Econometrica, Vol. 54, No. 6 (November, 1986), 1357-1373

AN EXAMINATION OF MULTIJURISDICTIONAL CORPORATE INCOME TAXATION UNDER FORMULA APPORTIONMENT

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This paper examines how corporate taxation of multijurisdictional firms using formula apportionment affects the incentives faced by individual firms and individual states. Under formula apportionment, a firm's tax payments to a given state depend on its total profits nationally (or internationally) times an average of the fractions of the firm's total property, payroll, and sales located in that state. This apportionment of a firm's total profits among states, based on three separate factors, in effect creates three separate taxes, each with complicated incentive effects. A large part of our analysis is concerned with the component of the tax tied to the allocation of property. Under this tax, price distortions differ in general among firms within the same state, creating incentives for firms producing in different states to merge their operations. State tax policies are also affected by this apportionment formula: states choose inefficiently low tax rates and are encouraged to shift to direct taxation of property.

The component of the tax based on payroll creates many similar incentives. With this tax, however, the merger of firms producing different goods is discouraged. When a sales component to the tax is added, there are incentives for the cross-hauling of output, with production in low tax rate states sold in high tax rate states, and conversely.

None of the above distortions are created when the corporate tax uses separate accounting to divide a firm's profits among states. The final section presents an alternative apportionment formula which retains the administrative advantages of existing law, yet creates the same incentives as separate accounting as long as there are no economic profits.

KEYWORDS: Formula apportionment, state corporate income taxation, corporate mergers, cross-hauling.

1. INTRODUCTION

TAXATION OF corporate income becomes administratively quite complicated when a corporation is located in more than one taxing jurisdiction. National governments, in taxing a multinational firm, have attempted to establish separate economic accounting for the activity of a firm in each country. This approach creates the difficulty that nonmarketed intermediate goods transferred across borders must be priced, however arbitrarily. In contrast, U.S. state governments, in taxing a multistate firm, have adopted one of various formulas to apportion the total profits of the firm among the various states where it does business.[2] With formula apportionment, internal prices need not be established. This advantage is sufficiently attractive that in recent years there has been some interest in replacing separate accounting with formula apportionment when taxing multinational firms.[3]

[1] We would like to thank Charles E. McLure, Jr., James R. Gault, Mark Gersovitz, and two anonymous referees for helpful discussion and comments. Most of the work on this paper was done while the first author was employed at Bell Laboratories and the second author was employed at Columbia University. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research, or of AT&T Bell Laboratories.

[2] The U.S. Supreme Court has recently ruled that a state may apply formula apportionment to all profits of a firm, and not just to domestic profits.

[3] See, for example, Musgrave (1972) or United Nations (1974).

While administrative simplicity is an important attribute of formula apportionment, this paper argues that the use of formula apportionment also changes in complicated ways the incentives faced by both individual firms and individual states. Several distortions arise which are not found under a corporate tax based on separate accounting, or under direct factor taxes on capital, payroll, or sales. Furthermore, when international profits are apportioned, use of the tax by U.S. states directly affects incentives to invest abroad, even without any change in market interest rates or other prices, though the direction of the effect depends on the relative tax rates and the specific definition of taxable income.

Most states use a three part apportionment formula, basing the apportionment on the location of sales, payroll, and property. Algebraically, the formula for the tax due by a firm to state i may be expressed by

$$T_i = t_i[\alpha_K(K_i/K) + \alpha_W(W_i/W) + \alpha_S(S_i/S)]\pi_i^T,$$

where S_i, W_i, and K_i represent sales, payroll, and property in state i, respectively; S, W, and K represent total domestic sales, payroll, and property of the firm, respectively; α_j is the weight given to factor j in the apportionment formula ($\sum \alpha_j = 1$); π_i^T represents total profits of a firm as defined by state i's tax law; and t_i is state i's tax rate. The Multistate Tax Commission has recommended weighting all three factors equally, but some states weight them differently, while others use fewer than three factors.

As pointed out by McLure (1981), this apportionment of a firm's total profits among states, based on three separate factors, in effect creates three separate taxes, each with complicated incentive effects. A large part of our analysis is concerned with the component of the tax tied to the allocation of property. Under this tax, price distortions differ in general among firms within the same state, creating incentives for firms producing in different states to merge their operations. Use of this tax, rather than a corporate income tax based on separate accounting, also changes the incentives faced by states. One state's tax policy, because of the formula per se, creates externalities affecting residents of other states. States choose inefficiently low tax rates, and have the incentive to shift to a direct tax on property.

Section 7 analyzes the component of the tax based on payroll. Under this tax, firms which operate in different states and produce the same good continue to possess the incentive to merge, provided the substitution elasticity between inputs in production is sufficiently small. Furthermore, a sufficiently small substitution elasticity insures that the incentives created for state behavior are similar to those described above. With this tax, however, the merger of firms producing different goods is discouraged.

Yet another type of distortion arises when sales are included along with property and payroll in the apportionment formula. Section 8 shows that this formula creates incentives for the cross-hauling of output, with production in low tax rate states sold in high tax states, and conversely.

None of the above distortions are created when the corporate tax uses separate accounting to divide a firm's profits among states. The final section presents an alternative apportionment formula which retains the administrative advantages of existing law, yet creates the same incentives as separate accounting, provided that there are no economic profits.

Throughout the paper, we confine our analysis to characterizing the behavior of individual firms. No attempt is made to examine the general equilibrium incidence of the tax, the focus of most previous work on state corporate taxes.[4]

2. THE MODEL

The economy contains many regions, which we call "states." In each state, competitive private firms use labor and capital to produce goods, which may be tradeable or nontradeable between states. Capital is perfectly mobile between states, and each state's labor is supplied by its residents, who are assumed for simplicity to be immobile.[5] For our purposes, we need not impose any restrictions on the elasticities of the supply of capital or labor to the economy, other than requiring that the labor supply in each state always remain positive.

All firms have access to the same production technology, which exhibits constant returns to scale and quasi-concavity. This assumption means that each firm is free to produce any set of goods and to spread its production activities across any set of states. In other words, each firm faces the same before-tax profit function, $\pi = \pi(v)$, where π is before-tax economic profits and v is a vector describing the firm's employment of capital and labor in each state. Pre-tax profits are defined here as revenue minus net-of-corporate-tax payments to all factor inputs. Of course, the function $\pi(v)$ depends on the existing product and factor prices. When discussing the decision-making of individual firms, we shall assume that these prices are fixed at their equilibrium levels.

Our final assumption about private production is that the production technology is separable between states. This assumption allows us to easily isolate the tax incentives affecting firm location decisions from those incentives stemming from purely technological factors. Although it is not used to prove Propositions 1 and 3, we impose it at the outset to avoid repetition.

As stated in the Introduction, we analyze in detail the case where property alone enters the apportionment formula so that $\alpha_K = 1$. With property consisting of mobile capital in this model, the tax due to state i by a given firm is $T_i = t_i(K_i/K)\pi_i^T$. Unless otherwise stated, all tax rates are positive, and no two states possess the same tax rates.

While taxable profits (π_i^T) may differ from actual economic profits (π) in complicated ways, and in ways which vary by state and by type of capital, we assume for simplicity that taxable profits equal $\pi_i^T = \pi + \mu K$ in all states. Thus,

[4] See, for example, McLure (1980, 1981).

[5] Labor mobility could be added to the analysis without changing the results. If individuals differ in their preferences for public goods, then tax rates and expenditure levels may differ across states, as assumed in the text, without causing all individuals to strictly prefer to reside in only the low tax state. See Wilson (1985a, b) for a discussion of models with both capital mobility and labor mobility.

the tax base includes pure profits plus a portion of capital costs.[6] We ignore variation in μ across states. While the value of μ implicitly depends on the after-tax interest rate, our analysis is confined to situations where the interest rate may be treated as fixed.

Given these assumptions, a firm's tax payments to state i are

$$T_i = t_i(K_i/K)(\pi + \mu K). \tag{1}$$

Consequently, total after-tax profits are

$$N = \pi - T = \pi - t(\pi + \mu K), \tag{2}$$

where T is total tax payments $(T = \sum T_i)$ and $t = \sum t_i(K_i/K)$. We call t the "average tax rate."

For most of the analysis, we will not need to make specific assumptions about how a state's tax revenue is spent. Here, we merely assume that, while state governments may directly control some production activities, the competitive private firms operate in every state when the economy is in equilibrium.

3. INCENTIVES FACED BY CORPORATIONS

In a competitive equilibrium, prices adjust so that each firm's after-tax profits equal zero. Setting $N = 0$ and solving (2) for π gives

$$\pi = T = (t/(1-t))\mu K. \tag{3}$$

By profit maximization, π must remain equal to T following a differential change in capital investment in any state. Differentiation of (3) gives the marginal impact of K_i on both π and T, calculated while holding fixed all K_j, $j \neq i$:

$$\partial\pi/\partial K_i = \partial T/\partial K_i = [t/(1-t) + (t_i - t)/(1-t)^2]\mu,$$

or

$$\partial\pi/\partial K_i = \partial T/\partial K_i = [(t_i - t^2)/(1-t)^2]\mu. \tag{4}$$

Equation (4) shows that two firms with different t's will face different tax distortions to the marginal cost of capital in the same state. These distortions may be positive or negative. In a state which does not tax corporate profits, investment is subsidized.[7]

A firm can alter its marginal tax by changing its allocation of capital across states and thereby changing its t. For any state i, the expression for the marginal tax in (4) obtains a maximum when capital is allocated so that $t = t_i$. This suggests

[6] In general, the appropriate value of μ depends on many details of the tax law as well as on market interest rates. If taxable income were defined to equal revenue less labor expense and less real economic depreciation, then μ would equal the opportunity cost of capital (the real after-tax interest rate). Throughout the paper, we assume that μ is positive, though see Fullerton-Gordon (1983) or the *Economic Report of the President* for 1982 or 1983 for some contrary evidence. Most results reverse if μ is negative.

[7] Observations similar to those in this paragraph have been reported previously in Mieszkowski-Morgan (1982), Frisch (1983), and Johnston (1983).

that no firm will want to locate all of its production activities in only one state. We now prove a much stronger result:

PROPOSITION 1: *In equilibrium, t is identical across all firms.*

PROOF: Assume, contrary to the proposition, that there exists an equilbrium with two firms employing input vectors, v^1 and v^2, which yield different t's, t^1 and t^2. By (3), the total after-tax profits of the two firms satisfy

$$N^1+N^2=\pi(v^1)+\pi(v^2)-[(t^1/(1-t^1))\lambda^1 + (t^2/(1-t^2))\lambda^2]\mu(K^1+K^2)=0, \tag{5}$$

where[8] $\lambda^i=K^i/(K^1+K^2)$.

Suppose now that the two firms merge for tax purposes, but do not alter their total factor demands, v^1+v^2. Total after-tax profits become

$$N^{12}=(1-t^{12})[\pi(v^1+v^2)-(t^{12}/(1-t^{12}))\mu(K^1+K^2)]; \tag{6a}$$

where

$$t^{12}=\sum t_j[(K_j^1+K_j^2)/(K^1+K^2)]=t^1\lambda^1+t^2\lambda^2. \tag{6b}$$

Since $t/(1-t)$ is a strictly convex function of t, $t^{12}/(1-t^{12})< [t^1/(1-t^1)]\lambda^1+[t^2/(1-t^2)]\lambda^2$. Furthermore, $\pi(v^1+v^2)\geqslant\pi(v^1)+\pi(v^2)$ under our assumptions about production. It then follows from (5) and (6) that the merger raises total profits: $N^{12}>N^1+N^2$. *Q.E.D.*

Thus, there exists tax induced pressure for firms to diversify (or merge with competitors in other states) until they all possess identical t's. This pressure represents a separate form of tax distortion from that affecting the capital-labor ratio in any state. It does not arise when separate accounting, rather than formula apportionment, is used.[9]

An example may help to clarify the result. Consider two firms, one operating solely in a state with no corporate tax and the other operating in a state with a tax rate t_*. Assume each employs one unit of capital, and is initially breaking even. The first then earns zero economic profits while the second must earn $t_*\mu/(1-t_*)$ to break even after the tax. Tax payments equal $t_*(\mu+t_*\mu/(1-t_*))$. If the two firms merge, tax payments become $(t_*/2)(2\mu+t_*\mu/(1-t_*))$. The tax on the normal return, μ, remains unchanged, but the tax on economic profits is halved. While all the economic profits are earned in the taxing state, only half are attributed to that state after the merger under formula apportionment.

[8] We assume that each firm uses a positive amount of capital, so that $\lambda_i>0$. This assumption is maintained throughout the paper.

[9] Detailed provisions of a corporate tax, even with separate accounting, may create incentives for mergers. For example, firms with tax losses gain by merging with profitable firms.

More generally, if two firms with different t's merge their operations and there is no efficiency gain from the merger, then the amount of taxes saved, as a fraction of initial tax payments, equals

$$\{(t^1-t^2)^2K^1K^2\}/\{(K^1+K^2)[(1-t^2)t^1K^1+(1-t^1)t^2K^2]\}. \tag{7}$$

If, for simplicity, $K^1=K^2$ and $t^2=0$, then this expression reduces to $t^1/2$. While this saving is quite modest at the level of tax rates characteristic of U.S. state corporate taxes, it would be substantial if formula apportionment were used by national governments.

Proposition 1 does not rule out the possibility that all production of a particular good will be located in one state because of some comparative advantage of production in that state. It does imply, however, that the firms producing the good will face competitive pressure to merge, if only for tax purposes, with firms located in other states, regardless of the composition of their output, and to do so until they achieve the common t.

4. DISTRIBUTIONAL CONSIDERATIONS BETWEEN STATES

States can tax corporate capital in various ways. In addition to using a corporate tax based on formula apportionment, states could, in principle, use a property tax or a corporate tax based on separate accounting. Their choice among taxes will depend on more than administrative simplicity. In this section, we argue that, relative to the two alternative taxes on capital, universal use of formula apportionment aids low tax rate states at the expense of high tax rate states.

Each state's tax law, given the tax law in other states, determines how much tax revenue that state collects per unit of capital locating in the state, and how much capital does locate in the state. Given how much capital locates in the state, the state benefits if it collects more revenue per unit of capital, and conversely. We will consider a universal shift by all states from formula apportionment to a property tax system which maintains the existing marginal tax on each state's capital, thereby leaving unchanged the capital allocation.[10] What we will show is that this change in tax systems raises tax revenue in high tax rate states and lowers tax revenue in low tax rate states.

To simplify the formal comparison, let us introduce some additional assumptions which allow us to abstract from general equilibrium complications:

ASSUMPTION A: *All goods are tradeable between regions.*

ASSUMPTION B: *All individuals possess identical homothetic utility functions, and each state's government spends its revenue in the same way as consumers.*

[10] We assume that a state's property tax is a proportional tax on the capital used by firms in the state. The results are identical if states shift instead to separate accounting rather than property taxes, but the algebra is slightly messier.

We now prove the following proposition.

PROPOSITION 2: *Suppose that formula apportionment is replaced by a property tax system where each state's property tax rate is set so as to produce the same marginal tax on that state's capital as existed under formula apportionment. Given Assumptions A and B, each state's total capital stock remains unchanged, but total tax revenue rises (falls) in any state i where $t_i > (<) t$ under formula apportionment.*

PROOF: Under formula apportionment, the average tax revenue in state i is

$$T_i/K_i = t_i((\pi/K)+\mu) = t_i\mu K/(1-t). \tag{8}$$

Using (4) and (8), simple algebra shows that

$$T_i/K_i = \partial T/\partial K_i - \mu t(t_i - t)/(1-t)^2. \tag{9}$$

In contrast, if a state replaces the corporate income tax with a property tax at rate b_i, then $\partial T/\partial K_i = T_i/K_i = b_i$. Comparing this equality with (9), we see that, with each b_i set to yield the same $\partial T/\partial K_i$ as under formula apportionment, the shift to property taxation raises T_i/K_i by $[\mu t(t_i - t)]/(1-t)^2$. Under Assumptions A and B, however, the shift does not alter the demand for any good or the total quantity of capital employed in any region. The average tax rate, t, remains unchanged, as do all equilibrium factor and product prices. Thus, T_i/K_i rises (falls) if $t_i > (<) t$. Since state i's total capital stock does not change, the proposition follows immediately. *Q.E.D.*

This result may be simply explained. A marginal rise in a firm's capital investment in a high tax state $(t_i > t)$ raises average tax revenue, T/K. With profits initially maximized, however, π/K rises by an amount which is just sufficient to keep after-tax profits equal to zero. As a result, the tax base per unit of capital, $\pi/K+\mu$, must also rise. Since all states share this tax base under formula apportionment, investment in a high tax state raises tax payments to all other states. In effect, each firm's investment in a high tax state is taxed by low tax states, thereby causing the marginal tax on this investment ($\partial T/\partial K_i$) to exceed the average tax payment, T_i/K_i, in the high tax state. By a symmetrical argument, $\partial T/\partial K_i$ falls short of T_i/K_i in low tax states.

Thus, we conclude that high tax rate states should favor a universal switch to property taxation (or separate accounting), while low tax states should oppose it.

5. POLITICAL INSTABILITY OF FORMULA APPORTIONMENT

Proposition 2 suggests that any state would gain from lowering its corporate tax rate to zero, obtaining a transfer from the other states under formula apportionment, and then replacing the lost revenue with an alternative tax on capital. In this section, we demonstrate the existence of this incentive, as long as the tax payments under the alternative tax are deductible from taxable income in other states (as are property tax payments under U.S. state tax law), thereby insuring that income earned by a firm to cover the tax does not increase taxable income in other states.

We assume that each state is sufficiently "small" that a change in its tax policy has a negligible impact on the after-tax return to capital (r) and the average tax rate (t). Since all firms possess the same average tax rates in equilibrium (Proposition 1), firms operating in any state all face identical marginal taxes and make identical average tax payments (T_i/K_i) to the state. With these observations in mind, we now prove the following proposition.

PROPOSITION 3: *Given r and t, a reduction in t_i, combined with an increase in the property tax rate, b_i, which keeps T_i/K_i unchanged, must lower $\partial T/\partial K_i$.*

PROOF: We have shown that, for a state imposing a corporate tax with formula apportionment, equation (9) must hold. If the state now imposes in addition a property tax at rate b_i, and property tax payments are deductible from taxable income in all states, then both $\partial T/\partial K_i$ and T_i/K_i rise by b_i, and equation (9) must still hold. It follows immediately that if a state lowers t_i, while raising b_i to maintain T_i/K_i, then $\partial T/\partial K_i$ falls. *Q.E.D.*

Each state would wish to select b_i and t_i together so as to minimize $\partial T/\partial K_i$ for any given T_i/K_i—by lowering $\partial T/\partial K_i$, a state can attract more capital into the state, raising tax revenues and real wage rates. If all states are free to make this change, then the only "political equilibrium" is where $t_i = 0$ for all i.[11] Politically, formula apportionment is very unstable.

Related to the issue of political stability is the question of how nonparticipating states are affected by the nature of the apportionment formula. An example of political interest at the current time is how foreign countries or multinational firms are affected by having U.S. states apportion worldwide profits rather than just the domestic profits of a firm. The outcome depends critically on whether foreign taxes on corporate capital are deductible from taxable profits as defined by U.S. state corporate tax law. If the taxes are deductible, the foreign countries gain by having U.S. states apportion worldwide profits. To see this, assume that a foreign country has a proportional tax at rate b_F on the capital, K_F, that a U.S. firm invests in that country.[12] If U.S. states apportion only domestic profits, the marginal tax on this capital is $\partial T/\partial K_F = b_F$. But if U.S. states apportion worldwide profits, then the foreign country effectively becomes a zero-tax-rate state in the apportionment formula. As we have seen, investment in such a state lowers total taxes paid in all other states. Thus, $\partial T/\partial K_F$ falls short of b_F under worldwide apportionment, stimulating investment abroad and raising foreign tax revenue. (Algebraically, $\partial T/\partial K_F$ is given by (9) for the case where $T_i/K_i = b_F$ and $t_i = 0$.)

[11] Note that if t had been negative, then each state would gain by raising its t_i back towards zero. If μ has been negative, however, then each state would instead gain by raising t_i and lowering b_i.

[12] It is notationally simpler to analyze a proportional tax, but the results are the same with a corporate tax based on separate accounting.

However, foreign corporate income tax payments are not currently deductible under U.S. state tax law. As a result, foreign countries and multinational firms lose (gain) by having U.S. states apportion worldwide profits rather than domestic profits if foreign tax rates are higher (lower) than U.S. state tax rates. To see this, consider a multinational firm initially facing a U.S. state corporate tax based on formula apportionment of domestic profits, and a proportional tax on capital, at rate b_F, in a foreign country. Then total before-tax profits in equilibrium must satisfy

$$\pi = b_F K_F + t\mu K_D/(1-t), \tag{10}$$

where K_D is the firm's capital invested in the U.S. and t is the average tax rate. If U.S. states switch to apportioning worldwide profits, with no deduction for foreign taxes, the firm's before-tax profits must now satisfy

$$\pi^* = (b_F K_F + t^*\mu K)/(1-t^*), \tag{11}$$

where $K = K_D + K_F$ and $t^* = tK_D/K$.

Simple algebra shows that, with no reallocation of capital $\pi^* > \pi$ if $b_F > t\mu/(1-t)$, and conversely. If foreign taxes are higher, required profits rise, and conversely. In particular, it is possible to show that apportioning worldwide profits, with no deduction of foreign taxes, implies that

$$\partial T/\partial K_F = b_F + (K_D/K)[t^*(1-t)/(1-t^*)^2][b_F - \mu t/(1-t)]. \tag{12}$$

The second term in equation (12) reflects the marginal effect of K_F on the tax base, $B = (\pi/K + \mu)$, used under formula apportionment. If $b_F > t\mu/(1-t)$, then an increase in K_F raises B, in which case foreign investment benefits the U.S. In this case, the switch to apportioning worldwide profits raises $\partial T/\partial K_F$, thereby discouraging foreign investment and lowering foreign tax revenue. Given that foreign tax rates are generally much higher than U.S. state corporate tax rates, foreign countries and multinational firms are both made worse off by the tax change.[13]

6. GOVERNMENT DECISION-MAKING

If all states charge the same tax rate t_i under formula apportionment, no transfers between states occur. We have argued, however, that each state, acting unilaterally, would still gain by switching to a property tax. But also, the states would generally gain even if they all simultaneously switched to a property tax (or to separate accounting), still avoiding transfers between states, because they would be induced to make more efficient decisions. The basic intuition is that, under formula apportionment, when a state raises its tax rate to increase revenue, its revenue goes up by less than it would under separate accounting or a property

[13] Of course, our constant returns to scale assumption precludes firms from being made worse off in the long run, since equilibrium net profits always equal zero. Given putty-clay capital, however, the switch to apportioning worldwide profits would reduce net profits below zero initially.

tax, for any given increase in the marginal tax on capital. Under formula apportionment, therefore, raising revenue is harder, tax rates will be lower, and utility should also be lower.

In formalizing the argument, we must recognize possible general equilibrium effects of universal changes in taxes and government expenditures. While the claim is true in quite general circumstances, for purposes of brevity we consider here the following special case ("Model S"), where issues concerning general equilibrium price changes and consumer heterogeneity are assumed away.

Model S: (a) The interest rate (r) and output price vector (p) are fixed, having been determined exogenously on international capital and product markets. (b) There is a single public good (quantity G_i for state i), which is produced using capital and the outputs of private firms. (c) The production technology for private and public goods is identical across states. (d) G_i is chosen in each state to maximize a utility function, $U_i = U(w_i, G_i, p, r)$; and the average tax rate, t, is treated as fixed in this maximization problem. The function U is identical across states.

The result may now be stated as follows.

PROPOSITION 4: *For model S, the equilibrium G_i and U_i are lower under formula apportionment than under property taxation.*

PROOF: Given the exogenously fixed p and r, the amount of labor supplied by a state's residents is a function of the wage rate and public good supply: $L_i = S_L(w_i, G_i)$. Given r, the wage rate is determined by the marginal tax on capital via the zero profit condition for private production: $w_i = w(\partial T/\partial K_i)$. The cost-minimizing capital-labor ratio employed by private firms can then be written as a function of $\partial T/\partial K_i$ alone. Combining this relation with the labor supply curve allows us to write the total amount of capital employed by a state's private firms as a function of $\partial T/\partial K_i$ and G_i: $K_{si} = K_s(\partial T/\partial K_i, G_i)$. This function does not depend on whether property taxation or formula apportionment is used.

If states use a property tax, then the government budget constraint for state i may be written:

$$p_G G_i = K_{si}\partial T/\partial K_i, \tag{13}$$

where p_G is the resource cost of a unit of the public good, as determined by p and r. Given the functions $K_s(\partial T/\partial K_i, G_i)$ and $w(\partial T/\partial K_i)$, (13) defines a production possibility frontier (PPF) on (w_i, G_i)-space: $G_i = G^p(w_i)$.

In contrast to (13), Equation (9) implies that the government budget constraint under formula apportionment is

$$p_G G_i = K_{si}[\partial T/\partial K_i - \mu t(t_i - t)/(1-t)^2]. \tag{14}$$

Since there is a one-to-one relation between t_i and $\partial T/\partial K_i$ for any given t (see (4)), (14) and the functions $K_s(\partial T/\partial K_i, G_i)$ and $w(\partial T/\partial K_i)$ define the PPF associated with formula apportionment for a given t: $G_i = G^F(w_i; t)$. It is immediately evident from (13) and (14) that

(15a) $$G^P(w_i) = G^F(w_i; t) \quad \text{when} \quad t_i = t.$$

Since w_i falls as t_i rises, (13) and (14) also imply that

(15b) $$-dG^P(w_i)/dw_i > -dG^F(w_i; t)/dw_i \quad \text{when} \quad t_i = t.$$

With all states identical, $t_i = t$ under the equilibrium for formula apportionment. Condition (15a) then implies that the equilibrium (w_i, G_i) under formula apportionment lies on the PPF's for both formula apportionment and property taxation.

Condition (15b) shows that the slopes of the two PPF's differ at the equilibrium point under formula apportionment, implying that equilibrium utility must be higher under property taxation. In particular, raising taxes and government expenditures is more attractive under property taxation, so in equilibrium G_i and $\partial T/\partial K_i$ must also be higher under property taxation. *Q.E.D.*

Even with property taxation, the equilibrium tax rate and government expenditures are inefficiently low under a wide variety of assumptions. For instance, each state treats as a loss the capital outflow resulting from a rise in its tax rate. But if the capital stocks in other states rise as a result of this outflow, then there is a positive externality.[14] States also ignore benefit spillovers. Shifting to formula apportionment from property taxation, by causing a further drop in government expenditures, further lowers utility.[15]

7. FORMULA APPORTIONMENT USING PAYROLL

The purpose of this section is to show that the inclusion of payroll in the apportionment formula dramatically alters the merger incentives facing firms. To isolate the role of payroll, we continue to analyze a one factor formula, but with payroll serving as the factor. In this case, a firm's tax payments to state i are $T_i = t_i(w_iL_i/W)(\pi + \mu K)$, where $W = \sum w_jL_j$. Thus, after-tax profits are $N = \pi - t(\pi + \mu K)$, as in (2), but with the average tax rate t now given by $t = \sum t_i(w_iL_i/W)$.

By differentiating the zero profit condition $(\pi = T = (t/(1-t))\mu K)$, the firm's first-order conditions can be shown to equal

(16a) $$\partial\pi/\partial K_i = \partial T/\partial K_i = (t/(1-t))\mu$$

and

(16b) $$\partial\pi/\partial L_i = \partial T/\partial L_i = [w_i(t_i - t)/(1-t)^2](uK/W).$$

In contrast to our previous analysis, labor is now taxed at the margin.

[14] See Wilson (1986) and Zodrow and Mieszkowski (1986) for a detailed analysis of this externality.

[15] If other sources of externalities exist which in themselves lead states to choose tax rates which are inefficiently high, however, then on second best grounds the effect of a shift to formula apportionment on utility would be ambiguous. For discussion of the various spillovers to nonresidents, see Gordon (1983).

The $\partial T/\partial L_i$ for the highest tax state falls to a minimum at zero when a firm concentrates all of its payroll in that state (so that $t = t_i$). This suggests that, in contrast to Proposition 1, firms may not want to merge their operations until they all possess identical t's. The next proposition supports this conjecture by showing that any firm, if it produces more than one form of output, will strictly prefer to operate in only one state for tax reasons.

PROPOSITION 5: *If* (i) *the production technology is separable across both goods and states, identical across states, and requires both inputs*; (ii) *whenever producers of two different goods face the same relative marginal factor prices, they choose different factor input ratios*; (iii) *all goods are tradeable across states*;[16] (iv) *the apportionment formula includes only labor*; *then, in equilibrium, any firm which produces more than one good locates in only one state.*

PROOF: We employ the following additional notation: $f^j(\cdot,\cdot)$ is the production function for good j; k_{ji} is the capital-labor ratio used to produce good j in state i; λ_i is the fraction of a firm's total payroll located in state i; β_{ji} is the fraction of a firm's payroll in state i which is devoted to good j production; and p^j is the price of good j.

Using this notation, the requirement that after-tax profits equal zero in equilibrium may be expressed:

$$N = (1-t)\left[\left(\sum_{i,j} (\lambda_i \beta_{ji} W/w_i) n_{ji}\right) - W\right] = 0, \tag{17a}$$

where

$$n_{ji} = p^j f^j(1, k_{ji}) - [r + (\mu t/(1-t))]k_{ji}. \tag{17b}$$

Suppose, contrary to the proposition, that in equilibrium some firm maximizes profits by producing more than one good using factors in more than one state. In particular, assume that at least two goods are produced within states 1 and 2. (No good need be produced in both states.) If good j were produced in both states, then, given assumptions (i) and (iii), (16a) implies that $k_{j1} = k_{j2}$. Therefore, $n_{j1} = n_{j2}$ under profit maximization. Trivially, N is independent of n_{ji} when good j is not produced in state i. Thus, we may set $n_{j1} = n_{j2} = n_j$.

In addition, profit maximization requires that $n_j = n_h$ for any goods j and h which the firm produces. If, say, $n_j > n_h$, we could find a state i producing good h, reduce β_{hi} while increasing β_{ji} by an identical magnitude, and raise profits.

With $n_j = n_h$, the firm must be indifferent between producing either only good j, only good h, or any convex combination of the two goods. This observation is crucial to the proof.

Let goods 1 and 2 be two of the goods produced in states 1 or 2, and let $n = n_1 = n_2$. Since states are assumed to possess different tax rates, we may suppose that $t_1 > t_2$. Then a rise in λ_1 and identical reduction in λ_2 raises t. By profit

[16] If nontraded goods are allowed, then the proposition can be amended to read: any firm producing more than one *traded* good locates in only one state.

maximization, however, this change creates no first-order change in after-tax profits. By (17a),

$$dN = (1-t)W[(n/w_1) - (n/w_2) - (t_1 - t_2)(\mu K/W)/(1-t)^2]d\lambda_1 = 0, \tag{18}$$

where "d" denotes a differential change.

Since $k_{1i} \neq k_{2i}$ by assumption, we may arbitrarily suppose that $k_{1i} > k_{2i}$. Since the firm is indifferent between producing goods 1 and 2, it may lower K/W without affecting N by reducing the share of its payroll in either state 1 or 2 which is devoted to good 1 production (β_{11} or β_{12}) while increasing by an identical magnitude the share of its payroll in that state which is devoted to good 2 production. But this change raises the expression for dN in (18) above zero. Consequently, once the firm has implemented this change in the β_{ji}'s, it may then raise after-tax profits above zero by transferring some of its total payroll from state 2 to state 1 (raise λ_1 and lower λ_2). It follows that the original production plan could not have maximized profits. *Q.E.D.*

A crucial aspect of this proof is that any firm producing more than one good can alter its capital-payroll ratio with no sacrifice in profits simply by changing its composition of output from one good to another. The elasticity of substitution between capital and labor in the production of revenue is infinite for such a firm. The proof of the proposition essentially consists of showing that no firm with an infinite substitution elasticity will produce in more than one state. This observation raises the possibility that a firm which produces only a single traded good will still have an incentive to produce in more than one state if the substitution elasticity in the production of this good is sufficiently small. In our working paper, we obtain a rather mysterious result which supports this conjecture: if only labor is included in the apportionment formula and the substitution elasticity in the production of *each* traded good is less than two, then all firms producing the same traded good must possess the same t. It follows that no firm would produce more than one traded good.[17] However, t can vary across firms which produce different goods.

Given these diverse results, our conclusion must be that formula apportionment creates complex pressures affecting the merger of firms, encouraging some mergers and discouraging others. Separate accounting, in contrast, has no effect on incentives to merge.

When payroll rather than property is used to apportion taxable income, our argument concerning the cross-subsidies between states under formula apportionment and the effect of use of formula apportionment on government expenditure levels must also be modified. In our working paper, we show that our previous conclusions remain valid only if the elasticity of substitution in the production function for each good is low enough, and can reverse otherwise. We also show, however, that states, if small, still have the incentive to shift to using factor taxes.

[17] An exception is the case where all of the economy's production of two goods occurs in only one state. All firms producing these goods will operate only in that state (and therefore possess the same t's), and they will be indifferent between producing one or both of the goods.

8. CROSS-HAULING

When capital, payroll, and sales are all included in the apportionment formula, a firm's after-tax profits can still be written in the form given for the one factor case, $N = \pi - t(\pi + \mu K)$, but now the "average tax rate" is defined

(19a) $$t = \alpha_S t_S + \alpha_W t_W + \alpha_K t_K,$$

where

(19b) $$t_S = \sum t_i(S_i/S), \quad t_W = \sum t_i(w_i L_i/W), \quad t_K = \sum t_i(K_i/K).$$

The present section describes some strange incentives facing firms when sales receive positive weight. We assume that sales, as defined in the apportionment formula, represent sales at destination, rather than origin. Most U.S. state tax formulas follow this practice.

With sales in the formula, interstate trade no longer equalizes product prices across states. When a firm redistributes its sales towards a high tax state, it raises the share of its total profits which are taxed by that state. As a result, its total tax payments rise. Thus, the firm must be compensated by a relatively high product price to be willing to sell its output in a high tax state.

If different firms in an industry produce in different states, and so face different values of $\alpha_W t_W + \alpha_K t_K$, then they face different incentives concerning where to sell their output. Intuitively, a firm which concentrates its production activities in a high tax state and therefore faces a high tax burden can benefit a lot from concentrating sales in a low tax state and thereby reducing this burden. On the other hand, a firm which produces mainly in a low tax state and does not face a high tax burden would require less compensation to induce it to sell in a high tax state. Thus, if we find two types of firms producing the same good, one producing mainly in high tax states and the other producing mainly in low tax states, then tax incentives should lead the first to transport its output to low tax states and the second to transport its output to high tax states, a situation we refer to as "cross-hauling."

This section demonstrates that "cross-hauling" should occur, provided firms possess sufficiently similar factor intensities. Superscripts are used to distinguish between firms, and a firm's factor intensity is measured by the ratio of its total output to its total capital stock, Y^i/K^i. Although the proposition concerns firms with identical factor intensities, it should be clear that the result can be extended to cases where factor intensities are sufficiently similar.

PROPOSITION 6: *Consider two firms,* 1 *and* 2, *which produce the same traded good and satisfy* $Y^1/K^1 = Y^2/K^2$ *in equilibrium. If, in equilibrium,*

(A) $$\alpha_W t_W^1 + \alpha_K t_K^1 > \alpha_W t_W^2 + \alpha_K t_K^2,$$

then $t_S^1 \leq t_S^2$, *with a strict inequality holding if the two firms together sell output in more than one state.*

PROOF: With superscripts omitted, after-tax profits may be expressed as follows: $N = (1-t)[\pi - (t/(1-t))\mu K]$. Let us normalize profits by dividing N by

$1-t$, giving $N^* = \pi - (t/(1-t))\mu K$. This normalization is permissible, because maximum after-tax profits equal zero and N and N^* always possess identical signs. By substituting for π, N^* may be written:

$$N^* = qY - \sum w_i L_i - rK - (t/(1-t))\mu K, \tag{20}$$

where q is the average sale's price for output: $q = S/Y$.

Since the distribution of sales may be varied independently of the firm's production decisions, there is a unique profit-maximizing q associated with any given value of t_S, namely the maximum q which can be obtained with a distribution of sales satisfying the constraint $\sum t_i(S_i/S) \leqslant t_S$. Let $q = q(t_S)$ denote this relation (which is independent of the firm's production decisions). By substituting $q(t_S)$ into (20) and fixing the firm's factor inputs at their profit-maximizing values, we may define a function, $N^i(t_S)$, which gives firm i's (normalized) after-tax profits at each t_S.

Since scale is irrelevant under our constant returns to scale assumptions, we may consider only firms with the same Y's. Under the assumptions of the proposition, these firms possess identical K's. Under assumption (A) in the proposition, $t^1 > t^2$ when $t_S^1 = t_S^2$. Equation (20) implies that

$$N^1(t') - N^1(t'') > N^2(t') - N^2(t'') \quad \text{for all } t' \text{ and } t'' \text{ where } t' < t''. \tag{21}$$

With t_S^i denoting the profit-maximizing t_S for firm i, we have $N^2(t_S^2) - N^2(t_S^1) \geqslant 0$ and $N^1(t_S^2) - N^1(t_S^1) \leqslant 0$. These inequalities would contradict (21) if $t_S^2 < t_S^1$. Thus, $t_S^2 \geqslant t_S^1$.

To complete the proof, we now show that this last inequality holds strictly when the output of the two firms is sold in more than one state. Suppose, instead, that $t_S^1 = t_S^2$. Then the two firms possess the same profit-maximizing distributions of sales across states (and the same average sale's price, $q(t_S^i)$). Thus, we may assume that there are two states, j and h, in which *both* firms sell output. For profit maximization, any small shift in each firm's sales from j to h must have a zero first-order effect on each firm's profits. Since $t^1 > t^2$ when $t_S^1 = t_S^2$, however, (20) shows that this small shift cannot have identical first-order effects on the two firms' profits. Thus, the assumption that $t_S^1 = t_S^2$ is not consistent with profit maximization. *Q.E.D.*

Proposition 6 provides a formal proof that firms which produce in higher tax states, and so face a higher value of $\alpha_W t_W + \alpha_K t_K$, sell in lower tax rate states, and so face a lower value of t_S.

Will firms end up producing in different states? Of course, there may be technological factors leading to this outcome. In addition, we have been able to show that if there are only two states, if there is a single good produced with a C.E.S. technology which is identical across states, and if $\alpha_K > 0$ and $\alpha_S > 0$ but $\alpha_W = 0$, then firms must face different values of t_K in equilibrium as long as the elasticity of substitution in production is sufficiently small.[18] Since a small elasticity also implies that the equilibrium Y/K's for different firms differ by only

[18] The proof is available from the authors upon request.

a small amount, we can conclude that a sufficiently small elasticity insures the existence of cross-hauling.

9. ALTERNATIVE FORMULAS

Throughout the paper, we have described various ways in which incentives under existing forms of formula apportionment differ from those created when separate accounting is used. Are there alternative formulas which approximate more closely the incentives implied by separate accounting, yet still maintain the administrative advantages of existing law?

Under separate accounting, taxable profits for a firm in state i would be $\mu K_i/(1-t_i)$, and total taxable profits would equal $\mu \sum K_j/(1-t_j)$. Consider then the formula assigning the fraction $(K_i/(1-t_i))/\sum (K_j/(1-t_j))$ of any firm's total profits to state i. After-tax profits of the firm now equal

$$N = \pi - \frac{\sum_i t_i(K_i/(1-t_i))}{\sum_i K_i/(1-t_i)}(\pi + \mu K). \tag{22}$$

If $N=0$ in equilibrium, then the first-order condition for the optimal value of K_i is simply $\partial\pi/\partial K_i = t_i\mu/(1-t_i)$, exactly the same as under separate accounting. Labor demand decisions and sales decisions are undistorted, also as under separate accounting. Yet this formula is at least as easy to administer as existing tax law. Thus, at least under the assumptions of the model, this formula is clearly preferable to existing tax law.

Complications arise when any of the assumptions are relaxed. If the tax parameter μ varies by state, the formula giving the same incentives as separate accounting would assign the fraction $(K_i\mu_i/(1-t_i))/\sum (K_j\mu_j/(1-t_j))$ of a firm's profits to state i. The tax parameter μ_j, however, would be a complicated function of depreciation schedules, tax credits, interest rates, and any other investment related incentives, making this formula very difficult to administer. Similar administrative complications arise if the formula must be modified to reflect different rate brackets which are often present under state corporate tax law. Furthermore, if firms receive true profits in equilibrium, then no feasible formula would maintain the incentives existing under separate accounting. To do so, the pure profits must be assigned to the state in which they are earned, yet, short of separate accounting, insufficient information is available to do this.

Despite these problems, we believe that the modification to existing tax law described by (22), if computed at all sensibly, would likely be an improvement.

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Manuscript received June, 1984; final revision received January, 1986.

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