Chapter 1

Implementing Tax Reform^{*,†}

George Zodrow
Rice University

The implementation of unanticipated changes in the tax structure results in essentially arbitrary redistributions of income. If the government is concerned about inducing such redistributions, the method of implementing tax reform is crucial; specifically, the redistributions can be reduced by altering the timing and extent of enactment of reform — postponing, phasing-in, or partially enacting the tax reform measure — at the cost of reducing the efficiency gains which would be obtained with immediate full enactment. The analysis indicates that, under fairly plausible conditions, immediate partial enactment is the optimal reform implementation policy; numerical simulations suggest that such a policy can significantly increase the social welfare gain obtained with postponed full enactment.

1. Introduction

The optimal taxation literature has generated a variety of prescriptions for optimal tax “design” — the design of tax systems which finance a

^{*}This chapter is reproduced from *National Tax Journal*, **34**(4), 401–418, 1981.

[†]Drawn from thesis that won the 1980 NTA-TIA Doctoral Dissertation Award.

fixed level of government services at minimal social cost (for surveys, see Mirrlees (1976) and Sandmo (1976). However, as pointed out by Feldstein (1976a), these results are derived without consideration of the transitional problems of moving an economy from an initially sub-optimal equilibrium to the tax design optimum when lump sum redistributions are infeasible. He stresses the need for a theory of optimal tax “reform” which would properly account for the fact that implementing efficiency-enhancing reforms induces redistributions of income which are essentially arbitrary and thus socially undesirable. Feldstein specifies a social welfare function which can be used to aggregate the net individual utility gains and losses caused by a reform in order to determine its social desirability. The method of implementing tax reform is crucial in the analysis, as the magnitudes of the income redistributions and efficiency gains which would be induced by an immediate movement to the tax design optimum can be altered by changing the time path of reform. Specifically, the redistributions can be reduced by altering the timing and extent of enactment of reform — postponing, phasing-in, or partially enacting the tax reform measure — at the cost of reducing the efficiency gains which would be obtained with immediate full enactment.

In this paper, I use the analytical framework developed by Feldstein to consider alternate methods of implementing tax reform. Within the context of a perfect information, instantaneous adjustment model, I show that under fairly plausible conditions the policy of immediate partial enactment (for example, the partial reduction of a distortionary tax differential, leaving the remaining differential in perpetuity) is the optimal implementation policy, dominating both phasing-in and postponing reform.

This result provides a counter-argument to Feldstein’s (1976a, 1976b) suggestion that the optimal reform implementation policy may be postponed full enactment (current enactment of a movement to the tax design optimum with a future effective date), which reduces the individual utility gains and losses associated with immediate full enactment by a factor of proportionality that increases with the length of the postponement. The intuition behind the optimality of immediate partial enactment is that the first movements toward the tax design optimum result in relatively

large marginal efficiency gains which dominate the effects of the associated redistributions on the social welfare function; these gains should be captured immediately rather than postponed. However, as one approaches full enactment, the marginal efficiency gains from reform become small, and, at some point, it is optimal from a social viewpoint simply to forego the incremental redistributions associated with further movements toward the tax design optimum, rather than just reducing them by postponed enactment.

Similar results obtain in two extensions of the basic model. First, I show that if the government is constrained to move eventually to the tax design optimum, immediate partial enactment is the optimal phasing-in policy. Second, I show that the basic result still obtains if social concern about the distribution of income is included in the analysis. Feldstein advocates an “impersonal justice” approach to the evaluation of tax reform proposals, where the government is indifferent to the actual utility levels of the individuals who experience the redistributions caused by the enactment of reform. Immediate partial enactment is still optimal when I modify his theoretical framework to study a “distributional justice” case so that, for example, the government is more averse to inducing an arbitrary loss of a given magnitude if it is experienced by a relatively poor individual.

In the following two sections, I describe the model utilized in the paper and define the optimal tax reform problem within the context of the model. In Section 4, I describe the conditions under which immediate partial enactment is the optimal reform implementation policy, using Feldstein’s “impersonal justice” approach to the analysis of tax reform. The extensions to the case where the government is constrained to eventual full enactment of reform at a fixed future date, and to the “distributional justice” case are presented in Sections 5 and 6. The results of some numerical simulations are provided in Section 7 in order to suggest the magnitudes of the social welfare gains that can be obtained with the various reform implementation options, while Section 8 offers some conclusions. Details of the model used in the simulations, as well as a description of the incidence of tax reform in the model, are provided in the Appendix.

2. The Model

I consider the optimal implementation of tax reform within the context of the following model. There are N individuals in an economy who act to maximize an identical utility function which is linear in income. Equilibria in the economy are defined by a general equilibrium system of equations known to all agents. A fixed amount of tax revenue must be raised and the government is assumed to have only two taxes at its disposal. In this case, equilibria are defined by a single exogenous tax variable (T), as the other tax rate must adjust to balance the government budget. The government thus can calculate the pattern of individual utilities $U^i(T)$ for any value of T .

Two values of the exogenous government control variable provide reference points for the analysis — the tax design optimum and the tax rate in the initial equilibrium. For the majority of the paper, I shall follow Mirrlees (1976) and define the tax design optimum (T_d) as the value of the exogenous variable which maximizes the unweighted sum of the individual utility levels of the economy's residents; in this case, the tax design optimum corresponds to the allocative efficiency optimum for the economy. I consider an alternate definition of the tax design optimum in Section 6 when the distributional justice case is analyzed.

The initial equilibrium (T_o) is assumed to differ from the tax design optimum. I arbitrarily assume that $T_o < T_d$, so that the relevant "tax rate interval" is $T_o \leq T \leq T_d$; partial enactment of tax reform refers to an increase in the tax rate from T_o by an amount less than $(T_d - T_o)$, and full enactment of reform refers to an increase in the tax rate to T_d .

To further simplify the analysis, I assume that all individuals can be divided into two groups — one group composed of N_G identical unambiguous "gainers" from reform ($dU^G/dT = dU^i/dT > 0$, $i = 1, \dots, N_G$) and a second group of N_L identical unambiguous "losers" from reform ($dU^L/dT = dU^i/dT < 0$, $i = N_G + 1, \dots, N = N_G + N_L$). The net individual utility changes dU^G/dT and dU^L/dT each have two components. Both gainers and losers share in the marginal allocative efficiency gain from reform, which is positive at T_o and declines monotonically to zero at T_d ,¹ while

¹The classic example of this pattern for the efficiency effects of taxation is provided by Harberger (1974), who shows that the efficiency loss caused by a tax distortion is proportional to the square of the distortion.

each marginal movement toward T_d causes a pure redistribution from losers to gainers. Note that I assume that the marginal redistribution dominates the marginal efficiency gain for the losers from reform ($dU^L/dT < 0$).

A crucial feature of the analysis is the calculation of the net individual utility changes which correspond to any time path of the exogenous tax variable T . I make two simplifying assumptions to facilitate this calculation. First, I assume that the economy moves instantaneously and costlessly from one equilibrium to the next at the actual time of a tax change. Second, I assume that the net utility changes associated with any future time path of the exogenous tax variable are perfectly capitalized as one-time windfall gains or losses when the reform policy is announced; note that this assumption implies that the reform is completely unanticipated.² Under these circumstances, the implementation of tax rates $T_1, T_2, \dots$ at times $t_1, t_2, \dots$ will cause changes in the present value of individual utility (ΔPV^i) given by:

$$\begin{aligned} \Delta PV^i &= \int_{t_1}^{\infty} [U^i(T_1) - U^i(T_0)] \exp(-nt) dt \\ &\quad + \int_{t_2}^{\infty} [U^i(T_2) - U^i(T_1)] \exp(-nt) dt + \dots \\ &= [U^i(T_1) - U^i(T_0)] S_1/n \\ &\quad + [U^i(T_2) - U^i(T_1)] S_2/n + \dots, \end{aligned} \quad (1)$$

where n is the social discount rate and $S_k = \exp(-nt_k)$ are the “speed of enactment factors” ($0 \leq S_k \leq 1$) for the delayed implementation times t_k ($k = 1, 2, \dots$).

To summarize briefly, tax reform is defined as a marginal movement toward the tax design optimum along the tax rate interval $T_0 \leq T \leq T_d$. Adjustment from one equilibrium to the next in response to changes in the tax structure is instantaneous and costless. The reform policy is unanticipated prior to its announcement, but the net effects of any time path

²The assumption that tax changes are completely unanticipated is obviously a strong one. The equity argument against immediate full enactment of reform clearly loses strength if the risks of tax changes are correctly perceived and thus reflected in asset prices. The importance of this point varies with the specific reform proposal being considered, as it depends on the extent to which it is reasonable to assume that the reform has been anticipated. For a further discussion of this issue, see Feldstein (1976a).

of reform are perfectly capitalized (according to Eq. (1)) at the time of the policy announcement. These effects can be viewed as windfall gains to one group of N_G identical “gainers” from reform and windfall losses to a second group of N_L identical “losers” from reform.

3. The Optimal Tax Reform Problem

I assume that the government is concerned about two effects of a movement toward the tax design optimum in the model described above. The first is the allocative efficiency gain from reform; if efficiency gains were the only concern of the government, an immediate movement to the tax design optimum would be the optimal tax reform policy.

However, I assume that the government is concerned also about a second effect of reform, *the horizontal equity effect* of the essentially arbitrary utility gains and losses which accompany unexpected changes in an existing tax structure. The equity problem associated with an immediate movement to the tax design optimum is that the incidence of tax reform is essentially capricious in many cases. This is especially true for changes in capital and land taxation where, if asset prices accurately reflect future net returns, the owners of an asset at the time of the enactment of a tax advantage capture all of its benefits. As assets change hands, the correspondence between current owners and the individuals who received the tax advantage will become so small that the incidence of tax reform designed to eliminate the “tax break” can be characterized as capricious. Capricious incidence, particularly when the capitalized amounts involved are fairly large, is a strong equity argument against tax reform.³

Governmental concern about the arbitrary incidence of reform makes the timing and extent of enactment of reform critical, as postponed or partial enactment may be desirable to reduce the arbitrary redistributions associated with an immediate movement to the tax design optimum. The optimal tax reform problem is the selection of the time path of changes in the tax structure which strikes the best compromise between the maximum efficiency gains obtained with an immediate movement to the tax

³See Feldstein (1976a, 1976b), for a detailed discussion of the capricious nature of the incidence of tax reform.

design optimum and the zero level of redistributions implied by remaining at the initial equilibrium.

To formalize the problem, I follow Feldstein in analyzing tax reform proposals using the following modified version of the general additive social welfare function used in the optimal taxation literature⁴:

$$W = \frac{1}{(1-e)} \sum_i [(U_r + \Delta PV^i)^{1-e} - 1], \quad 0 \leq e \leq \infty \quad (2)$$

where e is the constant elasticity of the marginal social valuation of individual utility and U_r is a common reference utility level.

In this approach, the e parameter is a measure of the degree of social concern about the arbitrary redistributions caused by tax reform. If $e = 0$, the utility changes experienced by the gainers and losers from reform are weighted equally from a social viewpoint; that is, only efficiency considerations are relevant to the government so that the optimal tax reform policy is immediate full enactment — an immediate movement to the tax design optimum. However, with a concave welfare function ($e > 0$), social equity concern about arbitrary redistributions is included in the welfare function, as arbitrary losses are weighted (negatively) more than proportionately, while windfall gains are weighted less than, proportionately. Since the concavity of the social welfare function increases as e increases, larger values of e imply greater social concern about the arbitrary nature of the redistributions which are caused by a change in the tax structure.

The U_r parameter is an arbitrary reference utility value used to scale the magnitudes of the present values of individual utility changes ΔPV^i caused by any time path of reform. I consider the case where U_r is the present value of a lifetime stream of the mean utility level in the initial equilibrium; this is approximated as $U_r = \bar{U}/n$ where $\bar{U}$ is the mean utility level in the initial equilibrium. Note in particular that the use of a common reference utility value implies that the government is unconcerned about the actual initial utility levels of the individuals who experience

⁴See Atkinson and Stiglitz (1980) for a discussion of the properties of this social welfare function.

windfall gains and losses as a result of the tax change. Instead, the social welfare function is simply a construct used to evaluate the magnitudes of individual utility changes implied by any particular tax reform proposal, independently of the utility levels of the individuals who actually experience the changes; all individuals are treated, in Feldstein's words, with "impersonal justice."⁵

Thus, the optimal tax reform problem is constructed so that it is equivalent to the optimal tax design problem when the government is concerned only with efficiency ($e = 0$). However, when there is social concern about arbitrary redistributions ($e > 0$), the optimal tax reform problem is the selection of the implementation times t_k (the speed of enactment factors S_k) and the corresponding tax rates T_k which generate the pattern of individual utility changes ΔPV^i which maximizes the optimal tax reform welfare function W .

4. The Optimality of Immediate Partial Enactment

Feldstein suggests postponed full enactment of reform (current announcement of a movement to the tax design optimum with a future effective date) as a reform implementation policy when $e > 0$. This approach limits the government to a single choice variable — the selection of the implementation time t^* (and the associated S^*) to move to the tax design optimum in order to maximize

$$W_p = \frac{1}{1-e} \sum_i \{ [U_r + (U^i(T_d) - U^i(T_o))S^* / n]^{1-e} - 1 \} \quad (3)$$

Thus, the only option available to the government is to reduce proportionately the gains and losses implied by a movement to T_d ; the factor of proportionality increases with the length of the postponement. In this section, I argue that postponed full enactment will never be the solution to the optimal tax reform problem posed in the previous section, and I describe

⁵ See Feldstein (1976b) for a defense of the impersonal justice approach to the analysis of tax reform.

the conditions under which immediate partial enactment (an immediate movement to T^* , $T_0 < T^* < T_d$) is the optimal reform implementation policy.⁶

First, note that the construction of the problem insures that some enactment of reform will be desirable. Since U_r is the common reference point for both the gainers and the losers from reform, the marginal individual utility changes are weighted equally at T_0 where there are no accumulated redistributions; since the marginal efficiency gain is positive at T_0 , a marginal increase in T , regardless of when it is put into effect, will increase the measure of social welfare W .

Second, similar reasoning shows that neither postponed nor immediate full enactment of reform to the tax design optimum T_d is desirable. At T_d , the sum of the net marginal effects on individual utilities is zero (a pure redistribution) since the marginal efficiency effect is zero. However, the utility gains and losses accumulated as the tax rate is increased from T_0 toward T_d insure that the net social valuation of the marginal redistributions at T_d will be negative, regardless of when the movement of T_d might be enacted. Thus, the last incremental movement to T_d must be socially undesirable; instead, the optimal implementation strategy is one of partial enactment to the point where the efficiency gain is large enough at the margin to outweigh the net negative effect of the redistributions implied by a further incremental movement toward the tax design optimum.

It is considerably more difficult to make general analytical statements about the optimal implementation of partial enactment of reform. The crucial determinant of the optimal time path of reform is the pattern of the marginal individual utility changes (dU^G/dT and dU^L/dT) at each equilibrium along the tax rate interval ($T_0 < T < T_d$); it is possible to construct situations where all three of the possible partial enactment implementation options (immediate, postponed and phased-in partial enactment) are optimal.

However, it is fairly simple to put a plausible restriction on the pattern of the marginal individual utility changes along the tax rate interval such

⁶For a formal proof of the results presented in this section, see Zodrow (1981).

that immediate partial enactment is the optimal implementation policy. The key variable is the “aggregate marginal utility tradeoff ratio,”

$$R(T) = -\frac{N^G dU^G/dT}{N^L dU^L/dT}, \quad (4)$$

which is the ratio of the aggregate marginal utility gain to the aggregate marginal utility loss at each value of T along the tax rate interval. A sufficient condition to insure the optimality of immediate partial enactment is that $R(T)$ decline monotonically over the tax rate interval to $R(T_d) = 1$. It is quite plausible, although not unambiguously true, that this condition will be satisfied, as the aggregate marginal efficiency gain, $(N^G dU^G/dT + N^L dU^L/dT)$, declines monotonically to zero at $T = T_d$.⁷

To see the intuition behind the optimality of immediate partial enactment when $R(T)$ declines monotonically over the tax rate interval, note that $R(T)$ is independent of the time of enactment of the movement to T , and consider the desirability of phasing-in reform. The necessary condition for a multi-step phasing-in reform policy to be optimal is that at each value of the tax rate T_k :

$$R(T_k) = \left[\frac{U_r + \Delta PV^G}{U_r + \Delta PV^L} \right]^e; \quad (5)$$

that is, the aggregate marginal utility tradeoff ratio must be equal at each value of the tax rate along a multi-step tax reform path.⁸ If this condition were not satisfied, say, for a two-step tax path, a marginal adjustment in the two tax rates would increase social welfare. Clearly, if $R(T)$ declines

⁷The effects of an incremental movement toward T_d can be decomposed into a pure marginal redistribution between the gainers and losers [$\tau(T)$] and the marginal efficiency gain [$\epsilon(T)$]. Denoting $\theta^G(T)$ and $\theta^L(T)$ as the gainers' and losers' share of the marginal efficiency gain, $R(T) = -(\tau + \theta^G \epsilon)/(-\tau + \theta^L \epsilon)$. Treating θ^G and θ^L as constants, $R(T)$ declines monotonically over the tax rate interval unless the marginal redistribution τ declines rapidly; my experience to date with general equilibrium simulations of the type described in Section 7 suggests that this is unlikely to occur, as τ tends to be approximately constant or to increase as T_d is approached.

⁸Equation (5) is obtained by setting the partial derivative of Eq. (2) with respect to each tax rate T_k equal to zero.

monotonically, the optimal partial enactment policy will be a one-step policy to a unique T^* , $T_o < T^* < T_d$.

This result obtains because postponing reform does not alter $R(T)$ for any T in the tax rate interval. Accordingly, if a marginal movement beyond T^* was undesirable at the time of the movement to T^* , it will still be undesirable if postponed. Moreover, since the individual tradeoff ratio is declining, all finite reductions beyond T^* will be even less desirable. Thus, nothing can be gained by phasing-in reform beyond T^* .

The final implication of a monotonically declining aggregate marginal utility tradeoff ratio is that the optimal one-step partial implementation policy will be enacted immediately. Postponement of a movement from T_o to T^* is desirable only to reduce proportionately the magnitude of the associated redistributions. However, if $R(T)$ is declining, it is preferable to reduce these redistributions simply by reducing the extent of reform and then enacting it immediately — this eliminates the less desirable utility changes (a relatively low tradeoff ratio) while enacting the more desirable utility changes (a relatively high tradeoff ratio) as soon as possible.

Thus, immediate partial enactment is the optimal tax reform implementation policy in the two-group case if the aggregate marginal utility tradeoff ratio declines monotonically between the initial equilibrium and the tax design optimum.⁹ In particular, postponed full enactment is undesirable because it constrains the tax rate variable to be T_d , so that the only way to reduce the arbitrary redistributions associated with full enactment is to postpone the entire movement from T_o to T_d . It is preferable to relax the requirement of full enactment. This permits immediate enactment of reform where $R(T)$ is high (the marginal efficiency gains from the reduction of a tax distortion are large when the distortion is large while the accumulated gains and losses are small) and eliminates the requirement that reform be pursued to the point where $R(T)$ is equal to its minimum value of one (the marginal efficiency gain declines to zero at T_d while the accumulated gains and losses increase with each incremental movement toward T_d).

⁹In the multi-group case, immediate partial enactment is optimal if the sum of the marginal individual utility changes, weighted by the social marginal valuation of changes in individual utility, declines monotonically over the tax rate interval.

However, the implementation policy of immediate partial enactment is not necessarily optimal when $R(T)$ does not decline monotonically between T_o and T_d . The following two examples illustrate this point.¹⁰

First suppose that the pattern of individual marginal utility changes along the tax rate interval is such that $R(T)$ does not decline monotonically but increases monotonically to $\tilde{T}$, $T_o < \tilde{T} < T_d$, and then declines monotonically to T_d .¹¹ Suppose further that the optimal immediate partial enactment would be to T^* ($T^b < T^* < \tilde{T}$). In this case delayed partial enactment to some T' such that $R(T') > R(T^*)$ may be desirable as it permits additional reform beyond T^* to take advantage of the higher marginal tradeoff ratio, while reducing the magnitudes of the redistributions associated with the relatively low marginal tradeoff ratios between T_o and T^* .

Second, suppose that $R(T)$ declines monotonically to $\tilde{T}$, $T_o < \tilde{T} < T_d$, at which point $R(T)$ increases discontinuously to $R(\tilde{T})$, and then declines monotonically to T_d .¹² Suppose further that the optimal immediate partial enactment would be to T^* ($T_o < T^* < \tilde{T}$), where $R(\tilde{T}) > R(T^*)$. In this case, a two-step reform implementation policy of immediate reform to T_1 ($T_o < T_1 < T^*$), followed by delayed or phased-in reform to T_2 ($\tilde{T} < T_2 < T_d$) could be optimal. Such a phasing-in policy captures the high marginal tradeoff ratios between T_o and T_1 and between $\tilde{T}$ and T_2 while reducing the magnitudes of the redistributions associated with the relatively low marginal tradeoff ratios between T_1 and $\tilde{T}$ (recall that $R(T_1) = R(T_2)$ for the optimal T_1 and T_2).

Thus, the optimality of immediate partial enactment cannot be assumed. However, the above two examples were contrived to illustrate this point and seem to be atypical; a monotonically declining $R(T)$ has been characteristic of all of the general equilibrium models with which I have experimented to date.

¹⁰ See Zodrow (1981) for further details and numerical examples of these two cases.

¹¹ Such a pattern for $R(T)$ obtains if the marginal efficiency gain declines linearly along the tax rate interval to zero at T_d , while the marginal redistribution decreases linearly from T_o to $\tilde{T}$ and is constant from $\tilde{T}$ to T_d .

¹² Such a pattern for $R(T)$ obtains if the marginal efficiency gain declines linearly along the tax rate interval to zero at T_d , while the marginal redistribution is constant between T_o and $\tilde{T}$ and constant at a lower level between $\tilde{T}$ and T_d .

In the following two sections, I describe extensions of the analysis of tax reform presented above. First, I consider the implications of constraining the government to full enactment of a movement to the tax design optimum at a fixed future date; in this case, the relevant question is the optimal phasing-in of reform prior to the fixed full enactment date. Second, I describe how distributional concerns on the part of the government can be included in the analytical framework. In particular, I relax the assumption that only efficiency is considered in the definition of the tax design optimum and the assumption that the government is indifferent to the utility levels of the individuals who actually experience gains and losses as a result of tax reform. Thus, I consider optimal tax reform within a “distributional justice” context, in contrast to the “impersonal justice” approach advocated by Feldstein.

5. Optimal Phasing-in of Reform Prior to a Fixed Full Enactment Date

In the previous section, the government was assumed to be unconstrained in its choice of time path for the exogenous tax variable. Suppose instead that the government, for some reason, is constrained to full enactment of reform at a fixed future date. For example, an eventual movement to the tax design optimum may be judicially mandated or dictated by political considerations. Alternatively, note that the analysis assumes infinitely-lived governments or that future governments will support the tax reform policies of the current government. In practice, the current government may believe that future governments will be less likely to alter the tax structure if the economy is at the tax design optimum when power is transferred; accordingly, the current government may impose the constraint of eventual full enactment by the time they anticipate that the transfer of power will take place.¹³

In any case, under these circumstances, the case for immediate partial enactment when $R(T)$ declines monotonically over the tax rate interval is only slightly altered. The requirement that full reform be enacted at a fixed

¹³Thus, as noted by Feldstein (1976b), an advantage of full enactment is that it eliminates one potential source of future horizontal inequities.

future date constrains the government to inducing a minimum level of redistributions so that the marginal individual utility changes are no longer weighted equally at T_0 as in the unconstrained case. As a result, it is possible that, even at T_0 where $R(T)$ is at its maximum, this implied level of redistributions will be sufficiently large that the marginal tradeoff ratio will be too small to justify any phasing-in of reform prior to the fixed full enactment date.¹⁴ However, if any phasing-in of reform is desirable, the remainder of the argument presented above is unchanged. That is, the optimal reform implementation policy will be one of some immediate partial enactment prior to the fixed full enactment date with no further phasing-in of reform. Note, however, that the extent of partial enactment will be less than in the unconstrained case due to the redistributions implied by the mandated eventual movement to T_d .

6. The Distributional Justice Case

The analysis thus far has dealt exclusively with the “impersonal justice” approach to the analysis of tax reform advocated by Feldstein. Introducing distributional concerns into the governmental optimization process alters the analytical framework described above in two important ways.

First, distributional concerns must be taken into account in the definition of the tax design optimum. The standard approach taken in the optimal taxation literature is to assume that the government selects its tax structure (T_d') to maximize the following weighted sum of individual utility levels:

$$W_D = \frac{1}{1-e'} \sum_i \{[U^i(T_d')]^{1-e'} - 1\}, \quad 0 \leq e' < \infty \quad (6)$$

where e' is the elasticity of the social marginal valuation of individual utility.¹⁵ (The case where $e' = 0$ and the individual utility functions are

¹⁴ In terms of Eq. (5), $R(T_0)$ is less than $[(U_r + \Delta PV^G)/(U_r + \Delta PV^L)]^e$ evaluated at the values of ΔPV^G and ΔPV^L implied by the fixed future movement to the tax design optimum with no phasing-in of reform; this implies the corner solution of no partial enactment prior to the fixed full enactment date.

¹⁵ For example, see Atkinson and Stiglitz (1980).

linear in income corresponds to the impersonal justice case examined above, where the tax design optimum was defined solely with respect to efficiency considerations.) Thus, even if efficiency considerations alone dictate the elimination of any tax differential in the model described in Section 2, the tax design optimum in the distributional justice case could specify a tax differential which would have the effect of raising the utility levels of the relatively poor individuals in the economy.¹⁶

Second, distributional concerns must be included in the formulation of the optimal tax reform problem in order to reflect governmental concern about the utility levels of the individuals who actually experience gains and losses from a movement toward the tax design optimum. This is done by replacing the common reference utility level U_r in the impersonal justice formulation (Eq. (2)) with the actual individual utility levels in the initial equilibrium. That is, the government chooses its reform implementation policy to maximize

$$W' = \frac{1}{1-e} \sum_i [(U_r^i + \Delta PV^i)^{1-e} - 1], \quad e' \leq e < \infty \quad (7)$$

where U_r^i is the present value of each individual's lifetime utility if the initial equilibrium is unchanged, the ΔPV^i are again the capitalized present values of the individual utility changes associated with any time path of tax reform (as given by Eq. (1)), and e' is the value of e used in the definition of the tax design optimum. If $e = e'$, an immediate movement to the "distributional justice" case tax design optimum is the optimal tax reform implementation policy;¹⁷ there is no social concern about the arbitrary redistributions of income caused by reform. This concern is introduced into the optimal tax reform problem when $e > e'$ (the concavity of the welfare function is increased). For individuals at the same initial utility level, a utility gain (loss) of a given magnitude is socially weighted less (more) than in the definition of the tax design optimum, as in the impersonal justice case (when $e > 0$). However, the point of reference for the

¹⁶ I assume that the optimal tax design problem has a unique solution, although, as pointed out by Harris (1975), this is by no means certain.

¹⁷ If $e = e'$, W' in Eq. (7) reduces to W_D in Eq. (6).

social evaluation of each utility change is based on the individual's actual initial utility level rather than the common reference level used in the impersonal justice case. For example, an arbitrary loss of a given magnitude will have a smaller negative impact on the social welfare function if it is suffered by a relatively rich individual. Thus, when $e > e'$, the government is always concerned about inducing arbitrary redistributions of income, but redistributions of a given magnitude have a larger impact on the governmental objective function if they are experienced by relatively poor individuals.

Once the analytical structure of the optimal tax reform problem has been modified to include distributional concerns as described above, the case for the optimality of immediate partial enactment is only slightly altered. Suppose that the tax rate interval is $T_0 \leq T \leq T_d'$. In the distributional justice case, the marginal utility changes implied by a movement from the initial equilibrium T_0 are not weighted equally as they were in the impersonal justice case (since each individual's reference utility value is U_r^i , rather than a common value U_r as in Equation (2)). Thus, for a high enough value of e , no reform may be optimal. However, if some movement from the initial equilibrium is desirable, and if the aggregate marginal utility ratio (which is defined precisely as in the impersonal justice case) is monotonically declining over the tax rate interval, the arguments supporting the optimality of the policy of immediate partial enactment are still valid; accordingly, the optimal implementation policy will be immediate partial enactment to T^* , $T_0 < T^* < T_d'$.

Thus, the extension of the results to the impersonal justice case is straightforward. Note that both the impersonal justice and distributional justice approaches to the analysis of tax reform require interpersonal cardinal utility comparisons. The choice between the two approaches requires a social judgment as to the appropriate way to weight the reform-induced redistributions which occur to individuals at different utility levels. Feldstein argues that a "procedure of ignoring income differences is of course common to most legislative and judicial procedures," and thus that the government should be indifferent to the actual utility levels of the individuals who experience the redistributions induced by the enactment of reform.¹⁸ Also, it is clear from the discussion in Section 3 that the

¹⁸ See Feldstein (1976b, p. 100) for further elaboration.

enactment of tax reform is not, in general, an appropriate way to remedy distributional inequities, as the incidence of reform will be arbitrary even within income classes.

Nevertheless, it is by no means obvious that simply ignoring distributional considerations in the analysis is appropriate. Distributional questions have frequently been emphasized in the optimal taxation literature (for example, see Atkinson (1973)) and distributional concerns frequently pervade legislative debate on a variety of issues. Also, academic studies of policy questions frequently include a distributive component; for example, both Arrow and Kalt (1979) and Loury (1981) use an income-weighting process in assessing the effects of changes in energy policy in the area of petroleum price deregulation. Thus, I feel that distributional questions are likely to arise in the evaluation of most tax reforms, so that the distributional justice approach is a relevant extension of Feldstein's framework for the analysis of tax reform.

7. Numerical Simulation Results

In this section, I report the results of some simulations with a simple general equilibrium model which provide a rough indication of how the social welfare gains obtained from the enactment of tax reform vary with the method of implementation. I compare the social welfare gains obtained with immediate full enactment, postponed full enactment, and immediate partial enactment in the impersonal justice case, the impersonal justice case when the government is constrained to full enactment at an arbitrary future date, and the distributional justice case.

The model¹⁹ has two jurisdictions, each with a fixed land supply. The supply of capital to the two jurisdictions is perfectly elastic and capital is perfectly mobile between the two jurisdictions. Profit-maximizing firms produce a single good (the numeraire) in both jurisdictions using capital and land; the production function is Cobb–Douglas. Government services are modeled as purchases of the consumption good and are provided as a pure public good to residents of both jurisdictions. These purchases are financed by property taxation of land and capital in both jurisdictions. The

¹⁹The equations of the model are listed in the appendix, along with the parameter values used in the simulations.

initial equilibrium is characterized by a property tax differential across the two jurisdictions; the tax reform question addressed is the reduction of this differential, holding the service level constant. The tax rate in the initially low-tax jurisdiction is the exogenous government control variable (T), while the tax rate in the initially high-tax jurisdiction must adjust to satisfy the revenue constraint.²⁰

7.1. *The impersonal justice case*

For the impersonal justice case, land ownership in the initially high-tax jurisdiction is divided equally among N_G identical individuals and land ownership in the initially low-tax jurisdiction is divided equally among N_L identical individuals; no individual owns land in both jurisdictions. All capital is owned by nonresidents of the two jurisdictions and the government is assumed to include only the $N(N = N_G + N_L)$ landowners in its welfare calculations. In the single good model, the individual utility level of the landowners is equal to the income from their land holdings. The “reference” income level in the social welfare calculations for the impersonal justice case is the present value of a lifetime income stream equal to the mean income level in the initial equilibrium; this is approximated as $\tilde{Y}/n$ where $\tilde{Y}$ is mean yearly income and n is the discount rate.

The tax design optimum (T_d) in the impersonal justice case corresponds to the allocative efficiency optimum of “tax equalization”; that is, the endogenous tax rate in the initially high-tax jurisdiction falls as the tax rate in the initially low-tax jurisdiction is raised, and the unweighted sum of the utilities of the N landowners is maximized when the two tax rates are equal.²¹ As the tax rate in the initially low-tax jurisdiction is increased from its initial value of T_o along the tax rate interval of $T_o \leq T \leq T_d$, all N landowners share in the efficiency gains from reform in proportion to their income shares, while the redistributions which occur are from

²⁰The model described above is a simplified version of a model used to analyze the optimal implementation of metropolitan property tax base sharing and rate equalization; see Zodrow (1980).

²¹ See the Appendix for a proof.

Table 1.1.
Social Welfare Gains — Impersonal Justice Case^a

e-Index of Social Concern about Redistributions	% Welfare Change with Immediate Full Enactment	% Welfare Change with Postponed Full Enactment	Optimal Postponement (years)	% Welfare Change with Immediate Partial Enactment	% Original Tax Differential Remaining	Welfare Gain Ratio Immediate Partial vs. Postponed Full
0	1.14	1.14	0	1.14	0	1.00
0.5	1.63	1.63	0	1.67	12.6	1.03
1.0	2.13	2.13	0	2.35	24.3	1.10
1.5	2.52	2.52	0	3.19	32.1	1.27
2.0	2.62	2.69	1.7	4.10	37.6	1.52
2.5	2.29	2.86	4.3	5.03	40.5	1.76
3.0	1.41	3.03	6.3	5.95	46.6	1.96
3.5	-0.08	3.18	8.1	6.81	49.9	2.14
4.0	-2.21	3.31	9.6	7.61	53.3	2.30

^aFor example, for $e = 3$, immediate full enactment of a movement to the tax design optimum results in a social welfare increase of 1.41 percent (all welfare changes are expressed as a percentage of the level of social welfare with no reform, leaving the initial tax differential in perpetuity), full enactment after a postponement of 6.3 years results in a 3.03 percent increase in welfare, and immediate partial enactment (reducing the original tax differential by 53.4 percent and leaving the remaining 46.6 percent in perpetuity) increases welfare by 5.95 percent. The welfare increase with immediate partial enactment is nearly twice that obtained with postponed full enactment ($5.95/3.03 = 1.96$).

landowners in the initially low-tax jurisdiction to landowners in the initially high-tax jurisdiction.²²

The relative magnitudes of the welfare gains in the impersonal justice case obtained from immediate full enactment, postponed full enactment, and immediate partial enactment are given in Table 1.1 for a range of values of e . For the parameter values chosen, the aggregate marginal utility tradeoff ratio $R(T)$ declines monotonically to one at $T = T_a$, so immediate partial enactment is the optimal implementation policy.

Several features of the results presented in Table 1.1 are of interest. First, as noted above, the largest welfare improvements for all values of $e > 0$ are obtained with the reform implementation policy of immediate

²²This is also proved in the appendix.

partial enactment. Note that the welfare improvements obtained with immediate partial enactment relative to those obtained with postponed full enactment increase as the concavity of the welfare function increases. That is, as social concern about arbitrary redistributions caused by reform increases, it becomes relatively more important to relax the full enactment constraint and instead to permit some immediate incremental reform. For example, for $e = 1(2, 3)$, immediate partial enactment results in a 10 percent (52 percent, 96 percent) larger welfare gain than postponed full enactment. Note also that the remaining tax differential increases as e increases; as social concern about redistributions increases, the extent of the optimal immediate partial enactment decreases.

Second, note that the optimal postponement becomes positive only for a sufficiently concave welfare function (the values of $e \geq 2$). Thus, postponement is an improvement over immediate full enactment only in these cases, while immediate partial enactment is preferable to immediate full enactment for all values of $e > 0$. For example, for $e = 1.5$, the policy of postponed full enactment cannot increase the welfare gain obtained with immediate full enactment, while immediate partial enactment (an immediate elimination of 67.9 percent of the original tax differential) results in a welfare gain more than 26 percent larger than that obtained with immediate full enactment.

Finally, note that for sufficiently concave welfare functions ($e = 3.5$, $e = 4.0$), immediate full enactment actually results in a welfare loss. In these cases, tax reform is undesirable unless postponed considerably (8.1 and 9.6 years) or unless partial reform is implemented immediately; the latter policy clearly results in much larger welfare gains.

7.2. Phasing-in reform prior to a fixed full enactment date

Results for the impersonal justice case when the government is constrained to full enactment of reform at a fixed future date are presented in Table 1.2. The simulation is identical to the one described in the previous section, except that the government must implement a movement to the tax design optimum of full tax equalization by the end of a fixed time period; this time period is arbitrarily chosen to be five years.

Table 1.2.

Social Welfare Gains — Government Constrained to Full Enactment After Five Years

e-Index of Social Concern about Redistributions	% Welfare Change with Immediate Full Enactment ^a	% Welfare Change with Postponed Full Enactment	Optimal Postponement (years)	% Welfare Change with Immediate Partial Enactment	% Original Tax Differential Remaining	Welfare Gain Ratio Immediate Partial vs. Postponed Full
0	1.14	1.14	0	1.14	0	1.00
0.5	1.63	1.63	0	1.65	14.8	1.01
1.0	2.13	2.13	0	2.22	26.8	1.05
1.5	2.52	2.52	0	2.83	37.6	1.12
2.0	2.62	2.69	1.7	3.33	46.6	1.24
2.5	2.29	2.86	4.3	3.66	56.9	1.28
3.0	1.41	2.98	5.0	3.74	64.6	1.26
3.5	-0.08	2.88	5.0	3.56	68.9	1.24
4.0	-2.21	2.52	5.0	3.09	73.6	1.23

^aWelfare changes are expressed as a percentage of the level of social welfare with no reform.

The basic pattern of the results is similar to that in the unconstrained impersonal justice case. In particular, the largest welfare gains are obtained with the policy of immediate partial phasing-in of reform prior to the fixed full enactment date, and the extent of partial reform decreases as the concavity of the social welfare function increases.

However, constraining the government to full enactment within five years changes the nature of the results in two important ways. First, the maximum welfare improvements are reduced relative to the unconstrained case presented above, as the government must eventually move to the tax design optimum even though, as explained in Section 4, such a movement is never desirable. Note that for each value of e the extent of partial enactment is also reduced; since the government must impose the redistributions implied by full enactment after five years, the losses (gains) induced by immediate phasing-in of reform are weighted more heavily (lightly) than in the unconstrained case so that less partial reform is enacted.

Second, recall that the welfare improvements obtained with immediate partial enactment relative to those obtained with postponed full

enactment increased as e increased in the unconstrained impersonal justice case. The same result obtains in the constrained case only as long as the constraint is non-binding in the calculation of the optimal postponement — that is, as long as the optimal postponed full enactment delay is less than five years. In these cases, immediate phasing-in of reform followed by full enactment at the end of five years increases welfare in two ways. First, immediate phasing-in of reform increases welfare by permitting immediate enactment of reform where the marginal efficiency gains are relatively large. Second, delaying full enactment (by the difference between five years and the optimal postponement period) increases welfare by reducing the gains and losses implied by the eventual movement to the tax design optimum which causes relatively large accumulated redistributions and relatively small marginal efficiency gains. However, when the optimal postponement period is greater than or equal to the maximum allowable delay of five years, none of the potential gains from delaying full enactment can be realized. Thus, one of the advantages of immediate phasing-in of reform prior to the fixed full enactment date in comparison to postponing reform is eliminated. As a result, the ratio of the welfare gains (in the last column of Table 1.2) declines as e increases, once the unconstrained optimal postponement period exceeds five years. In fact, recall that social concern about the redistributions implied by the mandated movement to full equalization after five years means that the losses associated with immediate phasing-in of reform are weighted more heavily than the gains at T_0 (where they were equally weighted in the unconstrained case). For a high enough value of e , this concern will imply that any immediate phasing-in of reform is undesirable, as explained in Section 5. In this case, the government will not be able to increase the welfare gain obtained with postponed full enactment after the five year delay.

7.3. *The distributional justice case*

Results in the distributional justice case are presented in Table 1.3. In this case, the government is again assumed to be unconstrained in its choice of tax reform implementation policy. The simulation differs from the impersonal justice case in three ways.

Table 1.3.
Social Welfare Gains — Impersonal Justice Case ($e' = 0.5$)

e-Index of Social Concern about Redistributions	% Welfare Change with Immediate Full Enactment ^a	% Welfare Change with Postponed Full Enactment	Optimal Postponement (years)	% Welfare Change with Immediate Partial Enactment	% Excess Tax Differential Remaining ^b	Welfare Gain Ratio Immediate Partial vs. Postponed Full
0.5	1.52	1.52	0	1.52	0	1.00
1.0	1.80	1.80	0	1.84	11.7	1.02
1.5	1.93	1.93	0	2.18	24.7	1.13
2.0	1.77	1.77	0	2.46	35.6	1.39
2.5	1.22	1.39	3.4	2.69	43.6	1.93
3.0	0.20	1.04	7.3	2.84	47.9	2.72
3.5	-1.35	0.73	11.3	2.90	52.5	3.97
4.0	-3.45	0.46	15.5	2.89	57.3	6.26

^aWelfare changes are expressed as a percentage of the level of social welfare with no reform.

^bThe excess tax differential refers to the difference between the original tax differential and the optimal tax differential (the tax differential which maximizes Equation 6 when $e' = 0.5$).

First, landowners in the initially high-tax jurisdiction are assumed to have an additional source of income such that they are relatively wealthier than the landowners in the initially low-tax jurisdiction.²³ Second, the tax design optimum is no longer the allocative efficiency optimum of tax equalization. Instead, as explained in Section 6, the tax design optimum is the value of the exogenous tax rate which maximizes W_D as given in Eq. (6) for $e' > 0$. The results reported in Table 1.3 assume $e' = 0.5$ which results in a tax rate interval of $T_o \leq T \leq T'_d < T_d$. That is, since the residents of the initially low-tax jurisdiction are relatively poor, the tax design optimum in the distributional justice case calls for a tax differential favoring the relatively poor jurisdiction rather than full equalization ($T'_d < T_d$). However, the initial equilibrium is assumed to be characterized by an even larger differential favoring the poor jurisdiction ($T_o < T'_d$), so that full

²³ For example, landowners in the initially high-tax jurisdiction could own some capital; since the return on capital is assumed fixed in the model, this would be equivalent to an exogenous source of income.

enactment of reform refers to a reduction of the initial differential to the “optimal” differential.

Third, in the impersonal justice case, the various reform implementation policies are evaluated according to the welfare criterion specified by Eq. (7). Since the welfare function is concave, a gain to an individual is still valued less than proportionately while a loss to the same individual is valued more than proportionately. However, the “reference” income level in the welfare calculation is the present value of a lifetime income stream equal to the individual’s income level in the initial equilibrium (denoted as Y^G/n (Y^L/n) for the individuals in the initially high (low)-tax jurisdiction who are gainers (losers) from reform). Hence, in the distributional justice case, the gains from reform are weighted less than in the impersonal justice case since they accrue to relatively wealthy individuals.

Increasing social concern about the redistributions caused by reform is associated with values of e in Table 1.3 which are increasingly higher than $e' = 0.5$, and full enactment of reform refers to the elimination of 83 percent of the original tax differential. Given this interpretation, the pattern of the results in the distributional justice case is identical to the impersonal justice case. The largest welfare improvements are obtained with immediate partial enactment, the improvement obtained with immediate partial enactment relative to the gain obtained with postponed full enactment increases as social concern about redistribution increases, and the extent of immediate partial enactment decreases as e increases. Postponement is preferable to immediate full enactment only for a sufficiently concave welfare function, while immediate partial enactment is preferable to immediate full enactment for all values of $e > e' = 0.5$. Finally, immediate full enactment again can result in a welfare loss for a sufficiently concave welfare function; both postponed full enactment and immediate partial enactment yield welfare gains in these cases, although the latter policy is clearly preferable.

8. Conclusion

I have considered the optimal implementation of tax reform proposals within the context of an instantaneous adjustment, perfect information model where changes in the tax structure are unanticipated. The analysis

shows that immediate partial enactment is the optimal method of implementing reform in a variety of situations involving different governmental objective functions and constraints; the numerical simulations suggest that immediate partial enactment yields substantially larger welfare gains than the alternate implementation policy of postponed full enactment. The basic intuition behind the optimality of immediate partial enactment is that the first movements toward the tax design optimum result in relatively large marginal efficiency gains which dominate the effects of the associated redistributions on the social welfare function; these gains should be captured immediately rather than postponed. However, as one approaches full enactment, the marginal efficiency gains from reform become small, and, at some point, it is optimal from a social viewpoint simply to forego the incremental redistributions associated with further movements toward the tax design optimum, rather than just reducing them by postponed enactment. This result obtains in (i) Feldstein's "impersonal justice" case, where the government is indifferent to the actual utility levels of the individuals who experience utility changes as a result of reform, (ii) the case where the government is constrained to eventual full enactment at a fixed future date (immediate partial enactment is the optimal phasing-in policy), and (iii) the "distributional justice" case where the government is concerned about the utility levels of the individuals who actually experience the redistributions. The numerical results suggest that sizable welfare gains, relative to those obtained with postponed full enactment, may be obtained with immediate partial enactment in all three cases.²⁴

Administrative and political considerations strengthen the conclusion that immediate partial enactment is the optimal implementation policy. From an administrative viewpoint, immediate partial enactment would appear to be superior to a complicated phasing-in policy. Moreover, data presented by Bloom, Ladd, and Yinger (1980) support the assumption that the effects of actual tax changes are capitalized into property values

²⁴"Note that the welfare improvements cited are clearly upper limits, as the assumption of instantaneous adjustment biases the optimal implementation result in the direction of immediate enactment by ignoring adjustment costs; I am currently investigating the optimal implementation of reform in models with adjustment costs.

but suggest that the effects of tax changes announced more than one year ahead of their enactment are not perfectly capitalized; this phenomenon would tend to make the calculation of the optimal postponement period rather tenuous.²⁵ Finally, immediate partial enactment may be a more realistic tax reform goal, as small changes seem to be more readily attainable within the political process than large ones.

Appendix

The seven equations of the general equilibrium model used in the simulations reported in Section 6 are as follows:

$$X_1 = K_1^a V_1^{1-a} \quad (\text{A.1})$$

$$X_2 = K_2^a V_2^{1-a} \quad (\text{A.2})$$

$$K_1/V_1 = [r(1 + P_1)/a]^{1/(a-1)} \quad (\text{A.3})$$

$$K_2/V_2 = [r(1 + P_2)/a]^{1/(a-1)} \quad (\text{A.4})$$

$$X_1 = (1 + P_1)(rK_1 + s_1 V_1) \quad (\text{A.5})$$

$$X_2 = (1 + P_2)(rK_2 + s_2 V_2) \quad (\text{A.6})$$

$$G = P_1 (rK_1 + s_1 V_1 + P_2 (rK_2 + s_2 V_2)) \quad (\text{A.7})$$

where X_j = production of the (numeraire) composite good in jurisdiction j

K_j = capital used in production of good X_j

V_j = fixed land supply in jurisdiction j

r = exogenously determined net return to capital

s_j = net return to land in jurisdiction j

P_j = ad valorem property tax rate in jurisdiction j

G = fixed total government purchases of the composite good

a = capital share parameter in the Cobb-Douglas production function.

Equations (A.1) and (A.2) are the production equations, while Eqs. (A.3) and (A.4) are the profit-maximizing factor demands. Equations (A.5) and (A.6)

²⁵This point was first made by Helen Ladd; see Ladd (1980).

are implied by the assumptions of perfect competition and constant returns to scale production functions, and Eq. (A.7) is the government budget constraint.

The effects of a change in the tax structure in the model can be seen by totally differentiating the above system (see Ballentine and Eris (1975) or Vandendorpe and Friedlaender (1976) for details of general equilibrium differential incidence analysis) and solving for the elasticities of the factor price changes with respect to an increase in the relatively low tax rate P_2 (the “ $\wedge$ ” notation indicates logarithmic differentiation):

$$\hat{s}_1 = [y_{v2}(d_1 + d_2) / (d_1 f_{v2}) + E](1 \hat{+} P_2) \quad (\text{A.8})$$

$$\hat{s}_2 = [-y_{v1}(d_1 + d_2) / (d_1 f_{v2}) + E](1 \hat{+} P_2), \quad (\text{A.9})$$

where

$$y_{vi} = s_i V_i / (s_1 V_1 + s_2 V_2) = s_i V_i / Y \quad i = 1, 2$$

$$f_{vi} = s_i (1 + P_i) V_i / X_i \quad i = 1, 2$$

$$d_i = (s_i V_i - P_i r K_i) / Y \quad i = 1, 2$$

$$E = (P_1 - P_2) [(1 - f_{v1}) / f_{v1}] y_{v1} y_{v2} / (d_1 f_{v2}).$$

Thus, y_{vi} is the income share of landowners in jurisdiction i in total landowner income, and f_{vi} is the land share of gross production costs in jurisdiction i . Differentiating the government budget constraint yields:

$$-(d_1 / f_{v1})(1 \hat{+} P_1) - (d_2 / f_{v2})(1 \hat{+} P_2) = 0.$$

Thus $(-d_i / f_{vi})$ is the elasticity of the government budget deficit with respect to a change in the tax rate in jurisdiction i , holding the other tax rate constant; I assume that each $d_i > 0$, that is, neither jurisdiction's tax rate is so high that a reduction in its tax rate increases its revenues. Finally, the aggregate marginal efficiency gain is equal to the increase in landowners' total income ($Y = s_1 V_1 + s_2 V_2$):

$$\hat{Y} = y_{v1} \hat{s}_1 + y_{v2} \hat{s}_2 = E(1 \hat{+} P_2).$$

Hence E can be termed “efficiency effect” of reform; since E is positive as long as $P_1 > P_2$, the allocative efficiency optimum is tax equalization.

The effects of an increase in P_2 on individual landowners (where landowners in jurisdiction 1 (2) are the gainers (losers) from reform) are given by:

$$\begin{aligned} dU^G &= s_1(V_1/N_G)\hat{s}_1 \\ dU^L &= s_2(V_2/N_L)\hat{s}_2. \end{aligned}$$

As noted in the text, the effects of reform can be split into two components; these correspond to the two terms in each bracket in Eqs. (A.8) and (A.9). The first term in each expression is the redistributive effect of reform, as an increase in P_2 causes a pure redistribution from landowners in jurisdiction 2 to landowners in jurisdiction 1:

$$\begin{aligned} &N_G s_1 (V_1/N_G) y_{V_2} (d_1 + d_2)/d_1 f_{V_2} \\ &- N_L s_2 (V_2/N_L) y_{V_1} (d_1 + d_2)/d_1 f_{V_2} = 0. \end{aligned}$$

The second term in each expression shows that all landowners share in the efficiency gain in proportion to their shares in total land income:

$$[N_G s_1 (V_1/N_G)/Y]E + [N_L s_2 (V_2/N_L)/Y]E = E.^{26}$$

The parameter values used in the simulations are $a = 0.8$, $V_1 = V_2 = 1$, $N_G = N_L = 100$, $r = 0.233$. The discount rate is assumed to be 9 percent and the initial property tax structure assumes a tax rate of 6 percent in the high-tax jurisdiction ($P_1 = 0.40$) and a tax rate of 3 percent in the low-tax jurisdiction ($P_2 = 0.25$).

In the impersonal justice case, the tax design optimum of property tax equalization occurs at $P_1 = P_2 = 0.294$, which implies a tax rate interval of $0.250 \leq P_2 \leq 0.294$. In the distributional justice case, the residents of the initially high-tax jurisdiction are assumed to have an exogenous source of income such that they would be fifty percent wealthier than the residents of the initially low tax jurisdiction in the equalized equilibrium; in this case, the tax design optimum is $P'_d = 0.282$ (the tax design optimum calls

²⁶ For the parameter values chosen, the efficiency gains never dominate the redistributive losses for landowners in the initially low-tax jurisdiction, who can be unambiguously classified as "losers" from reform ($dU/dT < 0$ for $T_o \leq T \leq T_d$).

for a tax differential of $P_1 - P_2 = 0.025$ which favors the relatively poor jurisdiction) and the tax rate interval is $0.250 \leq P_2 \leq 0.282$.

Acknowledgments

Research support from the National Science Foundation (Grant DAR-80011842) is gratefully acknowledged. This paper is based on my dissertation; I would like to thank David Bradford, Wallace Oates and Edwin Mills for their guidance and the NBER and the Sloan Foundation for financial support. I also benefited from the suggestions of Thomas McCaleb, Peter Mieszkowski, and especially Helen Ladd, whose comments on this paper as well on my dissertation (see Ladd (1980)) were extremely useful. Finally, I would like to thank Jackie Drane and Tom Herzfeld for research assistance.

References

- Arrow, Kenneth J. and Joseph P. Kalt, *Petroleum Price Regulation: Should We Decontrol?* (Washington: American Enterprise Institute, 1979).
- Atkinson, Anthony B., How Progressive Should Income Tax Be? in J. Michael Parkin, Editor, *Essays in Modern Economics* (London: Longmans, 1973).
- Atkinson, Anthony B. and Joseph E. Stiglitz, *Lectures on Public Economics* (New York: McGraw-Hill, 1980).
- Ballentine, J. Gregory and Ibrahim Eris, On the General Equilibrium Analysis of Tax Incidence, *Journal of Political Economy* 84 (February, 1975): 1–25.
- Bloom, Howard S., Helen F. Ladd and John Yinger, Intra-jurisdictional Property Tax Capitalization, Report for U.S. Department of Housing and Urban Development Grant H-2915RG (August, 1980).
- Feldstein, Martin S., Compensation in Tax Reform, *National Tax Journal* 29 (June, 1976a): 123–130.
- Feldstein, Martin S., On the Theory of Tax Reform, *Journal of Public Economics* 6 (July–August, 1976b): 77–104.
- Harberger, Arnold C., Taxation, Resource Allocation and Welfare, in Arnold C. Harberger, *Taxation and Welfare* (Boston: Little, Brown and Company, 1976).
- Harris, Richard G., A Note on Convex-Concave Demand Systems, Queen's University, Discussion Paper No. 197 (1975).

- Ladd, Helen F., Discussion, *Proceedings of the Seventy-Third Annual Conference on Taxation*, National Tax Association-Tax Institute of America (November, 1980): 251–252.
- Loury, Glenn C., An Analysis of the Efficiency and Inflationary Impact of the Decontrol of Natural Gas Prices, National Gas Supply Association (April, 1981).
- Mirrless, James A., Optimal Tax Theory: A Synthesis, *Journal of Public Economics* 6 (November, 1976): 327–358.
- Sandmo, Agnar, Optimal Taxation: An Introduction to the Literature, *Journal of Public Economics* 6 (July–August, 1976): 37–54.
- Vandendorpe, Adolph L. and Ann F. Friedlaender, Differential Incidence in the Presence of Initial Distorting Taxes, *Journal of Public Economics* 6 (October, 1976): 205–229.
- Zodrow, George R., Optimal Tax Reform: The Case of Property Tax Equalization, *Proceedings of the Seventy-Third Annual Conference on Taxation*, National Tax Association-Tax Institute of America (November, 1980): 240–250.
- Zodrow, George R., On the Optimal Timing and Extent of Enactment of Tax Reform, working paper, Rice University (January, 1981).