Optimal Domestic Redistribution and Multinational Monopoly

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ABSTRACT

The existence of a monopoly which is owned by citizens of several countries can affect income redistribution policies within a single country. Consider an economy in which the government can use lump-sum taxes for income redistribution but cannot regulate the price charged by a monopolist. If domestic consumers own the monopoly, the social planner does not equate social marginal utilities of income. Only if all monopoly profits flow outside the economy does the planner equate social marginal utilities of income, unless it moves prior to the monopolist. Thus, we can use aggregate welfare functions to study questions using a single representative consumer in this economy only under restrictive circumstances. The monopolist prefers to set its price in advance of the social planner choosing transfers, while the social planner does not necessarily have such a first-mover advantage. In an endogenous timing game, either the monopolist moves first or the monopolist and the planner move simultaneously, depending on slopes of the best replies.

1. Introduction

Income redistribution has become a major function of modern national governments. Economists have studied many aspects of the question of optimal redistribution. The second-best nature of this analysis has primarily focused on problems where the distortions arise as a result of the process of redistribution, such as in the study of the optimal linear income tax (Sheshinski [1972]). In the Ramsey pricing literature, economists have also studied how distributional goals modify standard rules to correct distortions. In this paper, we consider a different question—how efficiency distortions change income distribution policy rules. Our particular focus of study is a monopoly when a government cannot regulate its price directly or indirectly.

The growing globalization of economic activity has significant implications for the nature of redistribution. Some aspects of this, such as how increases in factor mobility limit governments' ability to redistribute income, have been widely studied.[1] The impact on redistribution of other aspects of globalization has received less attention. First, the integration of capital markets has made large corporations increasingly multinational in their ownership. Whether they produce in a single country or in several, they distribute profits to citizens of many countries. Second, globalization may affect the ability of governments to use antitrust measures to reduce monopoly distortions. While exposure to international competition by itself reduces some distortions, anticompetitive behavior abroad by international competitors may more easily escape a country's antitrust jurisdiction. Furthermore, to allow domestic firms to compete vigorously abroad, nations may allow mergers into large domestic near-monopolies (consider the U.S. government's response to the Boeing-McDonnell Douglas merger in 1997). Third, interactions between governments and large multinationals may be more complicated than in conventional models of government policy. In closed economy models, the typical model follows a principal-agent framework with the government as principal and firms and consumers as agents, treating the government as a Stackelberg leader making decisions in advance of firms. For a game between a national government and a multinational firm, other timing models might be appropriate. For example, firms make their production decisions on timetables which would be independent of a small country's legislative schedule.[2]

To study these issues, we consider optimal income redistribution when there exists an unregulated monopoly whose price the social planner cannot control either directly or indirectly. The only instruments available to the planner are redistributive taxes. This structure allows us to examine the general question of how to modify optimal distributional policies when there are multinational monopolies. To focus on this, we assume that redistribution is otherwise unrestricted—the planner knows each individual's preferences and budget constraint and can impose personalized lump-sum taxes. While these assumptions are clearly extreme, they capture the realistic fact that not all monopoly distortions can be eliminated and that redistribution is a major government function.

Other authors have examined different parts of the monopoly-income distribution nexus. Comanor and Smiley [1975] examine the contribution of monopoly rents to wealth inequality. Their main results indicate that an elimination of monopoly power in the U.S. would significantly reduce inequality in the wealth distribution. Thus, it is important to account for monopoly profits when redistributing income. More recently, Baker and Salop [2016] examine the scope for aggressive antitrust policy to alleviate inequality. While they point out that inequality concerns would have implications of the direction of antitrust policy, they also perceive that antitrust would have less impact on inequality than tax, labor and trade policy. Our emphasis is instead to ask how redistributive policy should adjust in response to monopoly power, especially when a national government has little ability to constrain a multinational monopolist.

Several important questions arise within this structure. First, how do the monopoly distortion and the mix of foreign and domestic ownership of the monopoly affect the government's distributional policy rules? Does the government do more or less redistribution when such monopolies are present? Second, does the timing of decisions by the government and the monopolist matter? Does the planner prefer to redistribute prior to or after the monopolist sets its price? Third, this timing of decisions may not be exogenous or fully under the government's control, so we consider the equilibrium of a timing game. Does one of them move first, or do the monopolist and the planner make simultaneous decisions? Fourth, how does monopoly behavior change as a result of the redistribution?

Although there has been much work on redistribution under a variety of constraints and on monopoly regulation with distributional goals, the questions above have not yet been considered. The most common constraint in analyses of income redistribution is that the government cannot identify individuals' tastes and budget constraints. Thus, it cannot levy personalized lump-sum taxes, but it can use nonlinear taxes subject to self-selection constraints (see Mirrlees [1971] and Stiglitz [1982]). To date, almost all of this literature studies problems where the government faces no restrictions other than self-selection constraints. Since individuals effectively face different marginal tax rates on all commodities, producer prices play a limited role in the economy. Monopoly problems only arise if the government cannot regulate producer prices or grant subsidies to cover monopoly losses from marginal cost pricing.

Another set of models considers linear commodity taxes with a common lump-sum benefit for all individuals (see Diamond [1975], Mirrlees [1975], and Deaton [1976]). The planner deviates from the standard Ramsey rule of equal percentage reductions in compensated demands to achieve a better distributional outcome. The focus is how to modify efficiency-oriented rules in the face of distributional considerations, rather than the reverse considered here.

In a perfectly competitive model with the planner acting as a principal and facing no constraints on taxation, redistribution is carried out to equate the social marginal utilities of consumption. Under this conventional rule, Samuelson [1956] has shown that problems with many consumers can be reduced to ones with a single representative consumer. In our model, this result does not generally hold. When the planner acts in advance of the monopolist, the transfer will differ from the conventional rule either to raise or lower profits depending on whether domestic consumers own a majority or minority share of the monopoly. When the planner sets the transfers after the monopoly price is set, the transfer takes account of the fact that the cost of taxing one consumer to give a dollar to another may be more or less than a dollar. Only when the monopolist sets price first and is owned completely by foreigners does the conventional rule apply. Therefore, single representative consumer models should be used with caution.

With respect to timing, the monopolist always benefits from moving first. The planner sometimes benefits from moving second. If they play an endogenous timing game, in equilibrium, the planner never moves before the monopolist. Thus, the standard principal-agent model in which the planner moves first may not be appropriate.[3]

Section 2 presents the basic model. Section 3 describes optimal redistributive taxes given the monopoly distortion. Section 4 analyzes the advantages and disadvantages for the government and the monopolist of moving first when the timing of moves is exogenous. Section 5 considers the timing of moves as endogenously determined by decisions of both the government and the monopoly. Section 6 contains our conclusions.

2. The Model

We study a deliberately simple model to focus on the particular questions raised in the Introduction. There are two consumers (or types of consumers) in the economy. Consumer a has a utility function $U^a(A)$ where A is her consumption bundle and consumer b has a utility function $U^b(B)$ where B is b's consumption bundle. Both U^a and U^b are continuous and strictly quasiconcave functions. We only analyze interior solutions with positive consumption for both types.

Each consumer is a net seller of some goods (including labor) and a net buyer of others. Money income has two components: a share of monopoly profits and a lump-sum transfer from the government. The transfer to consumer a is $T^a \equiv T$ and the transfer to b is $T^b \equiv -T$. Thus, we build the government budget constraint for redistribution directly into this problem.

In our analysis, we consider only redistribution of money income. If the planner allocated goods directly, it could potentially regulate the monopoly price indirectly. While this would be welfare-superior, we wish to take as given the presence of a distortion. In this light, we assume that no government actions directly aimed at reducing the monopoly distortion are possible, so the government cannot impose commodity taxes or subsidies.

Denote the monopolist's profit by Π, with consumer a receiving $\alpha\Pi$ and consumer b receiving $\beta\Pi$. Part or all of the monopoly may be owned by foreigners, so $0 \leq \alpha + \beta \leq 1$. All firms other than the monopoly are perfect competitors using constant returns to scale technologies, so these other firms earn zero profits in equilibrium. For simplicity, we further assume that other prices are independent of the monopoly price. To maintain the balance of trade, the foreign recipients of profits buy domestic goods other than the monopoly good. Similarly, if the monopolist produces abroad, foreign purchases of domestic goods maintain trade balance.[4]

Total lump-sum incomes are $I_a = T + \alpha\Pi$ and $I_b = -T + \beta\Pi$. Let x denote a's consumption and y denote b's consumption of the monopoly good. Let p denote the monopolist's price. The indirect utility functions are:

$$V^a(p, I_a) = V^a(p, T + \alpha\Pi) \text{ and } V^b(p, I_b) = V^b(p, -T + \beta\Pi).$$

The demand functions of consumers a and b for the monopoly good are, respectively:

$$x = x(p, T + \alpha\Pi) \quad \text{and} \quad y = y(p, -T + \beta\Pi).$$

The government maximizes a Bergson-Samuelson social welfare function (SWF):

$$W \equiv \hat{W}(U^a(A), U^b(B)).$$

Substituting the indirect utility functions into this welfare function yields the indirect social welfare function $\overline{W}(p, T)$. Nonresidents' utilities do not enter the planner's SWF.

An alternative interpretation is similar to Köthenbürger [2004, 2007]. In this case, the utility functions are the welfare functions for local governments with the same arguments as the individual indirect utility functions (the monopoly price, the transfer and the community's share of ownership of the monopoly). The federal government has a revenue sharing program with a balanced budget. When the government moves first, it sets the revenue sharing payments and does not adjust for resulting changes in the monopoly price. When the monopolist moves first, the federal government adjusts the revenue sharing for changes in the monopoly price. Alternatively, the federal government may commit to a policy where the revenue sharing varies with the monopoly price (if it uses a welfare-maximizing policy, this will be equivalent to choosing the transfers after the monopoly price is set).

The monopolist has no fixed costs and a constant marginal cost equal to c. Given that demand depends on the distribution of profits, we must take account of this in writing the profit functions. Profit for the monopolist equals:

$$\Pi(p, T) = (p-c)[x(p, T + \alpha\Pi(p, T)) + y(p, -T + \beta\Pi(p, T))]. \qquad \textbf{(1)}$$

The monopolist can set its price in the domestic economy independent of the prices it charges in any other markets it sells in.

In the games analyzed below, the preferences of the two players are described by these functions $\Pi(p, T)$ and $\overline{W}(p, T)$.[5] It is important to consider the properties of these functions. First, consider $\Pi(p, T)$. Equation (1) is only an implicit definition of Π since individuals' lump-sum incomes depend on the level and distribution of profits. When making decisions, the monopolist recognizes that its demand may shift because changes in its price cause changes in incomes. Given this interaction, assuming that Π is strictly quasiconcave in p and T may be stronger than assuming this for a profit function without such interactions, but we impose it for simplicity. The partial derivatives of Π are:

$$\frac{\partial\Pi}{\partial p} = \frac{x + y + (p-c)[x_p + y_p]}{1-(p-c)[\alpha x_I + \beta y_I]} \qquad \textbf{(2)}$$

$$\frac{\partial\Pi}{\partial T} = \frac{(p-c)[x_I - y_I]}{1-(p-c)[\alpha x_I + \beta y_I]} \qquad \textbf{(3)}$$

where $x_p \equiv \partial x/\partial p$, $y_p \equiv \partial y/\partial p$, $x_I \equiv \partial x/\partial I_a$, and $y_I \equiv \partial y/\partial I_b$. When taking price derivatives of x and y, Π (and hence, I_a and I_b) is assumed to be fixed. We assume that the denominators in (2) and (3) are positive. A sufficient condition is that, for both individuals, other goods are not inferior.[6]

The numerator of (2) is the difference between marginal revenue (without the direct income effects) and marginal cost. Reasonable restrictions on demand guarantee that it is positive for low values of p and negative for high values of p. The additional assumption of strict quasiconcavity assures that, for each T, there exists a unique p such that $\partial\Pi/\partial p = 0$. The locus of such points, denoted p(T), is the monopolist's best reply function in the games below. The numerator of (3) shows that redistributing money income towards individual a increases profits if and only if a's income derivative for the monopoly good exceeds that of b. This difference $x_I - y_I$ can depend on incomes, and hence on T. However, we assume that preferences are sufficiently different that, at least near the equilibria of the games we study, $x_I - y_I$ does not change sign as p or T vary. This term plays a crucial role in the results below. Although it is specific to our particular structure with just two types, it has a more general interpretation of whether an increase in redistribution raises or lowers the demand for the distorted commodity through the induced income effects.

To simplify further analysis of the monopolist's best reply, we assume that each consumer's demand curves are linear in price and parallel at different incomes:

$x_{pI} = y_{pI} = 0$ and $x_{pp} = y_{pp} = 0$.[7]

Second, consider properties of $\overline{W}(p, T)$. This payoff function is not independent of the monopolist's payoff function since consumer incomes include profit shares. Therefore, any change in the monopolist's payoff function also changes the planner's payoff function. We assume that $\overline{W}$ is strictly quasiconcave in p and T. In addition, in (p, T) space, there is a social bliss point which lies on the line p = c at T*, the optimal transfer for that price.[8] Assume without loss of generality that the planner would like to transfer income from b to a, either because a is poorer or a has a greater implicit weight in the welfare function. Hence, T* > 0. Since no inefficiency then exists, using lump-sum taxes, the first-best outcome is achieved there. Using (3), we can write:

$$\frac{\partial\overline{W}}{\partial T} = \frac{\hat{W}_a V_I^a (1-(p-c)(\alpha+\beta)y_I) - \hat{W}_b V_I^b (1-(p-c)(\alpha+\beta)x_I)}{1-(p-c)(\alpha x_I + \beta y_I)} \qquad \textbf{(4)}$$

where $\hat{W}_j = \partial W / \partial U^j$ and $V_I^j = \partial V^j / \partial I_j$. Denote the solution to $\partial\overline{W}/\partial T = 0$ as T(p), the planner's best reply function, which starts at (c, T^*) since the monopoly price would never be lower than c.

Appendix A derives the following properties for the best replies, p(T) and T(p):

(1) An increase in the transfer to a increases both monopoly profits and the monopolist's price if $x_I > y_I$ (and the reverse if $x_I < y_I$). Given this connection between the direction of increase for the monopolist's profit and the slope of its best reply, only two qualitatively different isoprofit contour maps are possible with the difference in the income derivatives determining which of the two exists (see Figure 1(a and b)).

(2) A decrease in price, holding T constant, raises welfare on or above the monopolist's best reply function, and on the planner's best reply function (for p > c). Since $\partial\overline{W}/\partial p$ is always negative along the planner's best reply, the slope of the planner's best reply and the direction of increase in social welfare are independent. There are then two possible qualitatively different isowelfare contour maps, as shown in Figure 2(a and b). Given that the direction of increasing welfare does not vary, the slope of the best reply completely defines these two cases.

(3) The planner's and the monopolist's best replies can slope in the same direction or in opposite

directions. All pairings of these preference patterns are possible, since they are essentially independent of the other, despite the connections between $\overline{W}$ and Π. Hence, there are four possible combinations of the preferences of the planner and the monopolist. In two of them, the slopes of the best replies have the same sign (Figure 3(a and b)). In the graphs, the slope of the monopolist's best reply is greater in absolute value in each case, which is necessary for stability.[9] In the other two cases, the slopes have different signs (Figures 4(a and b)). There is a weak tendency for Figure 3 to arise when the monopoly is mainly owned by domestic consumers and for Figure 4 to arise when there is mainly foreign ownership.

To complete the specification of the game, we must describe the timing of decisions by the planner and the monopolist. We consider three different cases: transfers are chosen before the monopolist sets its price; transfers are chosen after the monopolist sets its price; and transfers and the price are chosen simultaneously. We assume complete information on the part of both the planner and the monopolist in all cases. Typically, the literature has concentrated on the first case in which the planner commits to its transfer in advance of observing the price. In a principal-agent model, this treats the planner as the principal and the monopolist as the agent. However, this timing is not necessarily more realistic than the others. In other contexts, modelers have stressed the government's inability to make decisions without lags, thus forcing the government to move after private agents have acted. If the government observes and reacts to the firm's actions, the second timing would be appropriate. If lags in acquiring and transmitting information prevent the government from reacting to the firm's choice even when moving second, then the third timing is appropriate.

Other factors may affect the choice of timing in the model. A small country facing a multinational monopolist who can price discriminate may well act as a follower. In contrast, if we were to consider a model with many monopolies (with similar Engel curves for the different goods), the government might be more likely to act a leader. However, as in Grossman and Helpman [1994], the government could act as a common agent for several monopolists, in which case it moves after the monopolists commit themselves.

2.1 *The Planner Moves First*

The monopolist, moving second, simply chooses a price, p, to maximize $\Pi(p, T)$, taking T as given. From (2), this occurs where marginal revenue equals marginal cost, as in standard monopoly analysis. The planner, moving first, recognizes how varying T will change the monopolist's optimal p. By substituting the best reply function p(T) into the problem, we can write the planner's maximization problem in a simple form. The planner chooses T to maximize $W(T) = \overline{W}(p(T), T)$. The planner selects its most preferred point on the monopolist's best reply function. Let (p^1, T^1) denote the equilibrium outcome, and Π^1 and W^1 the equilibrium payoffs.

2.2 *The Monopolist Moves First*

The planner, moving second, takes p as given and maximizes $\overline{W}(p, T)$ with respect to T. The first-order condition is satisfied when the numerator of (4) equals zero. The monopolist chooses p prior to the planner's move and thus it recognizes the planner's response. The monopolist's problem thus differs from that when the planner moves first. It now maximizes $\Pi(p, T(p))$. The first-order condition for this is:

$$\frac{\partial \Pi}{\partial p} + \frac{\partial \Pi}{\partial T}\frac{\partial T}{\partial p} = 0.$$

The term $\partial\Pi/\partial p$ is the same as in (2). Since the signs of $\partial\Pi/\partial T$ and $\partial T/\partial p$ are independent, their product can take either sign. This term determines how a monopolist who moves first and anticipates the planner's response deviates from the standard behavior. The monopolist may set a price above or below that which equates marginal revenue and marginal cost, where we define marginal revenue by holding incomes constant (as is typically done). One can reinterpret this profit maximization rule as still equating marginal revenue and marginal cost by redefining marginal revenue to take account of the change in income distribution induced by a price change. In effect, the change in demand from a price change becomes $x_p + y_p + (x_I - y_I)(\partial T / \partial p)$, instead of $x_p + y_p$. Let (p^2, T^2) denote the equilibrium outcome, and Π^2 and W^2 the equilibrium payoffs.

2.3 *Simultaneous Moves*

When the monopolist chooses price and the government chooses the transfer simultaneously, the Nash equilibrium is the intersection of the best reply functions p(T) and T(p). Let (p^3, T^3) denote the equilibrium outcome, and Π^3 and W^3 the equilibrium payoffs.

3. Optimal Redistribution

Although the planner cannot act directly to reduce the monopoly distortion, the existence of monopoly affects the optimal income redistribution program. Here, we characterize the optimal lump-sum taxes and contrast them to those in an economy without a monopoly.

In a first-best world with no distortions, the optimal distribution rule is easy to specify. If the planner can choose the vectors of individual consumption A and B directly subject only to the constraint that aggregate consumption of each good equals aggregate output, the first-order conditions require that:

$$\hat{W}_a \frac{\partial U^a}{\partial A_i} = \hat{W}_b \frac{\partial U^b}{\partial B_i}, \qquad i = 1, n.$$

Thus, redistribution is carried out until the social marginal utility of consumption of each good is equal for all individuals. Needless to say, the planner need not distribute goods directly, but rather can distribute money income to individuals to purchase whatever goods they choose. As shown by Samuelson [1956], if all consumers face the same prices, equating the social marginal utility of consumption of each good across consumers is equivalent to equating the social marginal utility of income for each consumer:

$$\hat{W}_a V_I^a \; = \; \hat{W}_b V_I^b \, .$$

Of course, the optimal money transfers depend on equilibrium prices and cannot be chosen independently of those prices. We denote the transfer which satisfies this rule given the monopoly price as the Samuelson transfer.

Proposition 1 compares the optimal rule in the presence of monopoly under each timing to that in the absence of any distortion.

Proposition 1:   When the planner moves first, the difference between the social marginal utilities of consumption, $\hat{W}_a V_I^a \; - \; \hat{W}_b V_I^b$, and the difference in the income derivatives, $x_I - y_I$, have opposite signs if domestic consumers own more than half of the monopoly, and have the same sign if domestic consumers own less than half of the monopoly. When the monopolist moves first or the planner and the monopolist move simultaneously, the difference between the social marginal utilities of consumption and the difference in the income derivatives have opposite signs if domestic consumers own any part of the monopoly, but if there is 100% foreign ownership of the monopoly, the social marginal utilities of consumption are equal to each other regardless of the sign of $x_I - y_I$.

Appendix B contains proofs of all propositions.

Regardless of timing, the monopoly distortion and any positive degree of domestic ownership cause the planner to choose not to equalize social marginal utilities of income. With majority domestic ownership, the relative income effects on demand for the monopolist's good are the only determinant of the direction of the wedge in the social marginal utilities of income. If $x_I > y_I$, then $\hat{W}_a V_I^a < \hat{W}_b V_I^b$ in all three games. The planner transfers sufficient income to a so that giving one more dollar to a, holding p and b's income fixed, raises social welfare less than would giving a dollar to b, holding p and a's income fixed. The planner may actually carry out lump-sum transfers to the point that the inequality in social marginal utilities of consumption is reversed relative to that in the absence of redistribution.

This wedge occurs even when the planner moves last and takes price as given, since the planner takes into account the effect of lump-sum transfers on profits. Since consumers own shares in the firm, lump-sum transfers cause demand changes through income effects, which in turn affect monopoly profits. Because of this, the lump-sum transfers are not necessarily completely adequate as a redistributive tool. The first-order condition equates the social marginal utility of giving one dollar to a with the social marginal utility of giving one dollar to b, taking into account the resulting changes in profits.

The wedge between the social marginal utilities is due to the effect of a change in T on profits, but surprisingly not on the values of α and β, which specify how profits are divided between consumers. Assume $x_I - y_I$ is positive. When $\alpha = 1$ and $\beta = 0$, increasing I_a by \$1 requires less than a dollar increase in T, and hence less than a \$1 decrease in b’s lump-sum tax. When $\alpha = 0$ and $\beta = 1$, increasing I_a by \$1 requires increasing T by \$1, but I_b falls by less than \$1, since all the increase in profit goes to b. Hence, regardless of the profit shares, it is socially more desirable to raise T than when incomes trade off one for one. The planner acts to increase profits to raise total lump-sum incomes.

The unimportance of the division of profits between domestic consumers for the wedge in the social marginal utilities of consumption can be further seen by supposing that the planner taxes 100% of profits. The planner's budget constraint becomes $T^a + T^b = \Pi(p, T^a, T^b)$. The true marginal cost of transferring $1 to a in terms of how much b's income must fall continues to include the effect of the transfer on profits. Hence, a planner who receives all profits faces the same problem as that analyzed above when consumers own the monopoly.[10]

In contrast, when the majority of the monopoly is foreign-owned, if the planner moves first, it instead redistributes income in such a way as to lower the monopoly price (which also reduces profits). When the planner does not move first, it has no opportunity to influence price, so only the effect of the transfers on profits as described above matters. This effect disappears only if the monopoly has 100% foreign ownership.

While the planner may in some cases act to lower the monopoly price, it is not really trying to minimize the monopoly distortion. Adjusting the transfers only affects price by shifting the demand curve. Direct changes in consumer surplus from demand shifts outweigh changes in deadweight loss.

The existence of a wedge in social marginal utilities has an important implication. When the planner uses lump-sum transfers to equate social marginal utilities of income across consumers, then we can define a welfare function over aggregate consumption levels. Such an aggregate welfare function, whose contours Samuelson [1956] calls social indifference curves, has had a number of applications, particularly in international trade, reducing many-person problems to ones with a representative consumer.[11] By creating a wedge between the social marginal utilities of income, the presence of an unregulated monopoly causes difficulties for the use of an aggregate welfare function. Since the wedge exists in all circumstances, except when the planner moves second and domestic consumers receive no share of profits, reliance on a Samuelson aggregate welfare function is inappropriate.

The signs and magnitudes of $\hat{W}_a V_I^a - \hat{W}_b V_I^b$ in the different games do not necessarily indicate how the equilibrium transfers compare with each other or with the first-best levels, since the price differs across the games.[12] In the following results, we compare the transfers across different outcomes. The slope of the monopolist's best reply alone determines the ranking of the equilibrium values of T in the three games.

Proposition 2: If the monopolist's best reply function slopes up, then the transfer to a when the monopolist moves first is greater than when the planner and monopolist move simultaneously, and the latter is greater than when the planner moves first ($T^2 > T^3 > T^1$), and the reverse if the monopolist's best reply function slopes down.

Of course, since both p and T change across the different equilibria, an increase in T does not necessarily raise a's utility.

Comparisons of equilibrium T values with the first-best level T* depend on the slopes of both best reply functions.

Proposition 3: (A) If the planner’s and the monopolist’s best reply functions slope in opposite directions, then the first-best transfer is greater than all three equilibrium transfers when the planner’s best reply slopes down, and the first-best transfer is less than all three equilibrium transfers when the planner’s best reply slopes up.

(B) If the best reply functions slope in the same direction (whether up or down), then the transfer when the planner moves first can be larger or smaller than the first-best transfer. If both the planner's and the monopolist's best reply functions slope up, the first-best transfer is less than the equilibrium transfer when the monopolist moves first or they move simultaneously ($T^* < T^3 < T^2$). If both the planner's and the monopolist's best reply functions slope down, the first-best transfer is greater than the equilibrium transfers when the monopolist moves first or they move simultaneously ($T^* > T^3 > T^2$) .

A comparison of Propositions 1 and 3 indicates that the local direction of improvement for the planner (toward the Samuelson transfer, holding p fixed) may be in the opposite direction to the global move from an equilibrium to the first-best. Consider the case when the planner's best reply slopes down and the monopolist's slopes up (Figure 4(a)). The first-best transfer exceeds all three equilibrium transfers, but locally the planner gains from an decrease in the transfer when the planner does not lead or when the planner leads and $\alpha + \beta > ½$.[13] Figure 4 can still arise when $\alpha + \beta > ½$, since there is only a weak tendency as described above for Figure 3 to arise with predominantly domestic ownership.

As with the wedge, the division of profits between consumers given by α and β does not affect the relation of the equilibrium values to each other or to the first-best level. Indirectly, increasing α and lowering β, holding $\alpha + \beta$ fixed, increases a's income and leads to a reduction in the transfer to a in the first-best and in each equilibrium. The relation among these values is unaffected.

4. The Advantages and Disadvantages of Moving First

To maximize social welfare, should the planner choose the transfers before the monopolist sets its price or should it delay until after the monopolist acts? The answer depends on the slopes of the best replies.

Proposition 4: When the planner' and the monopolist's best replies slope in the same direction (whether up or down), social welfare is greater when the planner moves first than when they move simultaneously, which in turn is greater than when the planner moves last ($W^1 > W^3 > W^2$). Monopoly profits have the opposite ranking ($\Pi^2 > \Pi^3 > \Pi^1$).

In both cases in Figure 3, the players have a first-mover advantage, even though the best replies slope up in Figure 3(a). In each case, the second mover responds to the first mover's change from its simultaneous move choice in a way that benefits the first mover. Gal-Or [1985] has analyzed this question of first- and second-mover advantages for games with identical players. She shows that there is a first-mover advantage when best replies slope down and a second-mover advantage when they slope up. Our result differs from Gal-Or's because, not only are the players not identical, but they are not even qualitatively symmetric.[14] In Figure 3(a), best replies slope in the same direction, but the monopolist gains from an increase in T, while the planner gains from a price decrease.[15]

A first-mover advantage need not arise when best reply functions slope in opposite directions, as in Figure 4.

Proposition 5: When the planner's and the monopolist's best replies slope in opposite directions, social welfare may be higher or lower when the planner moves first rather than last, but welfare is lower under simultaneous moves than under either order of sequential moves (W^3 <

$\min\{W^2, W^1\}$. Profits when the monopolist moves first are higher than profits under simultaneous moves, which in turn are higher than profits when the planner moves first ($\Pi^2 > \Pi^3 > \Pi^1$).

Thus, there exist circumstances in which the planner prefers moving second to moving first. This might seem surprising since moving first incorporates a type of commitment—to a specific set of taxes regardless of the monopolist's response. Even if the planner moving first were to select the same transfer as it would in the equilibrium when moving second, the monopolist would choose different prices in the two cases. Our result shows that the monopolist's resulting price change is opposite the direction of change sought by the planner which could make moving first disadvantageous to the planner. If the planner moving first could instead commit to a rule specifying taxes as a function of the monopolist's price, it would do better than moving second, since it would not be constrained to choose an outcome on either best reply function.

5. An Endogenous Timing Game

In the previous section, either the planner selected the order of choices by itself relative to the monopolist or this was exogenous. In many circumstances, both the monopolist and the planner may have some power to determine the order of moves. This can significantly affect what type of outcome arises. Hamilton and Slutsky [1990] analyze an endogenous timing game with observable delay. Each player initially announces when it will move—at the first or last opportunity. Players then make their actual choices at the announced times. If both announce they will move first or last, a simultaneous move game occurs. If they announce different times, a sequential move game occurs. The particular qualitative isopayoff maps and the best reply slopes that arise in our model are sufficient to determine unique endogenous timing equilibria.[16]

Proposition 6: (A) When the planner's and the monopolist's best replies slope in the same direction, then, in the endogenous timing equilibrium, players move simultaneously at the first opportunity.

(B) When the planner's and the monopolist's best replies slope in opposite directions, in the endogenous timing equilibrium, the monopolist sets price and then the planner chooses transfers.

When the best replies slope in the same direction, each side prefers to move first and be a leader, but neither can achieve this outcome in the timing game, and thus they move simultaneously. When the planner's and monopolist's best replies slope in opposite directions, as shown in Proposition 5, the planner sometimes prefers moving first and sometimes second. Proposition 6(B) shows that, irrespective of which of these preferences holds, the planner always moves second in the endogenous timing equilibrium. Overall, in the endogenous timing game, the planner is never a leader, even when it would like to do so, so the timing of a principal-agent model is never valid.

Although two different types of endogenous timing equilibria exist, depending upon the best reply slopes of both players, the relation between optimal and equilibrium redistributions depends only on the slope of the planner's best reply. Let T^e be the equilibrium value of T in the endogenous timing game.

Proposition 7: The planner does more redistribution in the endogenous timing game than in the first-best outcome ($T^e > T^*$) if the planner's best reply slopes up, and the planner does less if it slopes down.

6. Conclusions

We have analyzed a model of a welfare-maximizing planner who uses lump-sum taxes for redistribution and interacts with a monopolist who sells to domestic consumers but whose profits are distributed to both foreign and domestic consumers. The interaction with the multinational monopoly changes the optimal redistribution policies of the planner and has some significant methodological implications for developing models, especially in international economics.

When facing a price-setting multinational monopoly, the planner changes both the extent of its redistribution from what it would have done in a first-best perfectly competitive world and the rule determining the amount of its redistribution. Our simplified model highlights a number of factors which influence whether there is more or less redistribution in equilibrium than in the first-best case. A major one was the difference in income effects between the consumers. In a more general model, what would matter is whether more redistribution increases or decreases demand for the monopolist's product. Another factor is the extent to which foreigners or domestic consumers own the monopoly. Since this may differ systematically between large and small countries, it provides one reason why distribution policies may differ with country size. Whether the planner prefers to do more or less redistribution as the monopolist's price increases in turn depended on a large number of factors. The difference in income effects and the share of domestic ownership affect the slope of the planner's best reply, as do difference in absolute risk aversion. Lastly, the timing of decisions by the planner and the monopolist is crucial.

It is also of interest to note some factors which do not directly affect these results comparing equilibrium and first-best redistribution. While the response of monopoly profits to changes in redistribution is crucial, the magnitude of the monopoly distortion and the relative profit shares of the domestic consumers matter only indirectly for this comparison. The total share of domestic owners has a direct effect on the optimal rule for redistribution and the comparison of equilibrium with first-best redistribution, but how this share of profits is divided among domestic consumers does not.

We now turn to the methodological implications. First, except in one special case (a foreign-owned monopoly which sets its price prior to or simultaneous with the planner's action), it is inappropriate to use a Samuelson social welfare function as a justification for assuming a representative consumer to study a many-person economy. Distributional complications cannot be easily circumvented when a monopoly is present. Second, it can often be inappropriate to assume the standard timing of decisions in which the government moves before private agents. Not only does changing the timing of decisions alter results, but the standard timing does not arise from an endogenous determination of the order of play. In the endogenous timing equilibrium with a price-setting monopolist, either the planner and the monopolist move simultaneously or the planner is a follower. The planner is never a leader. Third, at the equilibrium, it may appear that less redistribution is done than according to the Samuelson rule, but the global move to the first-best optimum could entail less redistribution. This occurs because price, as well as the size of the transfers, changes.

APPENDIX A
PROPERTIES OF PREFERENCES AND BEST REPLIES

Lemma 1: The sign of $\partial\Pi/\partial T$ (the direction of increasing profits with respect to T) and the sign of $\partial p/\partial T$ (the slope of the monopolist's best reply) are the same as the sign of x_I - y_I.

Proof of Lemma 1: The sign of $\partial\Pi/\partial T$ follows immediately from (3). To find the sign of $\partial p/\partial T$, set $\partial\Pi/\partial p = 0$, totally differentiate it, and use the assumptions of linear and parallel demand curves. This yields:

$$\frac{\partial p}{\partial T} = \frac{x_I - y_I}{-2(x_p + y_p)[1-(p-c)(\alpha x_I + \beta y_I)]}. \tag{A1}$$

The denominator is positive at the profit-maximizing price from second-order conditions. **QED**

Lemma 2: On or above the monopolist's best reply function (that is, when $\partial\Pi / \partial p \leq 0$), a decrease in price, holding T constant, increases social welfare. Similarly, on the planner's best reply function for p > c (that is, where $\partial\overline{W}/\partial T = 0$), a decrease in price, holding T constant, increases social welfare.

Proof of Lemma 2: Differentiating $\overline{W}$ with respect to p, we find:

$$\frac{\partial\overline{W}}{\partial p} = \hat{W}_a V_I^a\left(-x + \alpha\frac{\partial\Pi}{\partial p}\right) + \hat{W}_b V_I^b\left(-y + \beta\frac{\partial\Pi}{\partial p}\right). \tag{A2}$$

If $\partial\Pi/\partial p \leq 0$, then $\partial\overline{W}/\partial p < 0$. On the locus $\partial\overline{W}/\partial T = 0$, substituting (2) for $\partial\Pi/\partial p$, using (4), and using the Slutsky equation to replace x_p and y_p, we obtain:

$$\frac{\partial\overline{W}}{\partial p} = \hat{W}_b V_I^b \frac{(x+y)(\alpha + \beta - 1) + (p - c)\left(x_p^c + y_p^c\right)(\alpha + \beta)}{\left[1 - (p - c)(\alpha + \beta)y_I\right]} \tag{A3}$$

where x_p^c and y_p^c are compensated demand derivatives. Since $\alpha + \beta \leq 1$, the numerator must be negative. Since the denominator is positive from normality of other goods, $\partial\overline{W}/\partial p < 0$ along the planner's best reply. Hence, with optimal redistribution so that $\partial\overline{W}/\partial T = 0$, a price increase always lowers welfare. **QED**

Lemma 3: The slope of the planner's best reply function can be positive or negative, and which of these occurs is independent of the slope of the monopolist's best reply function. There is a weak tendency for the two best replies to slope in the same direction when the monopoly is owned mainly by domestic consumers and to slope in the opposite direction when the monopoly is owned mainly by foreigners.

Proof of Lemma 3: Consider the slope of T(p) at the simultaneous move Nash equilibrium (at the intersection of the best reply functions). At this point, $\partial\Pi/\partial p = 0$ which simplifies the derivation of $\partial T/\partial p$. Setting (4) equal to zero and totally differentiating, after some manipulation, $\partial T/\partial p$ has the same sign as:

$$\partial \ln\left(\hat{W}_a / \hat{W}_b\right)/\partial p + xR^a - yR^b +$$

$$(x_I - y_I)\frac{\alpha+\beta-1 + (p-c)(\alpha+\beta)(x_I + y_I - (p-c)(\alpha+\beta)x_I y_I)}{\left(1-(p-c)(\alpha+\beta)x_I\right)\left(1-(p-c)(\alpha+\beta)y_I\right)} \qquad \textbf{(A4)}$$

where $R^j \equiv -V^j_{II}/V^j_I$ is the coefficient of absolute risk aversion. The first term in (A4) can take either sign depending on how a change in the monopolist's price changes the slope of the social welfare contour by changing the distribution of utilities. The term depends on both the curvature of the social welfare contour and on the difference in individuals' demands for the monopolist's good. For a utilitarian social welfare function, this term equals zero since $\hat{W}_a$ and $\hat{W}_b$ are constants. The second term can take either sign depending upon the levels of x and y and the coefficients of absolute risk aversion of the two types. The signs of these first two terms are independent of the sign of $x_I - y_I$ which completely determines the sign of $\partial p/\partial T$.

The third term of (A4) relates directly to $x_I - y_I$. The denominator is positive from the stability condition if $x_I = y_I$. For $\alpha + \beta$ below some critical value (for large foreign ownership), the term multiplying $x_I - y_I$ is negative. To see this, rewrite the last term in parentheses as $x_I\left(1-(p-c)(\alpha+\beta)y_I\right)+y_I$. Again stability assures that $1-(p-c)(\alpha+\beta)y_I > 0$, and normality assures that $x_I > 0$ and $y_I > 0$, guaranteeing that this whole term is positive. Hence, this term provides a tendency for T(p) to slope in the opposite direction from p(T). When $\alpha + \beta$ is greater than that value, then the term multiplying $x_I - y_I$ is positive, providing a tendency for T(p) and p(T) to slope in the same direction. However, the first two terms can outweigh this third term and, for any level of foreign ownership, the signs of p(T) and T(p) can have any relationship. **QED**

APPENDIX B
PROOFS OF PROPOSITIONS

Proof of Proposition 1: Differentiating $\overline{W}$ (p(T), T) with respect to T, using $\partial\Pi/\partial p = 0$, and Roy's Identity, the first-order condition when the planner moves first reduces to:

$$\hat{W}_a V_I^a\left(1 + \alpha\frac{\partial\Pi}{\partial T} - x\frac{\partial p}{\partial T}\right) = \hat{W}_b V_I^b\left(1 - \beta\frac{\partial\Pi}{\partial T} + y\frac{\partial p}{\partial T}\right).$$

Both terms in parentheses are positive. Under the assumption of linear and parallel demand curves, $\hat{W}_a V_I^a - \hat{W}_b V_I^b$ has the same sign as $-(\alpha+\beta)\frac{\partial\Pi}{\partial T} + (x+y)\frac{\partial p}{\partial T}$, which, by substituting (A1), (3), and (2) using $\partial\Pi/\partial p = 0$, equals $\frac{(x_I - y_I)(2(\alpha+\beta) - 1)(p-c)}{-2[1 - (p-c)(\alpha x_I + \beta y_I)]}$. Thus, $\hat{W}_a V_I^a - \hat{W}_b V_I^b$ is opposite $x_I - y_I$ in sign when $\alpha + \beta > ½$, and has the same sign when $\alpha + \beta <$ ½.

When the planner does not move first, $\partial\overline{W}/\partial T = 0$. Using (4), $\hat{W}_a V_I^a - \hat{W}_b V_I^b$ has the same sign as $(p-c)(\alpha + \beta)(y_I - x_I)$. **QED**

Proof of Proposition 2: From Lemma 1, when the monopolist's best reply slopes up, then $\partial\Pi/\partial T > 0$. Therefore, when moving first, the monopolist chooses a point on the planner's best reply where T is greater than at (p^3, T^3), regardless of the slope of the planner's best reply. Thus, $T^2 > T^3$. From Lemma 2, $\partial\overline{W}/\partial p < 0$ at (p^3, T^3). Therefore, when choosing first, the planner selects a point on p(T) with a lower price than at (p^3, T^3). When p(T) slopes up, T is also lower, implying that $T^3 > T^1$, as required. See Figures 3(a) and 4(a) for these cases. The reverse inequalities hold when p(T) slopes down, as shown in Figures 3(b) and 4(b). Note that the slope of p(T) only at the outcome (p^3, T^3) needs to be specified for this result. **QED**

Proof of Proposition 3: Since T^*, T^2, and T^3 all lie on the planner's best reply function with T^* at the lowest price, $T^* > \max\{T^2, T^3\}$ if it slopes down and $T^* < \min\{T^2, T^3\}$ if it slopes up. From this and Proposition 2 (see Figure 4), we get the comparison of T^* and T^1 when best replies have opposite slopes. See Figure 3 for the cases where best replies slope in the same direction. The first-best outcome and (p^1, T^1) are both above or below (p^3, T^3), depending on whether the best replies slope up or down. How T^1 and T^* compare depends on how close T^1 is to T^3, which depends on the exact shape of the isowelfare contours. **QED**

Proof of Proposition 4: In all cases, players prefer moving first to moving simultaneously since the simultaneous move outcome is still feasible when moving first. Hence, $\Pi^2 > \Pi^3$ and $W^1 > W^3$. When the planner moves first, from Proposition 2, $T^1 > T^3$ when the best replies slope down (and $T^3 > T^1$ when they slope up). Since $\partial\Pi/\partial T$ has the same sign as $\partial p/\partial T$ from Lemma 1, $\Pi^3 > \Pi^1$ in both cases. Again, from Proposition 2, $T^2 > T^3$ when the best replies slope up, and hence, $p^2 > p^3$. Since $\partial\overline{W}/\partial p < 0$ from Lemma 2, $W^2 < W^3$. When best replies slope down, $T^3 > T^2$, implying $p^2 > p^3$ and $W^2 < W^3$ as before. **QED**

Proof of Proposition 5: The profit ordering follows from Proposition 2 and Lemma 1, as in the proof of Proposition 4. For the planner, $W^1 > W^3$ always holds. Consider the comparison of W^2 and W^3. In both cases in Figure 4, T(p) intersects the set of points that Pareto dominate (p^3, T^3). When the monopolist moves first and chooses a point on T(p), (p^2, T^2) must be in the set of points which Pareto dominate (p^3, T^3). To see this, note that, given that there is a social bliss point, T(p) could have a second intersection with the isowelfare curve through (p^3, T^3), and thus could go out of the Pareto preferred set. However, at this second intersection, $p < c$ must hold. The monopolist would never choose such a price, and therefore, (p^2, T^2) is in the set Pareto preferred to (p^3, T^3). Thus, $W^2 > W^3$. No general comparison of W^1 and W^2 is possible. **QED**

Proof of Proposition 6: (A) In these cases, neither best reply function enters the set of points which Pareto dominate (p^3, T^3). When either player chooses a best point on the other's best reply function, it makes itself better off and the other player worse off than under simultaneous moves. Thus, both have a dominant strategy (when choosing the time to move) of playing at the first opportunity: being a leader is preferred to moving simultaneously to being a follower. Both play their dominant strategies and thus they move simultaneously.

(B) When the best reply functions have different slopes, one and only one best reply function (the planner's) intersects the set of outcomes that Pareto dominate (p^3, T^3). As argued in Proposition 5, (p^2, T^2) lies in this Pareto-dominating set. Moving first is a dominant strategy for the monopolist, since $\Pi^2 > \Pi^3 > \Pi^1$. Since $W^2 > W^3$, when the monopolist moves first, the planner prefers to follow. In the unique timing equilibrium, the monopolist leads and the planner follows. **QED**

Proof of Proposition 7: From Proposition 6(A), $T^e = T^3$ when both best replies slope in the same direction, while from Proposition 6(B), $T^e = T^2$ when the best replies slope in opposite directions. The result follows immediately from Proposition 3. **QED**

Notes

[1] See, for example, Wildasin [1991] and Wellisch and Wildasin [1996].

[2] Köthenbürger [2004, 2007] considers federal-to-local government transfers under two different timings: the local governments chooses their policy variables first or the federal government chooses its transfers first. The case of the federal unit moving second also corresponds to setting a policy formula for the transfer which depends on the local governments' choices. Below we discuss how one can interpret our model as describing transfers to lower-level government units.

[3] While it is quite common to model the government as a leader, this is far from universal. Grossman and Helpman [1994] use a common-agency model in which lobbyists are the principals and the government is the agent to study issues in trade protection.

[4] Given the production assumptions of constant marginal cost and independence, it is immaterial whether the monopoly good is produced inside or outside the economy.

[5] Profit maximization is not necessarily the optimal policy for a monopolist. One difficulty is that the monopolist's choice may affect other relative prices in the economy (see Gabszewicz and Vial [1972]). Another is that the monopolist may consume his own product. In consequence, the correct problem is to maximize the utility of the firm's owner.

If the monopoly is 100% foreign-owned, then profit maximization is the appropriate goal.

[6] This is really a stability condition. If it were not true, an announcement to consumers of a higher level of profit would induce a sufficiently large increase in demand to realize at least the announced higher profits. Then, the monopolist could succeed in generating arbitrarily large profits.

[7] These assumptions need only hold approximately for the results below to hold. We make them here to simplify the derivations.

[8] With foreign ownership, the planner does even better if $p < c$, but the monopolist will never charge prices this low.

[9] When the slope of the monopolist's best reply is less in absolute value than the slope of the planner's best reply, no speeds of adjustment toward the two best replies will satisfy asymptotic stability of the dynamic system. When the best replies have opposite slopes, asymptotic stability depends on the relative speeds of adjustment, but dynamic stability is possible.

[10] Similar results might hold in other contexts where rents or profits exist even without distortions, provided the redistribution has a direct effect on the level of profits, taking as given others' decisions.

[11] Hamilton and Slutsky [2000] show that this approach to separating distributional concerns from other choices of a social planner is valid only when distribution decisions are made after the planner's allocation decisions.

Tower [1992] shows that the aggregate welfare function approach cannot be used to find the optimal tariff.

[12] For similar results, see Atkinson and Stern [1974] in a public good models or Diamond and Mirrlees [1974] in an externality model.

[13] It is even possible that $T^1 < 0$, so when the planner moves first, the redistribution is in the opposite direction to that in the first-best case.

[14] Hamilton and Slutsky [1990] define players to be qualitatively symmetric if the slopes of their best reply functions have the same sign and if the directions of increasing payoff with respect to the opponent's choice variable are the same.

[15] Replacing the planner's choice variable T with $T^b \equiv - T$ would restore qualitative symmetry, but the best replies would change sign, making Figure 3(a) look the same as Figure 3(b).

[16] See Hamilton and Slutsky [1990] for further details. Syropoulos [1994] develops an international trade application. In his model, all firms are perfectly competitive and two countries choose both the timing of their policies and whether to implement a tariff or a quota.

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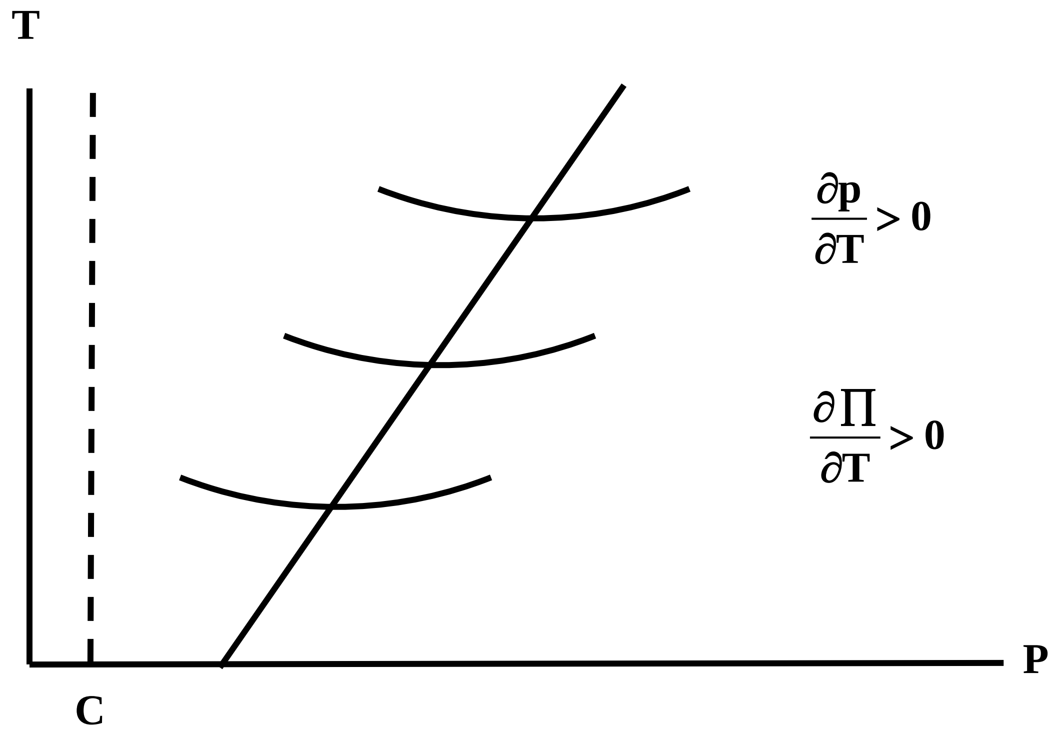

Figure 1a

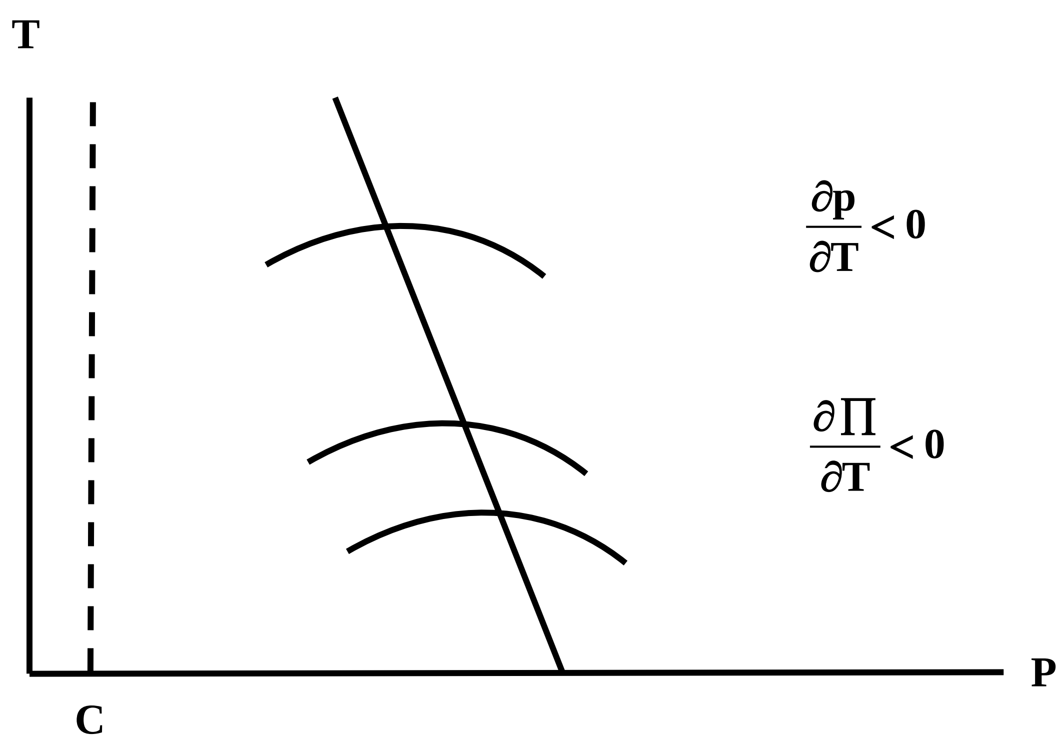

Figure 1b

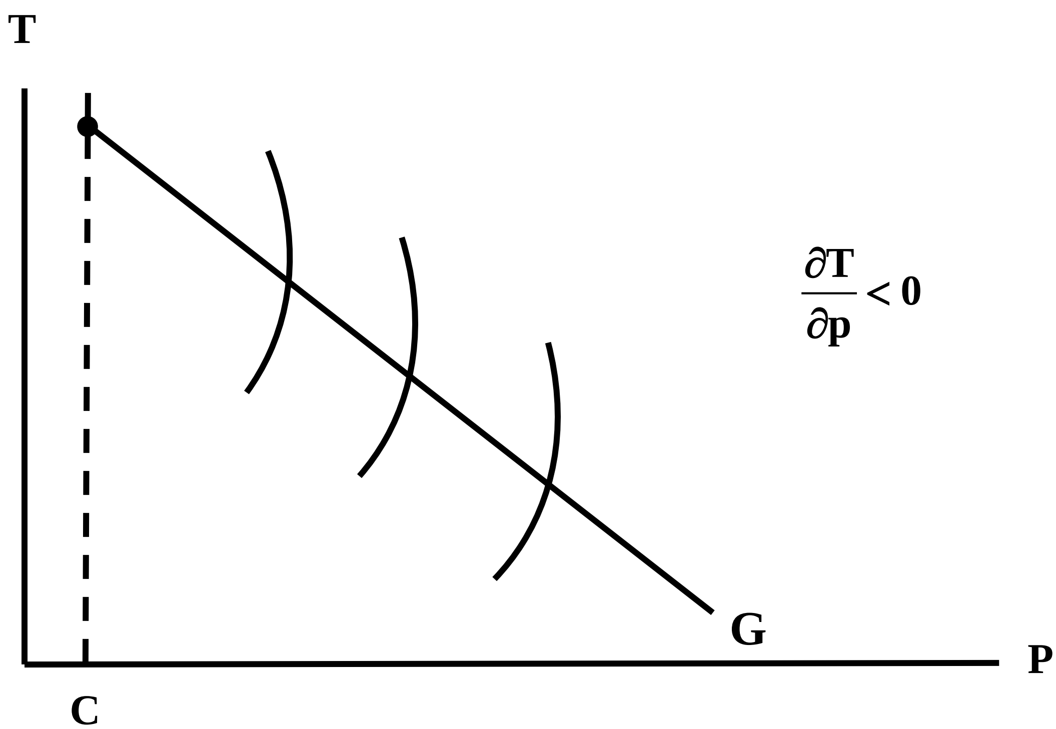

Figure 2a

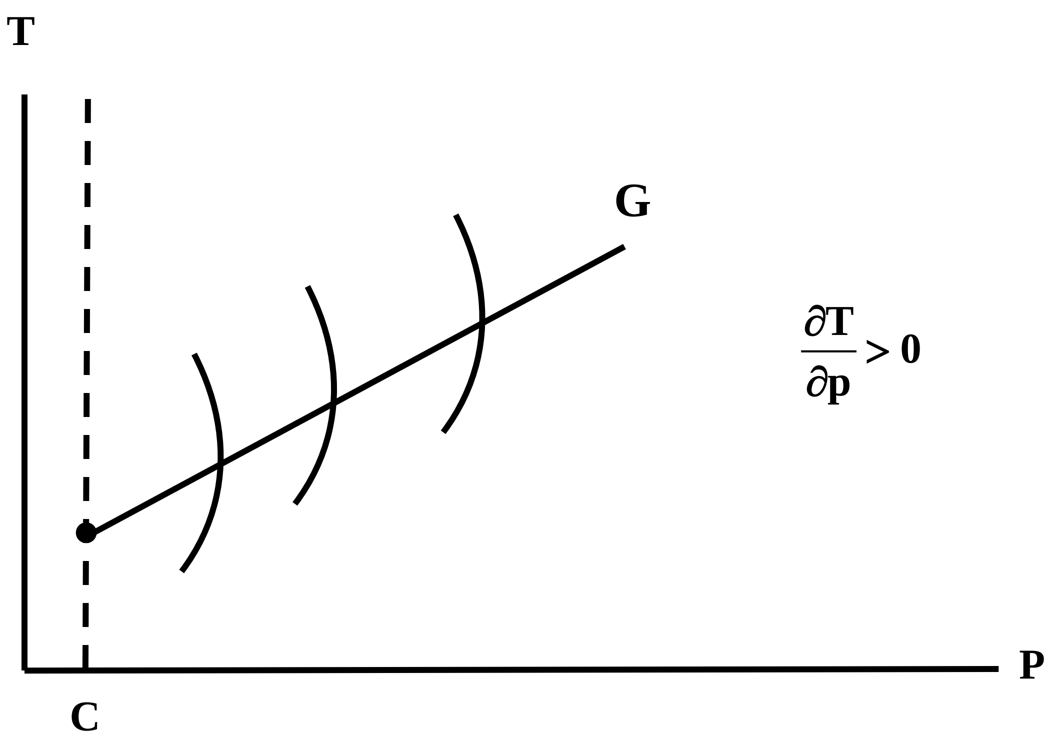

Figure 2b

Figure 2: The planner's bliss point is at the intersection of the planner's best reply and the line p = c.

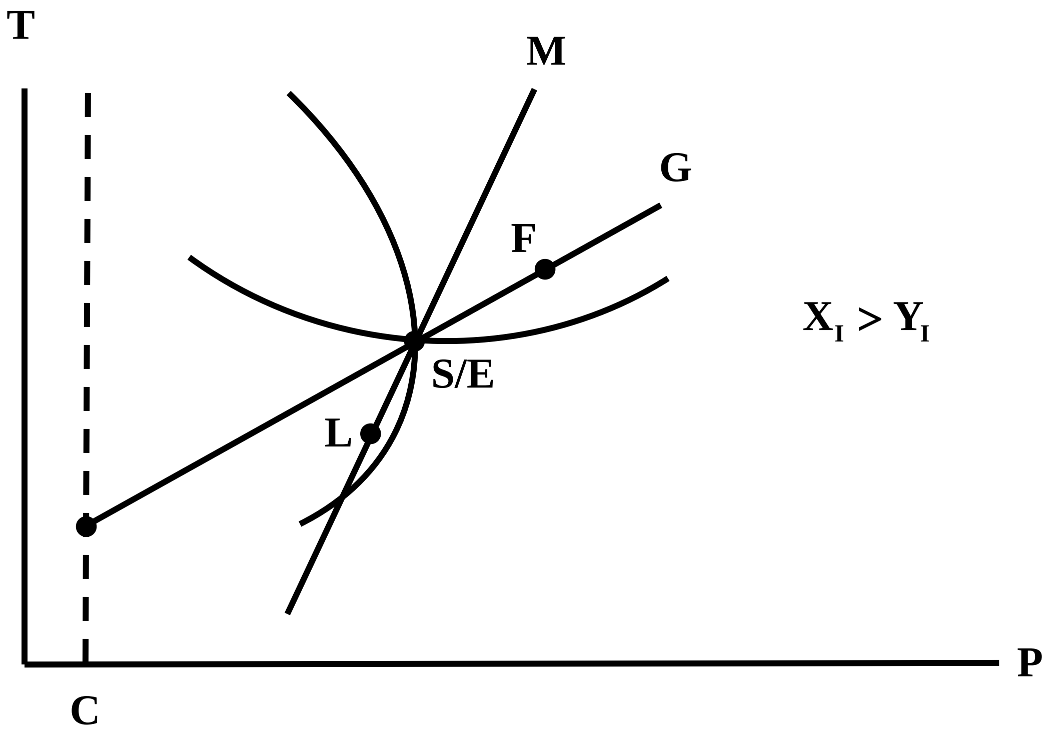

Figure 3a

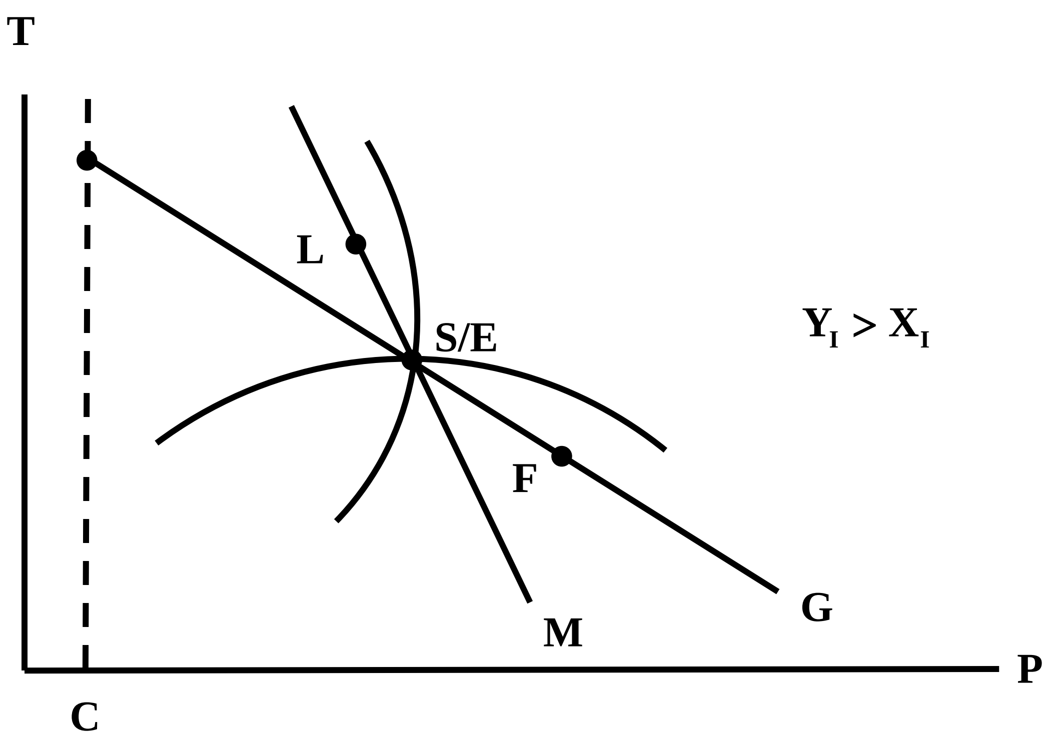

Figure 3b

Figure 3: S denotes the equilibrium with simultaneous moves, L the equilibrium when the planner moves first, F the equilibrium when the monopolist moves first, and E the equilibrium of the endogenous timing game.

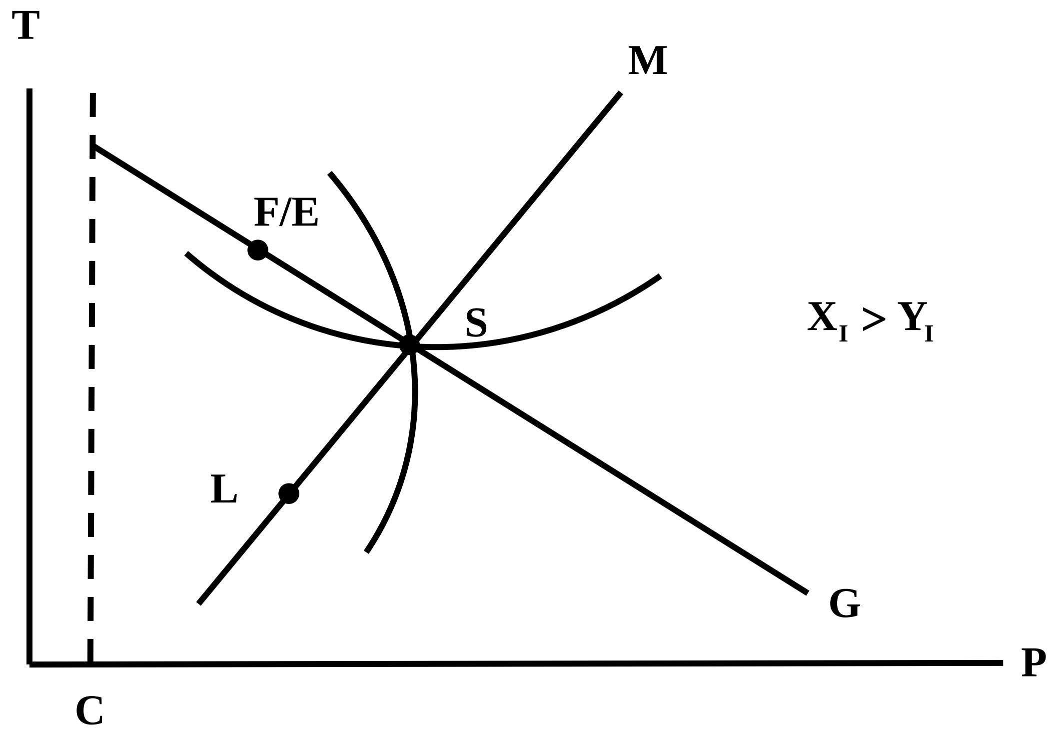

Figure 4a

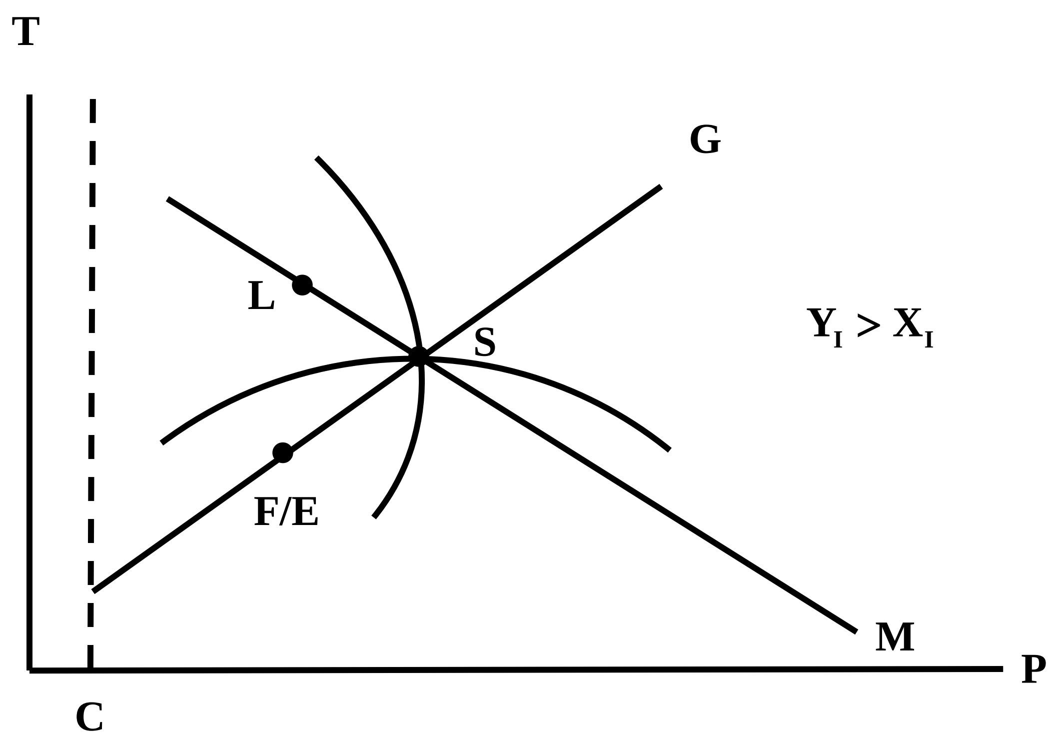

Figure 4b

Figure 4: S denotes the equilibrium with simultaneous moves, L the equilibrium when the planner moves first, F the equilibrium when the monopolist moves first, and E the equilibrium of the endogenous timing game.