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General Equilibrium Tax Incidence under Imperfect Competition: A Quantity-setting Supergame Analysis

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The incidence of various taxes is analyzed in a model with competitive and oligopolistic sectors. Friedman's "grim" trigger strategies support collusion with firms producing output to maximize joint profits subject to the constraint that no firm desires to cheat. The sustainable level of output depends on the capitalized value of future retaliation; therefore, tax-induced changes in the net return to capital (the discount rate) affect the output mix through their impact on the sustainability of collusion. This "collusive pricing effect" is isolated and analyzed. One result is that a general factor tax on capital (but not labor) is shifted.

I. Introduction

In the appendix to his seminal article on tax incidence, Harberger (1962) argued that the mechanism that determines the incidence of the corporate tax in a model with a monopolistic corporate sector "differs only in minute detail" from the mechanism at work in the competitive case. Several authors have observed that Harberger's treatment of imperfect competition was less than adequate, and thus there have been attempts to extend the basic two-sector model to allow for imperfect competition. Most notable are the studies by Anderson and Ballentine (1976) and Atkinson and Stiglitz (1980), in which one sector is assumed to be monopolistically competitive. In each of these papers the authors assume that the firms act in a Cour-

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not-Nash manner. Both papers provide significant insight into the effects of taxation in the presence of substantial levels of imperfect competition; however, the Cournot-Nash assumption directs attention away from the analysis of the consequences of group interdependence and collusion, factors that are of vital importance in oligopolistic industries when the level of concentration is high. In this paper we provide an alternative model that focuses on these factors and how they alter the standard results obtained in the tax incidence literature.

We model a two-sector economy with perfectly competitive and oligopolistic sectors. Rather than rule out collusion in the oligopolistic sector, we assume that tacit collusion is the norm. In modeling this sector we make use of the fundamental insight of the supergame literature (see Aumann 1959; Friedman 1971, 1977; Rubinstein 1979, 1980; Green 1980; Radner 1980; Abreu 1983; Porter 1983; Brock and Scheinkman, in press): if a market situation is repeated infinitely, the industry may settle at a collusive price even if the firms are not explicitly colluding. This implicit agreement is enforceable if firms deviating from the agreement suffer future losses (due to retaliation) that outweigh any immediate gains from cheating. Such models of oligopoly are especially interesting in a general equilibrium setting because of the central role played by the net return to capital, which is the discount rate for firms that maximize the present value of profits.

To see this role, observe that it is in the collective interest of firms in the oligopolistic sector to maintain an aggregate output as close as possible to that of a monopoly. In choosing industry output, however, they must beware of the individual firm's incentive to violate the implicit agreement, an incentive that varies inversely with industry output. Thus the chosen output must be sufficiently large that the individual gains from cheating on the agreement do not dominate the capitalized value of the losses due to retaliation. It follows that the sustainable industry output depends critically on the discount rate, for higher rates diminish the present force of future retaliation. In order to keep firms from cheating when the discount rate rises, the output level must be increased. Taxes that alter the net return to capital in general equilibrium will consequently affect the sustainable level of industry output and hence its market price.

The paper is divided into three additional sections. In Section II we outline a partial equilibrium model of oligopoly that captures the spirit of the supergame approach yet yields conditions appropriate for the kind of comparative statics used in general equilibrium tax incidence. In the next section we imbed our model of oligopoly into the standard two-sector general equilibrium economy with taxes and formally isolate the collusive pricing effect. A surprising result is that a general factor tax on capital is shifted. The reason lies in the dual

role played by the return to capital: the gross return allocates the fixed stock of capital, and the net return determines the sustainable level of collusive output. In the standard model the net return to capital falls to offset the tax, leaving unchanged the *gross-of-tax* factor price and therefore the equilibrium values of all other prices. In our model, on the other hand, this fall in the *net* return to capital increases the present value of retaliation by the cartel and thus allows it to sustain a lower level of industry output. This change in the economy's mix of output then induces changes in factor prices.

We also consider excise and partial factor taxes. In addition to the usual output and factor substitution effects, our model implies the existence of the collusive pricing effect. Section IV contains a few concluding remarks.

II. Partial Equilibrium in the Oligopolistic Sector

We model the oligopolistic sector as a repeated game (supergame) among N identical firms, each producing a single homogeneous good (X) under constant costs. Firms collude (tacitly or explicitly) to restrict output and enforce the chosen output levels through threat of retaliation against "cheaters" (firms that exceed their production quotas). Specifically, we consider agreements enforced by the "grim" trigger strategies; that is, all firms produce their share of the cartel quantity unless some firm cheats. If any cheating occurs at time t , the cartel dissolves, and each firm reverts permanently to the output level it produces in the static Nash equilibrium. We assume that any cheating is detected costlessly.

The potential cheater compares the current higher profits due to cheating and the future lower profits brought about by the dissolution of the cartel. More formally, let π^{ch} denote the profit earned when cheating; π^c the profit per firm if all abide by the production plan of the cartel; and π^n the profit earned by each firm in the static Nash equilibrium. The net gains from cheating (Z) are then

$$Z = (\pi^{ch} - \pi^c) - \frac{1}{r} (\pi^c - \pi^n). \quad (1)$$

The first term in parentheses is the extra profit earned at time t by exceeding the production quota; the second is the present value of all future lower profits due to retaliation. The discount rate is r . Cheating occurs when $Z > 0$.

In order to examine Z in more detail let $P_X(\bar{Q}, \omega)$ denote the twice differentiable inverse demand for good X , with \bar{Q} denoting industry output and ω a vector of shift parameters. If we let c denote the constant unit cost and Q_i the output of an individual firm, then profit per firm is

$$\pi_i = [P_X(\bar{Q}, \omega, c, r) - c]Q_i.$$

It is well known that existence problems trouble models of imperfect competition unless further restrictions are placed on demand conditions (see Roberts and Sonnenschein 1977). Hence we assume that industry profits defined by $P(\cdot)$ and c are single peaked. This assumption ensures that π^i is well defined. Note that once $P(\cdot)$ and c are given, π^i is determined and is independent of the cartel's actions. Cheating profits are obtained by maximizing π_i over Q_i , assuming all other firms are producing the cartel output level Q_c . Thus cheating output, cheating profits, and Z may be written as a function of Q_c .

Turning to the cartel's problem, we assume that it chooses the aggregate production level and its distribution among firms to secure as large a joint profit as is consistent with the absence of cheating.¹ Because all firms are identical, however, the distribution of output quotas will be symmetrical. Thus the cartel problem reduces to that of choosing output per firm, Q_c , from the set of sustainable outputs defined as $\Omega \equiv \{Q_c: Z \leq 0, Q_c \geq 0\}$. In this setting Ω may be interpreted as a constraint on the ability of the cartel to restrict output. Formally, the cartel solves

$$\begin{aligned} &\text{maximize } \pi^c \\ &Q_c \\ &\text{subject to } Q_c \in \Omega. \end{aligned} \quad (2)$$

Let Q_c^* denote the solution to (2). Because the number of firms is fixed, our assumption that profit functions are single peaked implies that π^c has a unique maximum, say π^m for $Q_c = Q_m$. If $Z(Q_m) \leq 0$, then $Q_c^* = Q_m$; that is, joint profit maximization is sustainable. This case is equivalent to having a monopolist in this sector, and since tax incidence in the presence of a monopolistic sector has been studied by Anderson and Ballentine (1976) and Atkinson and Stiglitz (1980), we will assume $Z(Q_m) > 0$. In this case, Q_c^* is the smallest level of output greater than Q_m that satisfies $Z(Q_c) = 0$. Collusion exists, but it is constrained collusion.

In general, writing Z as a function of Q_c and the other parameters of the model, we obtain the solution to (2) by solving equation (3) for Q_c :²

$$Z = \bar{Z}(Q_c, \omega, c, r) = 0. \quad (3)$$

Variable Q_c may then be substituted into the inverse demand function

¹ See also Brock and Scheinkman (in press), who adopt this approach for price-setting supergames.

² In Davidson and Martin (1984) it is shown that a solution to eq. (2) always exists and that the implicit function theorem holds for (3).

to obtain the cartel's price as a function of the basic parameters of the model:

$$P_X = P_X(\omega, c, r). \quad (4)$$

In the next section we imbed (4) in a general equilibrium model.

Of particular interest in (4) is the role of r , the discount rate. For a cost-minimizing firm, the discount rate will be equated to the net return to capital. In the absence of taxes r also represents the cost of capital and enters (4) through c . But r also enters separately as the third argument. This separate effect indicates the impact of the price of capital on the pricing decision of the cartel. A rise in r diminishes the present force of future retaliation, but it also increases the cost of capital. If the first effect dominates, then such a change will require an increase in output (fall in price) in order to keep firms from cheating on the agreement. Unlike the competitive model (or other models of imperfect competition) in which an increase in the cost of capital can result only in higher prices, in this supergame there is a possibility that the prices of output and capital may move in opposite directions. Formally, differentiating (4), we get

$$\frac{dP_x}{dr} = \frac{\partial P_x}{\partial c} \left(\frac{\partial c}{\partial r} \right) + \frac{\partial P_x}{\partial r}. \quad (5)$$

The positive first term in (5) captures the "cost-push" effect of the change in r ; the negative second term, the impact of the greater inducement to cheat on the original quantity assignments. We term this latter effect the "collusive pricing" effect, and in the next section we investigate how this additional force alters the standard results on tax incidence.

III. The Oligopolistic Sector in General Equilibrium

In this section we imbed the model of oligopoly into the standard two-sector model of general equilibrium. The basic model is well known, and we follow the presentation and notation of Atkinson and Stiglitz (1980). There are two goods, X and Y , and each is produced under constant returns. Perfect competition prevails in the Y sector, but the X sector is oligopolistic. Both sectors employ capital and labor, which are fixed in supply and fully mobile among firms and between sectors. Capital is infinitely lived and nondepreciable and is traded in a flourishing rental market. All firms, whether competitive or members of a cartel, are price takers in the capital market. This implies that the opportunity cost of using capital is the gross-of-tax equilibrium rental price, for both firms that own capital and those that rent. In the context of this model capital is putty-putty. There are no sunk costs.

We let q_j = the gross-of-tax output price of good j , c_j = the unit cost function for good j , w and r = the net returns to labor and capital, respectively, T_j = one plus the ad valorem output tax on good j , T_{ij} = one plus the partial factor tax on input i used in the production of good j , and M = aggregate income.

The innovation in our model is the pricing in the oligopolistic sector, which is governed by an equation analogous to (4). In the model the vector of shift parameters includes the price of good Y and income; that is, $\omega = (q_y, M)$. Then, assuming $Z(Q_m) > 0$, the cartel's gross price is given by

$$q_x = q_x(q_y, M, c_x T_x, r). \tag{6}$$

Assuming perfect competition in the Y sector, the price of Y must be equal to the marginal cost of production:

$$q_y = c_y(w T_{L_y}, r T_{K_y}) T_y. \tag{7}$$

Aggregate demands for the two products are

$$X = X(q_x, q_y, M), \tag{8}$$

$$Y = Y(q_x, q_y, M), \tag{9}$$

and since in equilibrium all income is spent,

$$M = q_x X + q_y Y. \tag{10}$$

Assuming fixed supplies of the two inputs, labor (L) and capital (K), the full-employment equations are

$$c_{L_x} X + c_{L_y} Y = L_0, \tag{11}$$

$$c_{K_x} X + c_{K_y} Y = K_0. \tag{12}$$

Here the c_{ij} are the partial derivatives of the j th unit cost function with respect to the i th factor and represent the i th input requirement per unit of output of the j th good; L_0 and K_0 represent the fixed stock of labor and capital, respectively.

Equations (6)–(12) comprise the general equilibrium model. Choosing w as the numeraire and dropping equation (9) from the model leaves six equations in six unknowns. The standard approach is to differentiate this system of equations totally and solve the resulting "equations of change." Unfortunately, differentiation of (6) yields, in general, quite an unwieldy expression involving relative shifts in the demand for X at the cartel, Nash, and cheating points. Thus for the remainder of this paper we focus on a specific case; we assume that the representative consumer has a utility function of the form

$$U(X, Y) = (1 - \alpha) \ln Y + \alpha \ln X.$$

In this case the inverse demand curve for X is

$$q_x = \frac{\alpha M}{X} \quad (13)$$

so that α is the budget share of good X . Equation (6) can now be simplified since (13) does not directly involve the price of good Y .

Carrying out the cartel's maximization problem (see eq. [2]) yields (assuming $r > 1/N$ so that the monopoly output is not sustainable)

$$Q_c = \frac{\alpha M(N-1)(rN-1)^2}{c_x T_x N^2 (rN+1)^2}. \quad (14)$$

Substituting into (13) we obtain the counterpart of (4) and (6):³

$$q_x = \frac{N(rN+1)^2}{(N-1)(rN-1)^2} c_x T_x. \quad (15)$$

Finally, differentiating (7) and (15) and subtracting we have

$$\hat{q}_x - \hat{q}_y = -(\theta^* + \Psi)\hat{r} + (\hat{T}_x - \hat{T}_y) + \theta_{Kx}\hat{T}_{Kx} - \theta_{Ky}\hat{T}_{Ky}, \quad (16)$$

where, as usual, the circumflex ($\hat{\cdot}$) indicates proportional change (e.g., $\hat{X} = dX/X$), $\theta^* = \theta_{Lx} - \theta_{Kx}$, $\theta_{Lj} \equiv w c_{Lj} T_j / c_j$ (the share of costs going to labor in industry j), $\theta_{Kj} \equiv r c_{Kj} T_j / c_j$ (capital's share in industry j), and θ^* measures the value of factor intensity. The second term in equation (16), $\Psi \equiv 4rN/[(rN)^2 - 1]$, captures the effect of changes in the discount rate on the ability of the cartel to enforce its output restriction. Note that $\Psi > 0$ for all $r > 1/N$, which is the present case.

Differentiation of the demand and full-employment conditions yields

$$\hat{X} - \hat{Y} = -(\hat{q}_x - \hat{q}_y), \quad (17)$$

$$\lambda^*(\hat{X} - \hat{Y}) = -(a_x \sigma_x + a_y \sigma_y)\hat{r} - a_x \sigma_x \hat{T}_x - a_y \sigma_y \hat{T}_y, \quad (18)$$

where $\sigma_j > 0$ is the elasticity of substitution in the production of the j th good, $\lambda^* \equiv \lambda_{Lx} - \lambda_{Kx}$, $\lambda_{ij} = c_{ij}/i_0$ (the share of factor i employed in industry j), and $a_j \equiv \theta_{Kj}\lambda_{Lj} + \theta_{Lj}\lambda_{Kj} > 0$. Obviously, $\lambda_{Lx} + \lambda_{Ly} = \lambda_{Kx} + \lambda_{Ky} = \theta_{Lx} + \theta_{Kx} = \theta_{Ly} + \theta_{Ky} = 1$ and $\lambda^*\theta^* > 0$.

³ It may seem that there is some legerdemain here in that P_y , M , c , and r are not fixed in general equilibrium. Should the cartel not anticipate the general equilibrium effects of its decisions and not act in accord with (4)? At a purely formal level this is true; however, following Harberger (1962, p. 239), we do not view the imperfectly competitive sector as a gigantic cartel but rather as comprising many cartels, each "small" relative to the economy but including firms that are large relative to the industry.

Equations (16)–(18) constitute a three-equation general equilibrium model with three unknowns: $\bar{X} - \bar{Y}$, $\hat{q}_x - \hat{q}_y$, and \hat{r} . We now consider the incidence of three types of taxes within this model: general factor taxes, output taxes, and partial factor taxes. In order to keep the discussion as simple as possible while focusing on what distinguishes our model from the standard, we will analyze the introduction of small taxes into a model with no existing taxes.⁴ The only existing distortion is that implied by cartel pricing. Although this implies that income is not constant (price exceeds cost in the X sector), the homotheticity of our product demands obviates any consideration of income effects (see Atkinson and Stiglitz 1980, pp. 182–83). Any tax revenue is refunded lump sum to consumers or spent according to equations (8) and (9).

A. General Factor Taxes

A general factor tax in the standard two-sector model is a tax on a factor in fixed supply and is borne entirely by the factor owners. That is, net returns fall to offset the tax exactly. Because the gross-of-tax factor price remains unchanged, the remainder of the economy is insulated from any tax-induced distortion.⁵

In our model, while this pattern remains for a general tax on labor,⁶ a portion of the general factor tax on capital may be shifted or capital owners may see their net returns fall by more than the tax payments. Furthermore, the mix of outputs, relative product prices, and returns to the untaxed labor will change with the tax on capital. The reason is that the net-of-tax price of capital (r) serves two functions: it allocates the fixed supply of capital between industries, and further it measures time preference. In this latter role, the level of r determines the present value of the punishment for cheating on the X sector cartel. A fall in r reduces the inducement to cheat, thereby allowing the cartel to sustain a higher price for its output.

⁴ Musgrave (1959, pp. 211–13) refers to this concept as differential tax incidence with equal money yield. We compare the incidence of various taxes with lump-sum taxes of equal monetary yield. The government will not generally be able to purchase the same bundle of real commodities. See Shoven and Whalley (1977) on various conceptions of equal yield taxation.

⁵ Feldstein (1977) shows that this need not hold in an intertemporal model. His fixed factor is land, which is a perfect substitute for capital as a store of wealth. The tax reduces the value of the stock of land, leading to an offsetting increase in capital holdings. In our model no such adjustment in the capital stock is possible, yet the tax is shifted.

⁶ The identity $wT_L = 1$ implies $\hat{w} = -\hat{T}_L$ and that a general tax on labor is borne entirely by workers. From (16)–(18) no other equilibrium values are affected.

In equations (16)–(18) set $\hat{T}_x = \hat{T}_y = 0$ and $\hat{T}_{Kx} = \hat{T}_{Ky} = \hat{T}_K$ and solve for the effects of changes in T_K on the three endogenous variables:

$$-iD^* = (\theta^*\lambda^* + a_x\sigma_x + a_y\sigma_y)\hat{T}_K, \quad (19a)$$

$$(\hat{X} - \hat{Y})D^* = -(a_x\sigma_x + a_y\sigma_y)\Psi\hat{T}_K, \quad (19b)$$

$$(\hat{q}_x - \hat{q}_y)D^* = (a_x\sigma_x + a_y\sigma_y)\Psi\hat{T}_K; \quad (19c)$$

$D^* \equiv a_x\sigma_x + a_y\sigma_y + \lambda^*(\theta^* + \Psi)$ must be positive for stability.⁷

Equation (19a) confirms that w/r increases with an increase in T_K , but the absolute value of the elasticity is less or greater than one as λ^* is positive or negative. If $\lambda^* > 0$, then the X industry is labor intensive. The tax-induced fall in r reduces cartel output, which concomitantly increases the relative demand for capital, mitigating the fall in its relative price. Some of the tax is then shifted toward labor. On the other hand, if the cartel sector is capital intensive ($\lambda^* < 0$), then the restriction in its output further increases w/r . Capital bears more than 100 percent of the tax.⁸

B. Selective Output Taxes

To examine the impact of a selective output tax on the X sector set $\hat{T}_{Kx} = \hat{T}_{Ky} = \hat{T}_y = 0$ in (16)–(18) and solve for $(\hat{X} - \hat{Y})$, $(\hat{q}_x - \hat{q}_y)$, and \hat{r} . We obtain

$$iD^* = \lambda^*\hat{T}_x, \quad (20a)$$

$$(\hat{X} - \hat{Y})D^* = -(a_x\sigma_x + a_y\sigma_y)\hat{T}_x, \quad (20b)$$

$$(\hat{q}_x - \hat{q}_y)D^* = (a_x\sigma_x + a_y\sigma_y)\hat{T}_x. \quad (20c)$$

Relative factor returns move inversely to the physical factor intensity of the taxed sector. The taxed sector contracts, and consumer prices for good X rise relatively (note that the price the firms receive may rise or fall depending on the strength of the collusive pricing effect). These results are consistent with those of the standard competitive model in sign, but the magnitude of the effects may be significantly different if the collusive pricing effect is large. The collusive pricing term, Ψ , affects D^* in the same direction as the sign of the measure of physical factor intensity, λ^* . If the taxed sector is labor intensive, the collusive pricing effect leads to a larger D^* and consequently smaller elasticities. Relative factor returns, outputs, and output prices are less

⁷ For a detailed discussion of the stability properties of this model see Davidson and Martin (1984).

⁸ For comparison with the standard two-sector tax model, in the competitive case $\Psi = 0$ and therefore $D^* = \lambda^*\theta^* + a_x\sigma_x + a_y\sigma_y$. From (19a) the elasticity of r with respect to the tax equals -1 and the right-hand sides of (19b) and (19c) vanish.

sensitive to taxation in this case. Intuitively, the tax-induced contraction in the X sector increases r , and the collusive pricing effect offsets a portion of the initial contraction. On the other hand, if $\lambda^* < 0$, the decline in X sector output reduces r and allows the cartel to restrict output further, augmenting the initial decline.

C. *Partial Factor Taxes*

Partial factor taxes induce output, factor substitution, and collusive pricing effects. Consider a tax on capital in the X sector. The incidence of such a tax is derived by setting $\hat{T}_x = \hat{T}_y = \hat{T}_{Ky} = 0$ in (16)–(18) and solving for the elasticities of relative outputs, prices, and factor returns. We obtain

$$\hat{D}^* = (\theta_{Kx}\lambda^* - a_x\sigma_x)\hat{T}_{Kx}, \tag{21a}$$

$$(\hat{X} - \hat{Y})D^* = -(\theta_{Ky}a_x\sigma_x + \theta_{Kx}a_y\sigma_y + a_x\sigma_x\Psi)\hat{T}_{Kx}, \tag{21b}$$

$$(\hat{q}_x - \hat{q}_y)D^* = (\theta_{Ky}a_x\sigma_x + \theta_{Kx}a_y\sigma_y + a_x\sigma_x\Psi)\hat{T}_{Kx}. \tag{21c}$$

The output and factor substitution effects appear as the additive terms on the right-hand side of (21a). As usual, the former decreases r unambiguously, and the latter raises r if X is labor intensive but lowers r if X is capital intensive. The collusive pricing effect appears in D^* , and the elasticity is smaller or larger as X is labor or capital intensive, respectively.

Equations (21b) and (21c) indicate that the taxed sector contracts and its relative price rises regardless of the net movement in factor prices. Suppose that the X sector is labor intensive and that the tax increases r . One might be tempted to infer that the higher r , through the collusive pricing effect, could lead to greater relative outputs for X . This cannot occur, however, because the tax-induced increase in r requires a contraction in the X sector in the first place.

Because Ψ appears on both sides of (21b), the impact of collusive pricing is not apparent. We differentiate the elasticity of relative outputs with respect to the collusive pricing term Ψ to obtain

$$\frac{d\left(\frac{\hat{X} - \hat{Y}}{\hat{T}_{Kx}}\right)}{d\Psi} = \frac{-(a_x\sigma_x + a_y\sigma_y)}{D^*} < 0. \tag{22}$$

Equation (22) clarifies the intuition that collusive pricing increases the elasticity when r falls but reduces the elasticity when r rises.

IV. **Conclusion**

This paper analyzes tax incidence within a general equilibrium model with oligopolistic and competitive sectors. We model the oligopolistic

sector as a supergame and assume that its output is the solution to a constrained maximization problem, where the constraint is the incentive of an individual firm to "cheat" on the oligopoly production plan. This approach allows comparative statics to be carried out in the traditional way. Further, we imbed our partial equilibrium oligopoly model into the standard two-sector model of general equilibrium. To our knowledge all of the supergame literature is partial equilibrium, and ours is the first general equilibrium treatment.

In our analysis of tax incidence we isolate a hitherto unnoticed collusive pricing effect that captures the impact of changes in the net return to capital on the output of the oligopoly. Because current output is enforced through threat of future retaliation, changes in the net return to capital, which is the discount rate of the firm, will affect the ability of the oligopoly to restrict output below Nash equilibrium levels.

One particular result stands out. A general factor tax on capital is shifted even though the factor is in fixed supply. In our model the *gross-of-tax* price of capital affects the cost of production, but the *net-of-tax* price affects the sustainable level of industry output. The introduction of a tax on capital must change either the net or gross price (or both), and therefore the impact of the tax "spills over" out of the capital market and affects the equilibrium values of all prices.

Finally, while we have considered a specific model of oligopoly, our results do not depend on the choice of this particular punishment scheme. For example, Abreu (1983) suggests a two-phase punishment scheme that, when the monopoly output is not sustainable, credibly supports more collusive output than the grim trigger strategies. In addition, in Abreu's model the punishment lasts only one period. Our results generalize to Abreu's model.⁹ The reason for this is that any punishment aimed at a potential cheater occurs in the future regardless of the number of periods it takes. The punishment is thus discounted, whereas the gains from cheating are immediate. An increase in the rate of interest always makes the capitalized value of the losses due to retaliation seem smaller and makes collusion more difficult to sustain. The collusive output must then expand to reduce the temptation to cheat. This interest rate-induced change in output is our collusive pricing effect.

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⁹ The derivation of our results in Abreu's model is available from the authors on request.

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