equal to ρ^P. P would be fine if its participation on S will be at least equal to the share of profit shifted to S due to the increase of Transfer Pricing. Thus,

$$\rho^P \geq (1 - \gamma)$$
$$\rho^P \geq 1 - \frac{P - TR_1}{P - TR_0}$$

In reality, P will propose a participation ρ^P on S profit according to the previous rule, augmented by the possibility of gain. This is a term influenced by P beliefs, which can increase or decrease ρ^P. In fact, when P see his profits decrease $\pi_{p,1} < \pi_{P,0}$, then he would like to ask for a lower participation ρ^P. On the contrary, if $\pi_{p,1} > \pi_{P,0}$, then P believes that has much bargaining power, and would ask for a greater participation on S profits.

This means that the participation ask by P on S profits is:

$$\rho^P \geq (1 - \gamma)(1 + Pr)$$

Where:

$Pr > 0$	if $\pi_{p,1} > \pi_{p,0}$
$Pr = 0$	If $\pi_{p,1} < \pi_{p,0}$

$\rho^P = f(TR, P, Pr)$

If S accepts, thus reciprocates, P would get the following payoff:

$$\pi_{p,1,r} = Q_p TP[\gamma(P - TR_0)] + \rho^P \pi_{s,1,n}$$

<u>Player S: Payoff function and strategic decision</u>

As already said, we assume a sort of asymmetric information between P and S. In fact, S does not have the same information of P, because only P knows that headquarter wants to increase profits just through TR moving, and P does not know anything about the production cost of the intermediate good from S.

At this point we can set the payoff of S:

time t=0:

$$\pi_{s,0} = Q_s TS(TR_0 - C)$$

Now S receives the proposal of P profits in the measure of (1- $\gamma)\pi_{p,0}$, and has to reciprocate or not to give back the quantity $\rho(\pi_{p,1})$ of its profits to P. Moreover, S profits increase following this rule:

$$(TR_1 - C) = (TR_0 - C) + (1 - \gamma)(P - TR_0)$$

$$(TR_1 - C) = (P - C) - \gamma(P - TR_0)$$

New gross margin of S is given by the sum of the former one plus the profit transferred from P.

Time t=1

$$\pi_{s,1,nr} = Q_s TS[TR_1 - C]$$

Since $$(TR_1 - C) = (P - C) - \gamma(P - TR_0)$$

$$\pi_{s,1,nr} = Q_s TS[(P - C) - \gamma(P - TR_0)]$$

At this point, π_s has grown respect to the profit at t=0. S can decide whether to reciprocate accepting the participation of P on its profits (ρ^P) or just keep the profit shifted through the increase of Transfer Pricing.

It all depends on ρ proposed by Parent ρ^P and on that S is willing to accept: ρ^s

However, S will accept only if the $\pi_{s,1}$ is at least greater than $\pi_{s,0}$.

Solving the following equation, the maximum level of ρ accepted by S ($\rho^S\ max$) in order to reciprocate is:

$$\pi_{s,1} \geq \pi_{s,0}$$

$$Q_s\ TS\ (TR_1 - C)\ (1 - \rho^S) \geq Q_s\ TS\ (TR_0 - C)$$

$$\rho^S\ max \leq 1 - \frac{TR_0 - C}{TR_1 - C}$$

$\rho^S = f(TR, C)$

Since ρ^s is a function of production costs C, and Parent does not know about the producing cost of S, P does not know the S willingness to accept the participation, and thus a mismatch between participation bid and ask arises. (ρ^S)

At this point, S will decide the strategy according to this rule:

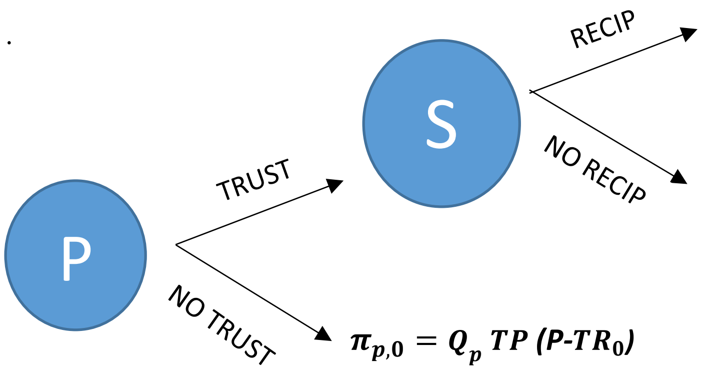
If $\rho^s \geq \rho^P$ S RECIPROCATES

If $\rho^s < \rho^P$ S DOES NOT RECIPROCATE

Where ρ^P is the participation proposed by P on S profits, and ρ^s the maximum level of participation that S accepts. Of course, in case ρ^P is larger than ρ^s, S will not reciprocate and will keep all the money gained through the increase of transfer pricing, not allowing P to have a participation on its profits. On the contrary, when the condition $\rho^s > \rho^P$ is verified, then the willingness to accept the P participation is larger then the participation proposed, thus S will shift back a share of its profits to P. In the latter case, S reciprocates and the S payoff would be:

$$\pi_{s,1,r} = Q_s TS[(P - C) - \gamma(P - TR_0)](1\text{-}\rho^P)$$

Payoff scheme tree



$$\boldsymbol{\pi_{p,1,r} = Q_p TP[\gamma(P - TR_0)] + \rho^P \pi_{s,1,n}}$$

$$\boldsymbol{\pi_{s,1,r} = Q_s TS[(P - C) - \gamma(P - TR_0](1\text{-}\rho^P)}$$

$$\boldsymbol{\pi_{p,1,t} = Q_p TP[\gamma(P - TR_0)]}$$

$$\boldsymbol{\pi_{s,1,nr} = Q_s TS[(P - C) - \gamma(P - TR_0]}$$

$$\boldsymbol{\pi_{p,0} = Q_p \, TP \, (P\text{-}TR_0)}$$

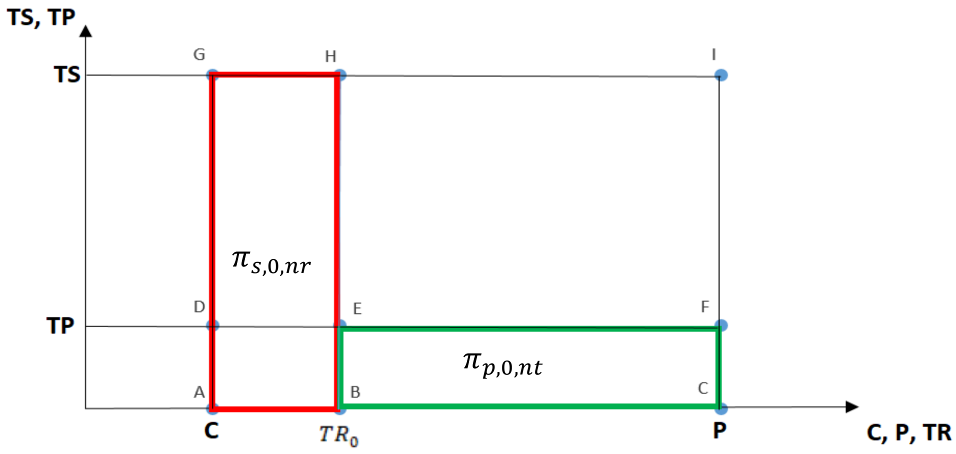
$$\boldsymbol{\pi_{s,0} = Qs \, TS(TR_0 - C)}$$

Now let us see what happens, in both graphic and mathematical terms, when the game starts and the transfer pricing variation is negotiated between P and S. A summary of the impact of a decentralized approach on the transfer pricing variation is provided into some concluding observations that complete the ones of the previous section.

Starting from the equilibrium in which $\pi_{p,0} = \pi_{s,0}$ and $TR = TR_0$, if P does not trust S, then the transfer pricing variation is equal to 0 and nothing changes. This situation is graphically represented in the figure II.3.

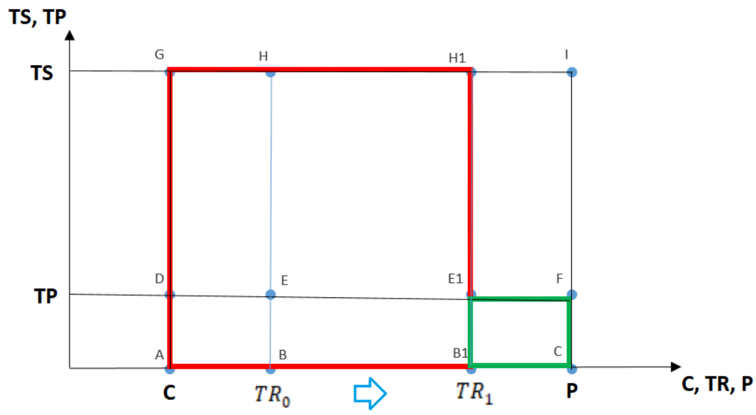
Fig. II.3 Box of potential profits with bargaining between P and S

NO TRUST - NO RECIPROCATE



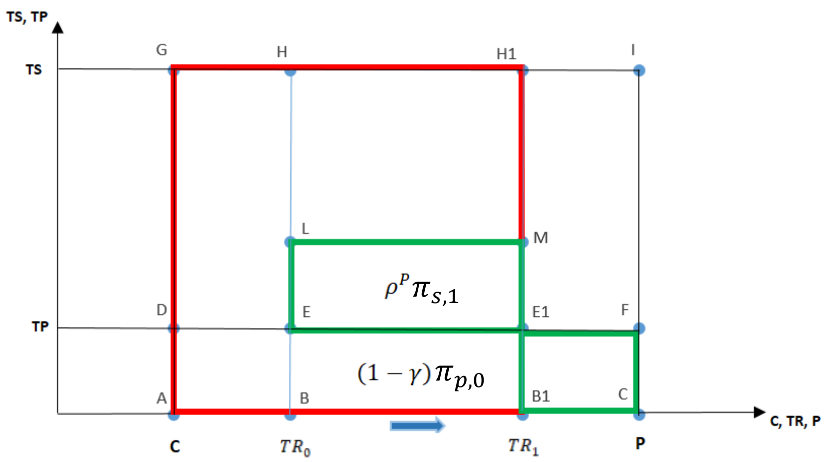
In case P does not trust, the strategy of S has no impact and the equilibrium is stable.

Fig. II.4 ***TRUST – NO RECIPROCATE***



In case P trusts S, so transfer pricing increases, the area of P profits (green rectangle) decreases while the one of S profits (red rectangle) increases. Graphically, it is the same result of a centralized positive shock of the transfer pricing (Fig II.4=FIgII.2).

Fig. II.5 ***TRUST – RECIPROCATE***



Exploiting the box of potential profits scheme, one can see that when transfer pricing increases from TR_0 to TR_0, means that P trusted S. The first effect is a reduction of P profits of $(1-\gamma)$ that is now represented by the area of the rectangle **B_1E_1FC** (the same as centralized approach). Then, the area of S profits depends on S strategy. In the graph, is represented the situation in which S reciprocates P. In this case, part of the new S profits is shifted to P, and this area is the one of the rectangle **$ELME_1$**. Another very important finding is that the overall MNE's profits remained unchanged respect to the effect of a centralized shock on transfer pricing. Thus, the bargaining activity between managers shows only within distributional effects.

Impact of TR variation on P profits

- P trusts and transfers part of its gross margin to S:

$$\pi_{p,1,t} = Q_p TP[\gamma(P - TR_0)] = Q_p TP(P - TR_1)$$

$$\frac{\partial \pi_{p,1,t}}{\partial TR_1} = \frac{\partial Q_p TP(P - TR_1)}{\partial TR_1} = -Q_p TP < 0$$

3rd observation: In the first stage of the game, the marginal impact of a transfer pricing variation on P profits is negative, the same as the Centralized approach.

Impact of TR variation on S profits

- S does not reciprocate**:**

$$\pi_{s,1,nr} = Q_s TS[(P - C) - \gamma(P - TR_0)]$$

$$\frac{\partial \boldsymbol{\pi}_{s,1,nr}}{\partial TR_1} = \frac{\partial Q_s TS[(P-C)-\gamma(P-TR_0)}{\partial TR_1} = Q_s TS > 0$$

4th observation: If S does not reciprocate P, the marginal impact of a transfer pricing variation on S profits is positive, the same as the Centralized approach.

Impact of S strategy on P profits

- S reciprocates giving back P the sum ($-\rho^P \pi_{s,1,n}$)

$$\pi_{p,1,r} = Q_p TP[\gamma(P - TR_0)] + \rho^P \pi_{s,1,n}$$

$$\frac{\partial \pi_{p,1,r}}{\partial TR_1} = -Q_p TP + Q_s TS$$

It is easy to see that the impact of a TR variation on the new profit function is not always negative. Rather, it could be positive in case the following rule holds:

$$\rho^P Q_s TS > Q_p TP$$

$$\rho^P > \frac{Q_p TP}{Q_s TS}$$

Thus, the critical value of the participation asked by P has to be larger than the ratio of corporate tax rates TP and TS multiplied by the ratio of quantities Q_p and Q_s.

5th observation: If S reciprocates P, the marginal impact of a transfer pricing variation on P profits could be positive, depending on the participation of P on S profits.

Impact of S strategy on P profits

$$\pi_{s,1,r} = Q_s TS[(P - C) - \gamma(P - TR_0](1\text{-}\,\rho^P)$$

$$\frac{\partial \pi_{s,1,r}}{\partial TR_1} = Q_s TS(1 - \rho^P)$$

$$Q_s TS(1 - \rho^P) > 0$$

$$\frac{\partial \pi_{s,1,r}}{\partial TR_1} > 0$$

Since $\rho^P < 1$ by definition, the first derivative of S profits respect to TR variation is positive.

6th observation: If S reciprocates P, the marginal impact of a transfer pricing variation on S profits is positive but lower from the one in case of No Reciprocate or Centralized TR, and it is negatively related to the participation of P on S profits.

Impact of TR variation on MNE

$$\pi_{M,t}=\pi_{p,1,r}+\pi_{s,1,r}$$

$$\frac{\partial \boldsymbol{\pi}_{\boldsymbol{M},\mathbf{t}}}{\partial TR_1}=\frac{\partial \pi_{p,1,r}}{\partial TR_1}+\frac{\partial \pi_{s,1,r}}{\partial TR_1}$$

$$\frac{\partial \boldsymbol{\pi}_{\boldsymbol{M},\mathbf{t}}}{\partial TR_1}=Q_s TS(1-\rho^P)-Q_p TP+\rho^P Q_s TS$$

$$\frac{\partial \boldsymbol{\pi}_{\boldsymbol{M},\mathbf{t}}}{\partial TR_1}=Q_s TS-Q_p TP$$

$$TS-TP>0$$

$$\frac{\partial \boldsymbol{\pi}_{\boldsymbol{M},\mathbf{t}}}{\partial TR_1}>0$$

7th observation: The bargaining activity between P and S translates only in distributional implications of P and S profits, but for the MNE overall profits, the increase in transfer pricing has the same impact of the centralized approach.

Tab II.3:

Impact of a transfer pricing positive shock

	centralized	negotiated	
		S reciprocates	S no reciprocates
$\pi_{M,\mathrm{t}}$	+	+	+
$\pi_{p,\mathrm{t}}$	-	+/-	-
$\pi_{s,\mathrm{t}}$	+	+	+

The bargaining has only distributional effects between P and S divisions, but the variation of M profits is the same as the centralized approach. This is confirmed both from the graphical analysis of the box of potential profits and from the analysis of the marginal impact of a transfer pricing variation.

II. 3 QUANTITATIVE EXAMPLE

This section aims to give a quantitative representation of the theoretical model in a MNE with initial endowments, first with centralized then with decentralized transfer pricing system.

Suppose the following initial endowments:

$Qp = Qs = 100, P = 100\$, , C = 10\$,\ TP = 0.4, , TS = 0.8, TR_0 = 40$

Initial payoffs:

$$\pi_{p,0} = 2400\$$$

$$\pi_{s,0} = 2400\$$$

$$\pi M_0 = 4800\$$$

II.3.1 Centralized transfer pricing example

In this case, the Head quarter sets the transfer pricing level. Supposing that transfer pricing increases from 40$ to 60$.

$$TR_0 = 40\$$$

$$TR_1 = 60\$$$

$$\boldsymbol{\pi M_1} = 100\ 0.4\ (100 - TR_1) + 100\ 0.8(TR_1 - 10) = 1600\$ + 4000\$ = 5600\$$$

$$\pi_{p,1} = 1600\$$$

$$\pi_{s,1} = 4000\$$$

Of course, P divisional profits decrease, in this case of -800$, because some profits shifted to S since TS>TP, while the S profit has increased of +1600$.

II.3.2 Negotiated transfer pricing example

P and S find an agreement to split profits according to the trust game approach:

P starts the game:

P will keep γ share of its past profits:

$$\gamma = \frac{(P - TR_1)}{(P - TR_0)}$$

$$\gamma = \frac{(100 - 60)}{(100 - 40)} = 0.67$$

Hence we can say that P transfers to S the portion of (1- γ), in this case transfers 33% of its profits.

$$\pi_{p,1,t} = Q_p TP[\gamma(P - TR_0)]$$

$$\pi_{p,1,t} = 100\ 0.4[0.67(100\$ - 40\$)] = 1600\$$$

S divisional profits grow:

$$\pi_{s,1} = Q_s TS[TR_1 - C]$$

$$\pi_{s,1,n} = Q_s TS[(P - C) - \gamma(P - TR_0)]$$

$$\pi_{s,1,n} = 100\ (0.8)[(100\$ - 10\$) - 0.67(100\$ - 40\$)] = 4000\$$$

At this point, S can decide whether or not to give back some money to P through ρ. Suppose P ask a participation on the $\pi_{s,1}$ of ρ=(1- γ)(1+Pr)=30% with $Pr = 10\%$. Now, S computes its willingness to reciprocate according to this formula:

$$\rho^S\ max = 1 - \frac{TR_0 - C}{TR_1 - C}$$

$$\rho^S\ max = 1 - \frac{40 - 10}{60 - 10} = 40\%$$

Thus, since the condition $\rho^S > \rho^p$ is verified, then S is willing to give back P a share equal to 40%. Since P asked a participation of 33%, then S will reciprocate.

$$\pi_{s,1,t} = \pi_{s,1,n}(1 - \ \rho) = 4000\$\ (0.7) = 2800\$$$

$$\pi_{p,1,r} = \pi_{p,1,t} + \ \rho(\pi_{s,1,n}) = 1600\$ + (0.3)4000\$ = 2800\$$$

Payoffs at t=1 with negotiated TR and initial endowments

$$\pi M_0 = 4800\$, \pi M_1 = 5600\$,\ \pi_{p,0} = 2400\$, \pi_{p,1,r} = 2800\$, \pi_{s,0} = 2400\$,$$

$$\pi_{s,1,t} = 2800\$$$

TAB II.4: Summary payoffs table

	START *T0*	*CENTRALIZED* *T1*	*NEGOTIATED* *T1*
πM	4800$	*5600$*	*5600$*
πP	*2400$*	*1600$*	2800$
πS	*2400$*	4000$	2800$

As one can see, the total profit of MNE has improved $\pi M_1 > \pi M_0$ both with centralized and negotiated system. In particular, as expected, the new MNE profit is equal in both systems. The main difference between the two approaches is the distribution of profits between P and S. In fact, starting with 2400$, with the centralized approach P would bear a loss of -800$ and S would gain +1600$. When P and S negotiate on transfer pricing, in particular in case they trust and reciprocate, then both division profits increase to 2800$.

TRUST GAME EQUILIBRIUM

S / P	R	NR
T	$\pi_{p,1,r}$=2800$ $\pi_{s,1,r}$=2800$	$\pi_{p,1,t}$=1600$ $\pi_{s,1,n}$=4000$
NT	$\pi_{p,0}$=2400$ $\pi_{s,0}$=2400$	$\pi_{p,0}$=2400$ $\pi_{s,0}$=2400$

As one can see from the scheme, the theoretical prediction of the trust game applied to the transfer pricing system is to not cooperate. In fact, the SPNE Equilibrium of the game is when P chooses the strategy "no trust" and S chooses "no reciprocate". This could be straightforward if one looks at the game from the P point of view, who is the player that starts the game. Suppose P decides to trust, then S get the higher payoff when he does not reciprocate because $\pi_{s,1,n}$=4000$ > $\pi_{s,1,r}$=2800$. At this point, in the following periods, P would not trust S anymore, thus the final equilibrium would be the absence of cooperation. However, this is not the optimal equilibrium. If P trusts and S reciprocates, the game would be cooperative and both payoffs would be larger than before, 2800$ respectively. Hence, even though the theoretical prediction is non cooperative, some experimental analysis find that in reality something differs. I will try to test which are the variables that influence the equilibrium simulating and validating the model in the following chapter.

II. 4 STATE REGULATION ON TRANSFER PRICING

This section attempts to remove the limit of the absence of tax regulation from the model so far proposed. In fact, once we take away the limit of centralized approach and absence of manager interests, we need now to remove also the strong limit of the absence of tax controls. In order to do so, the idea is to follow an approach similar to the one proposed by Kant on negotiated transfer pricing and uncertain regulation.

Here the model assumes that N multinational firms compose the market, all with the same structure of the $M_{j,t}$ proposed so far. Thus the market at time *t* is:

$$\text{Market} = \sum_{j=1}^{N} M_{j,t}$$

Where the index *j* identifies each of the *N* MNEs.

On the other hand, a State controls each year the tax activity and the transfer pricing level of the MNEs present in the market. Since it is impossible to control all the MNEs' transfer pricing system, due to the burden of costs, then the State intervenes with regulation, in terms of transfer pricing standards. The state intervention is assumed to be exogenous.

In practice, those standards are represented by a transfer pricing threshold that cannot be exceeded by each MNE, therefore a sort of maximum admitted transfer pricing exists. In fact, let us assume that the State wants to keep the transfer pricing equal to the Arm's Length Price, that in the model is assumed to be the initial $TR_{j,0}$= TR *. Then, If transfer pricing exceeds TR *, the parent company has to pay a penalty of amount $F_t$with a probability "α". It must be considered that the penalty is not certain any time the transfer pricing is exceeded. In fact, this depends on how difficult and costly controlling activities are. The model assumes that the State controls randomly a sample of the MNEs, and after the control, it will intervene with a penalty on the MNEs that showed an unfair transfer pricing level (higher than the ALP=TR_0).

In particular, there is a probability for each MNE to be fined, when their transfer pricing level is unfair, in this case when it is over a certain level given by the State as *Arm's Length Principle* (ALP).[5] Each year the State selects randomly a share of the MNEs present in the market, controls the respective transfer pricing level, and fine them with a penalty F_t given by the following equation:

[5] See OECD guidelines 2010.

Penalty function F_t

$Fj,_t = \{\beta(TR_{j,t} - TR_{j,0})\}$ with probability α

$F_t =$ 0 with probability $(1 - \alpha)$

Where

$\beta > 0$;

$0 \leq \alpha \leq 1$

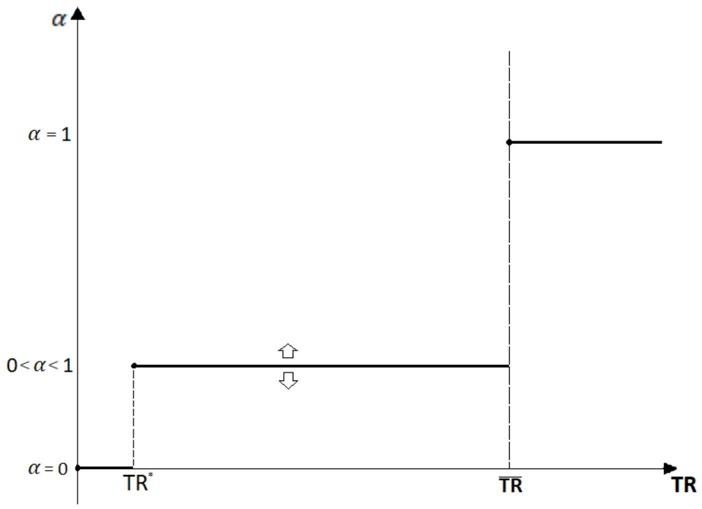
As one can see, the intervention of tax authorities is assumed as a linear function of the difference between the actual transfer pricing level and the starting one at time 0, which is assumed to be the ALP. In fact, the higher the transfer pricing level, the larger is the penalty that MNE has to bear. Then, the difference $(TRj,_t - TR_{j,0})$ is multiplied by the factor β that is a measure of the punishment of the State. In fact, when β increases, then each MNE would pay more for its unfair transfer pricing level, so that the State punishes less. On the contrary, if β decreases, then the State penalizes less for MNE's tax manipulation. It is a way to capture the fact that when MNEs rise too much the transfer pricing, then they risk much more in case them have been caught by the state. Moreover, the probability α is given by the number of MNEs controlled each year by the State. We assume a sort of asymmetric information between tax authorities (State) and MNEs, because companies do not know exactly the probability of being controlled. However, the State imposes a certain penalty on those MNEs that exceed the upper threshold, that we assume to be $\overline{TR}$. Thus, companies will never set a TR larger than $\overline{TR}$. For instance, suppose that N=50, if the tax authority decides to control 5 firms over the total of 50 present in the market, then there is a 10% of probability for each firm to be penalized.

FIG: II.6: Probability function α

$$\alpha = 1 \qquad \text{if} \quad TR_{j,t} > \overline{TR}$$

$$0 < \alpha < 1 \qquad \text{if} \quad TR^{*} < TR_{j,t} < \overline{TR}$$

$$\alpha = 0 \qquad \text{if } TR_{j,t} = TR^{*}$$



From the figure II.6, it is easily to see that the probability of controls is null when $TR < TR*$, and it is lower than one in the range from $TR*$ to $\overline{TR}$. Once TR>$\overline{TR}$, then α=1 and the penalty occurs for sure. The probability α just depends on the cost of controls, in terms of time and resources, that state has to bear, and can be modified exogenously. The model assumes that $0 < \alpha < 1$ because firms just move the transfer pricing within TR^* and $\overline{TR}$. At this point, one can compute the tax revenue R_p of the State. The tax revenue is composed by two parts: the first is the proportional tax rate imposed on parent company gross profits; the second is given by the sum of all the penalties collected in the market in a year. Thus, the tax revenue is expressed as:

$$R_{p,t} = (1 - TP)\sum_{j=1}^{N} \pi_{\ p,j,t} + \alpha \sum_{j=1}^{N} F_{j,t}$$

Since $Fj_{,t}$= $\{\beta(TR_{j,t} - TR_{j,0})\}$, and β is a constant, it is possible to rewrite it in:

$$R_p = (1 - TP)\sum_{j=1}^{N} \pi_{\ p,j,t} + \alpha\beta \sum_{j=1}^{N} (TR_{j,t} - TR_{j,0})$$

Let us call $\mathfrak{z}$ and Φ respectively the components $(1 - TP)\sum_{j=1}^{N} \pi_{\ p,j,t}$ and $\alpha\beta \sum_{j=1}^{N} (TR_{j,t} - TR_{j,0})$ so that:

$$R_{p,t} = \mathfrak{z}_t + \Phi_t$$

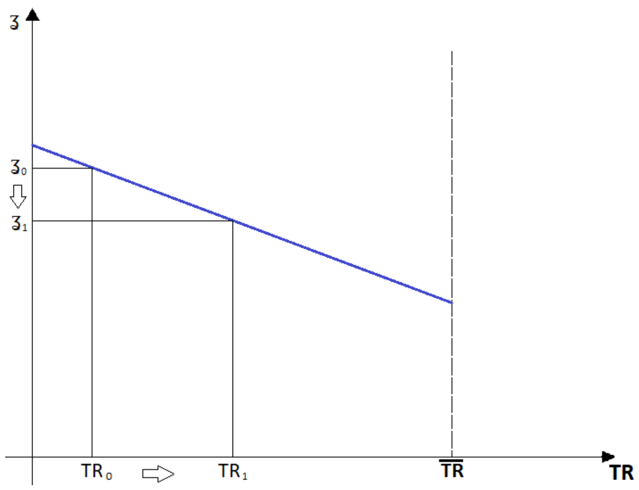
Suppose that the state does not intervene with a transfer pricing regulation liberalizing the market, then $\alpha = 0$ and $\Phi = 0$, thus the overall tax revenue of State P is given by:

$$R_{p,t} = ʒ_t$$

$$R_{p,t} = (1 - TP)\sum_{j=1}^{N} \pi_{p,j,t}$$

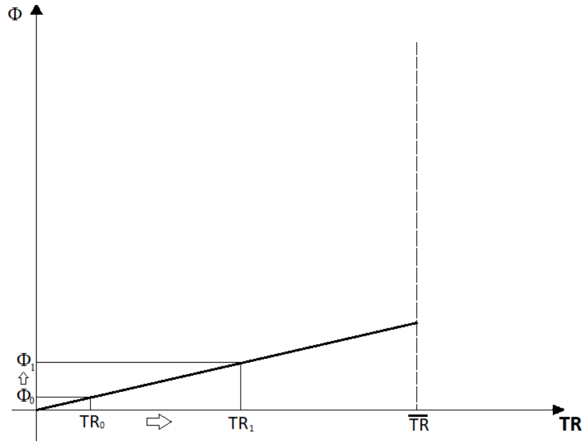
This equation is graphically represented into figure II.7.

FIG. II.7: Gross tax revenue when $\alpha = 0$



The shift of transfer pricing level translates into a lower tax revenue for the State. In order to offset this negative effect, the State intervenes imposing the regulation, thus some penalties occur with probability α >0. Then, the Φ function, according to the level of TR, is represented into figure II.8.

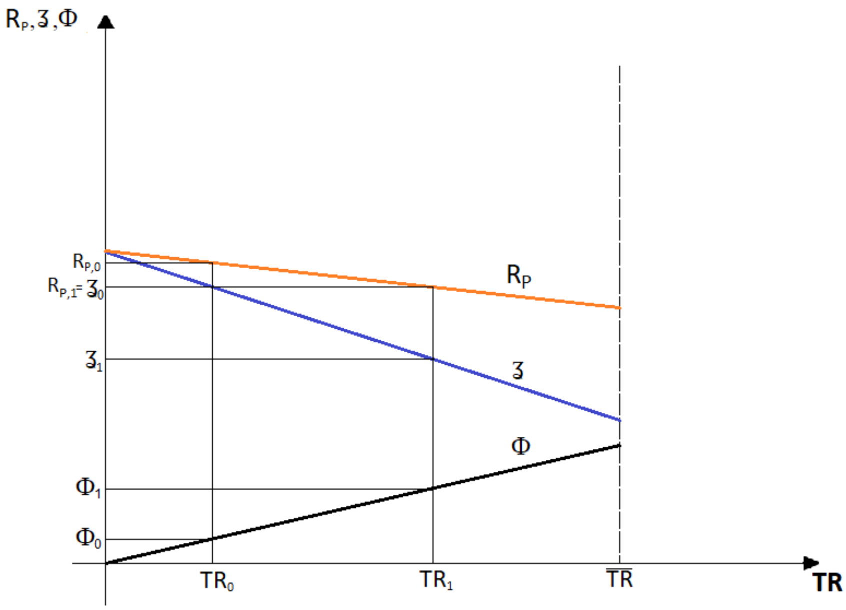
FIG. II.8: Penalty function



On this side, the shift in transfer pricing leads to a relative increase in tax revenue, given by the sum of all penalty imposed and collected. The slope of the curve is represented by the product $\alpha\beta$, hence an increase of either α or β has the same positive effect on tax revenue.

At this point, one can sum the two effect to see graphically the overall tax revenue function, showed in the figure II.9:

FIG. II.9: Gross tax revenue



The orange line represents the total tax revenue of the State. It is downward sloping since with the increase of transfer pricing, firms are de facto shifting profits to country S and avoiding to pay taxes in country P. However, the two component of the overall tax revenue behave differently and have a different impact.

As one can see from the graph above, supposing that the State did not intervene, when TR = TR_0 the tax revenue would have been at level $ʒ_0$. Then State intervenes, imposes and collects penalties, and the tax revenue at time 0 is $R_{p,0} > ʒ_0$. This positive difference is fully explained by the sum of the penalties collected (Φ_1). When transfer pricing increases, there are two opposite effects:

1) The tax revenue derived from proportional tax on gross profits decreases from $\mathfrak{z}_0$ to $\mathfrak{z}_1$.
2) The tax revenue derived from penalties collected increases from Φ_0 to Φ_1.

The vertical sum of these two effects, explains the new overall tax revenue level $R_{p,1}$. As one can see, this new tax revenue level is lower than the previous one ($R_{p,1} < R_{p,0}$), but is equal to the previous one without the State intervention ($R_{p,1} = \mathfrak{z}_0$). Thus, introducing the regulation, the State reduces the loss of tax revenue due to the shift of profits abroad.

Moreover, the State can exogenously raise the tax revenue increasing the level of corporate tax rate (TP), intensifying controls (α), and rising the punishment of the penalty (β). [6] At this point, it is necessary to understand how much does the State pay for each level of control. As already written, the State cannot control all the market because it would be an enormous cost in terms of both money and human resources. In fact, in the model, we assume a sort of linear control cost as a linear function of the number of the MNEs controlled. The cost of State control (SC) function is given by the following equation:

[6] These implications are true only if transfer pricing level remains at least constant when the State intervenes. In fact, this assumption does not hold when we assume that the transfer pricing is set take back to the ALP when the State intervenes on a MNE (TRt=TR0).

$$SC = (\alpha N)\theta$$

Where the term (αN) represents the number of MNEs controlled each year, multiplied by the cost of control θ, which is assumed to be constant and equal for each firm controlled. At this point, it is possible to obtain the net tax revenue function (NRp) as the sum of three functions:

$$\mathrm{NR}_{pt} = \mathfrak{z}_t + \Phi_t \text{ - } SC_t$$

$$\mathrm{NR}_{pt} = (1 - TP)\sum_{j=1}^{N} \pi_{\ p,j,t} + \ \alpha\beta \sum_{j=1}^{N} (TR_{j,t} - TR_{j,0}) - \ (\alpha N)\theta$$

Assuming the average market profit and transfer pricing level, we obtain:

$$\mathrm{NR}_t = (1 - TP)N[Q_p(P - TR_t)] + \ \alpha\beta N(TR_{\ t} - TR_0) - \ (\alpha N)\theta$$

It is important to consider the relationship between the transfer pricing level and alfa. In fact, we expect that the larger the state controls (alfa increases), the lower the average transfer pricing (TR goes down). The State would thus estimate a linear function between transfer pricing and alfa:

$$TR_t = A - \ \mathcal{E}\alpha$$

Where A is the maximum admitted transfer pricing, and Ɛ is the elasticity of transfer pricing respect to alfa. The function registers the negative effect of an increase in alfa on transfer pricing. In order to assess the functional form of the net tax revenue of the State, we should combine the two equations:

$$\begin{cases} NRp = (1 - TP)N[Q_p(P - TR_t)] + \alpha\beta N(TR_t - TR_0) - (\alpha N)\theta \\ TRt = A - \mathcal{E}\alpha \end{cases}$$

Substituting the equation of TRt into the net tax revenue function, we get:

$$NRp = (1 - TP)N[Q_p(P - (A - \mathcal{E}\alpha))] + \alpha\beta N[(A - \mathcal{E}\alpha) - TR_0] - (\alpha N)\theta$$

Dividing both terms by the market size N, we get the average net tax revenue of the representative MNE.

$$avgNRp = (1 - TP)[Q_p(P - A + \mathcal{E}\alpha)] + \alpha\beta[(A - \mathcal{E}\alpha - TR_0] - (\alpha)\theta$$

$$avgNRp = (1 - TP)Q_p(P - A) + (1 - TP)Q_p(P - A)\,\mathcal{E}\alpha + \alpha\beta(A - TR_0) - \boldsymbol{\beta}\mathcal{E}\boldsymbol{\alpha}^2 - (\alpha)\theta$$

$$avgNRp = -\boldsymbol{\beta}\mathcal{E}\boldsymbol{\alpha}^2 + \boldsymbol{\alpha}[\mathcal{E}(P - A)(1 - TP)Q_p + \beta(A - TR_0) - \theta] + (1 - TP)Q_p(P - A)$$

As one can see, there is some quadratic in the function because α is squared, and the coefficient is negative.[7] Thus, we expect NRp to be a concave quadratic

[7] Note that also the penalty function is a quadratic function with a maximum:
$F = \alpha\beta[(A - \mathcal{E}\alpha - TR_0]$

function, thus there will be an optimal level of α^* that would maximize the tax revenue of the State. This optimal level $\alpha^*$is obtained with the FOC, thus when the first derivative of NRp respect to α equals zero.

$$\frac{\partial NRp}{\partial \alpha} = 0$$

$$\frac{\partial'' NRp}{\partial'' \alpha} < 0$$

Since it is a quadratic form, when $a > \alpha^*$, then the State loses tax revenue, and this can be explained by four effects, someone positive or negative for the State:

1) Corporate tax effect (positive);
2) Penalty effect (positive);
3) Firm's size effect (negative);
4) Control cost effect (negative).

In general, one can say that the State Net tax revenue is given by the sum of these four effects. Until the sum of positive effects is larger than the sum of negative effects, the tax revenue increases. On the contrary, when the negative effects overcome the positive ones, then the State is over controlling the economy, thus the tax revenue is decreasing.

As first, when State does not intervene, a=0, hence control cost=0 and penalty = 0. The firm's size is the largest possible because the average transfer pricing level reaches the maximum admitted $TR_t = \overline{\overline{TR}}$.

Then, when $0 < a < \alpha^*$, the net tax revenue function is positive. In fact, when State starts to control some P, then the transfer pricing goes down and more taxable profits are back to P State, and corporate tax effect occurs (ʒ $+$). Moreover, both the function of penalty (Φ $+$) and Cost of control (SC-) increases. Due to a lower transfer pricing level, the size of the firms starts to reduce and the firm's size effect increases (-).

When the State increases the regulation more than α^*, the size of firms starts to decrease (TR_t<TR_{t-1}), and thus the taxable profits start to decrease too. Since there is lower tax avoidance and the average transfer pricing level is lower than before, the marginal impact of both corporate tax revenue and penalty on the MNE is lower and lower. On the other hand, the cost of control constantly increases with the increase of α, thus the net RP decreases. It must be considered that the gross tax revenue of the State is a concave and positive function in α. However, since the marginal impact of increasing α on gross tax revenue is constantly decreasing, and since the cost of control is represented by a constant and proportional function in α, the difference between the marginal benefit of taxation and marginal cost of control starts to decrease.

As first, when α increases from 0 to α*, the impact of the control is larger than the firm's size. On the contrary, when State controls too much, then the firm's size and the cost of control effects overcome the benefit gained from taxation on profits and penalty effects. Thus, there is no more convenience for the state to increase controls.

Despite it is assumed that more MNEs populate the market, let us see what is the impact of the State penalty on the representative MNE.

The new representative MNE's overall payoff is:

$$\pi M_{j,t} = \pi_{j,p,\mathrm{t}}\, TP + \pi_{j,s,\mathrm{t}}\, TS - F_{j,t}$$

$F_{j,t}$=Penalty on unfair transfer pricing of the MNE *j* at time *t*.

We assume that controls are made in the domestic market, so where P is located, and thus P is supposed to cover the cost of the potential penalty. This makes sense because increasing the transfer pricing over the ALP, P shifts profits abroad to S country, and the tax revenue of the domestic country decreased. Thus, P is responsible to bear the cost. At this point, another important assumption on the transfer pricing dynamics has to be made. Recalling the asymmetric information between managers and headquarter, where only P knows about the headquarter strategy, we can assume that the transfer pricing increases when the multinational has not been caught. This means that each $M_{j,t}$tries to shift profits abroad, but will increase the transfer pricing only in case the State did not control it. Otherwise, the transfer pricing decreases and goes back to the initial level (Arm's Length Price). In general, this can be summarized as follows:

The TR dynamic is:

$$TR_{j,t} = TR_{j,t-1} + \varepsilon_t \qquad \text{if } F_{j,t-1} = 0$$

$$TR_{j,t} = TR_{j,0} \qquad \text{if } F_{j,t-1} > 0$$

Where: $\varepsilon_t = [1]$

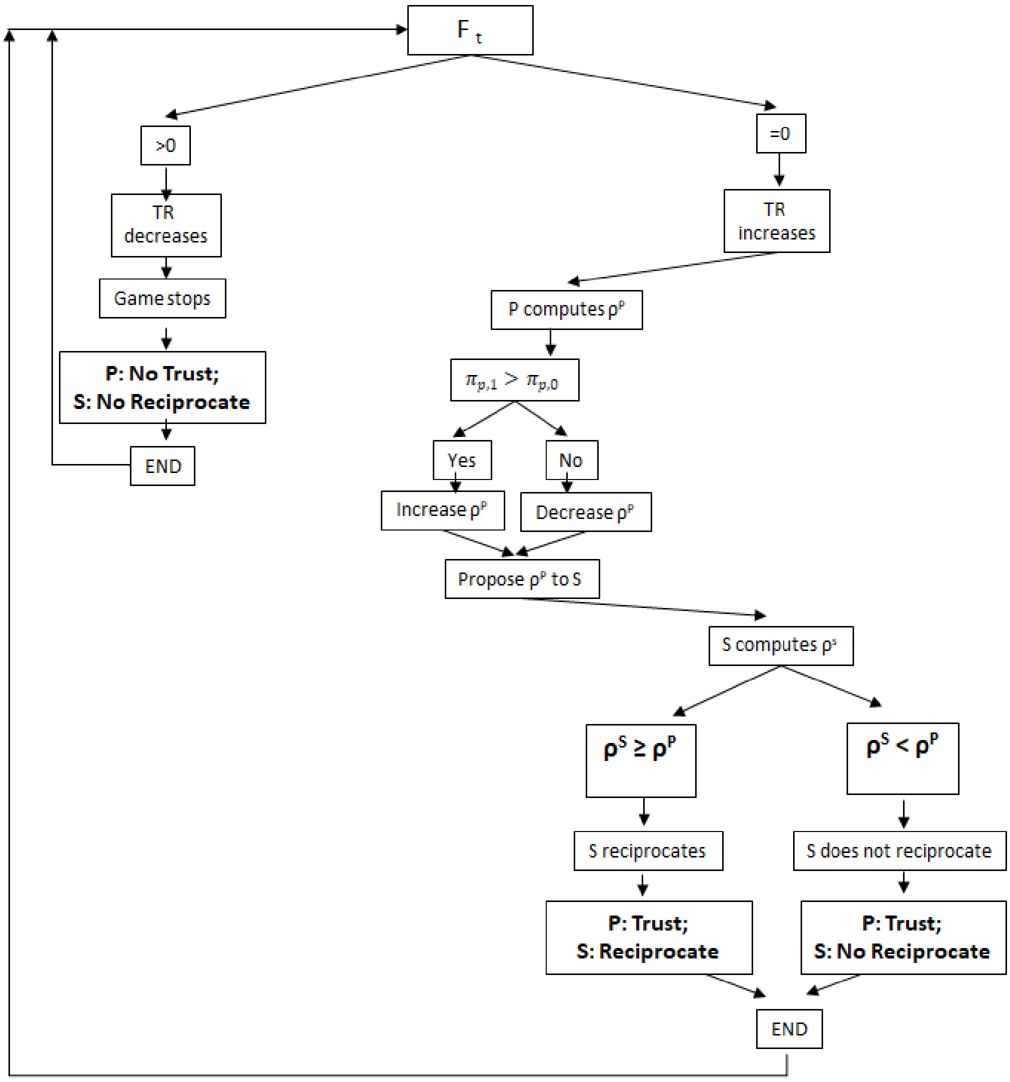
In in case the MNE has not been fined, then the transfer pricing would increase of one unit. On the contrary, when the State intervenes, the MNE has to bear the cost of penalty and the new transfer pricing level would be the ALP, equal to the initial transfer pricing $TR_{j,0}$.

II.5. SEQUENCE OF THE EVENTS

This section attempts to give an overview of the sequence of the events that are simulated into the algorithm. The sequence is made from the MNE point of view, and it is explained as follows:

The HeadQuarter checks whether or not the MNE has been caught by the random control of the State. In case it has been caught, then it is punished with a penalty F_t>0, hence the transfer pricing decreases to the ALP, the game stops and the game is non cooperative, because the State imposed the end of the game. On the contrary, when the MNE has not been punished (F_t=0), then tries to raise the transfer pricing to gain more profits. At this point, the transfer pricing increases with the dynamic explained in the previous paragraph. Since the transfer pricing has increased, now P transferred some profits to S, hence would ask a participation on S profits equal to ρ^P . Therefore, P computes ρ^P , and takes into account its relative level of profits in the previous period: if the profits has increased, then P would ask a higher share of S profits, equal to $\rho^P\ (1 + Pr)$. On the contrary, P would compute ρ^P as in normal times, asking a participation equal to the share of profits shifted through the increase of transfer pricing $(1 - \gamma)$. Now, P proposes the participation to S, which in turn will compute its willingness to accept: ρ^S . According to the ρ^S , the end of the game could be cooperative (P trusts and S reciprocates) or non cooperative (P trusts and S does not reciprocate). Then, the loop repeats in time for *t* periods and in space for *N* MNEs. We simulate this loop using C programming, whose code is attached in the appendix 1.The structure of the sequential algorithm simulated in C is represented into the following figure:

FIG. II.10: Algorithm



CHAPTER III: "SIMULATIONS OF THE MODEL"

III.1 SIMULATION RESULTS

This section deals with the simulation of the theoretical model proposed, with the aim to understand the key variables for setting the optimal state intervention level α^*, hence the optimal transfer pricing TR^* , that leads an optimal solution for both State and MNEs. First the model simulates a centralized approach, with the limitation that headquarter can increase the transfer pricing just of one unit more per year, and that the maximum level of transfer pricing is 80\$. Then, the simulation of the model with negotiated transfer pricing and state intervention is provided. The simulation is made on 50 MNEs (50 P and 50 S) over 300 periods. (N=50; t=300)

The market starts according to the following endowments:

$Qp = Qs = 100$, $P = 100\$$, $C = 10\$$, $TP = 0.4$, $TS = 0.8$, $TR_0 = 40\$$,

Pr=30%, $\alpha = 0, \theta = 2000$.

Several treatments are proposed according six level of State regulation:

$$\alpha = 0; 6\%; 10\%; 20\%; 50\%. 100\%$$

Treatments:

1) High tax rate and low penalty; [$(1 - tp)$=40%; β=100]
2) High tax rate and high penalty; [$(1 - tp)$=40%; β=200]
3) Low tax rate and low penalty; [$(1 - tp)$=60%; β=100]

4) Low tax rate and low penalty. [$(1-tp)$=60%; β=200]

The following graphs represent the time series of several key variables in the centralized approach (α=0) and in the negotiated system with the state intervention at 6% (α=6%), with TP=40% and β=100.

FIG. III.1

Taking a look to the FIG III.1 which shows the time series of the average market transfer pricing in two different treatments, one with the State regulation (orange curve-negotiated) and another without State intervention (blue curve-centralized), one can see how the path differs. As expected, in the centralized approach (blue curve) the head quarter exploits *the box of the potential profits*, increasing the transfer pricing gradually reaching the highest admitted level: 80$. This is not possible in the negotiated approach (orange curve), and when the state intervenes, the average transfer pricing of the market is stable around 53$. The dynamic that explains why the transfer pricing stabilizes around a lower level is explained in the following analysis over several treatments.

Moreover, we can use the TR as a proxy for the MNE's size, which is represented by the level of overall profits, hence we can see the similar path of overall profits time series in the figure III.2.

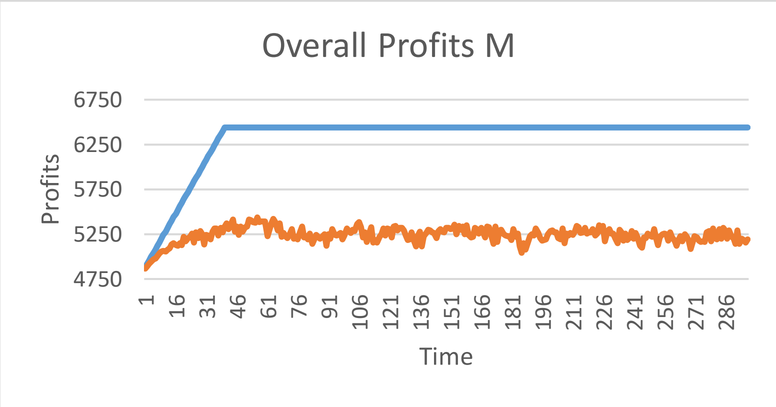


FIG III.2

Assuming the absence of State controls (α=0) and a centralized approach, the potential profit is reached and the area of the box of the potential profits is maximized at 6440$. On the contrary, when state intervenes and managers negotiate (α=6%), the overall profits stabilize on a greater level (5250$) than the starting equilibrium point at time 1.

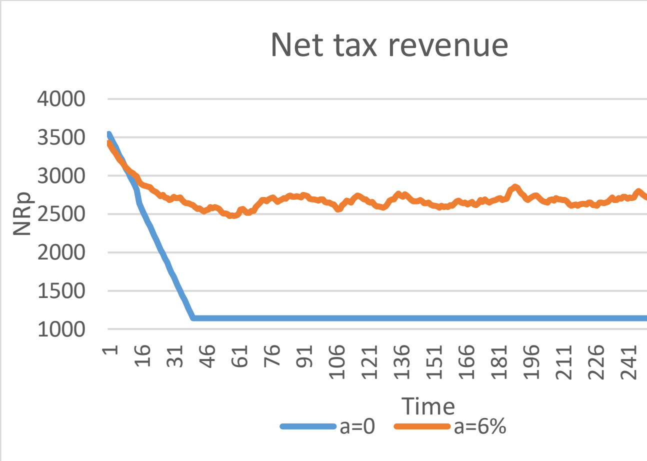


FIG. III.3

Also from the state point of view, when a transfer pricing State regulation exists, then the tax revenue is larger than the one without any State intervention. This is visible in figure III.3, and this result is quite straightforward because, when α>0, then the average transfer pricing goes down and capital are returned and taxed in P country.

Now, it is interesting to plunge into the results of all these variables across several treatments. We implement four different treatments for six levels of State control:

The summary of the result with different treatments is provided in the following tables and graphs.

TRANSFER PRICING				
	$(1-tp)$=40%		$(1-tp)$=60%	
	β = 100	β = 200	β = 100	β = 200
α = 0	80 (0)	80 (0)	80 (0)	80 (0)
α = 6%	53,1 (2,04)	53,5 (2,03)	53,22 (2,03)	53,7 (2,15)
α = 10%	48,36 (1,11)	48,1 (1)	48,42 (1,11)	48,3 (1,12)
α = 20%	43,55 (0,40)	43,6 (0,44)	43,60 (0,42)	43,6 (0,44)
α = 50%	40,78 (0,08)	40,8 (0,07)	40,79 (0,08)	40,8 (0,08)
α = 100%	40 (0)	40 (0)	40 (0)	40 (0)

TAB. III.1: Average market transfer pricing level across several treatments (standard error in brackets)

Starting from the transfer pricing level, it is possible to see from Tab:III.1 that in general, with the increase of α, the average transfer pricing level decreases.

Holding fix the level of α, the difference across different treatments seems to be negligible. As one can see from the first row (α=0), the transfer pricing is equal to 80$, which represents the maximum admitted level that leads to avoid the certain punishment. Since the standard error is 0, we can conclude that all the MNEs reach the maximum size, exploiting the box of potential profits. When the State intervenes α=6%, the average TR level drops from 80$ to an average of 53,6$, and the standard error increases. If we focus on the behaviour of the standard error, we can see that it is constantly decreasing with the increasing in α. This means that the more the

State intervenes, the more stabilizes the economy in terms of equality between MNEs. In fact, imposing more regulations and penalties, firms will converge to the same level of average transfer pricing, and so profits and firm size. However, the first shock of the State in the economy (α from 0 to 6%) raises just temporarily the inequality between firms. This can be explained because the State only fines the 6% of the overall Market (N), thus there will be some MNEs that would be punished less than others. This would lead to different level of profits in time across MNEs.[8] When the controls increase, α increases and TR decreases, then MNEs have less power to shift profits abroad, hence the possibility of gain is less for all the market, and the economy stabilizes around a mean. In the end, when the State controls the 100% of the MNEs, then the *TR* is equal to the desired level according to the Arm's Length Price, which is assumed to be ALP = 40$.

As one can see from the figure III.4 below, which shows the transfer pricing on the vertical axis, according to different level of State intervention on the horizontal axis, the relationship between TR and α is always decreasing. However, in the previous chapter, we assumed that TR is a linear function of α. Despite the difference

[8] The explanation of the standard error behaviour is common for all the analysed variables. Thus, we will omit the comment on the standard error in the following tables.

between the theoretical and the empirical result, the linear relationship captures effectively the link between TR and α. It is confirmed that the more α increases, the more TR decreases. The State is getting back capital which MNEs would otherwise show abroad. It must be considered that TR is a proxy for the firm's dimension, thus the more TR is higher, the larger would be the M size in terms of profits.

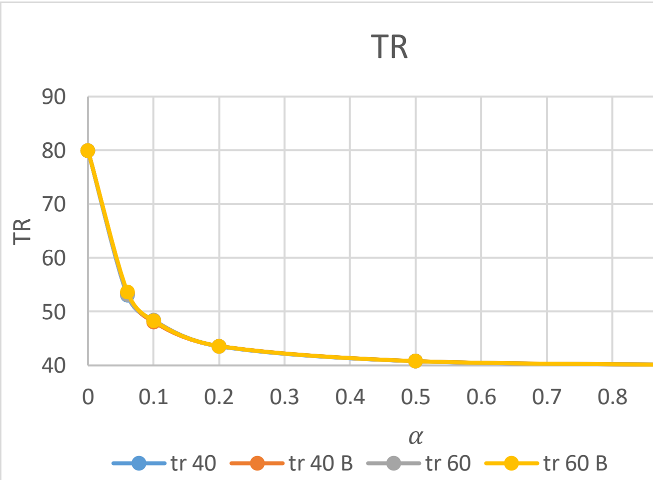


FIG. III.4

The decrease in TR due to the increase in α is a twofold fact: on one hand, overall M profits should decreases due to the fact that capital are re-shifted and taxed in P, where the tax rate is larger; on the other hand, capitals flow back to P, thus P profits should increase. These results are confirmed by the simulated data. Looking to the following table, which shows the average profit of the representative M in different treatments, it is visible the relationship between overall profits and State controls.

π_M MNE profits				
	$(1-tp)$=40%		$(1-tp)$=60%	
	β = 100	β = 200	β = 100	β = 200
α = 0	6440 (0)	6440 (0)	6820 (0)	6820 (0)
α = 6%	5238,6 (87,02)	5174 (104)	6178,9 (53,6)	6108 (92,4)
α = 10%	5047,0 (58,6)	4950 (84,4)	6081,2 (44,7)	5993 (73,4)
α = 20%	4862,8 (30,3)	4786 (54,7)	5992,4 (25,3)	5914 (52,7)
α = 50%	4781,0 (9,8)	4731 (17,7)	5965,4 (8,9)	5915 (17,7)
α = 100%	4800 (0)	4800 (0)	6000 (0)	6000 (0)

TAB. III.2: Average MNE profits (standard error in brackets)

As a first common result for all treatments, the increase in state controls leads to a decrease of overall profits. This result is consistent with the theoretical model. However, data suggest that this is true until $\alpha \leq 50$. In fact, the average M profit with the treatment "High tax rate" is 4781$ and 4731$ versus the initial level of both 6440$. The same happens with the "low tax rate" treatment in which profit P decreases from 6820$ to 5965.4$ and 5915$. When a=100%, there is an inversion of the profit curve. One may ask himself how is that possible, and here the result can be explained with a link to the previous table (TR table). In general, according to this model, an increase in transfer pricing would like to increase the overall profits, and this is verified because we assume that the corporate tax rate in S (abroad) is lower. Here the problem arises because this dynamic is not confirmed by data. Looking at the transfer pricing table, we observe that when α=50%, the average TR level is 40.8$ versus an ALP=40$. Thus, the dimension of the firms is very small, and this is due to the assumption on the dynamic of transfer pricing. In fact, we assume that when the firm is not controlled, the transfer pricing increases of one unit, but when it is fined, the transfer pricing comes back to the minimum (ALP). When the state controls 50% of N, then firms cannot grow anymore, and the State keeps almost all the capital that otherwise would flow abroad. At this point, when α=50%, the probability to be fined is very high, but there still will be some firms that try to increase the transfer pricing. However, the amount transferred abroad is on average too low to cover the negative effect of a State punishment. Thus, since the state punishment involves the 50% of the MNES, the punishment effect is larger than the increase of profits due to the transfer pricing, hence the overall profits of M are larger when the State controls all the firms. In that case, the penalty effect overcomes the transfer effect, no firms would transfer any money abroad, thus no fines occur and profits does not decrease but stabilize at 4800$ (6000$ in the treatment with low tax rate).

As one can see also from the graphical representation of the figure III.5, when the P tax rate decreases from 60% to 40%, then the profit curves shift to an upper level.

When the penalty is doubled to β=200, the M profits curves (yellow and orange) lie down the one with the lower State punishment β=100 (blue and grey), unless α=0% or α=100%.

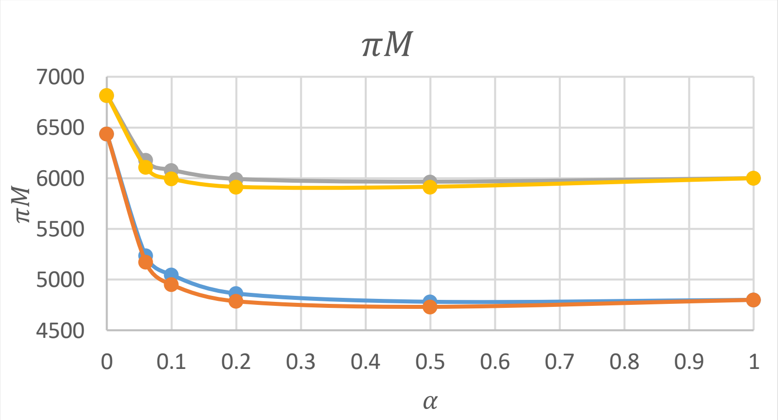


FIG III.5

One could concern about the fact that, since the state is imposing penalties on P, then the P profits would be negatively correlated with an increase in α. In reality, this does not happen and the reason is quite straightforward. So far we know that the more α increases, the more TR decreases, and the size of M decreases, until α=50%. We must remember that if TR decreases, then the unitary gross margin of P increases $\uparrow \pi_P = Q_p TP(P - TR \downarrow)$. However, this is true until a=50%. As one can see both from the following table and graph, the relationship between profit P and α is positive across all the treatments. The link between profit P and state control is represented by a positive and concave function. The marginal impact of an increase in control on the P profits is decreasing. Comparing the two treatments with high tax rates (TP=40%) against the two with the lower tax rate (TP=60%), we can see that when the corporate tax rate decreases, P profits increase. Moreover, the increase in punishment leads to a decrease on P profits, in both low and high tax rate treatment.

Profit P π_P				
	$(1-tp)$=40%		$(1-tp)$=60%	
	$\beta = 100$	$\beta = 200$	$\beta = 100$	$\beta = 200$
$\alpha = 0$	760 (0)	760 (0)	1300 (0)	1300 (0)
$\alpha = 6\%$	1824,11 (99,82)	1725,40 (126,33)	2754,18 (137,54)	2641,75 (168,14)
$\alpha = 10\%$	2017,17 (61,59)	1941,21 (87,48)	3046,18 (80,34)	2968,30 (101,91)
$\alpha = 20\%$	2215,95 (26,36)	2134,40 (49,68)	3342,32 (31,33)	3262,56 (53,16)
$\alpha = 50\%$	2339,62 (6,95)	2290,10 (14,71)	3523,86 (6,80)	3474,45 (14,83)
$\alpha = 100\%$	2400 (0)	2400 (0)	3600 (0)	3600 (0)

TAB.III.3: Average P profits (standard error in brackets)

These results are confirmed in the figure III.6, where the yellow and grey curves represent the low tax rate treatment, while the red and blue ones represent the high tax rate treatment. As one can see, the pattern is similar for both couple of curves, and a decrease in tax rate just shifts up the P profits line.

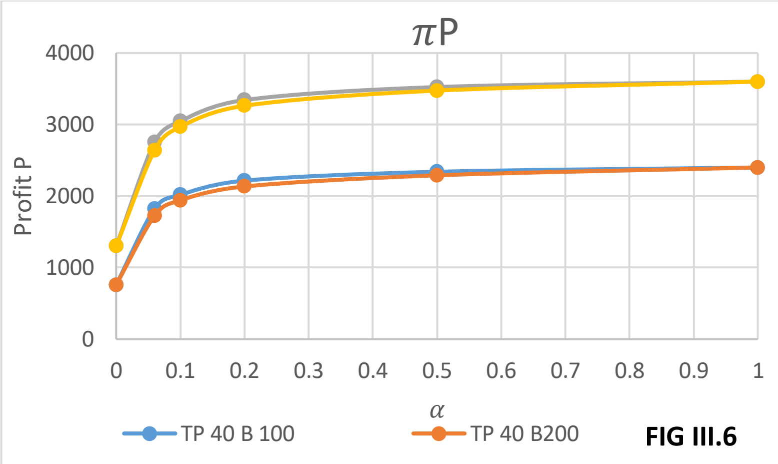


FIG III.6

If the relationship between state regulation and profits is positive for P, this is not true for S. In fact, the buying division is operating abroad in the lower tax rate country, and an increase in transfer pricing regulation would like to bring back foreign capital, decreasing S profits. The opposite effect is visible in the following table and graph, showing the relationship between state regulation and profits of Subsidiary.

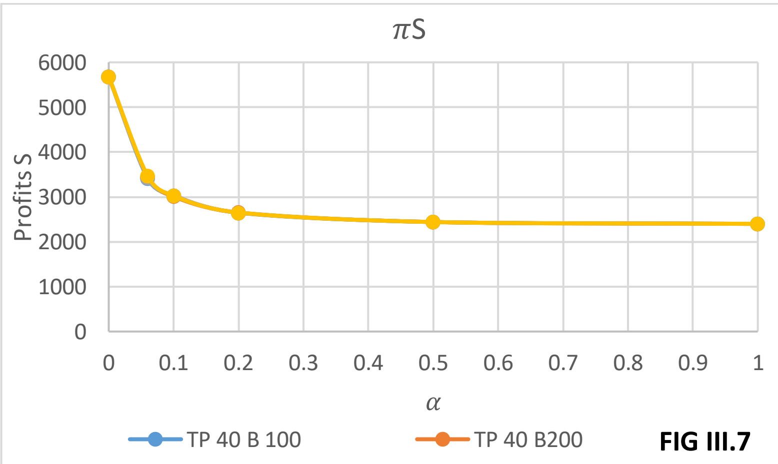


FIG III.7

The profits S graph III.7 shows the negative relation between α and S profits. However, comparing data across the low tax and high tax treatment, it is interesting to see that S is somehow “P policy invariant” In fact, the curves of the four threatens are always overlapping.

A decrease in P tax rate, has not significant impact on S profits, and this is because corporate tax rate in S is still below the P tax rate. We assumed that the average tax rate in S is 20%, thus TS=80%. On the other hand, when P decreases the tax rate to 40% (TP=60%), MNEs would transfer the same amount of money abroad. The only difference appears when on compare the different penalty treatment within the same tax rate treatment.

Profit S π_S				
	$(1-tp)$=40%		$(1-tp)$=60%	
	$\beta = 100$	$\beta = 200$	$\beta = 100$	$\beta = 200$
$\alpha = 0$	5680 (0)	5680 (0)	5680 (0)	5680 (0)
$\alpha = 6\%$	3413,87 (167,13)	3447,75 (166,23)	3424,15 (165,65)	3465,77 (175,39)
$\alpha = 10\%$	3029,31 (90,39)	3008,46 (81,66)	3034,37 (91,01)	3023,95 (91,51)
$\alpha = 20\%$	2646,28 (31,64)	2651,14 (35,36)	2649,47 (32,99)	2650,37 (35,48)
$\alpha = 50\%$	2440,82 (5,76)	2440,15 (5,23)	2440,91 (5,57)	2440,32 (5,44)
$\alpha = 100\%$	2400 (0)	2400 (0)	2400 (0)	2400 (0)

TAB. III.4: Average P profits (standard error in brackets)

If we combine the divisional profits into a unique graph, we can observe the opposite effect of an increasing regulation on P and S into the figure III.8.

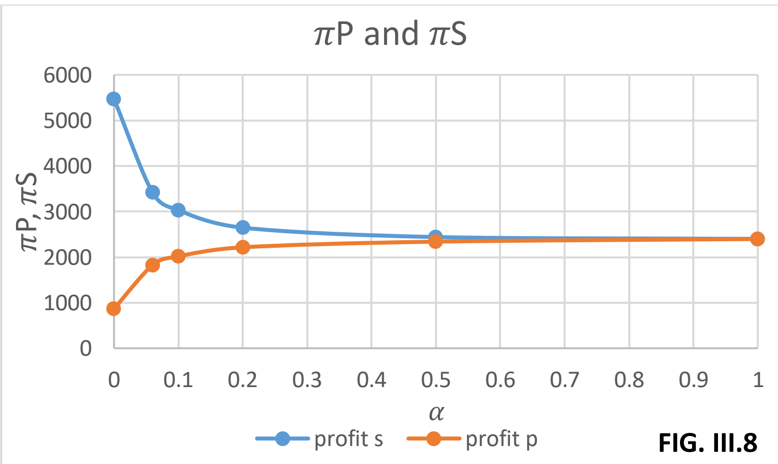


FIG. III.8

As one can see, when the State does not regulate, then the transfer pricing is maximized, and profit M too. This leads profits to the minimum because they are taxed with the higher tax rate in P, maximizing the profits in the abroad division. When the P state intensifies the regulation, then the two profit curves start to be closer and closer, until α=100%, and the transfer pricing is equal to the minimum (ALP). The mechanism is the following, and repeats with decreasing impact:

$$\alpha \uparrow = TR \downarrow = \pi_P \uparrow = \pi_S \downarrow = \pi_M \downarrow$$

Remember that this is true until the increase in profit P is smaller than the decrease in profit S, thus the overall M profits increase when a=100% respect to α=50%.

III.2 MICRO ANALYSIS

In order to have a better understanding of the profit P and S behaviour, let us analyse the result of the trust game approach in negotiated transfer pricing. In the previous chapter, we assumed that managers of Parent and Subsidiary negotiate on transfer pricing according to the trust game. We already know moreover that, in theory, the trust game is a non cooperative game because P has no interest to give money to S because probably the latter will not reciprocate. At this point, we supposed that P shifts part of profits to S, keeping the share γ and ask then a participation on S profits equal to ρ^P. Then S, the manager of the subsidiary, would compute the willingness to give back to P in terms of participation on S profits, equal to ρ^S. In case $\rho^s \geq \rho^P$, then the willingness to accept a participation is larger to the participation asked, thus S will reciprocate. Otherwise, if $\rho^s < \rho^P$, P asked too much and S will not be willing to give back money to P. Before to start analysing the empirical results, it must be considered that we are interested to look only at P and S who play the trust game. When the State intervenes on some P, then P gets money back and gamma increases, thus ρ^P is much larger than ρ^s by definition. Hence, in this case P and S are not really "playing" because the State already imposed the end of the game. Thus, taking away these cases, we can see graphically in figure III.9 how ρ^P and ρ^S behaved in the simulation, according to several level of State intervention.

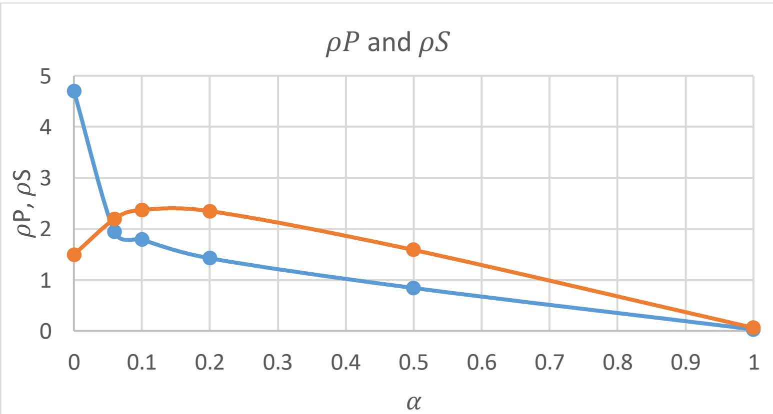


FIG. III.9

As a first impact, one can see that initially $\rho^P > \rho^S$, thus ρ^Sdoes not reciprocate P, until the state intervenes and $\rho^S$is always larger than ρ^P, and the game become cooperative. This kind of result is consistent with the hypothesis of the model, in which P would not trust S. As one can see, the two curves behave differently according to the increase in State intervention. As first conclusion, one can see that when the state does not intervene α=0%, ρ^P is much larger than ρ^S , thus S does not reciprocate. In this case, only with a centralized approach P would play the trust game. In fact, in case the TR system is negotiated, then P knows that S would never reciprocate, therefore P will decide to not trust S, and TR would stabilize at TR0. In reality, this is the outcome in the absence of the state, and it makes sense because when there is not any state regulation on transfer pricing, then all the margin would be transferred abroad through the increase of transfer pricing., exploiting the box of potential profits. This would happen only in case of centralized approach, where the decision of increasing TR is imposed on P manager, who otherwise would not raise the transfer pricing because it will lower its gross profits. When the state starts to regulate the market, the game becomes more cooperative, thus the negotiated TR approach is more effective. In fact, due to the asymmetric information that exists between P and S, the game would be on average cooperative. Let us see, in figure III.10, the curve of the possibility of cooperation, that is a representation of the area between the two curves of ρ^P and ρ^S.

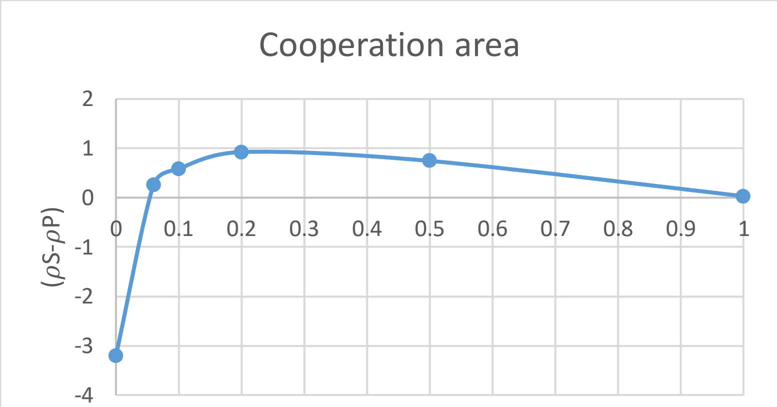


FIG. III.10

This graphical representation shows better the reasons just shown. Unless the State intervenes, the possibility of cooperation is negative, thus it is confirmed that the transfer pricing mechanism behaves like a non cooperative trust game, and a negotiated transfer pricing system would be ineffective if the market is not regulated by the state. The maximum possibility of cooperation, that is the difference between ρ^S and ρ^P , is when the state controls the 20% of the MNEs. Then, the more the State controls, the lower is the possibility of being a cooperative game. Indeed, when the State controls 100% of the MNEs, the possibility of cooperation is null, because P and S cannot bargain.

In this model, a proportional reward system of managers' division would be not fair. In fact, into his model of negotiated transfer pricing, *Vaysman* (1998) proposes a linear rewarding system, proportional to the divisional profits. $Manager\ i\ reward = [a_i + \beta_i \Pi_i]$.

However, in case of α=0, then the parent's manager would be penalized from this scheme, thus would be better to find some form of regressive rewarding system. In the latter case, managers can ensure a more stable reward and could avoid the loss of reward of P manager due to the general decrease of P profits. The negotiated transfer pricing system would work well when the state regulates the market, because in this way, the outflows of capital are regulated and managers can play a fairer bargaining game in which managers cooperate. It is interesting to investigate on the behaviour of both P and S. Let us start from analysing P behaviour. Recalling the ρ^Pfunction, we know that a decrease in transfer pricing means a lager profits for P. Since P is getting back money, it means that P keeps more money than before, therefore shifts to S a smaller share of profits. Since P shifts less to S, then ρ^P goes down by definition. Thus, the decreasing trend behaviour of ρ^P is expected. On the contrary, one may ask himself why ρ^S is not always increasing. In general, when α increases, profits of S decrease because the State is re-shifting capital to P. Before the State intervention, however, S was getting money free, since the system is assumed to be centralized, hence S is not obliged to give back money to P and the willingness to accept a P participation is low. However, when the State brings back capital to P, then S would like to offer more to P in order to not lose that money, thus ρ^S should increase. Here the functional form of ρ^S is not linear but is quadratic, and this can be explained as follows:

When α=0, thus the state does not control, then with the increase of transfer pricing, $\rho^S$is always decreasing. By definition, the more transfer increases, the more S knows that can cheat, the more ρ^S goes down. On the contrary, when the state intervenes and TR goes down, then ρ^S increases because of the outflow of profits. Indeed, in order to maintain that money, S would be willing to accept higher participation on profits. Let us see how a variation in transfer pricing impacts on $\rho^S avg$. Recalling the dynamic of transfer pricing, focusing on that part of the market that has not been punished by the state, we know that: TR_t=$TR_{t-1} + 1$.

Substituting this formula into the one that describes $\rho^S avg$ we get:

$$\downarrow \rho^S avg = 1 - \frac{(TR_t \uparrow -1) - C}{TR_t \uparrow -C}$$

The increase of the numerator is lower than the increase of the denominator, this because of the negative impact of -1. This leads, in dynamic terms, to a reduction of $\rho^S avg$. Let us understand this with a straightforward example over 4 periods. Suppose that in time 0, TR0=60 and it is dynamic, while C=10 and constant in time. At time 1, TR1=61 and C=10. At time 2 TR=62 and C=10 and so on.The dynamic of $\rho^S avg$ would be:

$$\rho^S avg_{\ 1} = 1 - \left(\frac{50}{51}\right) = 1.96\%$$

$$\rho^S avg_{\ 2} = 1 - \left(\frac{51}{52}\right) = 1.92\%$$

$$\rho^S avg_{\ 3} = 1 - \left(\frac{52}{53}\right) = 1.88\%$$

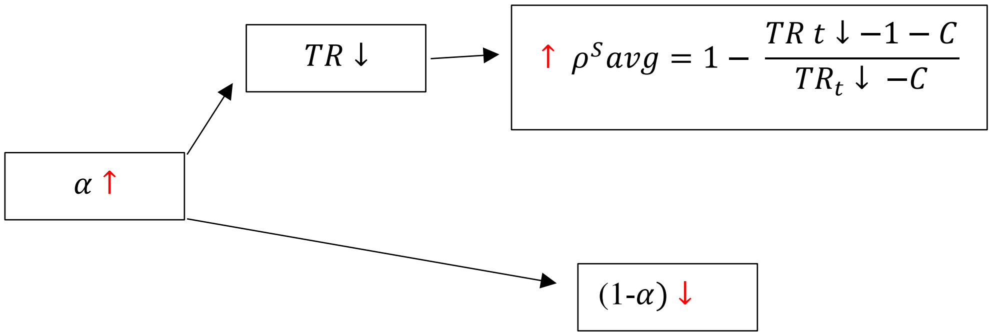
This dynamic goes on in time, hence it is demonstrated that an increase in transfer pricing lowers the average ρ^S, and in general this result confirms the inverse relation that exists between $\rho^S avg$ and TR.

At this point, since S would never reciprocate keeping all money abroad, the State intervenes with controls. As already said, the MNEs punished by the state do not play, thus the focus is on who really plays the trust game, that is the portion of the market represented by $(1 - \alpha)$.

Now, let us call $\widehat{\rho^S}$ the average $\rho^S$of MNEs that play. Thus,

$$\widehat{\rho^S} = \rho^S avg\ (1 - \alpha)$$

So far, in theory, an increase of α would lead to a decrease in transfer pricing, that means an increase in ρ^S. Let us see the impact of a decrease in transfer pricing on $\widehat{\rho^S}$:



Since the term $\rho^S\ avg$ is now multiplied by the number of players (1-α), now an increase in α would have a positive effect on $\rho^S avg$, but would lower the scale factor $(1-\alpha)$, that is a measure of the market effect. The product of these two opposite effects explains the quadratic behaviour or $\widehat{\rho^S}$. Initially, when the state intervenes with few controls, the $\rho^S avg$ growth overcomes the negative effect of the term (1-α). When α keeps growing, then the size of the negative effects is larger than the increase in $\rho^S avg$, hence the ρ^S function becomes decreasing.

Until the effect ρ^S is larger than the market effect, then the relationship between α and ρ^S is positive. However, there is a point in which this trend is reversed, because since the state intervenes too much, then a lot of firms do not play and it is all about the relative variation of transfer and α. When transfer pricing effect is low, then the negative effect of alfa let ρ^S decrease, until the state controls all the firms and no one can play (ρ^P=ρ^S=0).

It must be considered that the size effect is due to the dynamic of transfer pricing, that is assumed to grow of one unit when the MNE is not controlled, and is decreased to the minimum when the MNE is punished, limiting the market size. In case this dynamic was different, for instance, keeping TR_t equal to the previous period instead of bringing it back to the ALP, then the ρ^S and ρ^P impact would be larger. In order to do so, it is enough to assume that the State does not implement the controls all the years, but just in certain periods. In this way, the average transfer pricing would be larger and market could grow again.

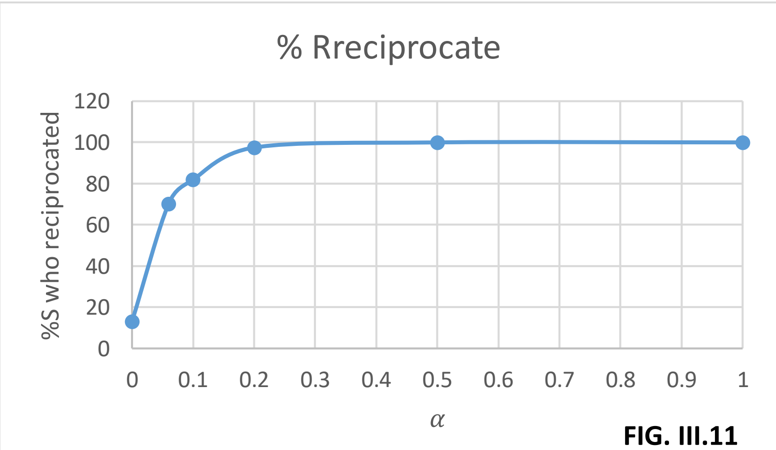


FIG. III.11

In figure III.11, it is visible that the more the State intervenes, the more the game becomes cooperative because the percentage of S who play is larger and larger. All the S reciprocate P when the State controls the 50% of the MNEs. With the increase of regulations, the TR goes down, the state brings back capital to P and this on average overcomes the negative effect of penalties, and the average level of P profits increases. This means that P gives less money to S (P trusts less), and so ρ^P drops, the participation asked decreases, S would be willing to accept more participation on its profits. A State intervention stimulates S to cooperation.

In the end, the State intervention is needed in order to let managers play, hence a negotiated TR model exists only when a State regulation exists. When the regulation is absent or negligible, then MNEs maximise the box of potential profits raising the transfer pricing with a centralized approach, because $\rho^P >> \rho^S$ and with a bargaining game, P would never trust S. In this case, a regressive reward system on gross divisional profits would be more desirable than a proportional one, because would keep the average reward of both managers more stable over time. The optimal level of state intervention, from a game theoretic point of view, is when the possibility of cooperation is maximized, thus when α =20%.

III.3 TAX POLICY ANALYSIS

Now it is time to understand which one is the optimal State intervention level α^* that leads to the maximum tax revenue. In order to do so, it is useful to analyse the simulated data of the component of the tax revenue function RP showed in the previous chapter. As already showed in mathematical terms, we expect to find a positive and concave function of gross RP that becomes a quadratic and differentiable function when it is computed considering the negative effect of State control costs. It is interesting to look at the gross RP, given by the sum of the two effects: the proportional tax rate on gross profits and the penalties collected by the State.

From the table it is visible the positive relationship between state intervention and gross tax revenue according to this loop:

$$\boldsymbol{\alpha} \uparrow = \boldsymbol{TRt} \downarrow = \boldsymbol{\pi p} \uparrow = \boldsymbol{RP} \uparrow$$

the more the state controls increase, the more TR decreases, the more the taxable gross profits, and the more tax revenue. This loop goes on with a decreasing impact, in fact the RP function becomes flatter and flatter in α. This is due to two main reasons: The first is that, as we have seen in the previous chapter, the penalty function is described by a function that, after a certain α, becomes decreasing. This was mainly due to the "size effect", which means that when the State intensifies the controls, then the transfer pricing drops a lot. Since the penalties are calculated on the gap between TR_t and TR_0, when a goes up, the size of firms falls, the gap decreases and the penalty function is decreasing.

The second is that the size effect is due to the dynamic imposed on TR, through which when the state controls a particular MNE, first imposes the penalty and then bring back the transfer pricing to the minimum (ALP=TR_0). This dynamic, makes possible the size effect, which translates into the impossibility for MNEs to grow too much when the state intensifies the controls.

These results are visible in the data arranged in the table. For instance, there is a generalized increasing trend on RP, but results are different according to each treatment. Looking at the treatment with high TP (TP=40%) when α=6%, one can see that when the penalty is β=200, then the overall tax revenue is lower (from 2821.29$ to 2754.7$). This behaviour is common until α=50%, because when the State intensifies controls to all the market (α=100%), the tax revenue is the same within the same treatment, respectively 3600$. This behaviour is not confirmed when the tax rate is lowered at TP=60%. In fact, in the latter case, when B is 200, then the tax revenue is larger than the one that the State gains with lower penalties (β=100). This suggests that an increase of punishment is more effective when tax rate is lower. On the contrary, a larger punishment negatively affects the tax revenue when the tax rate is high. Hence, if a state aims to lower its tax rate to attract FDI, it had better increase the penalty to compensate the loss of tax revenue. This means that there is a trade-off between tax rate and penalties: if a Sate wants to increase tax rate, then it is better to lower the penalties. Even though the data suggest that the optimal state intervention that maximizes the penalties is a*=10% in both treatments, then the impact on the tax revenue is different.

Rp				
	$(1-tp)$=40%		$(1-tp)$=60%	
	$\beta = 100$	$\beta = 200$	$\beta = 100$	$\beta = 200$
$\alpha = 0$	1300 (0)	1300 (0)	760 (0)	760 (0)
$\alpha = 6\%$	2821,29 (132,36)	2754,70 (139,94)	1921,27 (82,58)	1927,38 (89,35)
$\alpha = 10\%$	3112,66 (72,53)	3085,48 (74,04)	2117,58 (47,28)	2151,56 (50,67)
$\alpha = 20\%$	3402,92 (24,99)	3359,87 (33,39)	2307,41 (19,08)	2333,29 (26,35)
$\alpha = 50\%$	3559,34 (4,03)	3534,90 (6,62)	2399,15 (4,79)	2416,03 (7,52)
$\alpha = 100\%$	3600 (0)	3600 (0)	2400 (0)	2400 (0)

TAB. III.5: Average gross tax revenue per MNE. (standard error in brackets)

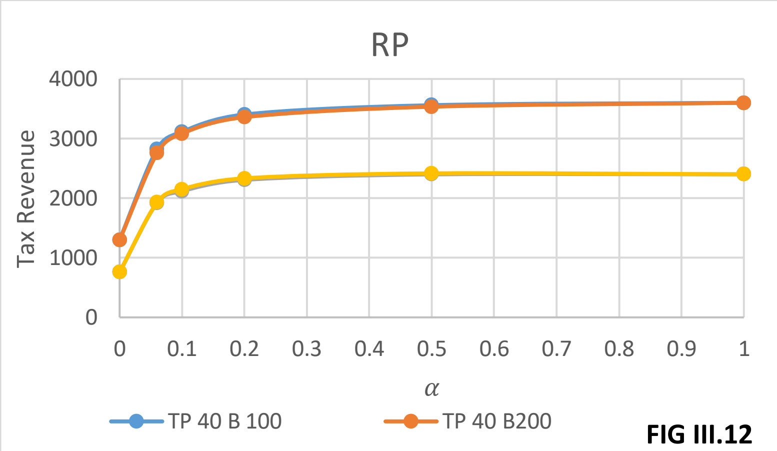


FIG III.12

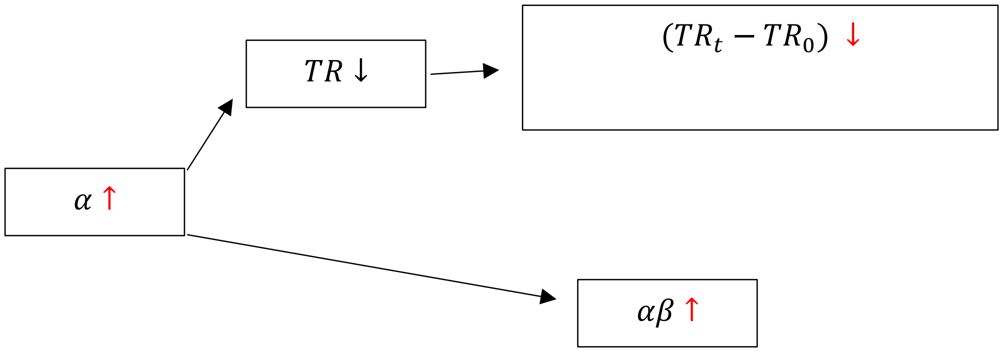
The figure III.12 shows the marginal decreasing impact of the state controls on tax revenue. As already seen, when the corporate tax rate is lower, the tax revenue is overall above the level of the high tax rate treatment. Let us now focus on the penalty function, which is expected to be a quadratic function with a maximum.

$$Ft = \alpha\beta[TR_t - TR_0]$$

Since TR_t is negatively correlated with α, we get:

$$Ft = \alpha\beta[(A - \text{Ɛ}\alpha - TR_0] = - \text{Ɛ}\alpha^2 + \alpha\beta(A - TR_0)$$

Due to the quadratic functional form, that depends on α and on the difference between $TR_t - TR_0$, we know that the more the state intervenes, the more the gap $TR_t - TR_0$ shrinks. Hence, an effect of α increase leads to two opposite effects:



Initially, we expect that the $\alpha\beta$ positive effect increases the penalties collected, because multiplies a large gap $(TR_t - TR_0)$. However, after a certain level of intervention, the size effect occurs, the gap between $TR_t - TR_0$ decreases too much and the penalty function decreases.

This result is confirmed by simulated data, and thus the optimal level of state intervention that maximizes the penalties collected, is when α=10%. At this level of control, the average penalty is maximized across all the four treatments, and this result can be viewed both from the table III.6 and from the following figure III.13.

Ft				
	$(1-tp)$=40%		$(1-tp)$=60%	
	$\beta = 100$	$\beta = 200$	$\beta = 100$	$\beta = 200$
$\alpha = 0$	0 (0)	0 (0)	0 (0)	0 (0)
$\alpha = 6\%$	85,12 (41,99)	166,60 (80,25)	85,14 (41,52)	166,21 (87,64)
$\boldsymbol{\alpha = 10\%}$	**86,90** **(39,63)**	**173,67** **(75,64)**	**86,80** **(39,40)**	**172,70** **(71,20)**
$\alpha = 20\%$	78,99 (23,50)	158,26 (49,13)	79,20 (22,77)	158,25 (50,47)
$\alpha = 50\%$	49,92 (7,98)	99,76 (16,00)	49,91 (8,05)	99,73 (16,83)
$\alpha = 100\%$	0 (0)	0 (0)	0 (0)	0 (0)

TAB. III.6: Average penalty collected per MNE (standard error in brackets)

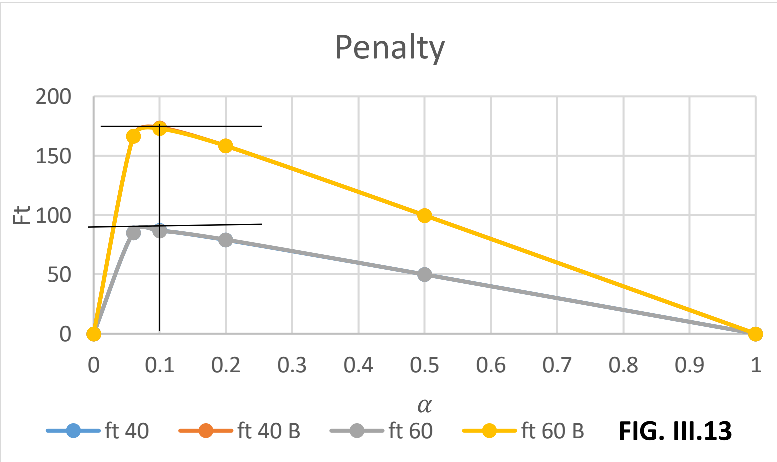


FIG. III.13

Despite the optimal α seems to be at 10%, so far we did not take into account the costs that the State bears when increases controls. In fact, in the model we insert a fixed cost of control, that is proportional with the intervention of the State. In other words, the State pays the same fixed cost for controlling one MNE. When the controls intensify, then this cost is multiplied by the number of MNEs controlled. Thus, the functional form of the Control cost SC is visible in the figure III.14.

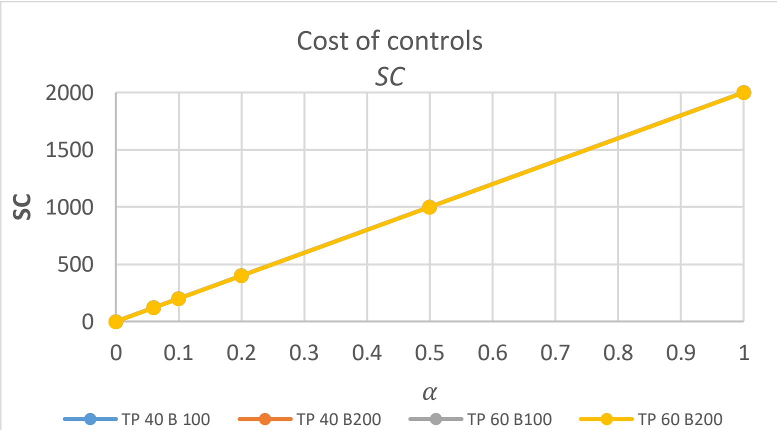


FIG. III.14

As one can see, the slope is positive and constant, thus the cost is proportional in α. At this point, it is possible to obtain the net tax revenue function, that is given by the sum of corporate tax rate on gross profits, penalties collected decreased by the cost of controls. As found in the previous chapter, we expect the net tax revenue (NRp) to be a quadratic form with a maximum.

Net Tax revenue *NRp*				
	$(1-tp)$=40%		$(1-tp)$=60%	
	β = 100	β = 200	β = 100	β = 200
α = 0	1300 (0)	1300 (0)	760 (0)	760 (0)
α = 6%	2701,29 (132,36)	2634,70 (139,94)	1801,27 (82,58)	1807,38 (89,35)
α = 10%	2909,97 (85,30)	2885,48 (74,04)	**1917,58** **(47,28)**	**1951,56** **(50,67)**
α = 20%	**3002,92** **(24,99)**	**2959,87** **(33,39)**	1907,41 (19,08)	1933,29 (26,35)
α = 50%	2559,34 (4,03)	2534,90 (6,62)	1399,15 (4,79)	1416,03 (7,52)
α = 100%	1600 (0)	1600 (0)	400 (0)	400 (0)

TAB. III.7: Net tax revenue per MNE (standard error in brackets)

As one can see, for all the four treatments, when α increases, then the net tax revenue increases first, and decreases then. Therefore, we can find the optimal a* that maximizes the net state benefit, in terms of tax revenue. In the treatment with high tax rate, the optimal α is at 20%, when the net tax revenue is respectively 3002.90$ and 2959.87$ according to the size of penalty. Instead, in the low tax rate treatment, the maximum net tax revenue is reached when a=10%, and the amount is respectively 1917.19$ and1951.56$.

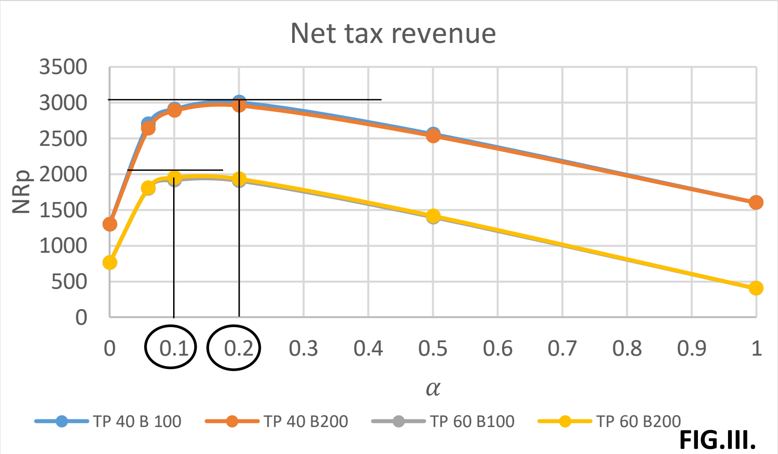


FIG.III.

As one can see, the graph III.15 shows that there are two different optimal state intervention levels according to the size of tax rate. In fact, when tax rate is larger (TP=40%), then the optimal State intervention is at α=20%. Instead, when the low tax rate treatment is implemented, the optimal level of state intervention is α =10%. This result suggests that the more the State increase taxes, the more has to intervene. Both NRp curves respect the quadratic form, that are expected because in the growing part of the function ($\alpha < \alpha^*$), the increase in controls leads to an increase in net tax revenue. Once the State intervention increases too much ($\alpha > \alpha^*$), the transfer pricing falls, the size effect occurs and penalties are lower and lower because computed on the difference between TR_t and TR_0. At this point, the gross tax revenue become flatter and flatter. Moreover, the State bears an increasing and proportional cost of controls, and the net tax revenue becomes decreasing. A State has no convenience to exceed the α^*, unless there is a system that imposes firms to internalize the social cost (or the lack of net state benefit in terms of tax revenue) deriving from the unfair increase in transfer pricing.[9] However, this model does not consider this case, and the state just stop controlling when α=20% (or 10% in the low tax rate treatment).

III.4 GAINERS AND LOSERS

So far, we observed the optimal state intervention from a MNE and a State point of view, and it is time to assess the impact of this State regulation mechanism on the overall economic conditions. We want to observe the impact of the different α* on the main economic indicators: average transfer pricing level, Profit P and profit S.

In order to get a comparative measure, it is enough to compare the variation on the level of these variables when α= α* (in both treatments) respect to when α=100%. In particular, we use as a common term α=100% because represents the "steady state" of the economy, when nothing changes because the state controls all the economy and all the variables are at the desirable level from the P State point of view. Let us start analysing the average transfer pricing level according to α:

[9] See the similarity with the "Polluter pays principle" as a silution to the negative esternatilies market failure.

For the sake of simplicity, let α*=20% be the optimal state intervention with the low tax rate treatment, and α**=10% the optimal regulation level with low tax rate treatment, and $\bar{\alpha}$=100% the level that ensure the steady state. Exploiting the previous tables, we derive the following table which shows the relative increase or decrease of a variable respect to the same level in $\bar{\alpha}$=100%. The variation is computed as follows:

$$\Delta TR_{\alpha^*} = \frac{TR,\alpha^* - TR,\bar{\alpha}}{TR,\bar{\alpha}}\%$$

$$\Delta TR_{\alpha^{**}} = \frac{TR,\alpha^{**} - TR,\bar{\alpha}}{TR,\bar{\alpha}}\%$$

Remember that $TR,\bar{\alpha}$ is the desired level of transfer pricing, according to the Arm's Length Price, ALP=40$.

Transfer pricing variation		
	$\beta = 100$	$\beta = 200$
ΔTR_{α^*}	+8.9%	+9%
$\Delta TR_{\alpha^{**}}$	+21.05%	+20.75%

TAB. III.8: Average transfer pricing variation, respect to the ALP.

When the State maximizes the tax revenue, the transfer pricing is larger than the level desired by the state, in both treatments. However, when the State shows a larger corporate tax rate (α*), then the average transfer pricing of the market is +9% than the ALP. This effect is also greater when the State lowers the corporate tax rate. In this way, α**=10% and the average transfer pricing is +21% than the ALP. These result confirm the fact that the State, even though is maximizing the tax revenue, cannot avoid completely the unfair transfer pricing mechanism. In particular, firms will benefit more increasing the transfer pricing and showing profit abroad, when the average tax rate is lower. There is no significant impact of the penalty treatment on the transfer pricing variation.

According to this finding, we expect that a share of profits would be shifted abroad where the corporate tax rate is lower than the domestic one.

In order to assess this effect, we can try to observe the effect of this level of transfer pricing on both P and S profits. We use the same methodology to assess the variation on P profits first and S profits then:

$$\Delta\pi_{p,}\alpha^{*} = \frac{\pi_{p,}\alpha^{*} - \pi_{p,}\bar{\alpha}}{\pi_{p,}\bar{\alpha}}\%$$

$$\Delta\pi_{p,}\alpha^{**} = \frac{\pi_{p,}\alpha^{**} - \pi_{p,}\bar{\alpha}}{\pi_{p,}\bar{\alpha}}\%$$

Profit P variation		
	$\beta = 100$	$\beta = 200$
$\Delta\pi_{p,}\alpha^*$	-7.67%	-11.07
$\Delta\pi_{p,}\alpha^{**}$	-15.38%	-17.55%

TAB.III.9: Average profit P variation respect to the maximum P

Since TR is larger and the State is unable to avoid this effect, then P always loses. Inparticular, P profits decrease most when a** and penalty is high, and decrease less when $\alpha = \alpha$ * and β=100. This is due to the fact that when the tax rate in P is lower, then the potential profits when a=$\bar{\alpha}$ would be much higher (3600$), hence a since the penalty is higher and the state intervenes only at 10%, the gap between the actual profits (2968.3$) and the potential one (3600$) is much larger than the other treatment.

$$\Delta\pi_{S,}\alpha^* = \frac{\pi_{S,}\alpha^* - \pi_{S,}\bar{\alpha}}{\pi_{p,}\bar{\alpha}}\%$$

$$\Delta\pi_{S,}\alpha^{**} = \frac{\pi_{S,}\alpha^{**} - \pi_{S,}\bar{\alpha}}{\pi_{S,}\bar{\alpha}}\%$$

Profit S variation		
	β=100	β=200
$\Delta\pi_{S,}\alpha^{*}$	+10.26%	+10.46%
$\Delta\pi_{S,}\alpha^{**}$	+26.43%	+26%

TAB.III.10: Average profit S variation respect to $\pi_{S,}\bar{\alpha}$

On the other hand, the table of the variation of S profits suggests that S always gains profits. In particular, S gains most when $\alpha = \alpha$ ** and β=100 ($\Delta\pi_{S,}\alpha^{**}$ = +26.43%), and least when $\alpha = \alpha$ * and β=100 ($\Delta\pi_{S,}\alpha^{*} = +10.26\%$). This is because of when α= α** means that the State allows P to shift much profits abroad, since TR can be higher. Moreover, since the penalty on unfair transfer pricing is low (β=100), then P would have more profits to shift in S.

These data confirm that when the State is tax revenue maximizer, it is unable to recover all the capital shifted abroad, and the transfer pricing level cannot reach the optimal level desired by the state (ALP=40$). Hence, there is still the possibility for MNEs to gain from tax manipulation, and the State cannot solve this problem alone. In fact, in order to cover this market failure, it is necessary a tax rate cooperation between States and an international common regulation that has to be imposed on all the MNEs. Until this goal, MNEs can manipulate taxes through the increase of transfer pricing. However, even though this cost is covered by State and

P loss, the increase transfer pricing effect could be sterilized if one takes away the assumption of exogenous final Price. In fact, since P is losing profits due to the fact that the State cannot intervene more than α*, then a possible solution for P would be to transfer this negative effect (loss of profits) on final customers, increasing the final price and keeping unchanged the gross margin ($\Delta Price = TR_t - TR_0$). However, in case the strong assumption of exogenous market price would be took away, then some quantity effect would be quite likely to happen: an increase in market price, due to the higher transfer pricing, would lead in turn to a general decrease in consumer demand. Also in this case, the analysis should be carried on according to the kind of final good and the relative elasticity of demand on price. For those goods who are price elastic, the decrease in quantity demand would offset the increase in market price, hence the P division would not be able to charge the loss on final customers through the increase in price. On the contrary, an increase in price would lower the consumer surplus, increasing the P surplus, for those goods that are price inelastic. All these effects can be analysed and simulated as a future development of this model.

CONCLUSION

This work attempted to give a contribution on the economic approach of transfer pricing, simulating an economy composed by several MNEs and one State, according to an agent based approach. Starting with the development of the theoretical model, we analysed the centralized transfer pricing mechanism, with the conclusion that without a State regulation and without any implication on managers' rewards, the MNEs would exploit the box of potential profits increasing the transfer pricing as much as possible. This would let MNEs show profits abroad, where they are taxed less. However, this is always true until when we took away the strong assumptions of both State absence and managers' interest absence. In the latter case, the transfer pricing system becomes negotiated, and different scenarios can happen. In particular, from the profits point of view, an increase in transfer pricing leads to a decrease in profits of parent divisions, to an increase of subsidiary's division profits, and the sum of these two effects translates into a general increase of the overall MNE profits. Moreover, when the State does not intervene with some random controls and penalties, the bargaining game seems to be non-cooperative, how in theory it should be. In this case, MNEs should employ a centralized transfer pricing system, because would be more effective for the goal of the international tax management. On the contrary, when the State increases controls, the game becomes cooperative and a negotiated transfer pricing system would be more appropriate. In fact, the state intervention is necessary to let the trust game be cooperative, otherwise P would never trust S and the only way to let the transfer pricing increase is with a centralized approach. In this case, a regressive reward system on gross divisional profits would be more desirable than a proportional one, because it would keep the average reward of both managers more stable over time. On the contrary, when the state regulates and controls the market, then the game becomes cooperative and a proportional reward system can be employed. From the State point of view, the relationship between the increase in controls and gross tax revenue is described by a positive and concave function. In fact, the more the state intervenes, the more gains in terms of gross tax revenue. However, the relationship becomes flatter and flatter, and once we took into account the proportional cost of controlling each MNE, we obtained the net tax revenue function that increases first, and decreases then. Therefore, we found the optimal level of intervention α^* that maximizes the net state benefit, in terms of net tax revenue. According to that level of State intervention, that is 20% in the treatment with high domestic tax rate and 10% with low domestic tax rate, we found that on average the transfer pricing level is larger than the ALP, which would be the desired level for the State. This means that the State is unable to completely nullify the tax manipulation activity of MNEs which in turn, will be able to shift profit abroad for increasing overall profits. On equilibrium, the average size of the transfer pricing is

+20% larger than the ALP. (+10% when the State controls are lower). This “failure of the market” would lead to several effects on the MNEs divisions:

The foreign subsidiary (S) would benefit most when the State controls are lower and penalties are low (S gains +26%); S would benefit least when State controls are high and penalties are low. (S gains +10.26%). On the other hand, Parent division profits decrease most (P loses -17,55%) when controls are low and penalties are high, and decrease least (P loses -7.67%) when the state controls are high and penalties are low. These results confirm that a State cannot solve this problem all by itself. In fact, in order to avoid strategic MNEs behaviours on transfer pricing, it is necessary a tax cooperation between States and an international common regulation that must be imposed on all the MNEs. Until this goal will be reached, MNEs can manipulate taxes through the increase of transfer pricing, and the two main stakeholders that will pay the negative effects of this unfair strategy are the State and final consumers.

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APPENDIX

C code

```
//INCLUDE
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
#include <string.h>
#include <conio.h>
#include <time.h>
#include <locale.h>


#define defPrice 100
#define defCost 10
#define penalty 100
#define defperiod 300
#define market 50
#define caught 3
#define trust 0.3
#define theta 2000

int period = 1;
int randcaught[50];
int recip = 0;

//create structures
struct S_struct {
    int Q_S;
    double TS;
    int cost = defCost;
    double ro_S[defperiod+1];
    double profitS[defperiod+1];
};

struct P_struct {
    int Q_P;
    double TP;
    int price = price;
    double gamma_P[defperiod+1];
    double ro_P[defperiod+1];
    double profitP[defperiod+1];
    double TR[defperiod+1];
};

struct out_struct {
    int t[defperiod+1];
    double Ft[market];
    double TR[market];
    double profitP[market];
    double profitS[market];
    double ro_P[market];
```

```
    double ro_S[market];
    double TS[market];
    double TP[market];
};

int FtIndex, TRIndex, profitPIndex, profitSIndex, ro_PIndex, ro_SIndex, TSIndex, TPIndex;

int main(){
    setlocale(LC_NUMERIC, "French_Canada.1252");

    //array structures
    struct S_struct sub[market+1];
    struct P_struct parent[market+1];
    struct out_struct output[defperiod+1];
    srand(time(NULL));

    for (int init = 0; init < market; init++){

    parent[init].TR[0] = 40;
    output[0].TR[TRIndex] = parent[init].TR[0];
    TRIndex++;

    //initialize S structure

    sub[init].Q_S = (100);
    double appTS =(80);
    sub[init].TS = appTS / 100;

    output[0].TS[TSIndex] = sub[init].TS;
    TSIndex++;

    sub[init].profitS[0] = sub[init].Q_S * sub[init].TS * (parent[init].TR[0]-defCost);

    output[0].profitS[profitSIndex] = sub[init].profitS[0];
    profitSIndex++;


    // initialize P structure
    parent[init].Q_P = (100);
    double appTP = (40);
    parent[init].TP = appTP/100;

    output[0].TP[TPIndex] = parent[init].TP;
    TPIndex++;

    parent[init].profitP[0] = parent[init].Q_P * parent[init].TP * (defPrice - parent[init].T
R[0]);
    output[0].profitP[profitPIndex] = parent[init].profitP[0];
    profitPIndex++;


    printf("MNE num. %d \n", init+1);
    printf("Q_S  %d \n", sub[init].Q_S);
    printf("profit S 0 %f \n", sub[init].profitS[0]);
```

```
    printf("Q_P  %d \n", parent[init].Q_P);
    printf("profit P 0 %f \n\n\n", parent[init].profitP[0]);
    }
        FILE *fp;

        fp=fopen("outputname.csv","a+");

        fprintf(fp,"t, Ft, TR, profitP, profitS, totProfit, ro_P, ro_S, recip, TP, TS, GP, GS, Tax P, RP, SC, NRP\n");
        fclose(fp);

         //cicle periods from t=-1
    for (int t = 0; t<defperiod-1; t++){

            printf("PERIOD N: %d \n", t);
            //faccio i controlli

            //inizialize aN caught
            printf ("Draw randomly MNEs: \n");

            //cicle for extracting caught
            for(int i = 0; i < caught; i++ ){
            int randomNumber = rand() % market;
            bool dummyControl = false;
                for (int control = 0; control < caught; control+
{
           if (randomNumber == randcaught[control]){
                        dummyControl = true;
                    }
                }
                if(!dummyControl){
                    randcaught[i] = randomNumber;
                }else{
                i--;
                }
            }

            for(int i = 0; i < caught; i++){
                printf("num: %d \n", randcaught[i]+1);
            }

            //control all N MNEs
            for(int i = 0; i < market; i++){

                bool dummySgam = false;
                int appSgam;

                for(int sgam = 0; sgam < caught; sgam++ ){


                    if (i == randcaught[sgam] && !dummySgam){
                    dummySgam = true;
                    appSgam = sgam;

```

```
                    }

                }

                    if(dummySgam){
                    printf("State controls MNE : %d \n", randcaught[appSgam]+1);

                    double Ft = penalty * (parent[randcaught[appSgam]].TR[period-1] - parent[randcaught[appSgam]].TR[0] );

                    output[period].Ft[FtIndex] = Ft;
                    FtIndex++;

                    printf ("penalty is: %f \n", Ft);
                    parent[randcaught[appSgam]].TR[period] = parent[randcaught[appSgam]].TR[0];

                    output[period].TR[TRIndex] = parent[randcaught[appSgam]].TR[period];
                    TRIndex++;

                    printf("TR of MNE is back to %f \n", parent[randcaught[appSgam]].TR[period]);


parent[randcaught[appSgam]].profitP[period] = (parent[randcaught[appSgam]].Q_P * parent[randcaught[appSgam]].TP * (defPrice - parent[randcaught[appSgam]].TR[period])) - Ft;

                    sub[randcaught[appSgam]].profitS[period] = (sub[randcaught[appSgam]].Q_S * sub[randcaught[appSgam]].TS) * (parent[randcaught[appSgam]].TR[period] - defCost);


                    output[period].profitP[profitPIndex] = parent[randcaught[appSgam]].profitP[period];
                    profitPIndex++;


                    output[period].profitS[profitSIndex] = sub[randcaught[appSgam]].profitS[period];
                    profitSIndex++;


                    printf("profit P = %f \n", parent[randcaught[appSgam]].profitP[period] );

                    printf("profit S  = %f \n", sub[randcaught[appSgam]].profitS[period]);


                    }

                    if(!dummySgam){

                    if(parent[i].TR[period-1]<= 80){//increase TR
                            parent[i].TR[period] = parent[i].TR[period-1] + 1;

               output[period].TR[TRIndex] = parent[i].TR[period];
```

```
                        TRIndex++;

                    }else{
                        parent[i].TR[period] = parent[i].TR[period-1]; //TR=max

                        output[period].TR[TRIndex] = parent[i].TR[period];
                        TRIndex++;
                    }
                    printf("MNE has not been controlled \n");
                    printf("TR increased to  %f \n", parent[i].TR[period] );

                    parent[i].gamma_P[period] = ((defPrice - parent[i].TR[period])/(defPrice - parent[i].TR[period-1]));

                    printf("P keeps %f \n", parent[i].gamma_P[period]);

                    //Compute ROp and ROs
                    if(parent[i].profitP[period] >= parent[i].profitP[period-1]){
                        parent[i].ro_P[period] = ((1-parent[i].gamma_P[period])*(1+trust));

                        output[period].ro_P[ro_PIndex] = parent[i].ro_P[period];
                        ro_PIndex++;

                    }else{

                        parent[i].ro_P[period] = ((1-parent[i].gamma_P[period]));
                        output[period].ro_P[ro_PIndex] = parent[i].ro_P[period];
                        ro_PIndex++;

                    }

                    sub[i].ro_S[period]  = 1 - ((parent[i].TR[period-1] - defCost)/(parent[i].TR[period]-defCost));

                    output[period].ro_S[ro_SIndex] = sub[i].ro_S[period];
                    ro_SIndex++;

                    printf("ro S = %f \n", sub[i].ro_S[period]);
                    printf("ro P = %f \n", parent[i].ro_P[period]);


                    if (sub[i].ro_S[period] >= parent[i].ro_P[period]){

                        recip++;

                        printf ("roS > roP \n");
                        sub[i].profitS[period] = (sub[i].Q_S * sub[i].TS) * (parent[i].TR[period] - defCost) * (1 - parent[i].ro_P[period]);

                        output[period].profitS[profitSIndex] = sub[i].profitS[period];
                        profitSIndex++;

```

```
                        parent[i].profitP[period] = parent[i].Q_P * parent[i].TP * (defPrice - parent[i].TR[period]) + (parent[i].ro_P[period] * ((sub[i].Q_S * sub[i].TS) * (parent[i].TR[period] - defCost)));

                        output[period].profitP[profitPIndex] = parent[i].profitP[period];

                        profitPIndex++;

                        printf("S reciprocates \n");
                        printf("profit P = %f \n", parent[i].profitP[period] );
                        printf("profit S = %f \n", sub[i].profitS[period]);

                    }else{

                        printf("roS < roP \n");
                        printf("S doesn’t reciprocate \n");
                        parent[i].profitP[period] = parent[i].Q_P * parent[i].TP * (defPrice - parent[i].TR[period]);

                        output[period].profitP[profitPIndex] = parent[i].profitP[period];

                        profitPIndex++;

                        sub[i].profitS[period] = (sub[i].Q_S * sub[i].TS) * (parent[i].TR[period] - defCost);

                        output[period].profitS[profitSIndex] = sub[i].profitS[period];
                        profitSIndex++;

                        printf("profitP = %f \n", parent[i].profitP[period] );
                        printf("profitS = %f \n", sub[i].profitS[period]);
                    }

                }

        }



    double avg_Ft, avg_TR, avg_profitP, avg_profitS, avg_ro_P, avg_ro_S, avg_TP, avg_TS, GP, GS, TaxP, RP, SC, NRP;
    double sum_Ft, sum_TR, sum_profitP, sum_profitS, sum_ro_P, sum_ro_S, sum_TP, sum_TS, totProfit;

    for (int i=0; i<FtIndex; i++){
        sum_Ft+= output[period-1].Ft[i];
    }
    for (int i=0; i<TRIndex; i++){
        sum_TR+= output[period-1].TR[i];
    }

    for (int i=0; i<profitPIndex; i++){
        sum_profitP+= output[period-1].profitP[i];
    }
```

```c
        for (int i=0; i<profitSIndex; i++){
            sum_profitS+= output[period-1].profitS[i];
        }
        for (int i=0; i<ro_PIndex; i++){

            sum_ro_P+= output[period-1].ro_P[i];
        }
        for (int i=0; i<ro_SIndex; i++){
            sum_ro_S+= output[period-1].ro_S[i];
        }
        for (int i=0; i<TPIndex; i++){
            sum_TP+=output[0].TP[i];
        }
        for (int i=0; i<TSIndex; i++){
            sum_TS+=output[0].TS[i];
        }


        avg_TR = sum_TR/market;
        avg_profitP = sum_profitP/market;
        avg_profitS = sum_profitS/market;
        avg_Ft = sum_Ft/market;
        avg_ro_P = sum_ro_P/market;
        avg_ro_S = sum_ro_S/market;
        avg_TP = sum_TP/market;
        avg_TS = sum_TS/market;

        totProfit = (avg_profitP+avg_profitS);

        GP = avg_profitP/avg_TP;
        GS = avg_profitS/avg_TS;
        TaxP = GP-avg_profitP;
        RP = TaxP+avg_Ft;
        SC = (caught*theta)/market;
        NRP = RP-SC;

        FILE *fp;
        fp=fopen("outputname.csv","a+");
        //append
        fprintf(fp,"%d;  %d;  %.1f;  %d;  %d;  %d;  %.2f; %.2f; %d; %.1f; %.1f; %.1f; %.1f; %.1f; %.1f; %.1f; %.1f\n",period, (int)avg_Ft, avg_TR,(int)avg_profitP,(int)avg_profitS,(int)totProfit, avg_ro_P*100, avg_ro_S*100, recip, avg_TP*100, avg_TS*100, GP, GS, TaxP, RP, SC, NRP);

        fclose(fp);

        sum_Ft = 0;
        sum_TR = 0;
        sum_profitP = 0;
        sum_profitS = 0;
        sum_ro_P = 0;
        sum_ro_S = 0;
        sum_TP = 0;
        sum_TS = 0;
```

```
        totProfit = 0;

        FtIndex = 0;
        TRIndex = 0;
        profitPIndex = 0;
        profitSIndex = 0;
        ro_PIndex = 0;
        ro_SIndex = 0;

        recip = 0;

        GP = 0;
        GS = 0;
        TaxP = 0;
        RP = 0;
        SC = 0;
        NRP = 0;


        period++;

    }


}
```