

# Partial Privatisation and Inducing Demand Firms: A Duopoly Game

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**Abstract:** *In recent years, the theoretical analysis of mixed markets and oligopolies has received large attention in the literature (Harris and Wiens [1980], Beato and Mas-Colell [1984], Ware [1986], De Fraja and Delbono [1988, 1989], Cremer, Marchand and Thisse [1989] and Fershtman [1990], Nett [1991, 1993, 1994]). Most of these papers are concerned with markets in which one private and one public firm are co-present. Nett [1991], taking into account the possible result of a three stages game, considers the possibility of the emergence of a mixed duopoly. More recently, a literature on privatisation has begun to appear too. Often, it highlights the effect on growth, but, generally, it considers total privatisation. Vice versa, Matsumura [1998] considers the possibility of partial privatisation and investigates how many shares in the privatised firm the government should hold. A large literature exists about the possibility of "induced demand". Health care seems an important example. In this sector there is a strong international trend to a privatisation process.*

*In this paper, we analyse the reaction-function of a "partial privatised firm" with respect to that of a private "selfish" firm (that manifest induced demand). This is based on a model (Salzano [2000]) that extend the results of Nett [1991,1994] to the possibility of the emergence of a mixed duopoly with a participated firm, and analyses the effect of sharing of a firm's ownership (Matsumura [1998]).*

*We will evaluate the reaction-functions in a Cournot-Nash game. Comparing the resulting reaction-function for the participated firm with that of a "private selfish" firms, and taking into account the main possible equilibrium of this game, we conclude with the different economic logic underlying the insurgence of a mixed firm when "private selfish" firms are on the market. We highlight the reasons to prefer a partial privatised firm or a public one to better contrast a selfish firm.*

## 1 Introduction

In recent years, the theoretical analysis of mixed markets and oligopolies has received large attention in the literature (Harris and Wiens [1980], Beato and Mas-Colell [1984], Ware [1986], De Fraja and Delbono [1988, 1989], Cremer, Marchand and Thisse [1989] and Fershtman [1990], Nett [1991, 1993, 1994]). Most of these papers are concerned with markets in which one private and one public firm are co-present. Nett [1991], taking into account the possible result of a three stages game, considers the possibility of the emergence of a mixed duopoly. More recently, a literature on privatisation has begun to appear too. Often, it highlights the effect on growth, but, generally, it considers total privatisation. Vice versa, Matsumura [1998] considers the possibility of partial privatisation and investigates how many shares in the privatised firm the government should hold. A large literature exists about the possibility of "induced demand". Health care seems an important example. In this sector there is a strong international trend to a privatisation process. Generally, the "... attainment of allocative efficiency requires that consumers and suppliers are equally knowledgeable and that consumers are all equally able to get a source of supply.... Furthermore, one assumes that consumers know what they need, can bargain with the supplier and can change suppliers if they are dissatisfied with the quality or price of their original purchase. (Bates et.al., 1990, p147). This is not always the case and supplier induced demand is an example".

A large part of literature deal with the fact that private firms could have a selfish behaviour. In that case the private firm could exploit customers inducing "shopping" behaviours. Of course, in this case there is a strong welfare effect, but what is more relevant for us is the fact that a private firm must take into account the incremental revenue. As a consequence the total revenue of a private firm will be increased by the amount obtained by selfishness. It will be different according to the markets' characteristics. On this subject there is a large literature. For a good survey see De Jaegher, Jegers [2000] and Labelle, R. Stoddart, G. And Rice, T. [1994].

Supplier induced demand occurs when "the supplier, in acting as agent for the consumer, brings about a level of consumption different from that which would have occurred if a fully informed consumer had been able to choose freely"(McGuire et.al., [1988, p160]). In that case "the agent relationship between ... [customer and] ... provider is not identical to the typical economic principal agent relationship. This is because ... [their utilities are] ... interdependent to the point where they are hard to distinguish" (McGuire et.al., [1988, p156]). "Supplier induced demand is present due to information asymmetry in the market." (Jacobs, [1991, p246]). "Search costs born by consumer associated with the acquisition of information may be very high." (McGuire et.al., [1988]). Many factors "... influence the consumer's reliance on the supplier. This reliance on the supplier is problematic since it becomes the duty of the supplier to maximise the utility

of the consumer. This requires the supplier to have full knowledge of the consumer's tastes, preferences, income etc. Relying on the supplier leaves the consumer open to exploitation" (Arrow, [1974, p37]). The extent to which patients are exploited depends upon the behaviour of the .... provider" (McGuire et.al., [1988, p156]). Consequently, providers are presented with an opportunity to capitalise on a consumer's exploitability.

Many examples are considered in the literature: the teaching sector, the judicial advice, and so on. The health market can be considered as the most relevant example<sup>1</sup>.

Consumers of health care may not have good information about their health status and about the effect of medical care on their health. Although consumers are not likely to be completely ignorant either, they will often rely on their health care provider to act as agents and inform them about these variables." (McGuire et.al., [1988]). It is important for patients to receive the correct information from doctors since this information is used by the patient to form their demand curve." (McGuire et.al., [1988]). "A number of studies have identified a range of goals, varying from pure altruism to pure selfishness." (McGuire et.al., [1988, p156]).

According to Buchanan, the government has protective and productive functions. "The protective function encompasses the government's maintenance of a framework of security and order, including the enforcement of rules against theft, fraud, and the use of violence. Government is assigned a monopoly on the legitimate use of force in order to protect citizens from each other and from outsiders. Thus, the protective state seeks to prevent individuals from harming one another and to maintain an infrastructure of rules within which people can interact with one another harmoniously. The crucial ingredients of this infrastructure include the enforcement of contracts and the avoidance of restrictions, regulations, and differential taxes that would restrain exchange. It is easy to see the economic importance of this function. When government performs its protective function well, individuals can have confidence that they will not be cheated and that wealth they create will not be taken from them by either selfish intruders or by the government via high taxes and the ravages of inflation. Simply put, this protection provides citizens with assurance that if they sow, they will be permitted to reap. When this is true, people will sow and reap abundantly"<sup>2</sup>.

Of course, the presence of a strong public offer will reduce the possibility to such selfish behaviour to manifest, and vice versa. This means that it will be inversely connected with the level of public offer. In this last period we have seen a strong trend favourable to privatisation or partial privatisation of the health sector. Then, it seems of relevance to analyse the different effect of contrast that a public or privatised firm can have in the case of possible existence of supplier induced demand. We call "selfish firm" a firm that induces such a demand.

In this case the interest is on the total quantity transacted. The point of view is from the supplier side. Of course, from an aggregate point of view there is an increase in demand - Medical care. The suggested approach is not very different from Lancaster characteristic one. The consequence is that the total demand for the considered good is not shifting while are incremented both the revenue for the firm and the consumer expenditure.

First, we summarise the mixed duopoly model and the possibility of its extension to partial privatisation. We consider only the cases when both competitors do not invest in innovation or R&D with the purpose of reducing variable costs. The more difficult case of investing as it presents complex behaviours and possible multiple equilibria is left for a specific analysis. Then, we analyse the reaction-function of a "partial privatised firm" with respect to that of a private "selfish" firm (that manifests induced demand). This is based on a model (Salzano [2000]) that extends the results of Nett [1991,1994] to the possibility of the emergence of a mixed duopoly with a participated firm, and analyses the effect of sharing of a firm's ownership (Matsumura [1998]).

We will evaluate the reaction-functions in a Cournot-Nash game. Comparing the resulting reaction-function for the participated firm and that of a "private selfish" firm, and taking into account the main possible equilibrium of this game, we conclude with the different economic logic underlying the insurgence of a mixed firm when "private selfish" firms are on the market. We highlight the reasons to prefer a partial privatised firm or a public one to better contrast a selfish firm.

## **2 The model: features of different firms and their reaction functions**

### **a) Features of different firms**

Private firms are assumed to maximize profits; we assume that a public firm maximizes output while facing a zero-profit constraint. If the public firm cannot fulfil the profit constraint it minimizes losses.

A partially privatised firm considers profits and social welfare jointly. The behaviour of participated firms presents a lack of empirical evidence; recent studies indicate that participated firms may behave differently from either private or public. The effect of mixed public and private ownership is evaluated by examining the effect of partial government ownership on the value of the shares of the target firms.

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<sup>1</sup> Donaldson, C., Gerard, K., [1990].

<sup>2</sup> In the case it exists the possibility of induced demand, the protective function means that the government must provide the goods by himself for reducing the possibility that this induction could be realized. See: Frech, H. E. (1997) Economic Progress and the Role of Government - PART III.

A private firm can manifest a selfish behaviour in the sense it could induce demand in a different market segment; this impacts on the revenue side of the private firm, but it does not modify the quantity offered in the market segment of interest for the other firm (Bates et. al., [1990, p.147]; Jacobs, [1991, p. 246]).

**b) The duopoly game - The Cournot-Nash equilibrium**

We deal with a mixed duopoly. The firms play a Cournot-Nash duopoly game choosing the output. Of course, the Nash equilibrium of each sub game is given by the intersection of the reaction functions of both firms<sup>3</sup>. A reaction function determines the firm's best response to any output of the other firm. Following Nett [1991], the market demand can be assumed to be linear<sup>4</sup>:  $P(z_1+z_2)=1-z_1-z_2$ , where  $z_1, z_2$  are the quantity offered by duopolistic firms. Nett suppose that both firms , public and private, have the same variable costs.

**c) Partial privatisation**

Matsumura used “the weighted average” of government and private purpose. This approach does not give reason of partial privatisation or shared participation. In fact, the total sum of supply of the single public and private firms “hypothetically” constituted with the same capital would be equivalent. Vice versa, as Besley and Ghatak (1999) highlight, welfare mix is a synergetic process in which each participant absolves its duty. Of course, if the efficiency between the two firms is the same there is no benefit in efficiency from a partnership. This benefit increases with the increase in this difference. Generally, it is supposed that, thanks to a better organisation, private firms are characterised by reduced variable costs. Therefore, we need to eliminate the Nett simplification regarding the equal variable costs of public and private firms. In fact, generally private firms are considered more efficient than public firms are. We have two levels of variable costs: a)  $ccw$  the basic variable cost of public firm; b)  $ccp = ccw - eff$  the variable cost of private firm were  $eff$  is the reduction in the cost caused by efficiency. In the partnership, this better organisation is spread all over the mixed firm according to the level of sharing. This is the synergetic effect of partnership (see Besley and Ghatak [1999]). All the output will be produced with the new process<sup>5</sup>.

Let  $aa_i = \alpha$  the level of share of private component. The effect of a share  $\alpha$  of private property in a public firm is<sup>6</sup>:

$$bb_i := \text{if} \left[ aa_i \geq .5, \left[ 1 - \left[ \frac{.5 - (aa_i - .5)^2}{.5} \right] - .5 \right], \left[ \frac{0.5 - (aa_i - .5)^2}{.5} - .5 \right] \right]$$

Taking into consideration the reaction function of the two firms we obtain the following result:

$$cv3 := \frac{\left[ [ccw - [ccw - (ccw - eff)] \cdot (\alpha)] + [(ccw - eff) + [ccw - (ccw - eff)] \cdot (1 - \alpha)] \right]}{2}$$

with usual simplification we have:

$$cv3 := ccw - eff \cdot \alpha$$

The reaction function of a mixed or participated firm (when it does not invest) will be:

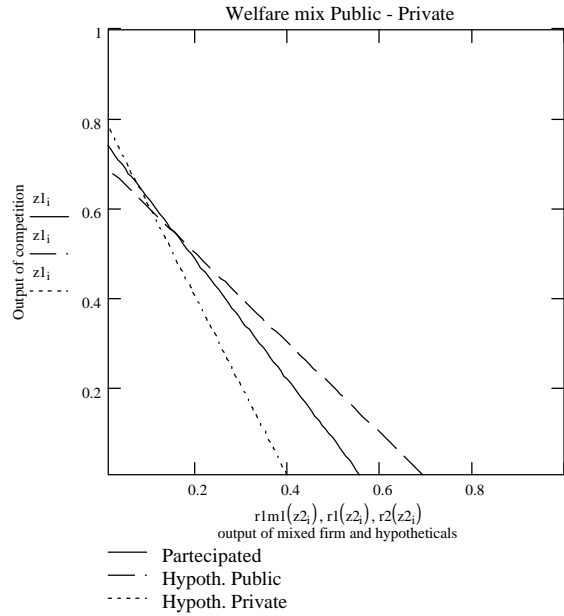
<sup>3</sup> It is, of course, possible that multiple equilibria occur. Multiple equilibria do occur when the public firm's reaction function intersects the revenue maximizing function of the private firm. Especially if both firms choose a rather high capacity and is sufficiently low, a private firm's reaction function may intersect the public firm's reaction function within any given interval. One way to operate in the case of multiple equilibria is to select the equilibrium which leads to the highest output of public firm. This has some operational advantage, but loses the different possibilities.

<sup>4</sup> For the symbolism used see the last page where the main symbols are summarised.

<sup>5</sup> This means that the reaction function of the mixed firm is larger and more elastic (for the concept of elasticity see: Nett 1991)

<sup>6</sup> For more details see Salzano [2000].

$$r1m1(z2) := \left[ (1 - \alpha) \cdot \max(0, 1 - z2 - cv3) \right] + (\alpha) \cdot \frac{(1 - z2 - cv3)}{2}$$



**Fig. 1 The effect of partial privatisation**

The graph highlights the differences between the reaction functions of participated and private firms. The confront with public and private firms highlights that the participated firm can manifest a larger reaction function with respect to a public one especially at the lowest level of supply. If the difference in efficiency between the public and private firms is low, this effect could be lost when supply increases. Vice versa, a reversed effect can be seen with respect to the private firm.

The equilibrium between private and participated firms can be calculated starting from the participated firm's reaction function:

$$r1m1(z2) := \left[ (1 - \alpha) \cdot \max \left[ 0, 1 - z2 - (ccw - \text{eff} \cdot \alpha) \right] \right] + (\alpha) \cdot \frac{\left[ 1 - z2 - (ccw - \text{eff} \cdot \alpha) \right]}{2}$$

and the inverse of private reaction function

$$zr2b(z1) := 1 - 2z1 - ccw + \text{eff}$$

We obtain:

$$EP := \frac{-(2 \cdot ccw - 2 \cdot \text{eff} - 2 \cdot cv3 - \alpha + \alpha \cdot cv3)}{(2 + \alpha)}$$

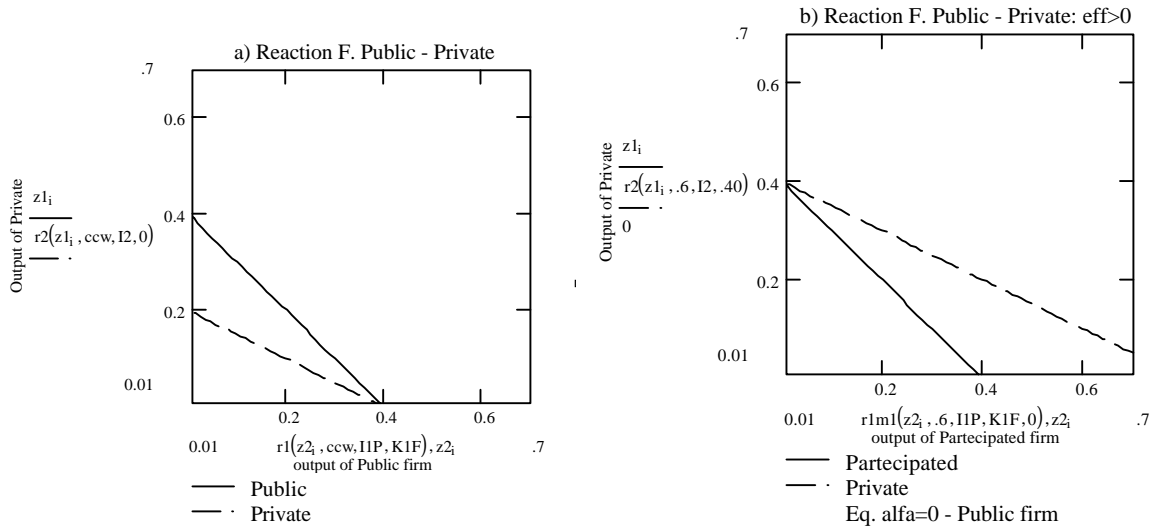


Fig. 2 a-b) Reaction function at different level of efficiency of private sector

The effect of taking into consideration the different efficiency of firms is that we obtain a private monopoly against a public monopoly in the case considered by Nett ( $eff=0$ ). This is easy to understand if we compare the first and second graphs of the preceding figure. In the first we have a public and a private firms, but  $eff=0$ ; in the second the we have substantially the same firms as the first is participated and quasi public. The difference is that in the second graph we take into consideration the different efficiency<sup>7</sup>. So, in the case of no investment, if we do not take into consideration the different efficiency, there seems to be no justification for privatisation. If different efficiency is considered, in case of high efficiency there is no effect of increase of share; in the case of low efficiency, on the contrary, there is a decrease in the reaction equilibrium.

### c) The Selfish firm

This is like a partial product differentiation, creating a demand that is not existent for the public firm. This effect is larger when the presence of public firm is decreasing.

In the case of selfishness we have,

$$rs2(z1, ccw, eff, sf) = \left( \frac{1 - z1 - ccw + eff}{2} \right) * \left( 1 + \frac{sf}{z1} \right)$$

where: " $sf$ " is the selfishness coefficient, and  $rs2(z1, ccw, eff, sf)$  is the reaction function of private selfish firm.

In the following graphs we plot the reaction function of a selfish firm for different values of parameters. It varies, both as localization and as structure, according to the level of  $sf$  and of  $ccw$ .

<sup>7</sup> For more details see: Salzano (2000)

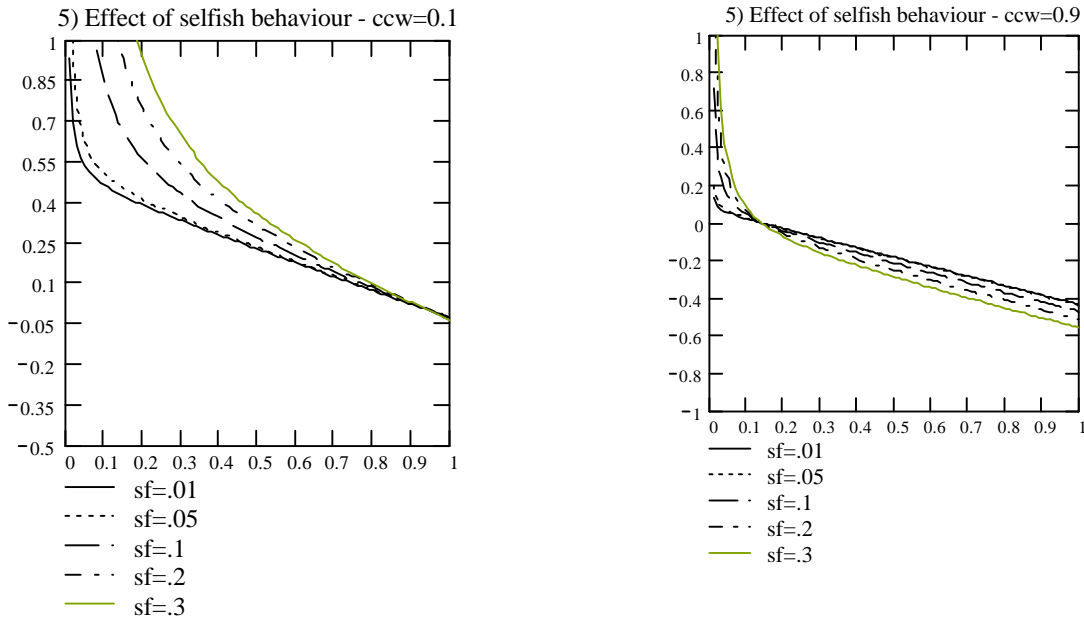


Fig. 3 a-b) Reaction function of selfish firm at different level of parameters

### 3 Partial privatisation and inducing demand firms duopoly game

Confronting the reaction functions for the participated and the selfish firms, it is easily seen that, depending on the value of  $sf$ , both a public and a private monopoly equilibrium or only a private monopoly are possible cases. The last case is valid for high levels of "induced demand". Of course, we are supposing the level of efficiency of selfish private firm is equal to the one valid for the private firms in the sector.

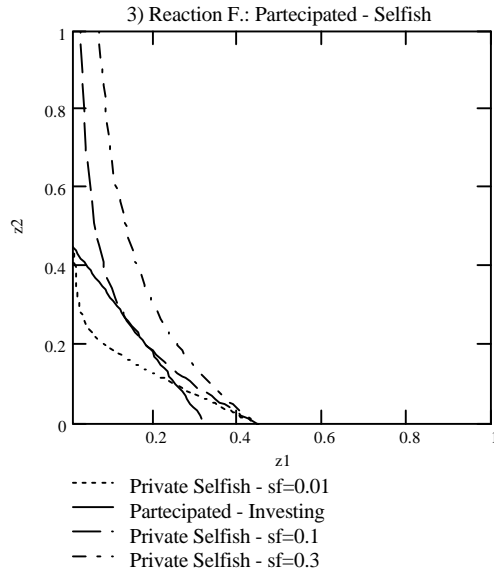
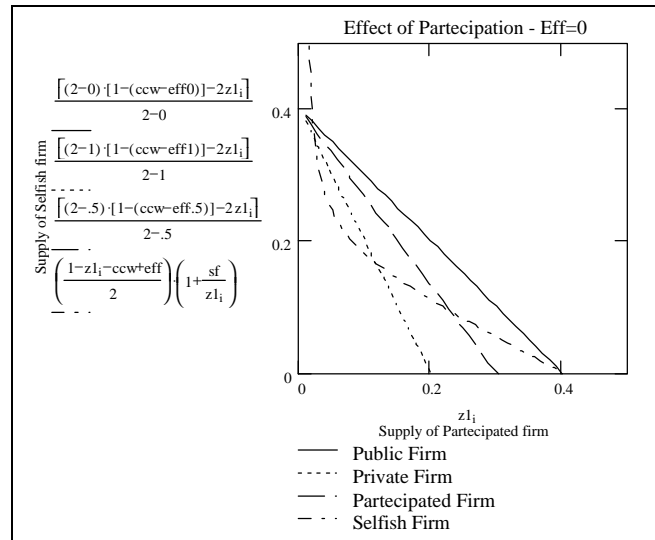


Fig. 4) Reaction function of Participated and Selfish firm

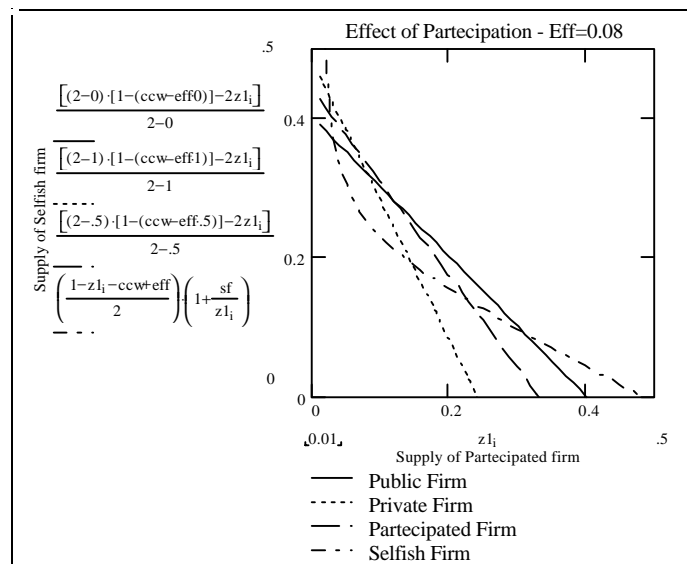
$$\left[ \frac{[2 \cdot z_1 - 2 + 2 \cdot (-\text{eff} \cdot \alpha + \text{ccw}) + \alpha - \alpha \cdot (-\text{eff} \cdot \alpha + \text{ccw})]}{(-2 + \alpha)} \right] - \left[ \left( \frac{1 - z_1 - \text{ccw} + \text{eff}}{2} \right) \cdot \left( 1 + \frac{\text{sf}}{z_1} \right) \right] = 0$$

$$\frac{[(2 - a) \cdot [1 - (\text{ccw} - \text{eff} \cdot a)] - 2z_1]}{2 - a}$$

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**Fig. 5 a) Equilibrium of Public and Selfish firm - eff=0**



**Fig. 5 b) Equilibrium of Public and Selfish firm - eff=0.08**

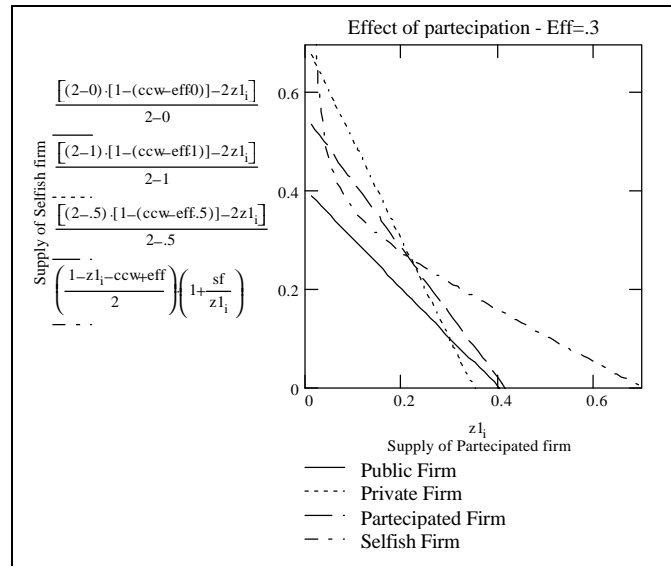


Fig. 5 c) Equilibrium of Public and Selfish firm – eff=0.3

In the case of not investing firms, if there is no difference in efficiency of public and private firms, we might have a public monopoly (or a private one) (First graph). In fact, when efficiency of private firms in the sector is low, the public firm will reach a monopoly situation (see Nett [1991,1994], Salzano [2000]). In this case the partial privatisation means an equilibrium at a larger level of selfish firm supply, but in the “fair” zone, where the induced demand is very low. A total privatisation will imply a larger supply by the selfish firm, while a completely public firm will imply a “quasi” public monopoly position. Therefore, the partial privatisation let the private selfish firm to operate on the market, but in the area in which its behaviour is characterised by large fairness. Of course, this happens, also, in case of low differences in efficiency (Second graph).

Vice versa, in case of high differences in efficiency, the partial privatisation implies the passage from a selfish private semi-monopoly or monopoly, with respect to the public firm, to a mixed market equilibrium (Third graph). This means that the participated firm has the “possibility to be on the market” inducing the selfish firm in an area of fairness. This effect can not be reached by a public firm. In fact, as we know [Salzano (2000)], if the efficiency is very high the public firm is not able to contrast the private firm. This effect is more evident in the case of selfish firm. Therefore, in the case of high efficiency, the partial privatisation allows the public sector to reach a “competitive-mixed” equilibrium with the selfish firm.

Of course, the value of *eff*, for which the inversion of such effects arises, depends on the values of other parameters appearing in the model (*ccw*, *sf*,  $\alpha$ ). When the selfish firm’s reaction function pass through the point in which public and participated firms’ reaction functions meet, we have an inversion of the participation effects (see following graph).

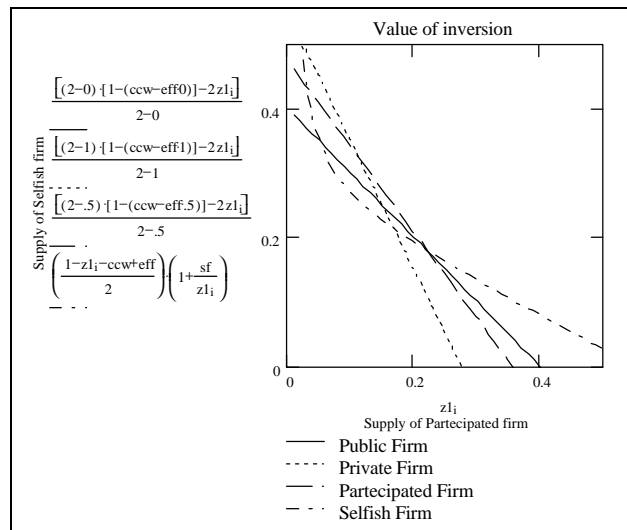


Fig. 5 d) Inversion of type of effect

To highlight the behaviour of this parameter, we can calculate the value of supply for which participated and public firm reaction functions meet. We have to solve the following system:

Given

$$\frac{[2 \cdot z1 - 2 + 2 \cdot (-\text{eff} \cdot \alpha + \text{ccw}) + \alpha - \alpha \cdot (-\text{eff} \cdot \alpha + \text{ccw})]}{(-2 + \alpha)} = z2$$

$$(1 - z1 - \text{ccw}) = z2$$

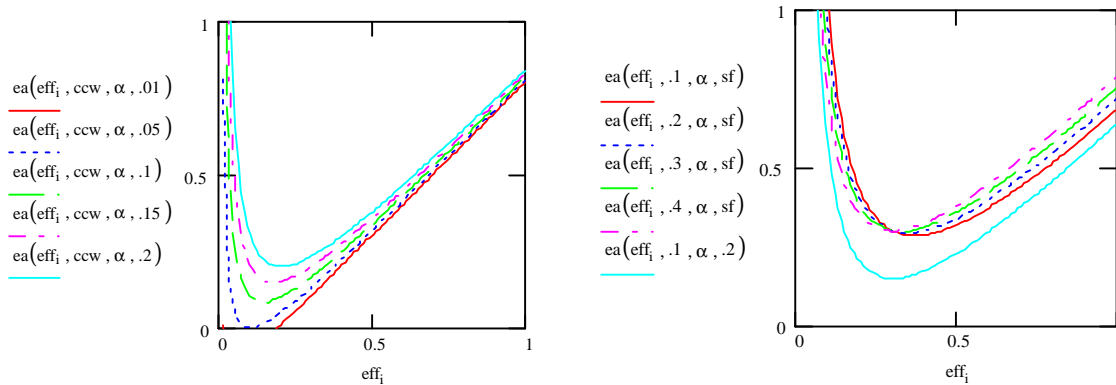
$$\text{Find}(z1, z2) \rightarrow \begin{pmatrix} 2 \cdot \text{eff} - \text{eff} \cdot \alpha \\ -2 \cdot \text{eff} + 1 + \text{eff} \cdot \alpha - \text{ccw} \end{pmatrix}$$

Substituting the solution values in the selfish firm reaction function we obtain:

$$\left[ \left[ \frac{1 - (2 \cdot \text{eff} - \text{eff} \cdot \alpha) - \text{ccw} + \text{eff}}{2} \right] \cdot \left[ 1 + \frac{\text{sf}}{(2 \cdot \text{eff} - \text{eff} \cdot \alpha)} \right] \right] = -2 \cdot \text{eff} + 1 + \text{eff} \cdot \alpha - \text{ccw}$$

Plotting the values of *eff* that respect the conditions posed it is easy to see how the results depend on the values of other parameters.

The next graphs highlight the dependence of *eff* from *sf* and *ccw*.



**Fig. 6 a, b) Levels of *eff* for the inversion of effect – different values of parameters**

The importance of efficiency varies according to the level of other parameters (*ccw*, *sf*,  $\alpha$ ). This dependence is highly non linear as shown in the graphs<sup>8</sup>. If the mix of the parameters is in the area over the inversion curve we have the first type of effect, otherwise under that curve, the second type. Of course, for values that are “on the curve”, we do not have any effect by participation (see the preceding graph (QUATTRO)). It is easy to understand that total privatisation is less beneficial (as welfare) than partial privatisation even in the case of induced demand. In fact, in the case of the first type of effect – relatively low efficiency -we have a larger supply (reaction level) from the partial privatisation than not from the total one, and at the same time we avoid a public monopoly. Vice versa, in the case of second type of effect we have a larger supply that the one from a public monopoly firm.

These results could be interpreted in welfare sense. In fact, De Jaegher, Jegers [2000] explain the negative effect of induced demand on welfare<sup>9</sup>. In this case, the partial participation decrease the amount of induced demand and increase also the market competition. Therefore, it is easy to infer an increase in welfare. This result is consistent with that by Matsumura. He shows the partial privatisation can allow a better welfare position tanks to the possibility of market

<sup>8</sup> Of course, we are disregarding the possibility that the participating private firm has a selfish behaviour.

<sup>9</sup> De Jaegher, Jegers [2000] consider different economic model and analyse the welfare effect of induced demand. Following their approach it is easy to show that in the case of partial privatisation there is a gain in welfare.

competition.

#### **4 Conclusions**

We have summarised the possible positive effect of participation when firms do not invest and the difference in the variable costs between private and public firm is large. We saw that, taking into account efficiency, there seems to be a strong justification on partial privatisation and the insurgence of a welfare mix. Then, we have highlighted the possible results of a mixed market Cournot – Nash equilibrium when a selfish firm is on the market.

In this case, we can conclude that a partial privatisation must be preferred to a public firm as it is more efficacy. Two different effects are possible in connection with the level of many parameters: private efficiency, variable costs, selfish parameter, and level of privatisation. We have seen that the final result is always favourable for the partial privatisation. We have analysed also the mix of parameters that implies the passage from one type of effects to the other. We have seen that it is characterised by a strong level of non linearity. Often, in practical conditions of real market intervention, the effective values of parameters are not exactly known. As a consequence, the fact that in both types of effect the partial privatisation is preferable to the polar cases increases the possibility to make a correct choice.

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