Pareto Inefficient Horizontal Mergers in Mixed Oligopolies

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Abstract

In this paper we analyze horizontal mergers in mixed oligopolies. We first consider a mixed duopoly where the merger creates a monopoly, and we distinguish two cases.

In the first case, the same parameter represents both (i) the weight of profit in the objective function of the new firm, and (ii) the fraction of the new firm's profits accruing to the private shareholder. In this case we show that there is no value of such parameter which allows a Pareto efficient improvement w.r.t. the pre-merger Cournot-Nash equilibrium. Then we consider the case in which (i) and (ii) do not coincide, and we show that there is room for Pareto efficient arrangements.

Secondly, we study a situation where in the pre-merger Cournot-Nash equilibrium two private firms and a public one are active. We characterize the properties of the post-merger Cournot-Nash equilibrium when the merger involves one private firm and the public one and we give conditions under which the mixed merger benefits both partners.

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1. Introduction

It is not obvious whether microeconomic theory can help to predict the outcome of some recent partnerships between public and private enterprises. Perhaps, the following quotation from Jacquemin and Slade (1989, p. 419) may hint at a promising line of research: "The problem of reaching an agreement is still more delicate when one considers ... asymmetries such as differences in preferences". In other words, one may argue that the intrinsic asymmetry between the goals of the public and the private enterprises yields a non negligible difficulty in the specification of any "mixed" agreement.

Indeed, the implementation of these agreements seems to meet several obstacles: for instance, the partnership between Fiat and Italtel in the telecommunication industry brooke down at the very preliminary stages of negotiation, and the current litigations between Eni and Montedison justify some skepticism about the future of the newly created Enimont. This is not to say that collaborative arrangements between public and private firms are bound to fail, as some apparently successful cases of mixed partnerships seem to suggest (1) . The relevant feature of all these horizontal partnerships - materialized in the form of horizontal mergers, joint ventures, and the like - is that they involve the participation of private and public stockholders. Then, given the aforementioned difficulties in the organization of the partnerships themselves, it may be interesting to isolate some theoretically grounded explanations of such difficulties. This is the aim of this paper, with special reference to horizontal mergers.

A further motivation behind such a research is that phenomena of "mixed mergers" have been neglected both in the small literature on mixed oligopolies - where, as documented by De Fraja and Delbono (1990), firms are assumed to behave noncooperatively - and in the huge literature on mergers, where the attention is confined to agreements between profit maximizing firms (see Jacquemin and Slade, 1989, for an excellent survey).

In this paper we present a simple partial equilibrium model where it is possible to explore the conditions under which a horizontal merger between a private and a public enterprise is mutually convenient with respect to a non-cooperative outcome. We first model a mixed duopoly where two firms, identical in all respects apart from their objective functions, compete à la Cournot in a homogeneous industry. In the Nash equilibrium of the one-shot game, the private firm maximizes its profits and the public firm maximizes social welfare (the sum of consumer and producer surpluses). Then, we analyze the consequences of an exogenous [2] horizontal merger between the two companies. The merger does not yield any technological advantage, but only a strategic one, in that it allows firms to coordinate the choice of output to be produced in the two plants of the new firm.

In modelling the negotiation between the two participants, it seems analytically fruitful to split it into three steps, redarding: (i) the capital to be brought in the new firm, (ii) the weight of each partner's interest in the new firm's objective function, and (iii) the distribution of the new firm's profits. We sidestep (i) by assuming that both firms participate on equal terms to the equipments of the new firm, and we focus on steps (ii) and (iii). By comparing the post-merger equilibrium and the pre-merger one, we prove that, if the same parameter describes the weight of one firm in both (ii) and (iii), then the merger is Pareto inefficient, i.e., at least one stockholder loses from the partnership. When steps (ii) and (iii) are governed by two different parameters, we show the conditions under which the horizontal merger is Pareto superior to the noncooperative outcome.

Finally, we study the effect of a merger when two private firms are initially active and only one of them merges with the public one. The comparison between the Nash equilibrium of the pre-merger tripoly and the Nash equilibrium of the post-merger duopoly allows us to underline the conditions that make the mixed merger a Pareto efficient arrangement.

In the next section we describe the basic model and we analyze the horizontal merger in a mixed duopoly. The case of tripoly is studied in section 3. Section 4 contains some concluding remarks.

2. A horizontal merger in a mixed duopoly

We consider a market where a public firm and a private firm produce a homogeneous product. We assume that the market demand function is the following:

$$p = a - Q \qquad a > 0 \tag{1}$$

where p is price and Q is total output. The technology is summarized by the following cost function, which is identical for both firms:

$$C(q) = c + (k/2)q^2 \qquad c, k > 0 \tag{2}$$

where q is individual output. The only difference between the two firms lies in their objective functions, in that the public firm maximizes social welfare (i.e., the sum of total profits and consumer surplus), while the private firm maximizes its own profit. We assume that before the merger firms play a one-shot noncooperative game in output levels; from De Fraja and Delbono (1989), we know that there exists a unique Nash equilibrium for this mixed duopoly in which the private firm's profit is

$$(3) \qquad \pi_A = \frac{a^2k^2(2+k)}{2[(1+k)^2 + k]^2} - c$$

where the subscript A denotes variables referred to this initial situation. Obviously, the private firm will be active only if its profit is positive, and thus we assume this to be the case (3). Moreover, in equilibrium, social welfare is

$$(4) \qquad W_A = \frac{a^2[(1+k)^3 + k(k^2+5k+2)]}{2[(1+k)^2 + k]^2} - 2c$$

It is possible to check that such equilibrium is generically Pareto inefficient, so that a cooperative arrangement could improve the equilibrium payoffs of both players. One may think that a horizontal merger represents an example of such cooperative arrangements, by means of which social welfare might be increased without reducing private firm's profit below the pre-merger level.

Thus, it is now interesting to analyze the effects of a horizontal merger between these firms. We assume that the merger does not yield any technological advantage, such as scale economies, but only a strategic one, in that the output levels of the two plants are now chosen in a coordinated way, and no longer in a noncooperative one. Of course, this may be seen as a restrictive assumption, but, as there is no general evidence about economies and diseconomies of scale, we prefer to assume away both possibilities, also in order to isolate the strategic effect of the merger, on which we focus.

Obviously, the new firm will be a monopolist. Its objective function must clearly take into account the goals of both participants. We specify the function that the new firm aims at maximizing as follows [4]:

$$(5) \qquad P = \alpha\pi + (1-\alpha)W \qquad 0 \leq \alpha \leq 1$$

The more immediate interpretation of α is the share of the private shareholder in the mixed firm: the weight of profits in the objective function coincides with the stake of private investors in the new firm. As the two merging firms participate on equal terms (they bring in the same capital assets, summarized by c), one may be tempted to assume that $\alpha = 1/2$; we prefer to postpone the exam of this special case after considering a more general formulation. Furthermore, it may seem natural to think of α as the share of the new firm's profits accruing to the private shareholder. We will start assuming that α plays both roles, while we shall analyze later the effects of distinguishing the weights in the objective function from the weights in the distribution of profits.

Writing (5) explicitly, we have

$$P = (a-q_M)q_M - k(q_M/2)^2 - 2c + (1-\alpha)q_M^2/2$$

where q_M indicates the output level of the new firm. As the two plants are completely identical, in equilibrium each of them will produce $q_M^*/2$, where q_M^* is determined by the first order condition $\delta P/\delta q_M = 0$:

$$(6) \qquad q_M^* = \frac{2a}{2(1+\alpha) + k}$$

Notice that equilibrium price, which is $a - q_M^*$, exceeds marginal cost whenever $\alpha > 0$. Given (6), the profit of the new firm is:

(7) $$\pi_P = \frac{a^2(4\alpha+k)}{[2(1+\alpha) + k]^2} - 2c$$

where the subscript P denotes variables referred to the post-merger equilibrium. The equilibrium level of social welfare is now:

(8) $$W_P = \frac{a^2(4\alpha+k+2)}{[2(1+\alpha) + k]^2} - 2c$$

The merger turns out to be profitable for the private shareholder if and only if $\alpha\pi_P > \pi_A$, i.e., if the profit he gets after the merger is larger than the one the private firm obtains in the mixed duopoly. On the other side, the merger is socially beneficial if and only if $W_P > W_A$. Some simple algebra (the details are available upon request) allows one to establish the following preliminary results.

Lemma 1. The function $\Delta\pi(\alpha) \equiv \alpha\pi_P(\alpha) - \pi_A$ has the following properties:

(1.i) $\Delta\pi(0) < 0$;
(1.ii) $\Delta\pi(1) > 0$;
(1.iii) $\delta\, \Delta\pi(\alpha)/\delta\alpha > 0$;
(1.iv) $\delta^2\, \Delta\pi(\alpha)/\delta\alpha^2 < 0$.

Lemma 2. The function $\Delta W(\alpha) \equiv W_P(\alpha) - W_A$ has the following properties:

(2.i) $\Delta W(0) > 0$;
(2.ii) $\Delta W(1) < 0$;
(2.iii) $\delta\, \Delta W(\alpha)/\delta\alpha < 0$;
(2.iv) $\delta^2\, \Delta W(\alpha)/\delta\alpha^2 < 0$.

Lemma 1 tells us that the function $\Delta\pi(\alpha)$, which denotes the change in profits accruing to the private shareholder, is continuous and monotonically increasing. Thus, there exists a unique value of α, indicated by $\alpha_\pi \in (0,1)$, such that $\alpha\pi_P(\alpha) = \pi_A$ and $\Delta\pi(\alpha) > 0$ for $\alpha > \alpha_\pi$. Analogously, Lemma 2 tells us that there exists a unique value $\alpha_W \in (0,1)$

such that $W_P(\alpha) = W_A$ and $\Delta W(\alpha) > 0$ for $\alpha < \alpha_W$. Hence, one may ask whether there is at least some value of α such that <u>both</u> $\Delta W(\alpha)$ and $\Delta \pi(\alpha)$ are positive, i.e., whether the post-merger equilibrium is Pareto superior to the pre-merger equilibrium.

Remark. It may be interesting to check whether $\alpha = \frac{1}{2}$ satisfies this requirement, i.e., whether a situation where the shareholders have the same weight in the decision process may lead to a Pareto improvement. By straightforward substitution, it is easily shown that $\Delta W(\frac{1}{2}) < 0$ and $\Delta \pi(\frac{1}{2}) > 0$. Therefore, equal weight in the payoff function of the new firm implies a loss for the public shareholder. This is no surprise once noticed that the public goal subsumes the private one, but not vice-versa. This can clearly be seen rewriting (5) as $P = \pi + (1-\alpha)S$, where S is consumer surplus. Relatively to the mixed duopoly, in this situation (with $\alpha = \frac{1}{2}$) producer interests are then attached a greater weight.

This simple remark underlines an important feature of a horizontal merger in a mixed duopoly. While a condition of equal weights of the two shareholders in the management of the new firm is often considered a fair way to strike a balance between conflicting interests, in our model such an agreement is never beneficial to the public authority, and turns out to be a way to neutralize (at least partially) the attempt of the public firm to constrain the other firm's monopolistic power. As a consequence, if there exists a value of α that makes both players better off relatively to the pre-merger equilibrium, this must lie within the interval $(0,\frac{1}{2})$.

Turning to the general question, the answer is contained in the following:

Theorem 1. There is no $\alpha^* \in [0,1]$ such that $\Delta W(\alpha^*) \geq 0$ and $\Delta \pi(\alpha^*) \geq 0$.

Proof. By Lemmas 1 and 2 we know that the functions $\Delta W(\alpha)$ and $\Delta \pi(\alpha)$ intersect just once. Hence, all we have to show is that this intersection occurs in the negative orthant. Our strategy is to show first that $\Delta W(\alpha_{\pi}) < 0$. When $\pi_{A} = \alpha\pi_{M}$, we have

(9) $\Delta W(\alpha_*) = (1-\alpha_*)\pi_P - \pi' - S_A$

where π' denotes the profit of the public firm in the pre-merger equilibrium [5]. The previous expression can be written as

$$\Delta W(\alpha_*) = (2\alpha_*-1)c + \frac{a^2}{2}\,\frac{[t^2(8\alpha+2k-8\alpha^2-2\alpha k+1) - z^2(k^3+6k^2+5k+1)]}{z^2t^2}$$

where $t \equiv [(1+k)^2+k]$ and $z \equiv [2(1+\alpha)+k]$. Notice that, by the remark above, $\alpha_* < ½$, so that $(2\alpha_*-1)c < 0$. If the expression in square brackets is negative, then $\Delta W(\alpha_*)$ is also negative. Let us show that this is indeed the case. Lengthy and tedious calculations allow one to write the relevant expression as:

$$k^5(1-2\alpha) + k^4(13-8\alpha-8\alpha^2) + k^3(-52\alpha^2-58\alpha-5) + k^2(-112\alpha^2+8\alpha-22) +$$
$$+ k(-68\alpha^2+2\alpha-16) - 12\alpha^2 - 3.$$

This expression can be rewritten as:

$$k^3[(1-2\alpha)k^2 + (13-8\alpha-8\alpha^2)k + (-52\alpha^2-58\alpha-5)] + k^2(-112\alpha^2+8\alpha-22) +$$
$$+ k(-68\alpha^2+2\alpha-16) - 12\alpha^2 - 3$$

which is negative if the expression in square brackets is negative. By simple inspection one can ascertain that there is no value of α in the interval $(0,½)$ that makes such expression positive. Hence, $\Delta W(\alpha_*) < 0$.

Now, we have to observe that, from Lemma 1, it follows that $\Delta\pi(\alpha) < 0$ for $\alpha < \alpha_*$; on the other hand, from Lemma 2, we know that $\Delta W(\alpha)$ is monotonically decreasing in α, so that $\Delta W(\alpha) < 0$ for $\alpha > \alpha_*$. Therefore, there is no value α^* such that both $\Delta\pi(\alpha^*)$ and $\Delta W(\alpha^*)$ are non-negative.▪

The content of the Theorem can be illustrated with the following diagram, which shows that the two functions $\Delta\pi(\alpha)$ and $\Delta W(\alpha)$ intersect in the negative orthant.

[Insert Figure 1 about here]

The result above is rather disturbing, because it implies that a relatively straightforward form of partnership between a private firm and a public one operating in a duopolistic market cannot yield a Pareto improvement. It may be thought that this result is driven, among other things, by the double role played by the parameter α, which denotes the weight of profits in the objective function of the new firm as well as the share of total profits accruing to the private shareholder. Therefore it is interesting to test this conjecture, analyzing the case in which α maintains the first meaning, while the division of profits is governed by another parameter.

To tackle this issue, we still assume that the new firm maximizes (5), while the fraction of profits assigned to the private partner is now denoted by the parameter β $(0 \leq \beta \leq 1)$. In this context, we redefine the increase in the profit accruing to the private shareholder as $\Delta^*\pi(\alpha) \equiv \beta\pi_P(\alpha) - \pi_A$. Thus, we ask whether there is a value of α such that $\Delta^*\pi(\alpha) \geq 0$, and $W_P(\alpha) \geq W_A$, with at least one strict inequality.

To this end, let us consider the extreme case of $\beta = 1$: clearly, if there is no value of α meeting the previous requirements, then the same conclusion would extend to cases where $\beta < 1$. If such α exists, then, the additional degree of freedom obtained distinguishing between α and β creates room for Pareto improvements.

To show that such α exists, we can give the following example. Suppose that α is such that the post-merger output level equals pre-merger total output. Such a value of α exists, and is equal to

$$(10) \qquad \alpha_G = \frac{k}{2(1+k)}$$

When $\alpha = \alpha_G$, consumer surplus does not vary because of the merger. Now, the two plants of the new firm produce the same levels of output and thus, as the cost function is convex, total cost in the post-merger equilibrium will be lower than in the pre-merger situation, where the two plants were producing different output levels. Because price and total output do not change, total revenue will not be affected by the merger; therefore, the new firm's profit will be higher than industry profits in the pre-merger equilibrium (i.e., $\pi_P > \pi' + \pi_A$). Obviously, this implies that social welfare in the post-merger equilibrium is higher than in the pre-merger equilibrium (not surprisingly, α_G is lower than ½).

With $\beta = 1$ and $\alpha = \alpha_G$, the horizontal merger is then Pareto superior to the non-cooperative pre-merger equilibrium. Hence, by a continuity argument there exist pairs of α and β such that the merger makes both partners better off. Clearly, the public shareholder will be indifferent to the way total profits are split, while the private shareholder will require a value of β such that $\Delta\pi^*(\alpha)$ is positive. This will be the case for β sufficiently close to 1.

Of course, another hypothesis to explore may be the one allowing side-payments from consumers to the private shareholder. For instance, fiscal incentives, such as tax reductions in favour of the private partner, may represent an example of these side-payments. However, it seems inappropriate to tackle such an issue within a partial equilibrium analysis, and therefore we do not consider this possibility.

3. An example of mixed merger in oligopoly

In the previous section we have analyzed a merger between a public and a private duopolists, so that the post-merger situation is one of monopoly. Now, we want to extend the previous analysis to a more complex setting, considering a case where the post-merger market is no longer a monopoly. For the sake of simplicity, we shall confine our attention to a rather special case, by assuming that in the pre-merger situation only three firms (two private, and one public) are active, and the merger involves only one private firm. Moreover, in the cost function we set k = 1. As a consequence of these restrictions, the model analyzed in this section represents little more than an elaborated example.

In this case, building on De Fraja and Delbono (1989), it easy to show that in the pre-merger Nash equilibrium, when the public firm competes against two private, independent firms, the equilibrium welfare level is:

$$(11) \qquad W_A = \frac{13}{36} a^2 - 3c$$

while each private firm has a profit equal to:

$$(12) \qquad \pi = \frac{a^2}{24} - c$$

When the public firm merges with one of the private firms, the new enterprise maximizes

$$(5') \qquad P = \alpha \pi_M + (1-\alpha) W$$

where the index M refers to the new "mixed" firm. One important feature of this case is that, given the partially public nature of the new firm, its objective function attaches a positive weight to the profit level of the outsider. Following the same procedure already used in the previous case, we can find the optimal output of each plant belonging to the new firm as :

$$q = \frac{a}{7 + 6\alpha} \tag{13}$$

The output of the outsider firm (indexed by 0) is

$$q_O = \frac{a(1+\alpha)}{7 + 6\alpha} \tag{14}$$

Thus, the two firms' profit levels in the post-merger Nash equilibrium are, respectively:

$$\pi_M = \frac{4a^2(1+4\alpha)}{(7+6\alpha)^2} - 2c \tag{15}$$

and

$$\pi_O = \frac{3a^2(1+2\alpha)^2}{2(7+6\alpha)^2} - c \tag{16}$$

The equilibrium level of welfare is:

$$W_P = \frac{2a^2(4\alpha^2+16\alpha+9)}{(7+6\alpha)^2} - 3c \tag{17}$$

The role of α is more ambiguous than in the previous case. It is easy to ascertain that, as expected, an increase in α increases the output level of the new firm, and decreases the output level of the ousider. The effect on total output is negative, so that the higher α, the higher the equilibrium price. The outsider's profit is also an increasing function of α, in accordance with the intuition.

As regards the relationship between α and the profit of the mixed firm, the situation is more complex: $\delta\pi_M/\delta\alpha > 0$ if and only if $\alpha < 2/3$. This confirms that sometimes a firm may have a larger profit when it does not maximize profit (as shown by Vickers, 1985): when α is large, the new firm will behave "too aggressively", and the effect on profit of putting "too much weight" on profit itself may be negative. Remember that $\alpha < 1$ means that the new firm attaches some weight to the outsider firm's profit, so that it tends to have a "quasi-collusive" behaviour, which may have a positive effect on its own profit.

The parameter α has an ambiguous effect on W_P as well: $\delta W_P/\delta\alpha < 0$ if and only if $\alpha > 1/10$. This result may be related to the well known trade-off between allocative efficiency and technological efficiency. When α is very small, the new firm behaves almost like a public firm, and thus, in order to achieve allocative efficiency (requiring marginal cost pricing), it tends to supply a very large output level. This, however, has the negative consequence that, because of increasing marginal costs, the new firm tends to produce with very high costs, which has a negative impact on social welfare.

We have now to check whether it is possible to have a Pareto efficient merger, i.e., whether it is possible to find some value of α such that $\Delta\pi(\alpha) \equiv \alpha\pi_M(\alpha) - \pi \geq 0$, and $\Delta W(\alpha) \equiv W_P(\alpha) - W_A \geq 0$, with at least one strict inequality. Notice that α plays two roles as in the first part of section 2. We have to observe first that $\Delta W(0) > 0$, and $\Delta W(1) < 0$. On the other hand, $\Delta\pi(0) < 0$, while $\Delta\pi(1) > 0$ if and only if $a^2 > 26c$. Analogously to the case examined in the previous section, equal weight of the two shareholders in the new firm ($\alpha = ½$) implies that the merger is privately beneficial, but socially detrimental.

To show that the merger may now be Pareto efficient for some value of α, it suffices to notice that, when $\Delta W(\alpha) = 0$, $\Delta\pi(\alpha) > 0$. Indeed, the value of α that makes the public shareholder indifferent between the pre-merger and the post-merger outcomes is approximately equal to 0.46, and $\Delta\pi(0.46) > 0$. Notice that $\Delta\pi(\alpha)$ is monotonically increasing in α, provided c is not too large. Thus, the situation is the one depicted in Figure 2 below.

[Insert Figure 2 about here]

Finally, it may be worth checking what happens to the outsider's profit after the merger. It is easy to show that its profit is increased by the merger if and only if $\alpha > 1/10 + \sqrt{1536}/60 \approx 3/4$. This shows, *inter alia*, that in this example the merger cannot be beneficial to everybody, as this condition requires $\Delta W(\alpha)$ to be negative.

4. Concluding remarks

In this paper we have studied the effects of a horizontal merger between a private and a public firm. Our analysis shows some of the difficulties that such an agreement can face in making conflicting interests compatible. In order to tackle this issue, we have introduced some simplifying assumptions, whose removal may suggest some directions for further research.

First of all, one may want to consider at the same time other incentives for mergers, such as the presence of technological advantages (e.g., economies of scale) that are sometimes indicated as an important reason for collaborative arrangements. Secondly, one may consider the issue in a broader framework, for instance analyzing the dynamic effects of a horizontal merger when cost-reducing activities are relevant (R&D, learning, ...). Finally, empirical evidence suggests that mixed mergers often occur in markets open to international competition, where this kind of agreements may have further strategic motives, whose analysis may considerably enrich the study we have began in this paper.

Footnotes

(1) The following is nothing but a small sample of several kinds of recent partnerships between public and private shareholders. The exchange of shares between Volvo and Renault in the automobile sector, the collaboration between the Spanish public holding Ini and the private Man-Daimler in the truck producer Enasa, and the cohabitation between the private holding CGE and several public partners within the French firm Framatome, one of the leaders in the sector of nuclear power stations.

(2) In this sense, our model is very much in the spirit of some recent models of horizontal mergers, such as Salant et al. (1983) and Perry and Porter (1985).

(3) Notice that this hypothesis is sensible, as the cost function is not linear. Indeed, with constant marginal cost (without capacity constraints) the optimal strategy for the public firm, i.e. marginal cost pricing, would leave no room to the private firm.

(4) Of course, other specifications may be used. Beyond its simplicity, we have adopted this formulation because it may capture the idea that the objective function of the new firm is a weighted average of the two original goals of the two shareholders. Moreover, α and $(1-\alpha)$ may be thought of as the relative weights of the shareholders in the executive committee.

(5) De Fraja and Delbono (1989) show that the public firm's profit is greater than the private firm's one which we assumed to be positive; hence, also the former is positive.

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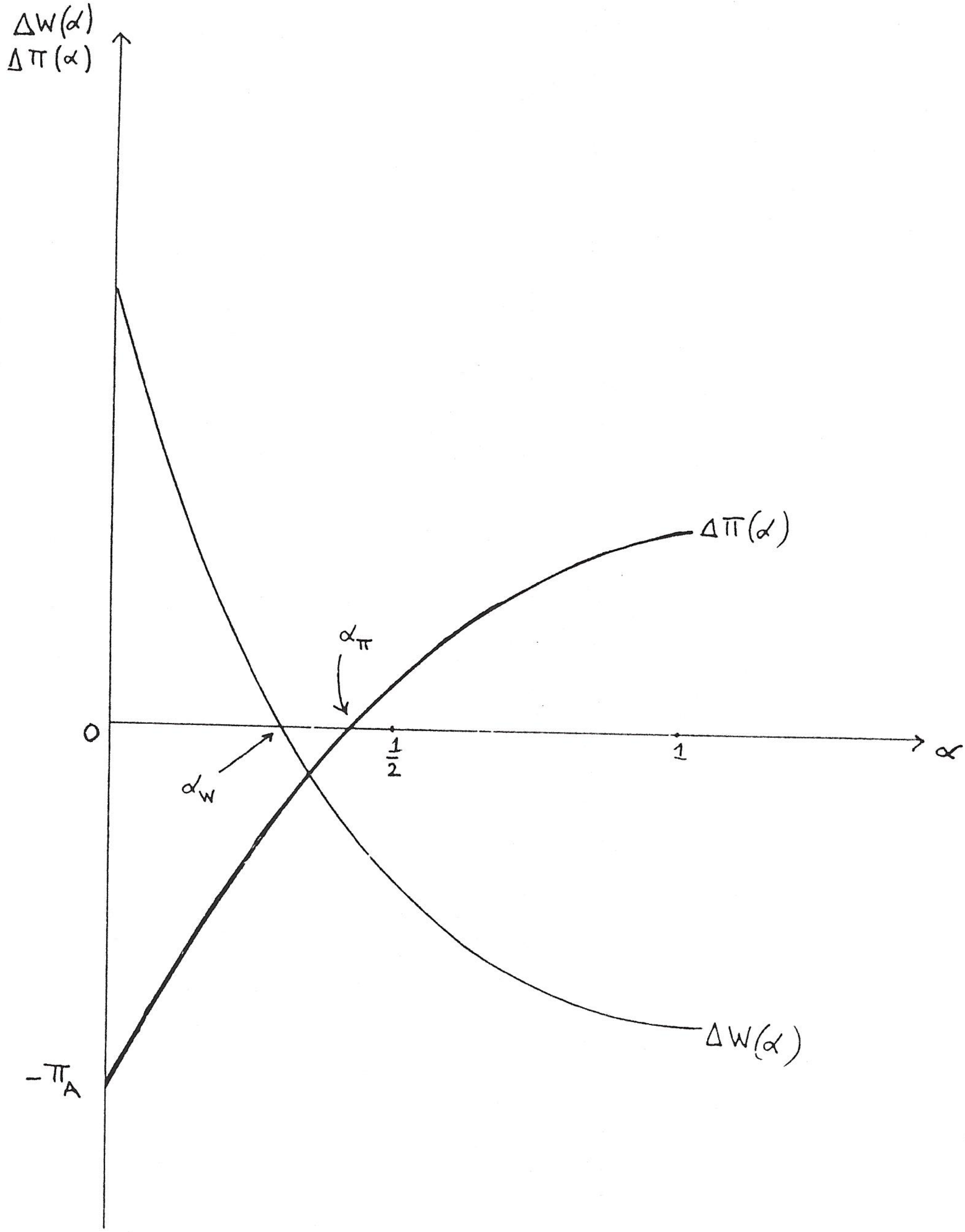

Figure 1.

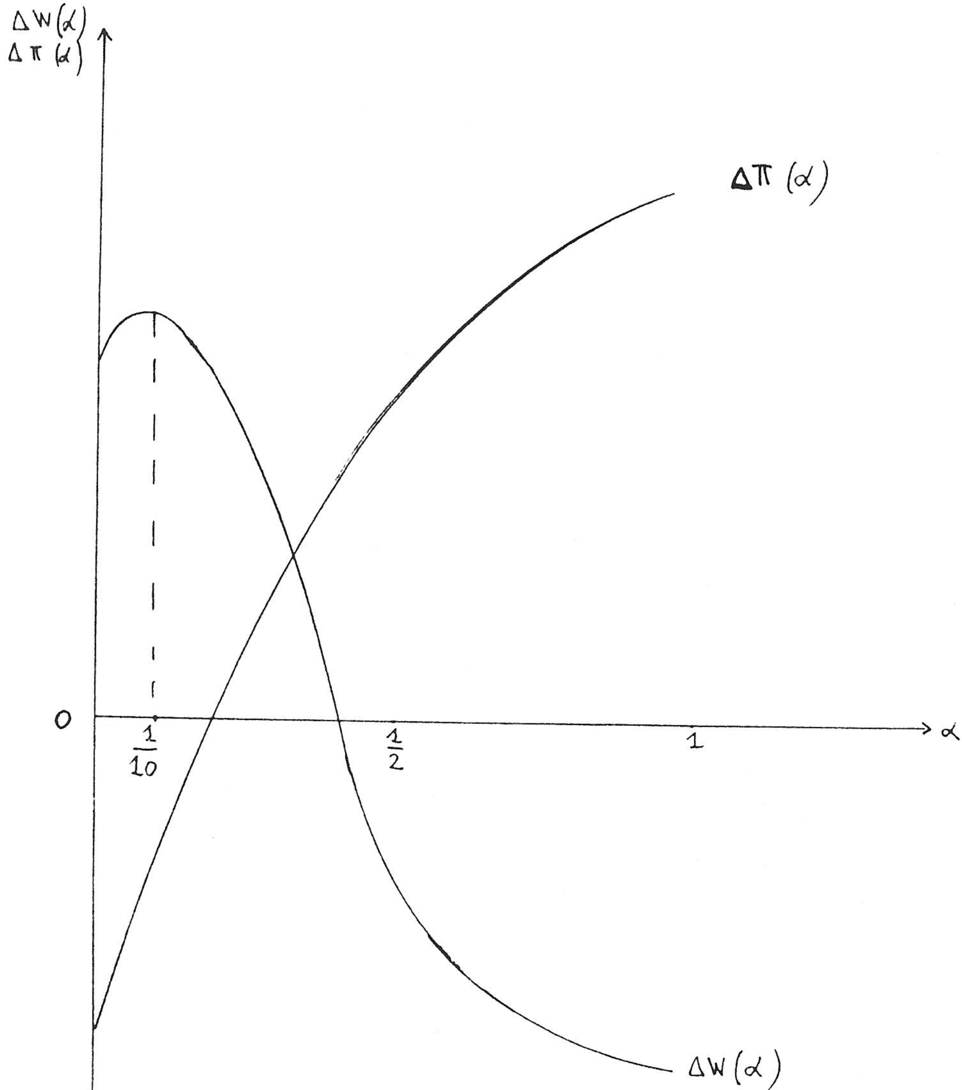

Figure 2