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EVALUATING TAX SYSTEMS FOR FINANCING THE UNEMPLOYMENT INSURANCE PROGRAM

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Unemployment insurance (UI) benefits are financed by state taxes on employers. The wide diversity of tax systems among states has received a great deal of attention recently because many state UI funds have run out of money.

When such a fund does run out, the state borrows from a Federal Trust Fund that is financed by a tax on employers in all states. There is a great

20 deal of disagreement over how and when debts to the Federal Trust Fund should be repaid. No one wants to add to the tax burden on firms, especially during a recession, but there is growing concern that the tax systems of some states can not support their benefit schedules. These states are being subsidized by states that have higher taxes and never need to borrow from the Federal Trust Fund.

PRI conducted a study for the National Commission on Unemployment Compensation to help UI administrators evaluate tax systems and predict how changes in tax systems would change fund balances. Several models of UI tax systems were developed, and their predictive power was tested. The best models were used to predict fund balances under a variety of hypothetical tax systems.

The adequacy of fund balances was also evaluated. Federal administrators now consider a fund adequate if the balance is a specified multiple of annual wages "at the beginning of a period of relatively high unemployment." Aside from the difficulty of determining when "relatively high unemployment" begins, this measure treats solvency as the only criterion for evaluating fund balances. States can keep their funds solvent by maintaining arbitrarily high balances or by raising taxes immediately when benefit outflows start to rise, but neither method is desirable. Very high balances represent idle funds that could have been used productively by the employers who pay unemployment insurance taxes and raising taxes when benefit outflows begin to rise means high taxes in a recession.

To reflect the actual--often competing--goals of UI fund managers, the study team evaluated UI tax systems by three criteria: the mean balance, the probability of insolvency, and the timing of the tax over the business cycle. A good tax system will produce a fund with a low mean balance and a low probability of insolvency, and will raise taxes in a boom rather than in a recession.

Simulations of many different tax systems for many different states showed that almost all state tax systems can be improved, although the changes required vary from state to state. The study concluded that a single, federally-mandated tax system would not suit all states. The best tax system for a state depends on, among other things, the amount of seasonal employment and the variations in employment over the business cycle. It would be better to finance deficits in state UI funds by charging interest on loans from the Federal Trust Fund and setting a minimum repayment schedule. These measures would encourage states to adopt fiscally-sound tax systems suited to their own conditions.

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PART I

AN EVALUATION OF UNEMPLOYMENT INSURANCE FUNDS

INTRODUCTION

In the 1970s heavy demands were made on the unemployment compensation trust funds which are used to finance unemployment benefit payments. The heavy demands were caused primarily by relatively severe and prolonged unemployment and by legislated changes in unemployment benefit entitlements. Consequently, benefit outflows have risen dramatically. In spite of the fact that tax inflows from the state payroll taxes also rose sharply, the total unemployment insurance funds were drawn down by nearly $25 billion between 1970 and 1977.

In view of the fact that the states' net reserves (actual reserves minus Federal loans) are close to zero and that total benefit payments have recently exceeded $11 billion annually, serious questions about the financial viability of the unemployment insurance system have arisen. Specifically, why were the increases in tax inflows insufficient (though substantial) to pay for the increases in benefit outflows? Further, is the insufficiency of tax inflows only temporary or permanent? In other words, is it necessary to revise the tax structure of the system radically in order to ensure its long-run financial viability? The research which underlies this report was designed to provide the answers to some of these questions. In particular, different aspects, characteristics, and implications of financing mechanisms have been examined.

The research has consisted of a theoretical part and an empirical part. In the theoretical part, the basic properties of unemployment insurance financing mechanisms and their implications for fund adequacy have been examined. While the theoretical research cannot generate quantitative estimates of the relevant variables, it does point to ways in which financing mechanisms should be changed to avoid fund inadequacies. Hence, the theoretical work has some relevant and possibly important policy implications.

The empirical part of the research was designed to discover the determinants of the desirable properties of fund balances. In particular, an attempt was made to discover whether changes in parameters of the tax structure reduced the average fund balance, reduced the probability of insolvency, or improved the timing of the tax burden over the cycle.

This first part of the final report should be regarded as a summary of the research and its main conclusions. Parts two, three, four and five contain a great deal of detail on the empirical research that was undertaken.

The remainder of this part of the report is structured as follows: In the next section the theoretical analysis is described in some detail. Thereafter, the conceptual framework of the empirical analysis is set out. A summary of the empirical research then follows. Finally, the conclusions and implications for policy are presented.

THEORETICAL ANALYSIS

The theoretical analysis consisted of an examination of some fundamental properties of various unemployment insurance financing mechanisms and, in particular, of their implications for the fund balance. Two questions are of special interest. First, what is the purpose of a positive average fund balance? Second, are there mechanisms which ensure automatic fund stability? An attempt is made to answer these questions in the ensuing two subsections.

Desirable Features of Financing Mechanisms

The problem of the optimal fund balance ought not to be approached in isolation but should be treated instead as part of the entire financing mechanism of the unemployment insurance system. Positive mean fund balances do have an opportunity cost because they could have been used by firms for economically productive purposes. Consequently, positive balances have to be justified in terms of an excess of benefits over costs within a particular financing mechanism. It is certainly easy to conceive of financing mechanisms in which the mean fund balances are trivially small. These mechanisms must be shown to have shortcomings which are absent in other mechanisms with substantial fund balances.

One financing mechanism that does not require a substantial fund balance is the reimbursable system currently in partial use in several states. Under this system, employers pay fully for all unemployment benefits charged to them after a relatively short time lag. Hence, funds are required only to cover the period between payment of benefits and reimbursement by employers. This "billing lag" can be made very short so that the system requires only a trivial positive mean fund balance. Thus, the reimbursable system requires complete and immediate experience rating. It internalizes the cost of unemployment to individual employers entirely and swiftly. While a surcharge for administrative costs, bankruptcies, and noncharged benefits may be required, the reimbursable system is a viable financing mechanism which obviates the necessity for a substantial mean fund balance.

What then are the shortcomings of the reimbursable system which would make us prefer another one with a substantial mean fund balance? Two such shortcomings appear to be particularly important.

- First, the reimbursable system eliminates completely an insurance principle from the unemployment insurance financing mechanism. By insurance principle, we mean that firms within the same risk class pay the same contributions although in any particular period some may have high and others low charged benefits. By risk class, we mean that firms have the same expected or average charged benefits. Since the reimbursable system requires that all firms pay for their own charged benefits entirely and almost immediately, there is no room for the short-term subsidization of the "unlucky" firms by the "lucky" ones within the same risk class.

- Second, the reimbursable system does not permit firms to even out their cash flows through good and bad times. When charged benefits are high, the typical firm is likely to have relatively low cash flows so that the immediate reimbursement of the charged benefits may put special financial stress on it. A preferred system may be one under which firms pay relatively high taxes in good times and relatively low taxes in bad times.

These two shortcomings of the reimbursable system may be the reason why most states have made very limited or no use of this system.[1] Systems which permit some insurance within risk classes as well as some cash-flow smoothing for firms require nontrivial fund balances, or substantial borrowing facilities, especially if the charged benefits of different firms in the same risk class tend to be highly correlated. In a recession the charged benefits of all firms in a given risk class tend to go up, so that a balance (or borrowing power) is required if immediate tax increases are to be avoided.

Since any excess of benefit outflows over tax inflows can be financed either by reducing a positive fund balance or by borrowing, the question of optimal borrowing power arises. Completely unrestricted borrowing power seems quite undesirable because it would permit ever-increasing negative fund balances: all benefit payments could be financed by borrowing which need never be repaid. Thus, some restrictions have to be imposed on the borrowing power of states. In particular, specific repayment schedules seem

[1] It should perhaps be noted that the reimbursable system also does not permit the subsidization of firms belonging to one risk class by firms belonging to another risk class. It is hard, if not impossible, to justify such subsidization across risk classes on economic grounds. As Becker has argued, an inefficient allocation of resources is likely to result from such cross subsidization. See Becker (1972).

desirable. In accordance with the previous arguments, the phasing of the repayments should have some cash-flow smoothing or counter-cyclical properties. Furthermore, states should be charged an interest rate on their borrowing which reflects accurately the opportunity cost of money. Such restricted borrowing powers would enable states to maintain lower average fund balances than would be possible in the absence of borrowing.

To sum up: The question of the optimal fund balance can be discussed only within a broad framework describing the purposes and desirable characteristics of the financing mechanism. Positive fund balances are unnecessary in a reimbursable system or in the presence of unrestricted borrowing power. The more insurance and/or cash-flow smoothing is in the system and the more restricted is the borrowing power, the higher need the average fund balance be.

Automatic Fund Adequacy

In later sections of this report, various evaluation measures of fund balances will be discussed in detail. In this section, the question of fund properties is approached from a purely theoretical point of view. In particular, it is shown that a financing mechanism can be designed which has some of the attractive features described in the previous subsection but which also ensures automatic fund adequacy.

Let us confine our attention to the reserve-ratio method of taxation which is most common among states. Each individual firm's reserve ration (R) is defined as its balance in the state unemployment insurance fund divided by its taxable payroll, or a moving average thereof. The firm's tax rate (τ_t) is a function of the lagged reserve ratio (R_{t-1}).

In figure I-1, two tax schedules are illustrated. The schedule labeled A-A is sloped continuously while schedule B-B consists of a series of steps. Let us consider the two schedules in turn. If the continuous tax schedule A-A were in effect, then all firms would be experience rated in the sense that, in the long run, their tax payments would be equal to their charged benefits. But the tax payments would lag behind the benefit outflows, first because of the discrete lag of τ_t behind R_{t-1} and second because the slope is less than unity. The less steep is the slope, the slower is the response of tax payments.[1]

[1]For a detailed discussion of these properties, see reference 2.

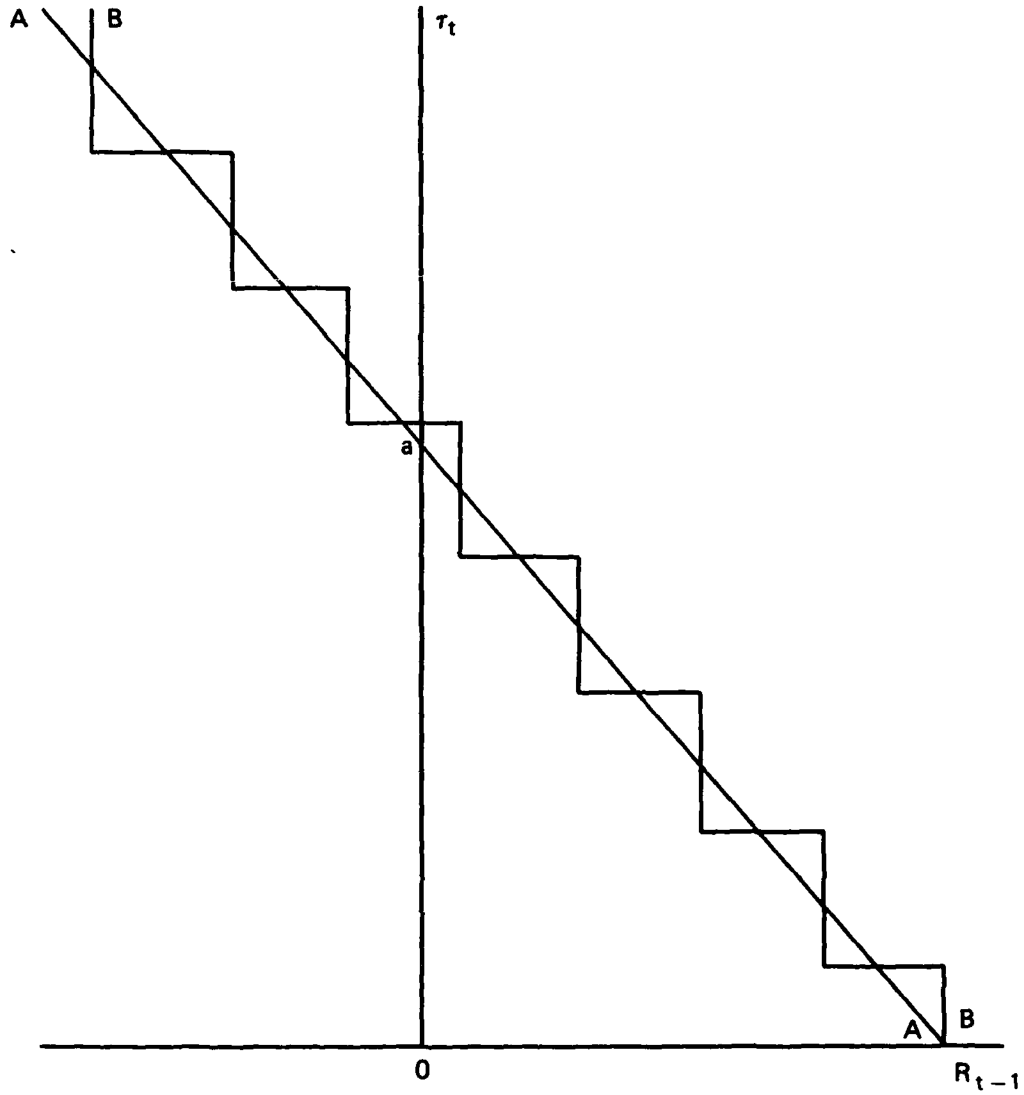

FIG. I-1: TAX SCHEDULES

If schedule B-B were in effect, the firms would not be experience rated as long as their reserve ratios remained within the bounds of a constant tax rate. One might argue that the firms on each step belong to the same risk class and, hence, have identical tax rates. Their expected charged benefits (when scaled by the tax base) are identical, and hence, their long-run tax payments are expected to equal their charged benefits.

The important point about tax schedules of the type illustrated in figure I-1 is that in the absence of noncharged benefits, the state unemployment insurance fund can not be rising or falling for long periods of time unless the ratio of benefits to the taxable payroll has a consistent long-run upward or downward trend over time. The reason for this is that each firm pays for its charged benefits completely in the long run. Formally, the time path of the reserve ratio for a firm can be described by the following equation:[1]

$$R_t = (1-s)R_{t-1} + a_t - \frac{b_t}{m_t} \tag{I-1}$$

where s is the slope of the tax schedule, a_t the intercept of the tax schedule and b_t/m_t is the ratio of total benefits to the total taxable payroll. This equation shows clearly that with a constant (a_t-b_t/m_t) and $o<s<1$ the reserve ratio will move to its steady state value

$$R_t^* = \frac{1}{s}(a_t-b_t/m_t) \ . \tag{I-2}$$

This steady-state value R_t^* may be negative if $a_t<b_t/m_t$. Furthermore, if (a_t-b_t/m_t) does fluctuate cyclically but does not have a long-run positive or negative time trend then R_t tends to fluctuate about R_t^*, but it will not be ever-increasing or ever-decreasing. Since this mechanism operates for each individual firm, it must, in the absence of noncharged benefits, also operate for the state as a whole.

[1]For a detailed derivation for the following results, see Brechling (1977).

The above theoretical discussion is designed to show that there exists a financing mechanism which has attractive features and, moreover, ensures fund adequacy virtually automatically. The essential characteristics of this mechanism are as follows:

- All benefit payments are charged to some firm's account.
- The difference $(a_t - b_t/m_t)$ is not allowed to have a positive or negative long-run time trend. Hence, increases in benefits (b_t) must be offset by increases in the taxable payroll (m_t) or increases in the intercept of the tax schedule (a_t).
- The difference $(a_t - b_t/m_t)$ is fixed at a level such that the value of $\frac{1}{s}(a_t - b_t/m_t)$ is equal to the desired long-run reserve ratio. This desired long-run reserve ratio need not be very large especially if the state has ample opportunity to borrow at relatively low interest rates.
- The tax schedule may be continuous or a series of steps, but it covers the range from very large negative reserve ratios to the positive ratio at which the tax rate becomes zero. Most importantly, there is no maximum tax rate which a firm can reach and still have an excess of benefit outflows over tax inflows.
- The slope of the tax schedule (or average slope in the case of (B-B)) is not as small as zero or as large as unity. The exact value of s depends on the amount of the desired cash-flow smoothing. Apart from the discrete lag of τ behind R_{t-1}, the closer s is to unity, the more coincident are tax payments with benefit outflows.

To sum up: In this subsection we have shown that there exists a financing mechanism which has desirable insurance and cash-flow smoothing properties and may not require very large mean fund balances but which ensures fund adequacy almost automatically. Such a system thus has much to recommend it.

EMPIRICAL ANALYSIS: THE CONCEPTUAL FRAMEWORK

The empirical analysis was designed to discover whether certain properties of the fund balance could be changed by changing some parameters of the tax structure and whether, thereby, the performance of the financing mechanism could be improved. For this purpose, the desirable properties of the fund balance must first be determined. In this section, we therefore discuss, first, the conventional approach to fund adequacy and, second, an alternative evaluation of the performance of the fund balance.

Conventional Evaluation Measures of Fund Balances

The conventional definition of an "adequate" state unemployment insurance fund is one which is sufficiently large for benefits to be paid through a typical recession without any borrowing from the Federal trust fund. In other words, the probability of having a negative balance should be reduced to close to zero.

The conventional measure of fund adequacy can be formalized in terms of a collective utility function with only one determinant, namely, the probability of having a negative balance (Pr):

$$U = U(Pr) \tag{I-3}$$

Since Pr can not be negative, utility is uniquely maximized when Pr = 0:

$$U^* = U(0) \tag{I-4}$$

The probability of having a negative balance can be assumed to be determined by the mean (M) and the variance (V) of the balance:[1]

$$Pr = Pr(M,V) \tag{I-5}$$

The influence of M on Pr is negative, and that of V on Pr is positive. Thus, the conventional recommendation is that M should be raised until Pr = 0 and U = U*.

There are several ways in which the conventional recommendation can be quantified. The most common number is the "high-cost multiple." According to this measure, at the beginning of a period of relatively high unemployment the fund balance should be sufficiently high to finance the previously highest benefit levels for about one and a half years.[2]

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[1]This is true strictly only if the distribution of the fund balance is normal. In other cases, higher moments of the distribution should be determinants of Pr.

[2]See the appendix to this part of the report for a precise definition of the high-cost multiple.

As is shown in the appendix to this part of the report, the majority of the states that did adhere to the high-cost multiple certainly avoided negative balances in the 1975-76 recession. Nevertheless, the conventional approach outlined above has some serious shortcomings, some arising from its underlying principles and some from the specific measure, the high-cost multiple.

- The conventional approach to fund balance adequacy places a very large value on the implied (shadow) cost of borrowing by states to cover negative balances temporarily. Hence, borrowing is virtually ruled out in this approach.
- The conventional approach to fund balance adequacy places a very low, probably zero, value on the implied (shadow) opportunity cost of fund balances. Hence, the recommended fund balances are likely to be too high.
- The high-cost multiple is derived from the fund balance and benefits paid. It completely ignores the responsiveness of tax inflows to benefit outflows. Hence, it is an imperfect measure of the probability of having a negative balance.
- The high-cost multiple is only a recommended target. It does not suggest any particular method of achieving this target. Nor does it tell states how to recognize "the beginning of a period of relatively high unemployment."

Thus, we conclude that the conventional approach to fund adequacy is based on extreme assumptions and that the concept of the high-cost multiple is not useful as a policy tool. The most that can be said for the high-cost multiple is that it may serve as a political instrument to exhort states to revise their financing mechanisms to ensure some (unspecified) long-run financial viability.

An Alternative Approach to Evaluation of Fund Balances

In view of the shortcomings of the conventional approach, an alternative approach to the problem of evaluating fund balances has been adopted for the purposes of the research underlying this report. In brief, a fund is regarded as more desirable, other things being equal, (i) the smaller the average balance, (ii) the smaller the probability of having negative values, and (iii) the larger is the amount of cash-flow smoothing or the countercyclical impact. Let us elaborate these three desirable features of the unemployment insurance fund.

The average long-run balance should be as small as possible (other things being equal) simply to minimize the opportunity cost of holding it. However, other things are unlikely to remain equal as the fund balance is changed. In particular, the probability of having a negative balance at any time must be expected to depend on the average balance. As stated in equation (4), this probability is assumed to depend negatively on the average balance and positively on the variance of the balance.

The three desirable features of the fund balance can be expressed formally in terms of a collective utility function:

$$U = U(M, Pr(M,V), C) \tag{I-6}$$

where U stands for the collective utility and C for the amount of cash-flow smoothing or the countercyclical impact. The marginal utility of V is negative and that of C is positive. The influence of M on U is, however, not unambiguous. An increase in M has two effects: directly it reduces U but indirectly, through Pr, it raises U. It is plausible, however, to suppose that the positive effect dominates when M is low and the negative effect dominates when M is high, so that there exists an optimum average fund balance M*: The marginal utility of M is positive or negative when $M<M^*$ or $M>M^*$, respectively.

Collective utility (U) may be changed by altering certain parameters of the tax and benefit structure which, in turn, affect the levels of M, V, and C.[1] Suppose that $M>M^*$ and that a change in a particular tax parameter leads to a fall M and V and to a rise in C. Such a change would raise the collective utility through all three variables, and hence, it would be unambiguously desirable. If such a parameter change can be found it would be an indication that there are "gross-inefficiencies" in the tax system.

It is more difficult to assess the desirability of a change that does not eliminate a gross inefficiency. What can be recommended if, for instance, a particular parameter change raises M and reduces both V and C? If $M>M^*$, then the first and third effects reduce collective utility, while the second raises it. In this and similar cases, there may still be inefficiencies, but the analysis has to be somewhat more complex. In particular, a second parameter has to be changed. The purpose of this change in the second parameter is to counteract the impact of the first parameter on one of the variables M, V, or C. Suppose a rise in the first parameter P_1 reduces C and a rise in the second one, P_2, raises C, then P_1 and P_2 must both be raised, so as to keep C constant. Then the <u>joint</u> effect of P_1 and P_2 on M and V is analyzed. If the joint

[1]See Part V of this report for further discussion of the countercyclical measure C.

impact of raising P_1 and P_2 holding C constant consists of a fall in both M and V, then there exists a net inefficiency. In such a case, both P_1 and P_2 should be raised. If, on the other hand, the above rise in P_1 and P_2 raises M but reduces V, then there is no inefficiency in the system, and no recommendation can be made without knowledge of the parameters of the collective utility function.

Let us illustrate net inefficiences by means of a set of diagrams. In figures 2a, 2b, and 2c, the partial relationships between (i) V and M, (ii) V and C and (iii) C and M are illustrated. They are conditional relationships in the sense that the appropriate third variable is held constant at $\overline{C}$, $\overline{M}$, and $\overline{V}$. The lines labeled (A-A) display net inefficiencies, because the simultaneous change in P_1 and P_2 would move the variables from, say x_1 to x_2 which represents an unambiguous gain in collective utility. The lines (B-B) illustrate efficient frontiers because a move from x_1' to x_2' would yield more utility through one variable and less utility through the other variable.

In this section, we have sketched an approach to the problem of evaluating unemployment insurance fund adequacy which differs from the conventional one of the high-cost multiple. Our alternative approach can be conceptualized by postulating a collective utility function in which the average fund balances and the probability of negative fund balances have a negative effect on utility, and the countercyclical or cash-flow smoothing properties have a positive effect on utility. A system is said to be grossly inefficient if a change in a single tax parameter reduces the average fund balance and the probability of a negative balance and raises the countercyclical effects. Net inefficiencies exist when two tax parameters are changed in such a way as to hold one of the determinants of utility constant and the joint impact on the remaining two determinants unambiguously raises the level of utility.

EMPIRICAL ANALYSIS: SUMMARY OF RESEARCH

The primary goal of the empirical research reported here consists of the determination of the extent of gross and net inefficiences in the unemployment insurance systems. A corollary of the discoveries of inefficiencies is a set of policies and recommendations about those parameter changes which would unambiguously raise the level of collective utility.

A very broad approach was adopted in the empirical investigation. In fact, three distinct but related research projects were undertaken.

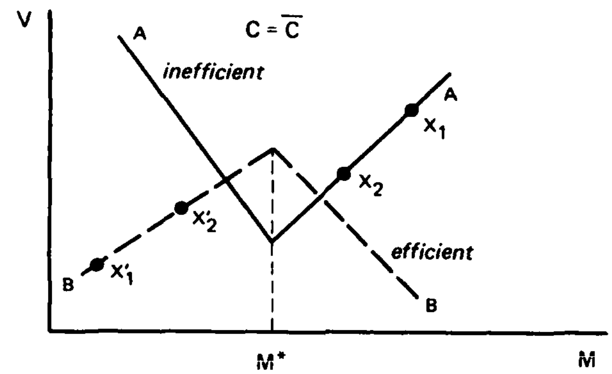

FIG. I-2a

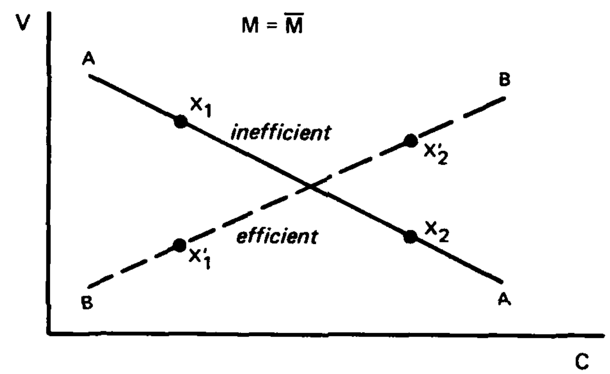

FIG. I-2b

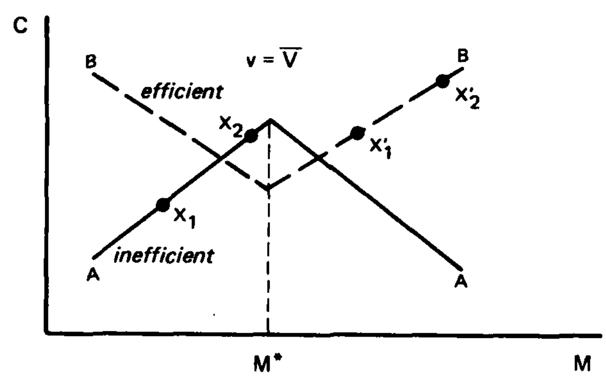

FIG. I-2c

FIG. I-2: ILLUSTRATION OF NET INEFFICIENCIES

The first was the development of a microeconomic state-specific model. Two versions of this model were constructed, one for Massachusetts and the other for New Jersey. The second project consisted of a micro simulation model for a typical (hypothetical) state. In this model, fund balances are simulated for several types of tax systems, using hypothetical distributions of firms and cyclical employment patterns. The third project consisted of the econometric estimation and simulation of macroeconomic models describing the behavior of thirty reserve-ratio states.

The three projects had a common methodology. Effort was first concentrated on developing a simulation model that yielded reasonable predictions of the fund balance. Where possible, simulated balances were compared with actual balances for individual states. Once a model appeared to work reasonably well, it was used for a second round of simulations.

In the second round of simulations, the tax parameters were allowed to vary while other variables retained their previous values. The six tax parameters considered were: $\tilde{W}$, the taxable wage base; NEGTAX, which applies to firms with negative balances; MAXTAX, which applies to firms with small positive balances; SLOPE, which is the average gradient of the sloped part of the tax schedule; MINTAX, which is the lowest tax rate; and MINRES, which is the reserve ratio at which MAXTAX ceases and the sloped part of the schedule begins. The last five parameters are sufficient to describe fully a typical tax schedule.

The simulations were done as follows. First, a base set of values for $\tilde{W}$, NEGTAX, MAXTAX, SLOPE, MINTAX, and MINRES was chosen; this set was the same for all three projects. In each of the simulations, one tax parameter was altered while the others were held constant at their base values. For each resulting series of fund balances, the average balance, the variance of the balance, and the cash-flow smoothing measure were calculated.

The simulation results were then used to regress the evaluation measures M, V, and C on the tax parameters from which we obtained estimates of the partial relationships between each of the six tax parameters and each of three evaluation measures. These partial relationships give direct evidence about the existence of gross inefficiencies in the tax system. Furthermore, they were used to compute measures of net inefficiencies.

Before presenting the findings of the three simulation models, it might be useful to explain why we used three alternative approaches rather than just one. We were aware that the results and corresponding policy implications of a simulation model are likely to depend on the assumptions underlying that model. Accordingly, we wanted to be able to check any conclusions from one type of model against those from another type. If the results from different types of models are the same, we can feel somewhat confident in making policy recommendations. If they differ, then strong recommendations do not appear justified.

Each of the three models we developed--the micro state-specific, the micro stylized-state, and the macroeconometric state-specific--has certain advantages and disadvantages. Theoretically, we expect a micro model to predict fund balances better than a macro model because of the increased information embodied in disaggregated data. However, the data requirements for a micro model are high. Moreover, given the limited amount of disaggregated data actually available, a macro model may in practice predict better than a micro model using semi-disaggregated data.

A state-specific simulation model is potentially very useful to the state it represents, but probably uninteresting to states with very different tax systems or firm distributions. A stylized-state model is more flexible and may be more useful in deriving general policy conclusions.

In the next three subsections, we present the findings of the three simulation models.

The Micro State-Specific Model

There are two possible ways of predicting taxes in a model which simulates the balance in a state's UI fund. What we call the "macro" approach uses aggregate data to predict a tax rate for the state as a whole. The "micro" approach, on the other hand, uses disaggregated data to predict tax rates for individual firms or groups of similar firms. The latter approach was used to develop both a state-specific simulation model, described in this section, and stylized-state model, described in the next.

We had two reasons for developing a micro state-specific (or "micro") model. First, we wished to test the micro approach against historical data. To do this, we needed to predict the fund balance for a particular state over a period of time for which data on that state's actual balance was available. The predicted and actual values could then be compared. Second, we wanted to compare the micro and macro approaches. To do this, we computed macro model predictions of the balance and compared them with the corresponding micro model ones. Statistics based on the forecasting errors from the two sets of predictions were used to determine which model predicted better.

Micro simulation programs were developed for two states, Massachusetts and New Jersey. 1970-1977 was the projected period.

For Massachusetts, it was found that the micro model tended to overpredict the fund balance while the macro model tended to underpredict. Statistical tests indicated that the macro model predicted better than the micro model did.

For New Jersey, it was again found that the micro model tended to overpredict the balance. In this case, however, the macro model overpredicted even more than the micro model did, so that the micro model was the better predictor.

We next used the micro model for simulations in which tax parameters were allowed to vary around a set of base values. The New Jersey version of the micro model was used for these simulations, with 1970-1977 again defined as the projection period.

From the results of this set of simulations, we concluded that there were some inefficiencies in the base tax system. The extent of inefficiency depends, however, on whether we think the average fund balance under the base system is greater or less than M*, the optimal average balance. The simulated balance using the base tax parameters declided dramatically during the projection period, and was negative for the last three years of the period. Accordingly, we might conclude that the marginal utility of M is positive. In this case there are a number of inefficiencies, both gross and net, in the base tax system. If, however, we think that the base average balance exceeds M*, we find no gross inefficiencies and few cases of partial inefficiency.

The Micro Stylized-State Model

The stylized-state model simulates a UI fund balance by aggregating the tax and benefit payments of 50 different hypothetical firms, each with different employment paths and turnover rates. Benefits charged to each firm are proportional to reductions in employment and turnover in the firm. Tax rates for each firm are determined according to a specified tax schedule, and taxes are paid on the taxable wages of each employee's annual salary; therefore, taxes paid by a firm are a function of its employment and turnover. The distribution of wages in the firm and the firm's labor turnover rate are determined at the start of the simulation by random draws from a normal distribution. Each year's change in employment in the firm is also random. The resulting employment pattern for each firm, which is a random walk, determines its tax and benefit payments under each specified tax schedule.

Simulations

There are two types of parameters in the model: (i) economic parameters that determine wages, employment levels, and turnover and (ii) parameters of the tax system. Each simulation covered a hundred-year period. The simulation exercises can be grouped according to the kind of change they considered. They were:

- Tax parameter changes. Different tax schedules were simulated for constant economic conditions and the identical pattern of random components. Four types of tax systems were simulated: two types of reserve ratio systems, the benefit ratio system, and the benefit wage ratio system. Each system was simulated repeatedly to test the effects of varying the parameters describing the tax schedule: (i) the minimum tax rate, (ii) the maximum tax rate, (iii) how the tax varied in between these two limits with variations in firm's experience, (iv) the wage base, and (v) average benefit levels per claimant.

- Economic parameter changes. The economic parameters were varied to determine the sensitivity of the model to the assumptions and to determine how differences in economic conditions across types of states might affect the state's balances, given the same tax system.

- Changes in the random component of yearly employment shocks. Many simulations were repeated with different random draws from the same distribution to make sure that the 100-year period used in the simulation was enough to make valid comparisons between the systems.

- Employment shocks. The model was simulated with several different kinds of employment shocks to determine how different tax systems responded to general declines in and fluctuations in employment.

In addition, the data from the simulations was aggregated to conform to the data in the <u>Handbook</u>, which is the data used by the macro model. The macro model regressions were re-estimated with data from the stylized-state simulation to enable comparison of the two models and obtain a quantitative measure of how quickly tax systems responded to benefit outflows.

Most of the simulation results can be described in terms of the effects of parameter changes on the percent of firms at the minimum and maximum tax rates and the slope of the tax schedule between these rates.

The average balance in the fund depends on the relation between the number of firms at the minimum and maximum tax rate. Firms at the minimum tax rate (who provide net inflows into the tax system) must balance net-deficit firms (firms at the maximum tax rate and most firms that have gone out of business). The fund balance also depends on the average reserve ratio of firms who are not at the minimum or maximum tax rate. This reserve ratio depends on the slope of the tax schedule.

The fluctuations in the balance also depend on the firm distribution and the slope of the tax schedule. A system will have few fluctuations in the balance if it has few of its firms at the minimum or maximum tax rate. A steep slope between the minimum and maximum tax rates also leads to smaller fluctuations in the balance. In general, a system which has little fluctuation in the balance (low variance) has little countercyclical power.

The Determination of Tradeoffs and Improvements

After the simulations described above were performed, a further set of simulations which involved systematically varying the tax parameters around their base values. The variance and the countercyclical measure moved together under most parameter changes so the simulations revealed few gross inefficiencies. The identification of net inefficiency depends on whether the actual mean is above or below the desired mean (M*). Most of the parameter changes result in better balances according to our evaluation criteria only if the mean balance should be reduced (M>M*). Varying the parameters of the tax schedule to hold the mean constant led to a lower variance and a better countercyclical timing in about half the cases. Most of the improvements, both assuming M>M* and M<M* involved increasing the fraction of firms that were on the sloped portion of the tax schedule, that is increasing the range of reserve ratios that would be subject to a change in tax rates when reserve ratios (balances) change.

The Macroeconometric Models for Specific-States

The models described here are macroeconomic in the sense that they contain as variables the aggregate taxable payroll, total taxes paid, the average tax rate, and so on, but they do not contain information for individual firms or for groups of firms. In this respect the macroeconomic approach differs crucially from the other simulation experiments which are reported in the previous two sections.

The Determination of the Taxable Payroll

Previous theoretical work suggests that the taxable payroll should typically be smaller than the actual payroll, should be a nonlinear function of the taxable wage base, should rise with interfirm labor turnover as well as with annual earnings. Consequently, the following specification has been used in the estimation of the taxable payroll:

$$m = C_0 + C_1 w + C_2 \tilde{w} + C_3 \tilde{w}^2 + C_4 u \qquad \text{(I-7)}$$

where m stands for the taxable payroll per employee, w for annual earnings, $\tilde{w}$ for the taxable wage base and u for the unemployment rate. The unemployment rate was used as a proxy variable for labor turnover. As is well known, interfirm labor turnover is highly procyclical.

Equation (I-7) was fitted to annual time series for the period 1948 to 1977. The resulting regression equations have substantial explanatory power. The coefficients C_1 and C_2 are positive and highly significant; C_3 tends to be weakly negative and C_4 strongly negative. All these signs conform to the theoretical expectations. Since interfirm labor turnover is negatively correlated with the unemployment rate, the negative sign of C_4 is consistent with the hypothesis that labor turnover has a positive influence on the taxable payroll.

<u>The Determination of Tax Rate</u>

The basic relationship which determines the tax rate (τ) can be expressed simply as:

$$\tau_t = \alpha + \beta R_{t-1} \qquad \text{(I-8)}$$

where R_{t-1} stands for the lagged reserve ratio. Both τ_t and R_{t-1} refer to state aggregates. In the initial estimation, a version of equation (I-8) was fitted to the annual time series for each state. The results turned out to be satisfactory by conventional standards.

Both α and β, however, are likely to be influenced by the parameters of the tax structure as well as by factors (such as the industrial composition) which may be peculiar to the state. Hence, the coefficients α and β were assumed to be linear functions of the five tax schedule parameters of the reserve-ratio method. They will be referred to as $P_i (i=1...5)$. Thus

$$\alpha = \gamma_0 + \sum_{i=1}^{5} \gamma_i P_i \qquad \text{(I-9)}$$

and

$$\beta = \delta_0 + \sum_{i=1}^{5} \delta_i P_i \qquad \text{(I-10)}$$

Hence, equation (I-10) becomes:

$$\tau_t = \gamma_0 + \sum_{i=1}^{5} \gamma_i P_i + \delta_0 R_{t-1} + \sum_{i=1}^{5} \delta_i P_i \quad R_{t-1} \qquad \text{(I-11)}$$

Equation (I-8) was fitted to annual data for 1961-1977 for each reserve-ratio state. The relatively short time series and lack of variability in some of the tax parameters led to some unsatisfactory results. Consequently, the states were grouped according to similarity of coefficients, and then equation (I-11) was re-estimated with pooled cross-section (states) and time series data, and all γ and δ parameters were allowed to vary from one group of states to another.

The results of the second empirical estimation turned out to be quite satisfactory. The overall R^2 was about .91 and many of the coefficients had the theoretically expected signs.

The Simulation

The estimated coefficient of equations (I-7) and (I-11) were used to compute fund balances for the period 1961 to 1977. For this purpose, total benefit payments, covered employment, and interest rates to the funds were assumed to equal their actual historical values. In the first simulation experiment, the computed and actual fund balances were compared. By and large, the computed fund balances tracked the actual ones reasonably well.

In the second experiment, the parameters of equation (I-11), including the state dummy variables, were used to estimate the effects of changes in the tax parameters (P_i) on the relevant fund measures, M, V, and C. The results were then used to compute gross and net inefficiencies.

The results of the second simulation can be summarized as follows:

- If M* falls short of M in all states, then there are relatively more states with inefficiencies than with efficiencies in M-V and M-C space. To obtain an unambiguous improvement, in utility in this case, the taxable wage base ($\tilde{w}$), the maximum tax for positive balance (MAXTAX), and the minimum tax (MINTAX) should all be lowered in pairwise changes with other parameters.

- If M* exceeds M in all states, there are relatively more efficiencies than inefficiencies in M-V and M-C space and no policy prescriptions emerge.

- The set of results which refers to the V-C space is fairly uniform. Their interpretation is also independent of whether M*<M or M*>M. they suggest that in the vast majority of states the frontier in V-C space is efficient because V and C can only be lowered or raised together when pairwise parameter changes are made.

The Results

Three sets of models were constructed and used for the simulations in the hope that all three would yield similar basic messages. Unfortunately, however, the results appear to be quite diverse.

To illustrate the diversity of results, let us compare the inefficiencies which have been found in the V-C space, holding the mean fund balance constant at $M=\bar{M}$.

- In the micro state-specific model the variance (V) can be lowered and the cash-flow smoothing or countercyclical measure (C) can be raised by:

  - increasing MAXTAX and decreasing $\tilde{w}$
  - increasing MINRES and decreasing $\tilde{w}$
  - increasing MAXTAX and decreasing MINRES

- In the micro stylized-state model, V can be lowered and C raised by:

  - increasing MAXTAX and decreasing $\tilde{w}$
  - increasing MAXTAX and decreasing MINTAX
  - increasing NEGTAX and decreasing MINTAX
  - increasing NEGTAX and decreasing $\tilde{w}$
  - increasing SLOPE and decreasing MINTAX
  - increasing w and decreasing MINTAX

  or by increasing both MAXTAX and SLOPE, or by decreasing both $\tilde{w}$ and SLOPE.

- In the macroeconometric models for specific states, there are not many inefficiencies in V-C space. In five states there appear to be net inefficiencies and V can be lowered and C raised by decreasing $\tilde{W}$ and raising SLOPE. In another four states, the same can apparently be achieved by decreasing $\tilde{W}$ and increasing NEGTAX.

The results derived from the three models are not entirely at variance with one another. For instance, the pairwise change of an increase in MAXTAX or NEGTAX with a decrease in $\tilde{W}$ emerges from the first two models and for a small number of states from the third as well. But while this and similar results may serve as a very general guideline to states, the evidence from the macroeconometric models for specific states suggests strongly that specific changes in the tax structure are not applicable to all states.

In the empirical research underlying this report, we constructed three types of models, two micro models, and one macroeconometric model. In our view, these types of models are useful in organizing the relevant arguments and material and in designing improvements in the performance of the financing mechanisms. The results of our simulations suggest, however, that specific parameter changes are not likely to have general applicability. State-specific models should, therefore, be constructed and used for the evaluation of individual state fund balances.

CONCLUSIONS AND IMPLICATIONS FOR POLICY

During the past decade, increased benefit payments, have made heavy demands on the unemployment insurance trust funds. Questions have arisen about the ability of the financing mechanisms to increase tax flows sufficiently to prevent ever-increasing indebtedness of the system as a whole. The research underlying this report was designed to answer some of these questions. Specific as well as general changes in the financing systems were examined in order to determine whether their performance could be improved.

A desirable financing system was defined as one which:

- provides sufficient funds to pay for benefits in the long run, so that it does not have a negative fund balance too frequently;
- is not wasteful in the sence of having too high a mean fund balance;
- does provide for some cash-flow smoothing or counter-cyclical timing of tax flows.

Improvements in the financing systems in one or more of the above three respects were studied both theoretically and empirically. The theoretical findings and policy implications are general and not quantitatively exact. The main theoretical result is that there exists at least one financing system which does have the above three desirable properties. The main features of such a system are as follows:

- There are no or negligible amounts of noncharged benefits.
- There is no maximum and no positive minimum tax rate. The tax schedule may have steps, but it keeps rising as individual firms' benefit withdrawals increase.
- Long-run increases in benefit payments, caused by either legislated benefit increases or by long-run trends in unemployment, are offset by equiproportionate increases in the taxable payroll or by increases in the entire tax schedule.
- The tax rate is adjusted to benefit outflows with a substantial lag; in other words, the tax schedule is not too steep.
- States have substantial powers to borrow either from the Federal government or from one another. But precise repayment schedules are laid down and adhered to rigidly. Further, realistic interests rates are charged on borrowed funds.

The general policy implications of the above theoretical results are fairly obvious.

- Noncharged benefits should be reduced and the sloped part of the tax schedule should be extended.
- The taxable wage base on the entire tax structure should be raised in response to long-run increases in total benefits.
- The Federal government ought to review its lending policies. Repayment terms ought to be adhered to strictly and a realistic interest should be charged.
- The possibility of the pooling of state trust funds ought to be investigated. Such pooling would permit states to borrow from one another. Such a system might act like the International Monetary Fund does in the international sphere.

The first two of the above policy recommendations can not be applied uniformly to all states because they differ in many relevant and important respects. For instance, the recently proposed uniform linking of the taxable wage base to average wages may yield too high a fund balance in states with low benefit rates and too high a fund balance in states with high beneift rates. To be sure, we feel that such linkings are desirable but oppose their uniformity across states.

In the empirical research, an attempt was made to discover inefficiencies in the tax systems represented by three different sets of models. Inefficiencies were said to exist if a change in one or more parameters of the tax structure would unambiguously improve the performance of the financing system. A large number of specific pairwise parameter changes were investigated.

The results of the three simulation experiments were quite diverse. Moreover, we found a substantial amount of diversity among states. It is also hard to interpret some of the results in terms of inefficiencies because the latter depend on whether the actual mean fund balance exceeds or falls short of the optimal mean fund balance.

Although we had hoped for greater generality of our empirical results than actually occurred, our research has an important policy implication. There seem to be no <u>specific</u> parameter changes which have very <u>general</u> applicability: They affect the performance of the financing mechanisms positively in some states and circumstances and negatively in others. States seem to differ sufficiently in their economic environment and their financing mechanisms that generalizations about specific parameter changes are hard to come by.

A further implication of the diversity of our results is that states should be encouraged to investigate their own financing mechanisms and search for ways of improving their performance. For this purpose, the conceptual framework and the three sets of models used for our simulations may serve as a suitable starting point.

Since federally imposed specific parameter changes are likely to be nonoptimal in, at least, some states, what role should the Federal authorities play? In our view, Federal policy ought to be directed at creating appropriate incentives which encourage states to seek improvements in their systems. Such incentives are embodied in Federal lending policies which have already been mentioned. Interest should be charged on funds borrowed by the states and repayment schedules should be enforced. Another Federal incentive to states might arise from the rebates of Federal taxes to states with experience-rated tax systems. Such rebates might be reduced or suspended if states do not comply with some broad principles of financial viability.

To sum up: Neither our theoretical nor our empirical research has led to specific quantitative recommendations which would improve the performance of the financing mechanisms in all states. It seems, therefore, that specific improvements can be implemented only at the state level and that most federally imposed specific changes can not be expected to improve all systems. If this conclusion is correct, then the role for the Federal authorities would be to create the appropriate incentives for the states to seek improvement in their systems. Such incentives may be embodied in Federal lending policies or in the method rebating Federal taxes to states with experience-rated tax systems.

REFERENCES

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2. Frank Brechling, "The Incentive Effects of the U.S. Unemployment Insurance Tax," in Research in Labor Economics, Vol. I, JAI Press, 1977

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APPENDIX TO PART I

CONVENTIONAL MEASURES OF FUND ADEQUACY
AN EVALUATION

The conventional evaluation measure of an unemployment insurance fund is fund adequacy. An adequate fund is one which is large enough for benefits to be paid through a typical recession without any borrowing from the Federal trust fund.

The current balance in the fund is always used to measure adequacy, and all states have provisions for altering tax schedules if the balance is judged to be too low.[1] The triggering point for raising tax rates varies widely across states, but almost all of them fall into one of the following categories.

Tax rates should be raised if:

1. the balance falls below some fixed dollar amount,

2. the balance as a percent of total or taxable payroll falls below a specified level,

3. the balance falls below some multiple of average yearly benefits or benefits paid during a very bad year.

For over a decade, the Department of Labor has been advocating a measure of fund adequacy that is a combination of the last two, known as the high-cost multiple. According to DOL, "at the beginning of a period of relatively high unemployment," the ratio of the balance in the fund (BAL_t) to total wages paid in the last year (TW_t) should be one and a half times the ratio of benefits in the high-cost year (BEN_{HC}) to total wages paid in that same high-cost year:

$$\frac{BAL_t}{TW_t} \geq (1.50) \frac{BEN_{HC}}{TW_{HC}} \qquad \text{(A-1)}$$

[1]Some states also base their tax schedules on a subset of the balance, often called a solvency account. This account reflects the danger to the fund from benefits that can not be charged to any employer. The solvency account reflects the long-term trend in the fund balance in the absence of economic fluctuations.

The high cost year is the twelve months since January 1958 with the highest dollar payout in benefits.[1] This formula takes into account both benefit experience and wage growth (or inflation). The formula can be rewritten as

$$BAL_t \geq (1.5)\ BEN_{HC} \cdot \frac{TW_t}{TW_{HC}} \quad . \qquad \text{(A-2)}$$

Thus, a balance is less likely to meet the high-cost criterion if the state pays out unusually high benefits, or there has been inflation or payroll growth since the high-cost year.

How well does the HCM work? If it does what it is supposed to, the HCM should predict whether or not a fund becomes insolvent during a recession. To evaluate the HCM, we look at how well it predicted fund behavior during the mid-seventies' recession. Table A-1 shows the HCM at the end of 1973 for the 52 UI jurisdictions. One of the worst recessions in recent decades began in 1974. Thus, the end of 1973 should qualify as the stipulated "beginning of a period of relatively high unemployment."

Table A-2 shows the relationship between the HCM and the behavior of the state fund balance from 1973 to 1976. Twenty-one states had HCM's greater than or equal to 1.5 at the end of 1973. Of these, only one--the District of Columbia--had negative balances during the next three years.[2] Thirty-one states did not meet the high-cost rule. Twenty of these states' funds had negative balances between 1973 and 1976. The best possible score for the HCM would have been 52, meaning that all jurisdictions had been perfectly predicted. The actual score for the HCM is 40 accurate predictions.

Most states do not use the high-cost multiple measure of fund adequacy. Instead, they focus on the reserve ratio, which is simply the ratio of the balance to taxable or total wages:

$$RR_t = \frac{BAL_t}{TW_t} \quad . \qquad \text{(A-3)}$$

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[1]Definitions of HCM were taken from U.S. Department of Labor (1978).

[2]The usual assumption made in designing fund adequacy measures is that the recession will last 18 months. Using the three years of the mid-seventies' recession to test the HCM gives it more of an opportunity to predict well.

TABLE A-1

HIGH COST MULTIPLE 1973

UNITED STATES	1.04[a]	NEBRASKA	2.01
		NEVADA	.66
ALABAMA	1.01	NEW HAMPSHIRE	1.92
ALASKA	1.12	NEW JERSEY	.29
ARIZONA	2.71	NEW MEXICO	1.60
ARKANSAS	1.15	NEW YORK	1.17
CALIFORNIA	1.02	NORTH CAROLINA	2.44
COLORADO	1.62	NORTH DAKOTA	1.27
CONNECTICUT	a	OHIO	1.06
DELAWARE	1.43		
DIST. OF COL.	1.80	OKLAHOMA	.90
		OREGON	.86
FLORIDA	1.69	PENNSYLVANIA	.64
GEORGIA	2.64	PUERTO RICO	.47
HAWAII	.70	RHODE ISLAND	.52
IDAHO	1.88	SOUTH CAROLINA	3.01
ILLINOIS	.75	SOUTH DAKOTA	2.75
INDIANA	1.55	TENNESSEE	1.58
IOWA	2.28	TEXAS	1.32
KANSAS	1.79		
KENTUCKY	1.22	UTAH	1.85
		VERMONT	.16
LOUISIANA	.89	VIRGINA	2.63
MAINE	.56	WASHINGTON	a
MARYLAND	.76	WEST VIRGINIA	1.20
MASSACHUSETTS	.63	WISCONSIN	1.55
MICHIGAN	.57	WYOMING	1.46
MINNESOTA	.61		
MISSISSIPPI	1.62		
MISSOURI	1.66		
MONTANA	.72		

[a]State ratio/multiple not calculated due to outstanding loan indebtedness at the end of the year. United States ratio/multiple includes all states.

TABLE A-2

STATE SOLVENCY (1973-1976)
AND THE HIGH-COST MULTIPLE (1973)

	HCM<1.5	HCM$\geq$1.5
negative balances any year	20	1
solvent all years	11	20

Each state decides what RR is adequate. We can compare HCM with RR by setting the additional factor in the HCM--(BEN_{HC}/TW_{HC})--equal to the national average (2). Thus, if the additional factor in the HCM had no predictive power, a RR > 3 should predict as well as a HCM > 1.5. Table A-3 shows the state breakdown using this RR rule. The score for this fund measures is only 33. Thus, the benefit factor does add predictive power. In particular, it has fewer mistakes of the kind shown in the lower left-hand box of tables A-2 and A-3. The HCM allows states with relatively low benefit payouts, due to either low benefit schedules or mild economic responses, to keep relatively low reserves.

TABLE A-3

STATE SOLVENCY (1973-1976)
AND RESERVE RATIOS (1973)

	RR<3	RR$\geq$3
negative balances any year	21	0
solvent all years	19	12

While the high cost multiple and the reserve ratio have the great advantage of being simple numbers which can be communicated and implemented quite easily, they suffer from serious shortcomings which are enumerated in Part I of this report.

PART II

THE MICRO MODEL

PART II

THE MICRO MODEL

GENERAL DESCRIPTION

Besides using aggregate (state) data to simulate the balances in state unemployment compensation funds, we developed a simulation program which makes use of disaggregated (firm) data. This program closely follows the ones created by William M. Mercer, Inc. for use by reserve ratio states (see George et al., 1977).

The differences between Mercer's approach (which we call "micro") and the aggregate or "macro" approach can be illustrated by explaining how each predicts the fund balance. Both approaches begin with the basic relationship

$$BAL_t = BAL_{t-1} + TAX_t + INT_t - BEN_t,$$

where

BAL_t = the state fund balance at the end of year t
TAX_t = total UI taxes paid during year t
INT_t = total interest earned by the fund during year t
BEN_t = total unemployment benefits paid during year t.

In the macro approach, taxes are predicted as the product of an aggregate tax rate, τ, and aggregate taxable payroll, $\tilde{W}$:

$$TAX_t = \tau_t \tilde{W}_t .$$

Values for the fund balance during the projection period are then computed based on an initial value for the balance, BAL_0, and predicted values for τ, $\tilde{W}$, INT, and BEN during the projection period.

In the micro approach, the state fund balance is predicted as the sum of the balances for individual firms:

$$BAL_t = \sum_{i=1}^{n} BAL_{i,t} = \sum_{i=1}^{n} (BAL_{i,t-1} + TAX_{i,t} + INT_{i,t} - BEN_{i,t}),$$

where the subscript i refers to firm i, n is the number of firms, and $TAX_{i,t} = \tau_{i,t}\tilde{W}_{i,t}$.[1] Now in order to predict the fund balance it is necessary to have initial account balances for individual firms and predicted values for $\tau_i, \tilde{W}_i$, INT_i, and BEN_i during the projection period. In the Mercer program, predicted values for $\tilde{W}_i$, INT_i, and BEN_i are derived from predicted values for $\tilde{W}$, INT, and BEN using sets of weights for the distribution of aggregate taxable payroll, interest, and benefits among firms.

These weights are derived as follows. One input into the Mercer program is an initial distribution of employers by reserve ratio. This distribution should include as many reserve ratio categories as possible (Mercer suggests up to 280), since in the simulation, all the firms initially in a given category are treated as one employer. In addition, it should include benefits paid and taxable payroll for each "employer" during the base year and beginning balances for the employers' accounts.

Firm i's benefit weight, KB_i, is then computed as the ratio of benefits charged to firm i's account in the base year to total benefits paid during the base year:

$$KB_i = BEN_{i,o}/BEN_o .$$

Similarly, firm i's taxable payroll weight, KW_i, is the ratio of firm i's taxable payroll in the base year to aggregate taxable payroll in that year:

$$KW_i = \tilde{W}_{i,o}/\tilde{W}_o .$$

Interest weights are defined only for those states which credit interest earned on the fund to employer accounts. In such states, firm i's interest weight in year t is zero if firm i had a negative balance at the end of year t-1, and equals the ratio of firm i's balance at the end of year t-1 to the sum of all positive balances at the end of year t-1 if the firm had a positive balance.

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[1] In general, $X_t = \sum_i X_{i,t}$.

An important assumption of Mercer's model is that each "employer" pays the same proportion of aggregate benefits and taxable payroll in each year of the projection period as in the base year. This assumption, together with the other inputs into the program, allows the distribution of employers to be updated each year as new account balances and reserve ratios are computed.

The preceding discussion illustrates the major similarities and differences between the macro and micro approaches. The two are similar in that for both it is necessary to predict aggregate taxable payroll, interest, and benefits during the projection period. These variables may be predicted directly. Alternatively, they may be predicted from the size of the labor force, the unemployment rate, and other exogenous variables using coefficients from regression analysis of pre-projection period data.

The two approaches differ primarily in the method of determining the state's aggregate tax rate τ. In the macro model, τ is predicted from data for the state as a whole using coefficients from regression analysis. The micro model, on the other hand, predicts τ as a weighted average of individual firms' tax rates:

$$\tau_t = TAX_t/\tilde{W}_t = \sum_i \tau_{i,t}\tilde{W}_{i,t}/\sum_i \tilde{W}_{i,t} \ .$$

$\tau_{i,t}$, in turn, is determined from the tax schedule in effect for the state in year t, and depends on the firm's reserve ratio in the previous year, $R_{i,t-1}=BAL_{i,t-1}/\tilde{W}_{i,t-1}$

Mercer's programs have been available to all reserve ratio states for over two years, and in fact several states have used them to predict their fund balances. It does not seem, however, that many comparisons have been made between predicted balances using this approach and actual balances. Accordingly, we decided to test the micro model by seeing how well it would have predicted fund balances during some past period given perfect prediction of values of the exogenous variables during that period. 1969 was chosen as the base year and 1970-77 as the projection period for these simulations. Massachusetts and New Jersey were the states for which simulation programs were developed.

Besides comparing the micro model predictions with actual fund balances, we were interested in comparing how well the micro and macro models predicted.

Accordingly, we ran macro model simulations for Massachusetts and New Jersey using the same initial data, base year, and projection period as in the micro simulations. In order to focus on the difference in the prediction of tax rates by the two methods, actual values for taxable payroll, interest, and benefits were used as the predictions for those variables. Predicted values of τ in the macro simulations were based on the coefficients from regressions which used annual data from 1961-77.

In the sections that follow, the micro simulation approach is described in more detail, and the simulation results and comparisons with the macro model results are presented.

THE SIMULATION PROGRAMS

In this section we discuss the sources of data for the micro simulations and some general features of the Massachusetts and New Jersey UI tax systems which were incorporated into the simulation programs.

Values of most of the aggregate variables needed for the simulations were taken from the Handbook of Unemployment Insurance Financial Data 1938-1976. One problem with this data is that it can be used to construct alternative estimates of the balance in the UI fund which do not, in general, agree.

These estimates are computed as follows. Among the data items available in the Handbook are:

(1) "net reserves, balance as of end of year"

(2) "contributions collected"

(3) "interest credited to trust fund"

(4) "benefits paid"

(5) "state share of extended benefits paid"

(6) "average employer tax rate as a percent of taxable wages"

(7) "taxable wages paid in covered employment during year."

Item (1) contains information on the stock of reserves in the fund, while items (2)-(7) deal with the flows into and out of the fund. In particular, (3) = INT and (4) + (5) = BEN, while (2) and (6).(7) refer to UI taxes collected and UI taxes incurred, respectively.

The change in the stock of reserves during year t should equal the sum of the flows into and out of the fund during year t. However, we found that for most states in most years

$$(1)_t-(1)_{t-1}\neq(2)_t+(3)_t-(4)_t-(5)_t\neq(6)_t\cdot(7)_t+(3)_t-(4)_t-(5)_t.$$

This meant that we could compute three estimates of the fund balance: BAL, equal to the stock of reserves; BALC, based on the flows using collected taxes; and BALI, based on the flows using incurred taxes.

The reason that BAL $\neq$ BALC $\neq$ BALI is a problem is that it is not clear which balance is really being predicted by the micro and macro models. The predictions from these models were therefore compared with all three sets of actual values. In most cases only the comparisons between the predicted balances and BAL are discussed.

Besides the aggregate data, an initial distribution of employers was required for the micro simulations. The primary source of information for this distribution was section D of Form ES-204, "Experience Rating Report," submitted annually by the states to the Department of Labor. Section D contains a distribution of employers by reserve ratio category which includes the number of accounts, total payroll, taxable payroll, and the balance for each category. It does not, however, include benefits paid by reserve ratio category.[1] This led to problems in the formulation of the weights to distribute benefits among employers, which will be discussed more fully below. A further problem with the ES-204 data was the relatively small number of reserve ratio categories; most states grouped employers into fewer than 50 categories.

Having collected the data for the simulations, we turned to description of the UI tax system. Some of this information was obtained from the state itself. Other sources were the Department of Labor's Comparison of State Unemployment Insurance Laws and Commerce Clearing House's Unemployment Insurance Reports, both of which contain basic information which is updated periodically.

[1]We wrote nine states -- Arizona, California, Indiana, Massachusetts, Michigan, New Jersey, New York, Ohio, and Wisconsin -- asking for a distribution of benefits by reserve ratio category for 1969. Of the seven who responded only one, New Jersey, had the data available to provide such a distribution.

Inspection of the data revealed that Massachusetts and New Jersey are both fairly large states in terms of the size of the insured labor force. Since both use the reserve ratio method of experience rating, their tax systems are broadly similar. There are, however, several differences which affected the structure of the simulation programs; some of these are discussed below.

A major difference between the Massachusetts and New Jersey tax systems concerns the charging of benefits. In Massachusetts only regular benefits[1] are chargeable to employers; dependents' benefits and the state share of extended benefits are to be charged instead to a special account called the Solvency Account. In every state some proportion of benefits chargeable to employers ends up not being charged to them due to overpayments, disqualifications, and other reasons. The ratio of such "noncharged" benefits to chargeable benefits has historically been relatively high in Massachusetts. Information from Section B of Form ES-204 indicates that on average over 14 percent of the regular benefits paid between 1969 and 1977 were not charged to employers.

In contrast, in New Jersey both regular benefits and the state share of extended benefits are chargeable to employers (there are no dependents' benefits). Moreover, the proportion of noncharged benefits has historically been relatively low. On average only about four percent of total benefits paid between 1968 and 1976 were not charged to employers. It should also be noted that interest earned on the UI fund is not credited to employers in either Massachusetts or New Jersey.

Another difference between the Massachusetts and New Jersey UI systems concerns the transfer of reserves between employer accounts and the solvency account. In Massachusetts, if an employer's reserve ratio is above an upper limit (which was 13 percent between 1970 and 1977), reserves are transferred from his account to the solvency account until his reserve ratio equals that limit. Similarly, if his reserve ratio is below a lower limit (-3 percent between 1970 and 1977), reserves are transferred from the solvency account to the employer's account until his reserve ratio equals that limit. In New Jersey, on the other hand, employers' positive and negative balances are allowed to accumulate without limit.

---

[1]"Regular benefits" as used here refers to benefits paid to the unemployed worked during the first 26 weeks of unemployment.

Finally, there are differences in the provisions for the taxing of employers in Massachusetts and New Jersey. In both states, three categories of employers are defined for the purpose of determining regular tax rates: eligible -- regularly rated, eligible -- specially taxed, and ineligible. Eligible -- specially taxed employers are primarily inactive employers, that is, firms which have gone out of business but whose account balances have not yet been written off. Ineligible employers are firms which have not been in business long enough to qualify for experience rating; the necessary period of time is one year in Massachusetts and three years in New Jersey. Employers of these two types are taxed at standard rates rather than at rates determined by their reserve ratios. Eligible-regularly rated employers are active firms which have been in business long enough to qualify for experience rating. Their tax rates depend on their reserve ratios and are determined from the schedule of rates in effect in a given year.

Both Massachusetts and New Jersey levy special UI taxes in addition to the regular tax. While the regular tax is credited to employers in each state, the special tax is credited to the solvency account. In Massachusetts, a solvency tax is levied when the ratio of the balance in the solvency account to the taxable payroll is low. The tax rate is a flat rate of up to one percent and applies to all employers. New Jersey does not have a solvency tax but is one of the few states which has an employee UI tax. The taxable wage base for this tax is the same as that for the employer tax, and the tax rate is the same for all employees.

Having discussed the nature of the micro simulation programs for Massachusetts and New Jersey, we turn now to the results. For each state, first the micro model predictions are presented, then the corresponding macro model predictions, and finally the two sets of predictions are compared.

MASSACHUSETTS

The first three columns of table II-1 present BAL, BALC, and BALI for Massachusetts from 1970-77 (all are based on the 1969 figure for BAL). They show that the balance in Massachusetts' UI fund declined drastically between 1969 and 1977. This decline occurred despite an increase in the schedule of employer tax rates, indicated in table II-2 by the movement from schedule A in 1969 to schedule "maximum" in 1975.

Two sets of predictions of the Massachusetts fund balances, one from the micro model and one from the macro model, are also presented in table II-1. The derivation of these predictions is discussed below.

TABLE II-1

ACTUAL AND PREDICTED UI FUND BALANCE
FOR MASSACHUSETTS, 1969-1977 (In $000's)

Year	BAL	BALC	BALI	BAL1	BAL2
1969	412,531	412,531	412,531	412,531	412,531
1970	377,463	381,887	380,208	380,393	370,724
1971	223,611	235,379	229,912	267,469	222,041
1972	198,366	208,420	202,672	260,969	167,032
1973	212,001	214,066	212,818	294,720	142,563
1974	150,810	155,116	158,825	244,266	70,888
1975	-99,146	-100,148	-90,358	26,048	-193,242
1976	-171,301	-160,016	-147,585	- 1,107	-228,773
1977	-158,508	-144,763	-118,734	46,577	-176,683

Micro Model Predictions

The 1969 ES-204 form for Massachusetts grouped employers into 37 categories so the micro model simulation is based on 37 "employers." As noted earlier, the distribution of benefits by reserve ratio category in 1969 was not available for Massachusetts. An alternative method of deriving weights to distribute benefits among employers therefore had to be used.

First, it was assumed that benefits equaled taxes paid for each employer in the base year:

$$\widehat{BEN}_{i,1969} = \tau_{i,1969}\tilde{W}_{i,1969}, \text{ where}$$

$\widehat{BEN}_{i,1969}$ = estimated benefits for firm i in the base year. We would clearly not expect this to be true for every firm in a particular year, but given the lack of benefit data it seemed the most reasonable assumption to make. The benefit weight for firm i, $\widehat{KB}_i$, was then computed as the ratio of firm i's estimated benefits to total estimated benefits for all firms.

TABLE II-2

SET OF UI TAX SCHEDULES FOR MASSACHUSETTS, 1969-1977
(All figures in %)

Firm reserve ratio	Tax rate in schedule							
	A	B	C	D	E	F	G	Maximum
$R_i \geq 10.5$	.5	.7	.9	1.1	1.3	1.5	1.7	2.9
$10.5 > R_i \geq 10.0$	.7	.9	1.1	1.3	1.5	1.7	1.9	2.9
$10.0 > R_i \geq 9.5$	.9	1.1	1.3	1.5	1.7	1.9	2.1	2.9
$9.5 > R_i \geq 9.0$	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.9
$9.0 > R_i \geq 8.5$	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.9
$8.5 > R_i \geq 8.0$	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9
$8.0 > R_i \geq 7.5$	1.7	1.9	2.1	2.3	2.5	2.7	2.9	2.9
$7.5 > R_i \geq 7.0$	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.7
$7.0 > R_i \geq 6.5$	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.7
$6.5 > R_i \geq 6.0$	2.3	2.5	2.7	2.9	3.1	3.3	3.5	3.7
$6.0 > R_i \geq 5.5$	2.5	2.7	2.9	3.1	3.3	3.5	3.7	3.7
$5.5 > R_i \geq 0.0$	2.7	2.9	3.1	3.3	3.5	3.7	3.9	3.7
$0.0 > R_i \geq -1.0$	2.9	3.1	3.3	3.5	3.7	3.9	4.1	4.1
$-1.0 > R_i \geq -2.0$	3.1	3.3	3.5	3.7	3.9	4.1	4.1	4.1
$-2.0 > R_i$	3.3	3.5	3.7	3.9	4.1	4.1	4.1	4.1
Fund reserve ratios for which the schedules are in effect	$R \geq 6.5$	$6.5 > R \geq 5.5$	$5.5 > R \geq 4.5$	$4.5 > R \geq 4.0$	$4.0 > R \geq 3.5$	$3.5 > R \geq 3.0$	$3.0 > R \geq 2.5$	$2.5 > R$

The micro model predictions are presented in table II-1 as BAL1. It can be seen that while BAL1 moves up and down as BAL does, the micro model consistently overestimates BAL.

Macro Model Predictions

The tax rate regression equation for Massachusetts was

$$
\begin{aligned}
\tau_t = {} & .004735 - .005004(SL_t) - .1321(NEGT_t) + .873(MAXT_t) \\
& + .23394(MINR_t) - .02105(MAXR_t) - .00332(R_{t-1}) \\
& + .06638(SL_t)(R_{t-1}) + 3.324(NEGT_t)(R_{t-1}) \\
& - 9.044(MAXT_t)(R_{t-1}) - 2.451(MINR_t)(R_{t-1}) \\
& + .2714(MAXR_t)(R_{t-1}).^{1}
\end{aligned}
$$

Among the independent variables in this equation are five parameters which describe the shape of the UI tax schedule (see figure II-1):

(1) NEGT, the tax rate paid by firms with negative reserve ratios;

(2) MAXT, the highest tax rate paid by firms with positive reserve ratios;

(3) MINR, the reserve ratio above which the tax rate is reduced below MAXT;

(4) SL, the amount by which the tax rate declines per unit increase in the reserve ratio above MINR;

(5) MAXT, the reserve ratio above which the lowest tax rate (MINT) applies.

The predictions based on this equation are presented in table II-1 as BAL2. It can be seen that BAL2 underestimated BAL in every year of the projection period.

Comparison of the Predictions

The desire to compare how well the micro and macro models predicted led to an investigation of criteria for evaluating forecasts. Mincer and Zarnowitz (1969) and Theil (1965 and 1966) propose several possible criteria, some of which are employed here.

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[1]For a detailed explanation of this equation, see the section on the macro model.

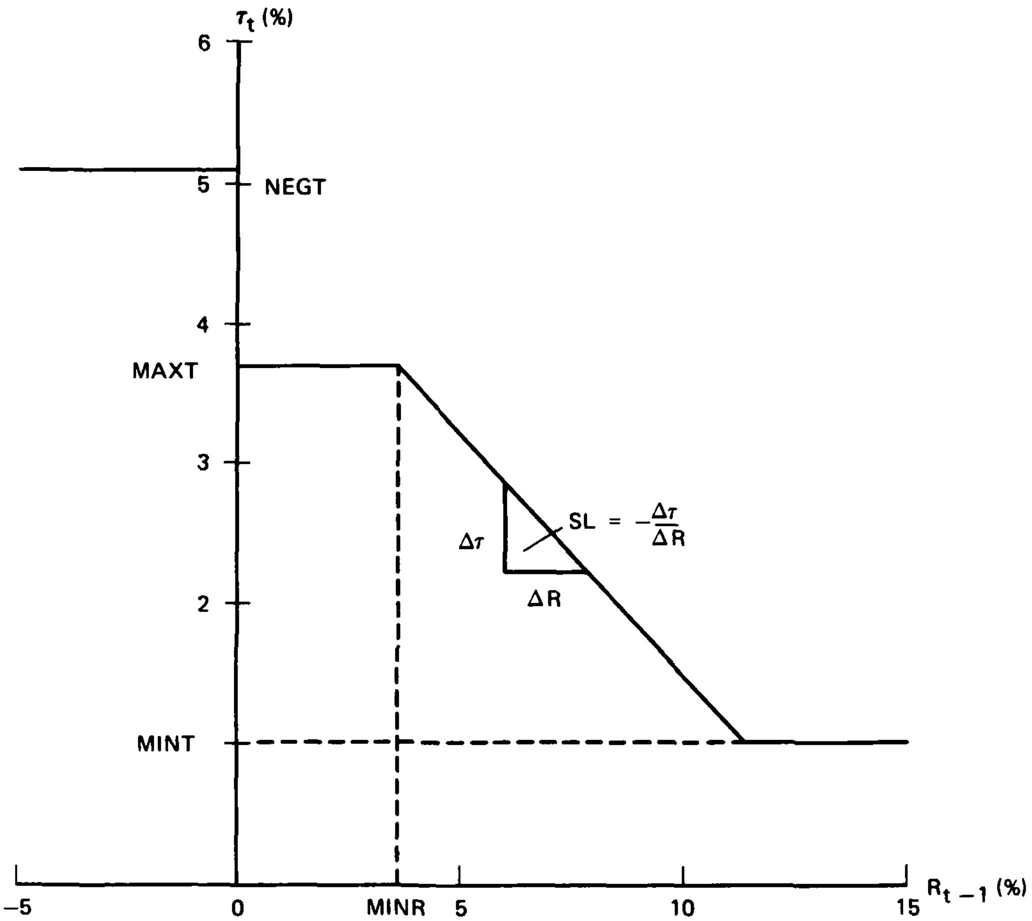

FIG. II-1: THE BASE TAX SCHEDULE

Table II-3 presents various measures of central tendency and dispersion of the forecast error from the micro and macro simulations. Each measure is a possible criterion of the goodness of a set of predictions, with values closer to zero indicating "better" predictions. It can be seen that no matter which criterion is employed, the macro model looks better than the micro model.

TABLE II-3

COMPARISON OF MACRO AND MICRO PREDICTIONS FOR MASSACHUSETTS
(A_t=BAL_t) *in $000's

P_t	Mean error*	Root-mean-square error*	Mean absolute error*	Mean percentage error	Root-mean-square percentage error	Mean absolute percentage error
BAL1	-98,250	116,300	98,250	-.635	.785	.635
BAL2	44,843	55,595	44,843	.305	.424	.305

The fact that the macro model predicted the 1970-77 Massachusetts fund balance better than the micro model did is somewhat disturbing. A priori, we would hope that a model using disaggregated data would work better than one using aggregate data. We therefore decided to investigate some possible reasons for the relatively poor performance of the micro model.

There would seem to be at least two major reasons for this performance. First, as was noted earlier, in some respects our data did not conform to the requirements of the original Mercer model. For example, we did not have a distribution of benefits by reserve ratio for the base year, and the number of employers in our simulation (37) was much smaller than the number recommended by Mercer (280). Second, there may be deficiencies in the assumptions of the Mercer model. Biases may arise because the model treats a large number of firms as one employer. Also, it may be inappropriate to assume that benefit and taxable payroll weights are constant over time.

If deficiencies in the data and in the assumptions of the Mercer model are to blame for the performance of the micro model, the question arises whether we can find better data and/or better assumptions. Fortunately, we were able to obtain information from the state of New Jersey which could be used both to improve the initial distribution of employers and to relax one of the assumptions of the Mercer model. The consequent improvements in the micro model relative to the macro model are discussed in the following section.

NEW JERSEY

It was noted earlier that in general three estimates of the actual UI fund balance -- BAL, BALC, and BALI -- can be derived for a state from data in the Handbook of Unemployment Insurance Financial Data. For New Jersey, however, only BAL and BALC can be computed. This is because although "contributions collected" in the Handbook includes both employer and employee taxes collected, "average employer tax rate as a percent of taxable wages" refers only to employer taxes incurred. We thus have no estimate of employee taxes incurred to add into BALI.

Accordingly, the only actual balances presented in table II-4 are BAL and BALC; both are based on the 1969 figure for BAL. It can be seen that the UI fund balance declined even more dramatically in New Jersey than in Massachusetts between 1969 and 1977. In addition, BAL and BALC seem to diverge more in table II-4 than they do in table II-1.

Undoubtedly, part of the reason that the New Jersey UI fund fared worse during the 1970s than the Massachusetts fund did was that employer tax rates did not increase as much in the former state as in the latter. Table II-5 presents the set of tax schedules for New Jersey for the rate year 1975-76.[1] From 1969-72 tax rates similar to those in schedule D were in effect; from 1973-77 rates similar to those in schedule F were in effect.

Table II-4 presents five sets of predictions of the New Jersey fund balance, four from the micro model and one from the macro model. The source of these predictions is discussed below.

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[1]While there was ony one set of tax schedules for Massachusetts between 1969 and 1977, there were four distinct, though similar, sets for New Jersey during this time. Moreover, on several occasions the New Jersey state legislature provided for temporary changes in tax rates, so that these rates were not determined strictly in accordance with the set of tax schedules then in effect. This did not happen in Massachusetts.

TABLE II-4

ACTUAL AND PREDICTED UI FUND BALANCE
FOR NEW JERSEY, 1969-1977 (In $000's)

Year	BAL	BALC	BAL1	BAL2	BAL3	BAL4	BAL5
1969	482,698	482,698	482,698	482,698	482,698	482,698	482,698
1970	447,697	447,215	447,657	449,221	447,657	447,962	457,171
1971	255,450	279,514	284,553	287,123	291,220	285,074	306,097
1972	137,728	130,899	150,439	155,165	178,629	152,481	187,945
1973	154,844	124,404	174,281	184,052	233,850	179,712	193,061
1974	41,056	-332	61,588	72,376	155,008	70,443	64,473
1975	-347,514	-375,852	-276,813	-274,380	-140,415	-261,441	-270,077
1976	-482,187	-556,054	-401,985	-403,967	-218,652	-375,874	-350,400
1977	-569,572	-623,329	-436,008	-428,394	-193,077	-398,942	-342,009

Micro Model Predictions

It has been noted that New Jersey, unlike Massachusetts, has an employee UI tax. The Handbook lists the value of aggregate taxable payroll for the employer tax but not for the employee tax. It was therefore necessary to determine whether aggregate employer taxable payroll could reasonably be used to compute the employee tax.

In general, the amount of payroll subject to the employer tax in a state will exceed the amount subject to the employee tax. Taxable payroll for an employee equals the first $\$\tilde{W}$ earned by that employee in a year, regardless of how many jobs he held in that year. Taxable payroll for a firm, on the other hand, equals the sum of the first $\$\tilde{W}$ earned by all employees of that firm in a year. This means that when a worker changes jobs, aggregate employee taxable payroll stays the same but aggregate employer taxable payroll may increase.

TABLE II-5

SET OF UI TAX SCHEDULES FOR NEW JERSEY, 1975-1976
(All figures in %)

Firm reserve ratio	Tax rate in schedule A	B	C	D	E	F
$R_i \geq 11$	.4	.4	.4	.7	1.0	1.2
$11 > R_i \geq 10$	.4	.4	.7	1.0	1.3	1.6
$10 > R_i \geq 9$	.4	.7	1.0	1.3	1.6	1.9
$9 > R_i \geq 8$	.7	1.0	1.3	1.6	1.9	2.3
$8 > R_i \geq 7$	1.0	1.3	1.6	1.9	2.2	2.6
$7 > R_i \geq 6$	1.3	1.6	1.9	2.2	2.5	3.0
$6 > R_i \geq 5$	1.6	1.9	2.2	2.5	2.8	3.4
$5 > R_i \geq 4$	1.9	2.2	2.5	2.8	3.1	3.7
$4 > R_i \geq 3$	2.2	2.5	2.8	3.1	3.4	4.1
$3 > R_i \geq 0$	2.5	2.5	2.8	3.1	3.4	4.1
$0 > R_i \geq -10$	3.4	3.7	4.0	4.3	4.6	5.5
$-10 > R_i \geq -20$	3.7	4.0	4.3	4.6	4.9	5.9
$-20 > R_i$	4.0	4.3	4.6	4.9	5.2	6.2
Fund reserve ratios for which the schedules are in effect	$R \geq 12.5$	$12.5 > R \geq 10.0$	$10.0 > R \geq 7.0$	$7.0 > R > 4.0$	$4.0 > R > 2.5$	$2.5 > R$

Algebraically, taxable wages for the two types of taxes can be represented as follows. If all employees have an annual wage of at least $\tilde{w}$, aggregate taxable payroll for the employee tax will equal $\tilde{w}N$, where N = the number of employees. Brechling (1977) has shown that if the size of the labor force is constant, all employees earn an annual wage $w \geq \tilde{w}$, and q = the turnover rate, then aggregate taxable payroll for the employer tax is $\tilde{w}N[1+q(1-\tilde{w}/w)]$. Combining these two expressions, the ratio of aggregate employee taxable payroll to aggregate employer taxable payroll is

$$k = \frac{1}{1+q(1-\tilde{w}/w)} .$$

It can be seen that k increases when $\tilde{w}/w$ increases or when q decreeases. Values of k for New Jersey during the projection period were computed in order to determine whether k was close to 1.

To do this, it was necessary to find values for $\tilde{w}/w$ and q. Between 1970 and 1977 the ratio of the taxable wage base to the average annual wage, $\tilde{w}/w$, ranged between .422 and .475 in New Jersey. The turnover rate, q, was computed as the average of the total accession rate and the total separation rate in manufacturing, as given in Employment and Earnings. Statewide accession and separation rates for New Jersey were not available; but annual values of q for the seven metropolitan areas in the state for which data are published ranged from 2.5 percent to 5.0 percent. The lowest value of k using any of these figures for $\tilde{w}/w$ and q is .972.

This would indicate that, if the assumptions used in deriving k are approximately correct and if the q values for the metropolitan areas are representative of the state as a whole, the employee taxable payroll for New Jersey was at least 97 percent of the employer taxable payroll between 1970 and 1977. However, using 97.2 percent rather than 100 percent of the employer taxable payroll to compute the employee UI tax would result in a decrease in the 1977 simulated fund balance of only about $8 million. Because this amount is relatively small compared to the size of the fund and because of the lack of a statewide value for q, it was decided to compute the employee tax using aggregate employer taxable payroll.

Despite the taxable payroll problem, on the whole we were able to obtain better data for the New Jersey simulation than for the Massachusetts one. New Jersey's Department of Labor and Industry sent us, for rate years 1970-71 and 1971-72, a table of experience rating data by reserve ratio labelled "section F." This information constitutes an improvement over the data on Form ES-204 in two respects. First, while section D of the ES-204 form for 1970-71 separates employers into 21 reserve ratio categories, the table from New Jersey includes 72 categories. Second, more variables are available on section F than on section D. Both tables list the number of accounts, total payroll, taxable payroll, and the account balance for each group of employers. Section F includes, in addition: cumulative contributions, i.e., total UI taxes paid in all years by the firms in a reserve ratio category; cumulative benefits, and three-year-average wages.[1]

The additional variables found in section F were used to make two changes in the micro simulation model. First, better benefit weights were calculated. Although we still did not have benefits paid in the base year by reserve ratio group, we did have benefits paid in all years through the base year for each group. Benefit weights were calculated as

$$KB_i = \sum_{t=38}^{69} BEN_{i,t} / \sum_{i=1}^{72} \sum_{t=38}^{69} BEN_{i,t} .$$

Second, the information on taxable payroll was used to devise taxable payroll weights that changed over time. The 1969 taxable payroll weight was computed as

$$KW_{i,69} = \tilde{W}_{i,69} / \sum_{i=1}^{72} \tilde{W}_{i,69} .$$

Next, a weight for 1968 was computed by assuming that in each category, taxable payroll in 1968 equalled average taxable payroll for 1967-69:

$$KW_{i,68} = \tilde{W}_{i,67-9} / \sum \tilde{W}_{i,67-9} .$$

Finally, weights for the projection period were calculated by projecting the observed change in weights from 1968 to 1969 forward in time:

$$KW_{i,t} = KW_{i,69} + a(t-69)(KW_{i,69} - KW_{i,68}),\ t=70,\ldots,77^{2} .$$

We were thus able to relax one of the assumptions of the original Mercer model, namely the assumption that taxable payroll weights

[1]New Jersey uses the average value of taxable payroll over the past three years as the denominator of the reserve ratio.
[2]In the actual simulation program, a<1 to avoid the problem of negative taxable payroll weights.

are constant over time. Unfortunately, there was not enough benefit data to calculate benefit weights that changed over time.

In sum, it was felt that three improvements on the Massachusetts simulation model were achieved in the New Jersey model: more employers, better benefit weights, and variable taxable payroll weights. In an attempt to gauge the importance of these improvements for the simulation results, four simulations of the New Jersey fund balance were done. In the first, the benefit and taxable payroll weights described above were employed. The results for this simulation are presented in table II-4 as BAL1.

In each of the other simulations, one of the three improvements discussed above was eliminated. To get BAL2, the data given in section F was aggregated further so that there were 36 instead of 72 "employers." BAL3 is based on the type of benefit weight used in the Massachusetts simulation model, i.e., $\widehat{KB}_i = \tau_{i,69}\tilde{\hat{W}}_{i,69} / \sum \tau_{i,69}\tilde{\hat{W}}_{i,69}$. In the last micro simulation, taxable payroll weights are assumed to be constant over time and equal to the ratio of firm to aggregate taxable payroll in 1969. BAL4 gives the results of this simulation.

It is evident from table II-4 that in general the micro model overestimated the fund balance. BAL2 overestimated BAL in every year of the projection period, while BAL1 and BAL3 overestimated BAL in all the years except 1970 (in which they underestimated BAL very slightly). Moreover, in most years BAL2, BAL3, and BAL4 overestimated BAL even more than BAL1 did. In all years except 1970, BAL3 is the highest of the four micro simulation balances.

Further information about the relative performance of the micro simulations is given in table II-6. In all but one of the columns in the top half of the table, BAL1 looks the best, followed by BAL2, BAL4, and BAL3. It thus appears that the simulation with 72 employers, benefit weights based on cumulative benefits, and variable taxable payroll weights yielded the best micro model results.

TABLE II-6

COMPARISON OF MACRO AND MICRO PREDICTIONS FOR NEW JERSEY WITH BAL *in $000's

	Mean error*	Root-mean-square error*	Mean absolute error*	Mean percentage error	Root-mean-square percentage error	Mean absolute percentage error
BAL1	- 45,780(1)	62,330(1)	45,790(1)	-.180(1)	.227(1)	.180(1)
BAL2	- 50,460(2)	65,710(2)	50,460(2)	-.228(2)	.312(3)	.228(2)
BAL3	-139,600(5)	185,800(5)	139,600(5)	-.691(5)	1.070(5)	.691(5)
BAL4	- 57,740(3)	79,370(3)	57,740(3)	-.233(3)	.309(2)	.233(3)
BAL5	- 76,095(4)	101,449(4)	76,095(4)	-.287(4)	.325(4)	.287(4)

Macro Model Predictions

The regression used to predict the aggregate employer tax rate for New Jersey was

$$\begin{aligned}\tau_t = {} & .004735 - .005004(SL_t) - .1321(NEGT_t) + .873(MAXT_t) \\ & + .24532(MINR_t) - .02105(MAXR_t) + .021466(R_{t-1}) \\ & + .14674(SL_t)(R_{t-1}) + 1.616(NEGT_t)(R_{t-1}) \\ & -7.197(MAXT_t)(R_{t-1}) - 1.995(MINR_t)(R_{t-1}) \\ & + .3219(MAXR_t)(R_{t-1}),\end{aligned}$$

where, for this state,

$$R_t = \frac{BAL_t}{(\tilde{W}_{t-2}+\tilde{W}_{t-1}+\tilde{W}_t)/3} .$$

Employee taxes were calculated the same way as in the micro simulations, as the product of the employee tax rate and aggregate employer taxable payroll.

The macro simulation results are given in *table II-4 as BAL5. It* can be seen that BAL5 overestimated BAL in every year of the projection period.

Comparison of the Predictions

Table II-6 indicates that BAL5, the macro model predictions, ranked second worst of the five sets of predictions for New Jersey using each of the six criteria. That is, for this state the best version of the micro model (BAL1) did a better job of predicting the 1970-77 fund balance than the macro model did. This conclusion is not surprising in view of the fact that BAL5 consistently overpredicted BAL even more than BAL1 did.

In the next section we compare the Massachusetts and New Jersey simulation results, and draw some conclusions about the micro and macro models.

EVALUATION OF THE SIMULATION MODELS

One purpose we had for developing both macro and micro simulation models was to see which approach might be better for predicting fund balances. Theoretically, if we had sufficiently disaggregated data and if the assumptions of the Mercer model are not too inaccurate, we would expect the micro model to predict very well. The main disadvantage of the micro model is its greater data requirements -- for example, knowledge of the initial distribution of firms by reserve ratio is necessary.

Due to time and data limitations, micro models were developed for only two reserve ratio states. We could thus make only two direct comparisons between macro and micro model predictions. We found that in one of the states (Massachusetts) the macro model predicted better, while in the other (New Jersey) the micro model predicted better. Because of the small number of comparisons and this disparity in the results, it is impossible for us to conclude whether a macro or micro approach is preferable for a state wishing to predict its future fund balance.

Since neither type of model appeared to dominate the other, both were used for further simulations based on hypothetical rather than actual sets of UI tax parameters. The results of these simulations for the micro model are described in the next section.

FURTHER SIMULATIONS

Methodology and Results

In this section, we describe how the Mercer-type micro model was used to simulate the UI fund balance with hypothetical sets of UI tax parameters. Because the model previously developed for New Jersey was found to predict better than the one developed for Massachusetts, we used the New Jersey model as the basis for these simulations. As before, 1969 was the base year and 1970-1977 the projection period.

In these simulations, we continued to employ the data on economic conditions from the original New Jersey simulations. However, six parameters of the UI tax system were allowed to vary: $\tilde{W}$ (the wage base), NEGT, MAXT, MINR, SL, and MINT.

The simulations were done as follows. For each parameter, a base value was chosen from approximately the middle of the range of the actual values assumed by that parameter in New Jersey between 1970 and 1977. Six sets of simulations were then done; in each, one parameter was varied, while the other five were kept constant at their base values. The values assumed by a parameter in the simulations were chosen to reflect a wide range of possible tax schedules.

The base value, simulation values, and number of simulations done for each parameter are given in table II-7. Altogether, there were 95 simulations. In figure II-1, the base tax schedule is drawn, while in figure II-2, the range of variation of the base schedule is illustrated.

TABLE II-7

Parameter[a]	Base Value	Range of Values in the Simulations	Number of Simulations
$\tilde{w}$	$4600.	$3000. to $12,000.	19
MAXT	.037	.027 to .051	13
MINT	.010	.000 to .024	13
MINR	.035	.00 to .12	13
SL	.3375	.20 to 1.00	17
NEGT	.051	.037 to .075	20

[a]There is a seventh tax parameter which is implicitly defined by four of the six listed above. MAXR, the reserve ratio above which the tax rate becomes MINT, equals MINR + (MAXT-MINT)/SL. When MAXT, MINR, SL, or MINT varies in our simulations, we assume that MAXR also varies in such a way as to keep all other parameters constant.

The choice of these six parameters for the simulations necessitated some changes in the New Jersey micro model. For one thing, since the wage base now differed from its historical values, it was no longer appropriate to use the actual values of taxable payroll to compute the UI tax. Instead, the regression equation for taxable payroll per man, estimated in conjunction with the macro model, was used to forecast aggregate taxable payroll as

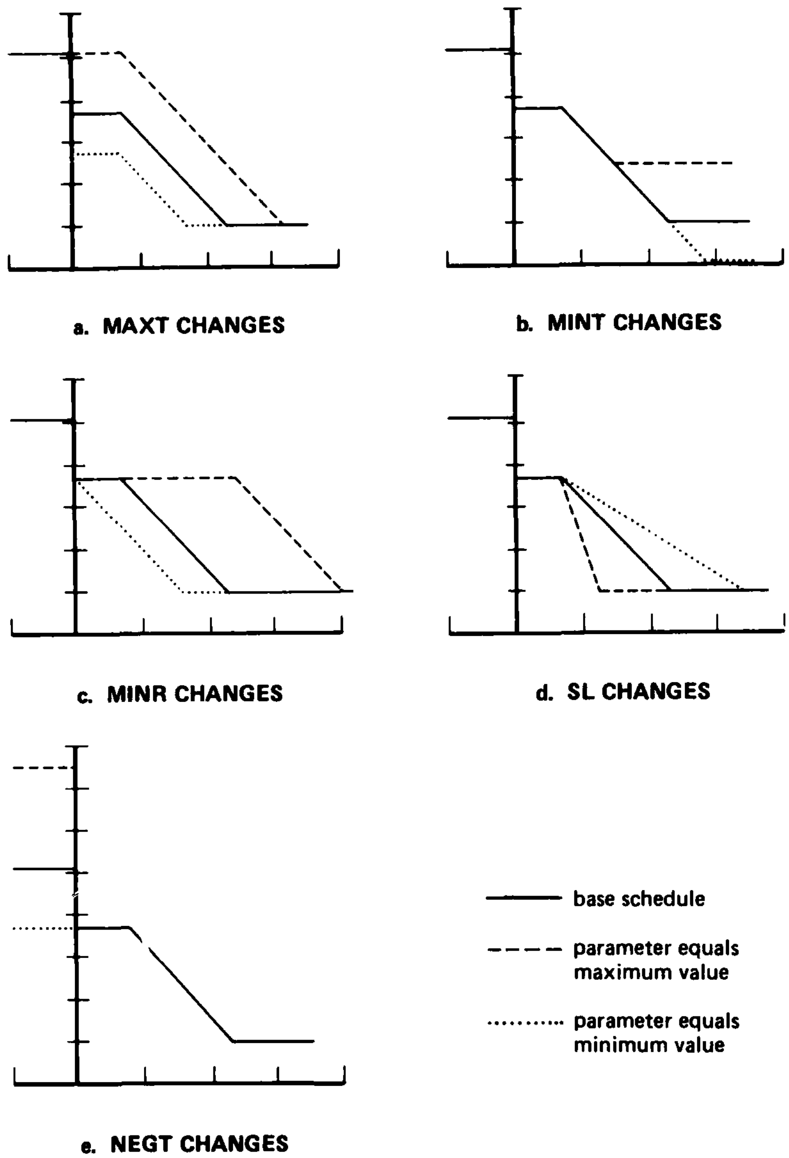

FIG. II-2: SIMULATED CHANGES IN THE BASE SCHEDULE

$$\tilde{W}_t = \left(\frac{\tilde{W}_t}{N_t}\right) N_t = [615.601 + .158810(w_t) + .503167(\tilde{w}_t) + .00000902074(\tilde{w}_t^2) - 9.84791(u_t)]N_t$$

where u_t = the insured unemployment rate in year t.

A second alteration involved changing the tax schedule from a step function (see table II-5 in the section describing the original New Jersey model) to a function which was continuous for firms with positive reserve ratios, as in figure II-1.

For each simulation, three measures of UI fund adequacy were computed:

a. M = the average fund balance

$$= \frac{1}{8} \sum_{t=70}^{77} BAL_t \; .$$

b. V = the variance of the fund balance

$$= \frac{1}{8} \sum_{t=70}^{77} (BAL_t - M)^2 \; .$$

c. C = a measure of the degree to which the tax system is countercyclical

$$= \sum_{t=70}^{77} (TAX'_t - BEN'_t)(\overline{RBEN'} - RBEN'_t)$$

where

TAX'_t = real taxes in year t

BEN'_t = real total UI benefits in year t

$RBEN'_t$ = real regular (as opposed to extended) UI benefits in year t

$\overline{RBEN'}$ = average real regular benefits over the period 1970-1977.

We assume that, ceteris paribus, the lower V is the better, and the higher C is the better. There is also assumed to be an optimal average balance, M_0, which may be positive. It should be noted that M and V are calculated in nominal terms, while C is calculated in real terms. The units of M are dollars, while the units of V and C are dollars squared.

Tables II-8 through II-13 give the values of these three measures for each of the simulations. In order to make the numbers manageable, in these tables and in succeeding calculations, we use $M^* = M/10^6$, $V^* = V/10^{15}$, and $C^* = C/10^{15}$ rather than M, V, and C.

Our ultimate aim in doing the simulations was to determine whether there were inefficiences in the UI tax system. That is, could the parmeters be altered in such a way as to improve at least one of the three measures of fund adequacy without worsening the other two? As a first step toward answering this question, we used regression analysis to estimate the relationship between each of the measures and each of the tax parameters. For example, using the data from table II-8, we obtain

$$M^* = a_0 + b_0\tilde{w}$$
$$V^* = a_1 + b_1\tilde{w}$$
$$C^* = a_2 + b_2\tilde{w} ,$$

where the a's estimated intercept terms, and the b's are estimated slopes.

Table II-14 contains the estimated coefficients of the tax parameters from the regressions described above. Graphs of the measures versus the parameters generally indicated a very smooth relationship between the two with a linear approximation being reasonable in most cases.

The regression coefficients were used to perform three experiments. In each one, the six parameters were varied two at a time in such a way as to keep one of the measures of fund adequancy constant, and the effect of this on the other two measures was determined. Tables II-15, II-16, and II-17 present the information generated by these experiments. In each table, there are four matrices. Their meaning is discussed below, first for table II-15 and then for tables II-16 and II-17.

TABLE II-8

SIMULATION RESULTS WHEN $\tilde{W}$ VARIES

$\tilde{W}$	M*	V*	C*	Y
3000	-167.78751	247.858635	27.9140926	4
3500	-90.70917	212.145168	28.8803579	4
4000	-13.70810	179.135774	29.4649191	3
4500	61.75074	152.245374	30.4219906	3
5000	141.38974	125.638676	31.1622359	3
5500	221.55788	101.750539	32.1619660	3
6000	304.20596	79.547759	32.8756247	2
6500	387.76543	61.243285	33.7262392	1
7000	472.00618	45.918681	34.5421965	0
7500	555.48304	34.661095	35.4938705	0
8000	640.82473	26.172457	36.3687032	0
8500	726.97700	21.110894	37.3166256	0
9000	814.23306	19.319001	38.2865493	0
9500	902.34848	21.175303	39.3289579	0
10000	991.99128	26.613196	40.2783967	0
10500	1081.74148	35.740656	41.2647469	0
11000	1173.24274	48.919256	42.3172792	0
11500	1265.25654	65.945676	43.2739099	0
12000	1357.51059	86.738710	44.3469253	0

TABLE II-9

SIMULATION RESULTS WHEN MAXT VARIES

MAXT	M*	V*	C*	Y
0.027	-86.416330	186.768752	26.3152965	4
0.029	-55.798626	175.570980	26.6815704	3
0.031	-20.810224	164.886455	27.5627228	3
0.033	12.055779	157.020623	28.5328377	3
0.035	44.291347	151.564750	29.2498966	3
0.037	77.826445	146.579492	30.6286374	3
0.039	114.874412	139.151536	31.4968515	3
0.041	152.234768	131.682468	32.5436518	3
0.043	190.163134	124.148263	33.5261092	3
0.045	228.178522	116.521195	34.4562654	3
0.047	265.513626	109.915837	35.4377174	2
0.049	302.684525	103.560151	36.4201310	2
0.051	339.624755	97.682463	37.4129301	2

TABLE II-10

SIMULATION RESULTS WHEN MINT VARIES

MINT	M*	V*	C*	Y
0.000	74.950087	145.726488	30.3681576	3
0.002	75.244663	145.801500	30.3933871	3
0.004	75.702504	145.953233	30.4367006	3
0.006	76.211627	146.104104	30.4836577	3
0.008	76.930976	146.332189	30.5531819	3
0.010	77.826445	146.579492	30.6286374	3
0.012	79.369110	147.023246	30.7614545	3
0.014	81.485211	147.497202	30.9332875	3
0.016	85.567827	148.280075	31.2234764	3
0.018	91.977890	149.328612	31.6118128	3
0.020	102.798388	150.077917	32.2352785	3
0.022	121.332187	148.752077	32.8590041	3
0.024	149.717727	142.743904	33.3693877	3

TABLE II-11

SIMULATION RESULTS WHEN MINR VARIES

MINR	M*	V*	C*	Y
0.00	-93.999341	185.757083	26.3006788	4
0.01	-48.352164	171.034070	26.8825232	3
0.02	1.922564	159.128926	28.3181673	3
0.03	50.562876	152.235469	29.9006224	3
0.04	103.779066	142.184218	31.3487316	3
0.05	155.788249	132.555261	32.8178383	3
0.06	205.997642	123.750573	34.2600464	3
0.07	254.050209	115.164738	35.5040567	3
0.08	298.979573	107.199325	36.6377893	2
0.09	341.310231	98.619255	37.4803950	2
0.10	379.772332	89.461077	37.9041214	2
0.11	412.229345	79.979945	37.8123971	1
0.12	438.062793	71.200200	37.3659562	1

TABLE II-12

SIMULATION RESULTS WHEN SL VARIES

SL	M*	V*	C*	Y
0.20	183.288814	131.885029	33.7183348	3
0.25	138.028311	139.637460	32.6082333	3
0.30	100.840107	144.641974	31.4681056	3
0.35	71.053946	147.018464	30.3698088	3
0.40	47.580542	147.823935	29.4136533	3
0.45	29.491438	148.138042	28.6869886	3
0.50	15.652010	148.475789	28.2030099	3
0.55	4.553244	148.652457	27.7887928	3
0.60	-4.363949	148.896613	27.4964177	3
0.65	-11.718987	149.175498	27.2593319	3
0.70	-17.890584	149.591906	27.0682337	3
0.75	-22.737976	149.724582	26.9046307	3
0.80	-25.936618	148.561139	26.5936214	3
0.85	-30.399872	149.215901	26.4869190	3
0.90	-34.700871	150.146258	26.3822553	3
0.95	-38.482992	151.038924	26.2851850	3
1.00	-42.085902	151.977619	26.1938842	3

TABLE II-13

SIMULATION RESULTS WHEN NEGT VARIES

NEGT	M*	V*	C*	Y
0.037	5.593674	179.619309	30.2165512	3
0.039	16.527871	174.365351	30.2616048	3
0.041	27.462067	169.193451	30.3066583	3
0.043	37.956702	164.287132	30.3634195	3
0.045	48.367706	159.596751	30.4207269	3
0.047	58.050429	155.219722	30.4654007	3
0.049	68.132185	150.663581	30.5435931	3
0.051	77.826445	146.579492	30.6286374	3
0.053	86.697352	142.865893	30.6414908	3
0.055	95.383490	139.278050	30.7081607	3
0.057	104.594357	135.483997	30.7556382	3
0.059	114.182645	131.363471	30.7492184	3
0.061	123.872865	127.208071	30.8030477	3
0.063	132.906115	123.717703	30.8983317	3
0.065	141.660091	120.760352	31.0731945	3
0.067	150.911336	117.152883	31.0737404	3
0.069	158.382964	114.224533	31.2375462	3
0.071	167.033483	111.211923	31.3681933	3
0.073	175.510346	108.429393	31.5269961	3
0.075	184.441580	104.801138	31.3486141	3

TABLE II-14

ESTIMATED SLOPES FROM THE REGRESSIONS OF THE MEASURES ON THE TAX PARAMETERS

	$\tilde{W}$	MAXT	MINT	MINR	SL	NEGT
M*	.1697	17880.43	2350.71	4597.57	-239.86	4667.56
V*	-.0187	-3587.04	76.49	-917.30	14.46	-1941.27
C*	.0018	480.81	116.92	107.36	-8.52	32.59

(M1) $M1_{ij} = \frac{-\partial M^*}{\partial P_j} \bigg/ \frac{\partial M^*}{\partial P_i} = \frac{dP_i}{dP_j}\bigg|_{M^*}$, where $P = (\tilde{W}$,MAXT,MINT, MINR, SL, NEGT). This matrix tells how much parameter i must be varied relative to parameter j in order to keep the average balance constant. For example, $M1_{34}$ indicates that if MINR is raised by .01, MINT must fall by .01956 in order to keep M* constant.

Similarly, in table II-16 $V1_{ij} = \frac{dP_i}{dP_j}\bigg|_{V^*}$ and in table II-17

$C1_{ij} = \frac{dP_i}{dP_j}\bigg|_{C^*}$.[1]

[1]Note that in all of the matrices in tables 15 through 17 the diagonal elements have no meaning, since we are only considering how two distinct parameters can be varied so as to keep M, V, or C constant.

TABLE II-15

TRADEOFFS BETWEEN V AND C WHEN M IS CONSTANT

M1

$\tilde{W}$	MAXT	MINT	MINR	SL	NEGT
0	-105380.207	-13854.152	-27096.283	1413.658	-27508.750
-0.0000095	0	-0.131	-0.257	0.013	-0.261
-0.0000722	-7.606	0	-1.956	0.102	-1.986
-0.0000369	-3.889	-0.511	0	0.052	-1.015
0.0007074	74.544	9.800	19.167	0	19.459
-0.0000364	-3.831	-0.504	-0.985	0.051	0

M2

0	-1616.86	335.51	-410.71	-11.97	-1426.97
0.0153	0	548.07	5.03	-33.66	-1004.90
-0.0242	-4168.87	0	-1066.91	22.27	-2093.16
0.0152	-19.55	545.50	0	-33.40	-1010.01
-0.0085	-2508.97	218.22	-640.10	0	-1659.85
0.0519	3849.57	1054.17	994.86	-85.30	0

M3

0	289.45	91.76	58.15	-5.95	-17.37
-0.0027	0	53.71	-16.27	-2.07	-92.92
-0.0066	-408.54	0	-121.32	3.41	-199.57
-0.0021	63.29	62.03	0	-2.92	-76.40
-0.0042	-154.32	33.42	-55.96	0	-133.21
0.0006	355.97	100.51	75.26	-6.85	0

M4

0	-5.586	3.656	-7.063	2.010	82.168
-5.586	0	10.204	-0.309	16.258	10.814
3.656	10.204	0	8.794	6.529	10.488
-7.063	-0.309	8.794	0	11.440	13.220
2.010	16.258	6.529	11.440	0	12.461
82.168	10.814	10.488	13.220	12.461	0

TABLE II-16

TRADEOFFS BETWEEN M AND C WHEN V IS CONSTANT

V1

$\tilde{W}$	MAXT	MINT	MINR	SL	NEGT
0	-191861.919	4091.373	-49064.295	773.544	-103833.967
-0.0000052	0	0.021	-0.256	0.004	-0.541
0.0002444	46.894	0	11.992	-0.189	25.379
-0.0000204	-3.910	0.083	0	0.016	-2.116
0.0012928	248.030	-5.289	63.428	0	134.232
-0.0000096	-1.848	0.039	-0.473	0.007	0

V2

0	-14673.82	3044.92	-3727.43	-108.61	-12950.52
0.0765	0	2732.00	25.06	-167.77	-5009.17
0.7442	128115.21	0	32787.59	-684.30	64325.64
0.0760	-98.00	2734.09	0	-167.38	-5062.21
-0.1404	-41612.74	3619.38	-10616.44	0	-27529.62
0.1247	9255.83	2534.63	2392.03	-205.09	0

V3

0	132.40	124.35	18.26	-7.12	-155.97
-0.0007	0	127.17	-15.60	-6.58	-227.62
0.0304	5963.77	0	1509.50	-30.63	2999.91
-0.0004	61.01	125.87	0	-6.83	-194.61
-0.0092	-1632.46	161.99	-433.06	0	-1111.09
0.0015	420.60	118.21	91.96	-8.28	0

V4

0	-110.833	24.486	-204.173	15.264	83.031
-110.833	0	21.482	-1.606	25.491	22.006
24.486	21.482	0	21.721	22.344	21.442
-204.173	-1.606	21.721	0	24.515	26.012
15.264	25.491	22.344	24.515	0	24.777
83.031	22.006	21.442	26.012	24.777	0

TABLE II-17

TRADEOFFS BETWEEN M AND V WHEN C IS CONSTANT

$\tilde{W}$	MAXT	MINT	MINR	SL	NEGT
		C1			
0	-264767.585	-64384.693	-59117.396	4691.[illegible]95	-17945.621
-0.0000038	0	-0.243	-0.223	0.018	-0.068
-0.0000155	-4.112	0	-0.918	0.073	-0.279
-0.0000169	-4.479	-1.089	0	0.079	-0.304
0.0002131	56.432	13.723	12.600	0	3.825
-0.0000557	-14.754	-3.588	-3.294	0.261	0
		C2			
0	-27044.12	-8573.79	-5433.20	556.22	1622.63
0.1[illegible]21	0	-1997.35	605.22	76.99	3455.65
0.1332	8213.67	0	2439.18	-68.56	4012.36
0.0919	-2710.60	-2656.50	0	125.02	3271.92
0.1186	4344.47	-940.89	1575.26	0	3750.11
-0.0904	-50984.19	-14395.40	-10778.54	[illegible]980.45	0
		C3			
0	1363.04	1280.22	187.95	-73.26	-1605.76
-0.0051	0	948.77	-116.39	-49.10	-1698.15
-0.0199	-3901.60	0	-987.54	20.04	-1962.59
-0.0032	521.26	1075.53	0	-58.34	-1662.82
-0.0156	-2770.91	274.95	-735.08	0	-1885.96
0.0895	25054.29	7041.33	5477.74	-493.07	0
		C4			
0	-19.841	-6.697	-28.907	-7.593	-1.011
-19.841	0	-2.105	-5.200	-1.568	-2.035
-6.697	-2.105	0	-2.470	-3.422	-2.044
-28.907	-5.200	-2.470	0	-2.143	-1.968
-7.593	-1.568	-3.422	-2.143	0	-1.988
-1.011	-2.035	-2.044	-1.968	-1.988	0

(M2) $M2_{ij} = \frac{\partial V^*}{\partial P_j} + \frac{\partial V^*}{\partial P_i}\frac{dP_i}{dP_j}\Bigg|_{M^*} = \frac{dV^*}{dP_j}\Bigg|_{M^*}$. This matrix gives the

change in the variance per unit of increase in parameter j when parameters i and j are varied so as to keep the average balance constant. For example, $M2_{34}$ indicates that if MINR is raised by .01 (and MINT is decreased by .01956), V* will fall by about 10.669, and so V will fall by about $(10.669)10^{15}$.

Similarly, in table II-16 $V2_{ij} = \frac{dM^*}{dP_j}\Bigg|_{V^*}$ and in table II-17

$C2_{ij} = \frac{dM^*}{dP_j}\Bigg|_{C^*}$.

(M3) $M3_{ij} = \frac{\partial C^*}{\partial P_j} + \frac{\partial C^*}{\partial P_i}\frac{dP_i}{dP_j}\Bigg|_{M^*} = \frac{dC^*}{dP_j}\Bigg|_{M^*}$. This matrix is

similar to M2, except that it deals with the change in the countercyclical measure when parameters i and j are varied. $M3_{34}$ indicates that the changes in MINR and MINT discussed above will lead to a decrease in C* of about 1.213, and so to a decrease in C of about $(1.213)10^{15}$.

Similarly, in table II-16 $V3_{ij} = \frac{dC^*}{dP_j}\Bigg|_{V^*}$ and in table II-17

$C3_{ij} = \frac{dV^*}{dP_j}\Bigg|_{C^*}$.

(M4) $M4_{ij} = M2_{ij} \big/ M3_{ij} = \frac{dV^*}{dC^*}\Bigg|_{M^*}$. This matrix gives the change

in the variance per unit of increase in the countercyclical measure when parameters i and j are varied so as to keep the average balance constant. Similarly, in table II-16

$$V4_{ij} = V2_{ij}/V3_{ij} = \left.\frac{dM^*}{dC^*}\right|_{V^*}$$ and in table II-17

$$C4_{ij} = C2_{ij}/C3_{ij} = \left.\frac{dM^*}{dV^*}\right|_{C^*} .$$

In the next section, we discuss the inefficiencies revealed in tables II-14, II-15, II-16, and II-17.

Interpretation of the Results

As indicated at the beginning of this report, two types of tax system inefficiencies were investigated. A gross inefficiency is said to exist if a change in one tax parameter causes all three measures of fund adequacy to improve. A partial inefficiency exists if a simultaneous change in two parameters causes two of the measures to improve while the third one stays the same. The signs of the regression coefficients in table II-14 indicate whether gross inefficiencies exist, while the signs of the elements in M4, V4, and C4 in tables II-15, II-16, and II-17 indicate the extent of partial inefficiency.

If a state's UI fund balance is stable or growing over time, we might expect the average fund balance to be higher than optimal, i.e., $M>M_0$. In New Jersey, however, the fund balance declined dramatically between 1970 and 1977 under both the actual tax parameters and the base parameters (see table II-18). Accordingly, we might conclude that the average balance in New Jersey between 1970 and 1977 was lower than optimal.

When $M<M_0$, there is a gross inefficiency if a change in one tax parameter lends to an increase in M, a decrease in V, and an increase in C. There is a partial inefficiency if a simultaneous change in two parameters leads to one of the following:

(a) a decrease in V and an increase in C with M held constant (indicated by a negative sign in M4)

(b) an increase in M and an increase in C with V held constant (indicated by a positive sign in V4)

(c) an increase in M and a decrease in V with C held constant (indicated by a negative sign in C4).

TABLE II-18

NEW JERSEY UI FUND BALANCE ($000s)

	Actual	Simulated Using Base Tax Parameters
1970	447,697	520,222
1971	255,450	426,609
1972	137,728	337,880
1973	154,844	323,525
1974	41,056	185,512
1975	-347,514	-208,238
1976	-482,187	-417,135
1977	-569,572	-545,762

Assuming $M<M_0$ for New Jersey between 1970 and 1977 leads to the following conclusions about inefficiency.

Table II-14 indicates several gross inefficiencies. An increase in $\tilde{W}$, MAXT, MINR, or NEGT, or a decrease in SL, ceteris paribus, will lead to an increase in the average balance, a decrease in the variance of the balance, and an increase in the countercyclical measure.

Table II-15 indicates that there are three sets of parameter changes which would decrease V and increase C while keeping M constant:

-- an increase in MAXT and a decrease in $\tilde{W}$
-- an increase in MINR and a decrease in $\tilde{W}$
-- a decrease in MINR and an increase in MAXT.[1]

[1]It should be noted that while the signs of the elements of M4 indicate which pairs of parameters can be altered so as to decrease V and increase C while keeping M constant, the elements of M1, M2, and M3 are necessary to determine in what proportion the parameters should be altered and in what direction. Similar remarks apply to tables II-16 and II-17.

According to table II-16, there are twelve sets of parameter changes which would increase M and C while leaving V constant. These may be summarized as follows:

-- increase MINT and either: increase $\tilde{w}$, increase MAXT, increase MINR, decrease SL, or increase NEGT

-- decrease SL and either: decrease $\tilde{w}$, decrease MAXT, decrease MINR, or decrease NEGT

-- decrease NEGT and either: increase $\tilde{w}$, increase MAXT, or increase MINR.

Finally, table II-17 indicates that there are fifteen sets of parameter changes which would increase M and decrease V while keeping C constant. These may be summarized as follows:

-- increase SL and either: increase $\tilde{w}$, increase MAXT, increase MINT, increase MINR, or increase NEGT

-- increase NEGT and either: decrease $\tilde{w}$, decrease MAXT, decrease MINT, or decrease MINR

-- increase $\tilde{w}$ and either: decrease MAXT, decrease MINT, or decrease MINR

-- decrease MINT and either: increase MAXT or increase MINR

-- increase MINR and decrease MAXT.

If we thought the average fund balance under the base tax system was higher than optimal, i.e., $M>M_0$, we would reach much different conclusions about inefficiency. Since we now would want to decrease M, decrease V, and/or increase C, we would conclude that there are no gross inefficiencies and few partial inefficiencies. Partial inefficiencies would be indicated by negative signs in M4 (as before), negative signs in V4, and positive signs in C4. Acordingly, we would find:

(a) three sets of parameter changes which would decrease V and increase C while keeping M constant;

(b) three sets of parameter changes which would decrease M and increase C while keeping V constant; and

(c) no sets of parameter changes which would decrease M and V while keeping C constant.

It should be noted that the assumption of a linear relationship between the measures of fund adequacy and the tax parameters theoretically implies that we could, for example, reduce V to zero through sufficiently large changes in the appropriate parameters. This is, however, impracticable for two reasons. First, in many cases, the assumption of linearity is inappropriate for large changes in the parameters. Second, reducing V or M below a certain level might require changes in the parameters which are infeasible or undesirable. For example, it does not make sense for any of the parameters (with the possible exception of MINT) to be negative, and it is undesirable to have MAXT > NEGT.

In conclusion, we wish to issue some warnings about the generality of these results. The micro simulation results (and indeed the results from any UI fund simulation model) are based on a particular initial distribution of firms by reserve ratio and on a particular time path for benefits, employment, etc. We therefore believe it would be dangerous to apply the conclusions reached above without qualification to a situation in which the firm distribution and/or economic conditions differed substantially from those in New Jersey between 1969 and 1977.

APPENDIX TO PART II

EVALUATION OF PREDICTIONS

If forecasters are to improve their prediction methods, they need some means of evaluating the forecasts resulting from those methods. This appendix discusses some possible criteria for such evaluations. In it, the methods for evaluating predictions which have been employed by various economists are presented and compared.

Consider the general problem of forecasting values for a particular variable over time. Let

A_t = actual value of the variable being predicted at time t
P_t = predicted value of the variable at time t
T = length of the projection period.

Depending on the problem being studied, P_t may refer to the level of some economic variable (say X_t), to the change in the level of the variable $(X_t - X_{t-1})$, or to the percentage change in the variable $((X_t - X_{t-1})/X_{t-1})$. Generally, criteria for evaluating the goodness of a set of predictions are a function of the forecast errors $u_t = A_t - P_t$.

As with any estimator, we use measures of central tendency and measures of dispersion to judge how good a predictor is. The most commonly used measure of central tendency is the mean forecast error of the set of predictions,

$$ME = \frac{1}{T} \sum_{t=1}^{T} (A_t - P_t) \quad .$$

The most commonly used measure of dispersion, and in fact the criterion most frequently used to evaluate forecasts, is the root-mean-square error,

$$RMSE = \sqrt{\frac{1}{T} \sum (A_t - P_t)^2} \quad .$$

An alternative measure of dispersion which, unlike RMSE, does not give more than proportionate weight to large errors, is the mean absolute error,

$$MAE = \frac{1}{T} \sum |A_t - P_t|.$$

For some economic problems we may be interested in the percentage by which predicted values deviate from actual ones. In this case we can compute the mean percentage error (MPE), root-mean-square percentage error (RMSPE), or mean absolute percentage error (MAPE) by replacing $(A_t - P_t)$ in the above formulas with

$(A_t - P_t)/|A_t|$.[1]

It is easy to compute the measures suggested above, but difficult to know whether particular values of those measures indicate that a set of predictions is "good" in an absolute sense. One set of tests of the absolute accuracy of a forecast has been proposed by Mincer and Zarnowitz (1969). They begin with the regression of the actual values of the variable being predicted on the predicted values: $A_t = \alpha + \beta P_t + v_t$. They then define an unbiased forecast as one for which the expected forecast error is zero -- $E[u] = \alpha + (\beta - 1)E[P] = 0$ -- and an efficient forecast as one for which $\beta = 1$.[2]

Since only samples of predictions and realizations are available in empirical work, it is necessary to use statistical tests to determine whether a particular forecast is unbiased and/or efficient. The hypotheses to be tested and the corresponding test statistics are indicated in table A-1.

---

[1]The absolute value sign is included in the denominator because we desire the percentage error to have the same sign as $(A_t - P_t)$.

[2]This definition of efficiency differs from the one usually employed. Kmenta, for example, defines an efficient estimator as the unbiased estimator with the lowest variance (1971, p. 158). For Mincer and Zarnowitz, efficiency does not require unbiasedness, although it does require lowest variance of the forecast error.

TABLE A-1

TESTING FOR UNBIASEDNESS AND EFFICIENCY

Hypothesis	Test statistic
1. $\alpha = 0$ and $\beta = 1$	$F_{2,T-2} = \dfrac{(\Sigma u_t^2 - \Sigma v_t^2)/2}{\Sigma v_t^2/(T-2)}$
2. $E[u] = 0$	$t_{T-2} = \dfrac{\hat{\alpha} + (\hat{\beta}-1)\bar{P}}{\sqrt{\Sigma v_t^2/T(T-2)}}$
3. $\beta = 1$	$t_{T-2} = \dfrac{\hat{\beta} - 1}{\sqrt{\Sigma v_t^2/(T-2)\Sigma(P_t-\bar{P})^2}}$

The first hypothesis is that the forecast is both unbiased and efficient, while the second and third involve separate tests for unbiasedness and efficiency, respectively. In each case the hypothesis is rejected for values of the test statistic which are high in absolute value.

The tests proposed by Mincer and Zarnowitz from a part of what they call absolute accuracy analysis; the given set of predictions is implicitly compared with the (unattainable) set of perfect predictions ($A_t = P_t$ for all t). Another approach to the evaluation of forecasts involves relative accuracy analysis. Much of the work that has been done in this area has followed the ideas of Theil.

Beginning with the assumption of a quadratic loss function, Theil suggested using RMSE to measure the seriousness of a set of forecast errors. In addition, he proposed two ways of standardizing RMSE. In (1965, p. 32) he defined an inequality coefficient

$$U = \frac{\sqrt{\frac{1}{T}\sum(A_t-P_t)^2}}{\sqrt{\frac{1}{T}\sum A_t^2}+\sqrt{\frac{1}{T}\sum P_t^2}} .$$

U has the merit of being bounded by 0 and 1. U = 1 when the forecast is so bad that predicted values are inversely proportional to actual ones ($P_t = -kA_t$ for all t, with $k>0$).

U = 0 if and only if the forecast is perfect. Theil noted that the latter feature makes U superior as a measure of forecast accuracy to the correlation coefficient r. For, while a perfect forecast implies r = 1, r = 1 need not imply a perfect forecast.

Theil later concluded that a disadvantage of U is that it is not uniquely determined by the mean square prediction error (1966, p.28). He therefore defined a new inequality coefficient

$$U' = \frac{\sqrt{\frac{1}{T}\sum(A_t-P_t)^2}}{\sqrt{\frac{1}{T}\sum A_t^2}} .$$

Like U, U' = 0 if and only if all predictions are correct; but unlike U, U' has no finite upper bound. U' = 1 when $P_t = 0$ for all t.

What U' really involves is a comparison of the RMSE from the given prediction method with the RMSE from an alternative prediction method, namely one which predicts that the variable equals zero in every period. Mincer and Zarnowitz generalized this notion of comparing forecast errors by considering other possible "benchmark" methods. They defined the relative mean square error

$$RM = \frac{\frac{1}{T}\sum(A_t-P_t)^2}{\frac{1}{T}\sum(A_t-P'_t)^2}$$

where P'_t = predicted value of the variable using the benchmark method.

The benchmark that Mincer and Zarnowitz proposed was extrapolation of the past own history of the variable to be predicted: $P'_t = \alpha + \beta_1 A_{t-1} + \beta_2 A_{t-2} + \ldots + \delta_t$. Their justification for this choice was that extrapolation "is a relatively simple, quick, and accessible alternative" (p. 21). The formula for RM is general in the sense that P'_t can be considered to result from any desired benchmark method; for example, U' is a special case of RM in which $P'_t=0$.

So far we have discussed comparison of a proposed prediction method with a naive benchmark method. If RM is less than 1, we can conclude that the proposed method is "better" than the benchmark in terms of mean square forecast error; if RM exceeds 1, the benchmark appears better. Another problem that economists frequently confront is how to evaluate the goodness of alternative proposed prediction methods.

Sometimes it is desired to compare several sets of predictions of a given set of outcomes. For example, we wanted to compare different ways of predicting a given state's UI fund balance. In this case, comparing the RM values for the different methods gives the same ranking among methods as comparing the RMSE values does, since A_t and P'_t are the same for all the sets of predictions.[1] Other times, it is desired to compare predictions of differing sets of outcomes. For example, we wanted to compare the best prediction method for one state's fund balance with the best ones for other states. In this situation it would be inappropriate to compare the RMSE for one state with the RMSE for another because the average fund balances observed in the two states are likely to differ. Comparing RM values is one way of

---

[1] Comparing the U values does not necessarily give the same ranking among methods as comparing the RMSE values does. In general it seems that U is not a good index for comparing sets of predictions. Consider, for example, two sets of predictions of the set of outcomes A for which the RMSE's are the same. The set of outcomes with the higher value of $\sum P^2$ will have the lower value of U and will thus appear "better." But in itself a high value of $\sum P_t^2$ says nothing about he goodness of a set of predictions.

eliminating the scaling problem which occurs when sets of outcomes differ.[1]

The discussion of relative accuracy analysis has focused on comparison of the RMSE's of different sets of predictions; MAE's and ME's can, of course, also be compared. It should be kept in mind, however, that while such comparisons may indicate that one prediction method is better than another, they do not indicate how much better. Cardinal comparison of prediction methods would require knowing the costs of producing different sets of predictions and the costs associated with different forecast errors; this information is rarely available.

[1]It should be noted that the ranking of prediction methods when both predicted and actual values differ between methods is not independent of the benchmark method chosen.

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PART III

THE STYLIZED-STATE SIMULATION MODEL

PART III -- SECTION 1

THE STYLIZED-STATE SIMULATION MODEL

INTRODUCTION

Unemployment Insurance (UI) benefits are paid in each state out of a fund that is maintained through taxes on employers. Each state's tax system is different and quite complex. In our project to evaluate these tax systems, we have used three different simulation models. Each of the simulations uses data at different levels of disaggregation, and each makes different assumptions in order to predict balances under different tax systems. The three models were developed to give three different approaches to the same question: How do the various provisions of a tax system affect the balance in the fund over time (both the mean and variance) and the ability of UI to counteract the cycle (countercyclical power)? This part of the paper describes the simulation model that uses the most disaggregated data. We have called this the "stylized-state" simulation.

Three broad classes of tax systems account for almost all the states: the reserve-ratio system, the benefit-ratio system, and the benefit-wage-ratio system. These names reflect differences in the variable that is used to assign tax rates to employers. Within each group, there is a great diversity in the relationship between the tax variable and the assigned tax rate (the parameters of the tax schedule vary across states). All three of the simulation models that we have developed have been used to simulate balances for reserve-ratio tax systems, the most common type (32 states as of January 1980). The stylized-state model has also been used to simulate balances for the two other tax systems. In the first part of this paper, the stylized-state simulation is described in detail and the reserve-ratio simulation results are presented. The second part of the paper presents the simulations for the two other tax systems.

RESERVE-RATIO SIMULATIONS

Reserve-ratio states keep track of taxes paid by each firm and benefits paid to employees of that firm. The balance (BAL) for each firm is the sum of all past taxes collected (TAX) minus all past benefits paid out (BEN).[1]

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[1] All states except Michigan go back at least as far as 1958. Michigan uses the last 5 years.

The reserve ratio (R) at time t is defined as

$$R(1)_t = \frac{BAL_{t-1}}{\tilde{W}_{t-1}}$$

or

$$R(3)_t = \frac{BAL_{t-1}}{AVG_{\tilde{W}}}$$

where $\tilde{W}$ is the taxable payroll and AVG $\tilde{W}$ is the average taxable payroll for an employer. The average is usually taken over the last three years. The tax rate (τ) for year t is a negative function of the reserve ratio. The taxable payroll is the first $\tilde{W}$ dollars of each employee's annual earnings where $\tilde{W}$ is the taxable wage base. Historically, the taxable wage base has grown from $3000 to around $6000 in most states.

The Stylized-State Simulation Model

There are 50 hypothetical firms in the simulation; the number of employees attached to each firm is determined by a specified starting position and random yearly shocks drawn from a normal distribution. Each employee has a wage determined by a draw from a normal distribution.

Each year, the benefits charged to each firm's account are generated from two sources:

(1) reductions in employment

(2) turnover and temporary layoffs. Benefits are charged to firms even when there is no change in the desired level of employment (positions). The fraction of positions that generate benefits for firm i is q_i.

Benefits charged to firm i in period t (BEN_{ti}) are a function of both reductions in employment and turnover:

$$BEN_{ti} = \bar{B}\,(\Delta N^{-})_{ti} + q_i \cdot N_{ti}$$

where

$\bar{B}$ = the average dollar amount of benefits drawn per claimant per year

N_{ti} = number of position at firm i in year t

$(\Delta N^-)_{ti}$ = reductions in employment, viz:

$$\text{if } N_t - N_{t-1} > 0,\ (\Delta N^-) = 0$$

$$\text{if } N_t - N_{t-1} < 0,\ (\Delta N^-) = N_{t-1} - N_t \quad .$$

The turnover rate q_i differs from firm to firm but each firm has the same turnover rate from year to year. This feature of the model was designed to reflect the observation that some firms or industries are heavier users of the UI system than others, regardless of whether they or the economy in general is growing or declining. Each firm is assigned a q_i (turnover rate) by a draw from a random normal distribution.[1]

In the simulation, turnover (q_i) generates not only benefits but also taxes. If an employer replaces one employee by another, his taxes go up because the taxable payroll is the first $\tilde{W}$ dollars of each employees's annual salary. In the initial period (t=0), the taxable wages for each firm are

$$\tilde{W}_{oi} = \int_o^{\tilde{W}} y \cdot f_i(y) \quad (1+q\ )dy + \int_{\tilde{W}}^{\infty} w\ f_i(y) \quad (1+q_i)dy$$

where $f_i(y)$ is the distribution of annual salaries for firm i. In subsequent periods, changes in taxable payroll are proportional to changes in employment:

[1]Salaries and turnover rates were both restricted to positive numbers by taking the absolute value of the random number.

$$\tilde{W}_{ti} = \frac{N_{oi}}{\tilde{W}_{oi}} N_{ti}$$

The tax rate for each firm is determined by a simplified tax schedule. The reserve ratio determines the tax rate:

$$R(3)_{ti} = BAL_{t-1,i} \Bigg/ \left(\frac{1}{3} \sum_{j=t-3}^{t-1} \tilde{W}_{ji} \right)$$

or

$$R(1)_{ti} = BAL_{t-1,i} \, / \, \tilde{W}_{t-1,i}$$

where

$$BAL_{ti} = \sum_{j=0}^{t} (TAX_{ji} - BEN_{ji})$$

and

$$TAX_{ti} = \tau_{ti} \cdot \tilde{W}_{ti}$$

The tax rate (τ) is a negative, linear function of the reserve ratio with a minimum tax rate (MINTAX) and maximum tax rate (MAXTAX):

$$= \text{MAXTAX if } R < 0$$

$$= [\text{MAXTAX} - s(R)] \text{ if } 0 \leq R \leq \text{MAXRES}$$

$$= \text{MINTAX if } R > \text{MAXRES}$$

where s is the slope of the tax schedule and MAXRES is the lowest reserve ratio where MINTAX is effective. Figure III-1 illustrates this relationship between tax rates and reserve ratios.[1]

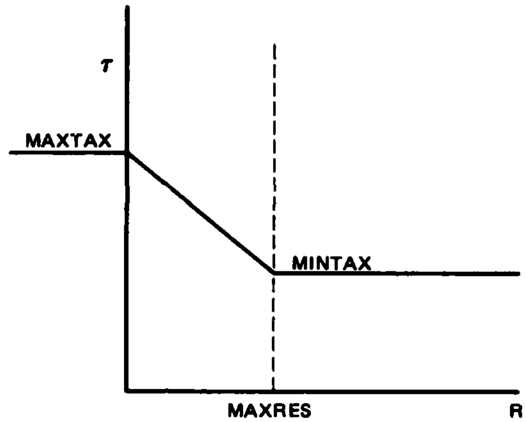

FIG. III-1: STYLIZED TAX SCHEDULE

This type of tax schedule can be completely described by any three of the following parameters:

i MAXTAX

ii MINTAX

iii Slope (s)

iv MAXRES

With this type of tax schedule, firms can be categorized into one of three groups:

---

[1] Actual state tax schedules are more complex than the one in figure III-1; they are step functions where the sloped section appears, and many states have more than one tax rate for negative reserve ratios. For the purposes of this paper, we need only a simplified schedule.

1. Firms that pay MAXTAX, the maximum tax rate. In general, these are firms that generate more benefits than taxes; they are net drains on the UI fund.

2. Firms on the sloped portion of the tax schedule, with reserve ratios greater than zero and less than MAXRES. These firms pay their own way; on average, their tax payments are equal to their benefit charges.

3. Firms at the minimum tax rate. These firms generate more taxes than benefits; they account for net inflows into the fund.

Firms do not necessarily remain in the same category over time. Because of the random walk nature of employment levels, firms can move from one group to another. But there are some firms that experience a general decline or increase in employment and this combined with the firm's natural turnover rate (q_i) means that some firms will be consistently at MAXTAX and some firms will be consistently at MINTAX.

In this simulation model, a firm goes out of business when its employment level is less than or equal to zero. During the year that employment goes to zero, the firm does not pay taxes. Benefits are paid to the workers who are terminated during the last year. Random yearly shocks are continually added to the nonpositive employment level of the deceased firm. When employment reaches a level greater than or equal to zero, a new firm is created. All firms, including those who first appear at t = 0 pay the maximum tax rate (MAXTAX) for the first three years.

The last equation in the simulation model defines the balance in the state fund (BAL_t):

$$BAL_t = BAL_{t-1} + \sum_{i=1}^{50} TAX_{ti} - \sum_{i=1}^{50} BEN_{ti}$$

Simulation Parameters

To clarify and summarize the assumptions and mechanics of the simulation, table III-1 lists the simulation parameters. There are two types of parameters. The first type describes the economic environment. There are eight economic parameters, the mean and standard deviation of four distributions: (i) initial firm size, (ii) changes in employment, (iii) annual salaries, and (iv) turnover rates.

TABLE III-1

PARAMETERS OF THE STYLIZED-STATE SIMULATION

Economic Parameters

Distributions of (μ, σ)

- initial firm size
- changes in employment
- annual salaries
- turnover rate (q_i)

UI Tax Parameters

- average benefit amount $(\bar{B})$
- wage base $(\tilde{W})$
- maximum tax rate (MAXTAX)
- minimum tax rate (MINTAX)
- slope of the tax schedule (s)

The second set is the five parameters that describe the UI system in each state. The parameters are subject to change by the state legislature. A major purpose of this project is to evaluate these tools in terms of their effect on the level and timing balances in the UI fund.[1]

Simulation Results

Selecting a Base Case

The first task in the simulation exercise after developing and testing the model was to select a base case for comparison purposes. The criteria for the base case were: First, that the balance over the hundred-year period be roughly stable; the fund should be neither consistently increasing nor consistently declining. The second criterion was that the simulation be as realistic as possible. The unknown quantities in this simulation are the economic parameters; one check that these parameters are

[1]The benefit schedule is as complex as the tax schedule. Only one aggregate benefit parameter has been included here because concurrent research for the National Commission on Unemployment Compensation is concentrating on the parameters of the benefit schedule. The two projects should be linked for an analysis of all the interactions between the tax benefit schedules.

not totally out of line is to require that they produce realistic results.

By realistic, we mean that with tax parameters that are averages of observed parameters, the fund should have a tax balance that is close to average observed balances. Also, we wanted firms in all three regions of the tax schedule because this is what we observe in all reserve-ratio states.

Table III-2 lists the parameters of the base case. All firms were started out at 100 employees. Because of this somewhat arbitrary simplification, it takes several years before any firms go out of business. Thus, the beginning of the simulation should be viewed as a break-in period and not as part of the steady-state resolution of the parameter influences.

TABLE III-2

BASE CASE PARAMETERS

Economic Parameters

	μ	σ
Initial firm size	100	0
Annual employment change	0	5
Wage distribution	10K	4K
Turnover rate q_i	.05	.05

UK Tax Parameters

Average benefit amount ($\bar{B}$)	$ 800
Wage base $\tilde{w}$	4,000
MAXTAX	.05
MINTAX	.01
Slope	.4

Figure III-2 is the graph of the fund balance for the base case. the average fund balance over the 100-year period is $2.3M.[1]

[1] An average fund balance of $2.3M is 4.6 percent of total wages. This is about average for the U.S. as a whole since 1938 (see U.S. Department of Labor, Handbook, [1938-1976] p. 173, col. 19).

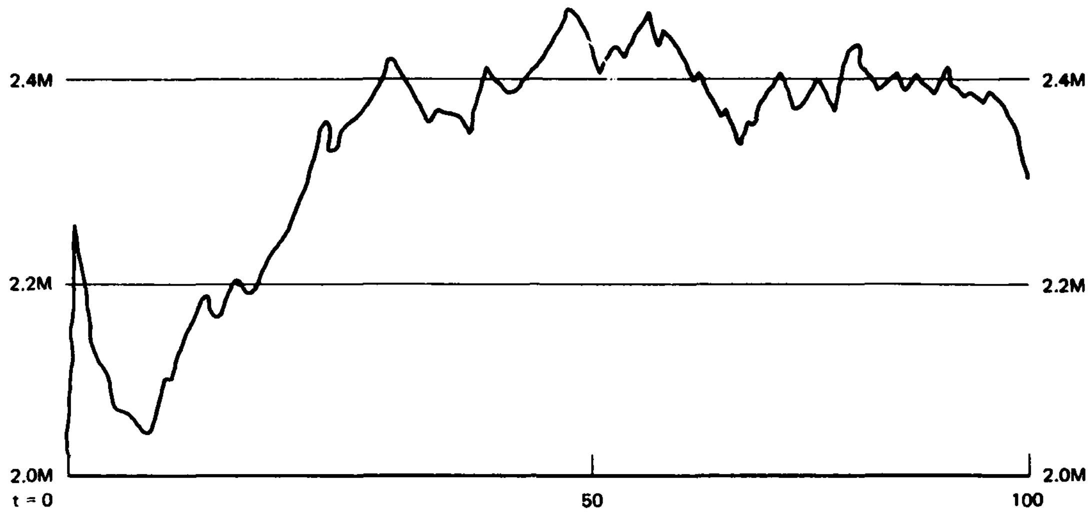

FIG. III-2: BASE CASE SIMULATION (R(3))

The fund is growing in the beginning. Firms build up healthy reserves during the first three years because they pay the maximum tax rate; it takes a while before any firms have negative reserve ratios and start becoming net drains on the system. The average number of firms with a reserve ratio less than zero (those with negative balance) is about three percent. The average over the last 60 years of the simulation, when the fund has stabilized, is nearly double that but still quite small considering the fact that more than a third of the firms are paying the minimum tax rate, which means that they are in general the source of net inflows for the fund. One general conclusion of this simulation exercise is that there have to be many more firms at MINTAX (net contributors to the fund) than at MAXTAX (net drains on the fund) because the distribution of existing firms by reserve ratio does not reflect firms that have gone out of business. The reserve ratios of firms that go out of business are usually negative; their debt to the fund can never be recaptured. If the fund is to stay in balance, the drain caused by dying firms must be balanced by firms that have greater tax payments than benefit changes.

After the fund stabilizes, fluctuations in the balance are due to fluctuations in employment. Although the expected value of the change in employment for each firm is zero, the realized value can be above or below zero. In general, when the average employment change is above zero for a few years in a row, the fund increases; conversely, when the average employment change is below zero, the fund balance decreases.

Simulating Alternative Tax Parameters

After the base case was selected, the tax parameters were changed and the model was resimulated with the same random components.[1] Figure III-3 illustrates how changes in the tax parameters affect the tax schedule. Most schedule changes involve changing two tax parameters, since three of the four tax parameters are sufficient to describe a tax schedule. The last change illustrated in figure III-3 is an exception; the schedule change can be described by a change in only MAXRES, because MAXTAX is extended into positive reserve ratios.

Table III-3 reports aggregate statistics from simulations where the reserve ratio is calculated using a three-year average of taxable payroll or:

$$R(3)_{ti} = BAL_{t-1,i} \Bigg/ \frac{1}{3} \sum_{j=t-3}^{t-1} \tilde{W}_{ji}$$

Some changes in the tax parameters change the relationships between tax inflows and tax outflows; the fund balance is no longer stable, and there is a general increase or decline in the balance. There are some changes in the tax parameters, on the other hand, that affect only the level of the balance; the average balance is changed, but the fund stabilizes at a higher or lower level.

In general, changes in $\overline{B}$ and $\tilde{W}$ affect the stability of the balance, because these changes affect the ratio of benefit outflows and tax receipts per worker each year. On the other hand, most changes in the tax schedule, (except for changes in MINTAX) affect only the level of the balances; they are not destabilizing changes.

There are two ways that changing the parameters of a tax system affect the balance in the fund. The first is by changing the distribution of firms by reserve-ratio region. This type of change will affect the ratio of net-surplus to net-deficit firms and create a permanent change in the annual ratio of benefits to taxes. Raising the wage base ($\tilde{W}$) from $4000 to $6000, for instance, increases the number of firms at MINTAX (net-subsidy firms) and decreases the number of firms with negative reserve ratios (net-deficit firms). the two types of firms do not balance out at a

[1] Most of the tax parameter combinations were simulated for two random sequences of employment shocks for each firm. Because there are so many years in each simulation, the sequence of random shocks had almost no effect on the aggregate statistics reported here.

wage base of $6,000, so the fund increases on average (the trend line around random fluctuations is positive).

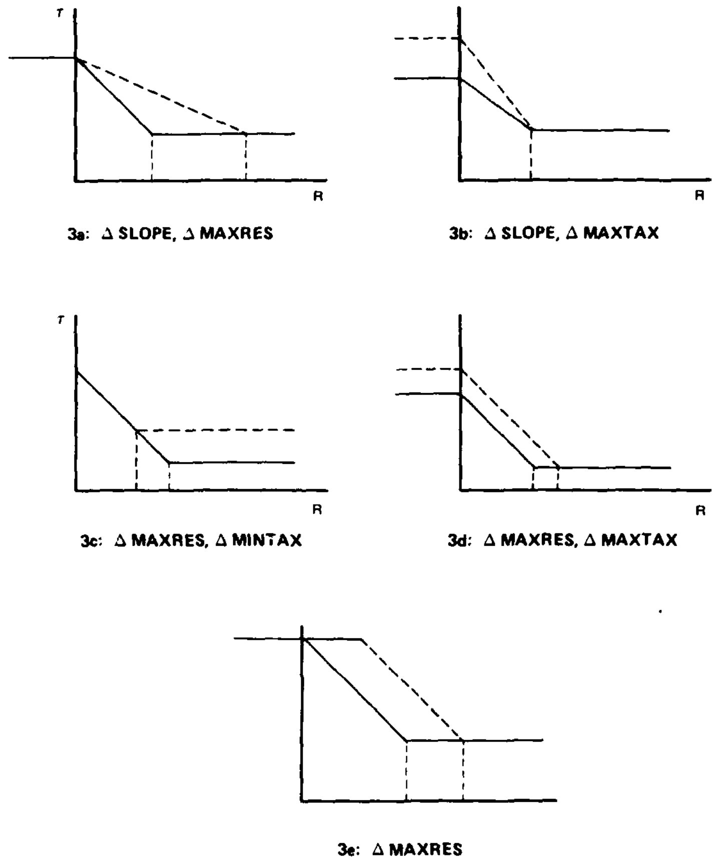

FIG. III-3: ILLUSTRATION OF CHANGES IN TAX SCHEDULES THAT RESULT FROM CHANGES IN TAX PARAMETERS

The second way that changes in the tax parameters affect the balance in the fund is by changing the average balance of firms on the sloped portion of the tax schedule. A change in reserve ratios changes the level of the balance; it does not change the equilibrium ratio of annual taxes to benefits.

Figure III-3a, reproduced below, illustrates two tax schedules, each with a different slope.

If the tax schedule does not affect the employment decisions of a firm, then any firm with an equilibrium tax rate of τ^* would have the same tax rate (MINTAX<τ^*<MAXTAX) under each schedule, but the

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TABLE III-3

SIMULATION RESULTS - CHANGES IN TAX PARAMETERS
R(3)
(three year average used in reserve ratio)

Simulation type	Mean balance	Average % of firms R<0	Average % of firms at MINTAX	Trend in balance
Base Case	2.31M	03.0	36.2	Stable
$\bar{B}$ 600	3.25	01.3	49.1	Increasing
700	2.74	01.3	41.8	Increasing
900	1.97	03.9	31.2	Slight Decline
999	1.68	05.4	26.0	Declining
$\tilde{W}$ 3200	1.34	05.4	26.0	Declining
5000	3.78	01.6	46.1	Increasing
6000	5.47	00.9	56.4	Increasing
Slope, MAXRES see Fig. 3a				
.2 .2	3.46	02.0	29.9	Stable
.3 .1130	2.62	02.5	33.0	Stable
.5 .08	2.16	03.4	38.7	Stable
.6 .067	2.06	03.7	40.4	Stable
Slope, MAXTAX see Fig. 3b				
.3 .04	2.01	04.5	32.6	Stable
.5 .06	2.62	02.3	40.0	Stable
MAXRES, MINTAX see Fig. 3c				
.1250 .000	1.41	03.2	00.9	Declining
.1130 .0050	1.45	03.2	11.6	Declining
.0880 .0150	4.16	03.0	52.8	Increasing
MAXRES, MAXTAX see Fig. 3d				
.075 .04	1.80	05.3	35.3	Stable
.125 .06	2.82	01.8	37.2	Stable
MAXRES see Fig. 3e				
.08	2.10	03.1	38.2	Stable
.09	2.20	03.0	37.2	Stable
.10	2.31	03.0	36.2	Stable
.11	2.42	04.6	35.1	Stable
.12	2.54	04.6	34.4	Stable

firm would have a higher average balance under the tax schedule with the flatter slope.[1] Thus, for the type of schedule change shown in figure III-3a, flatter slopes are associated with a higher average fund balance for the total UI fund. The opposite is true for the type of schedule change shown in figure III-3b: steeper slopes are associated with higher average balances. The effect on the balance of a change in the slope does not depend on whether the slope is made steeper or flatter, but on whether the schedules move to the right or left, raising or lowering the reserve ratio associated with each tax rate.

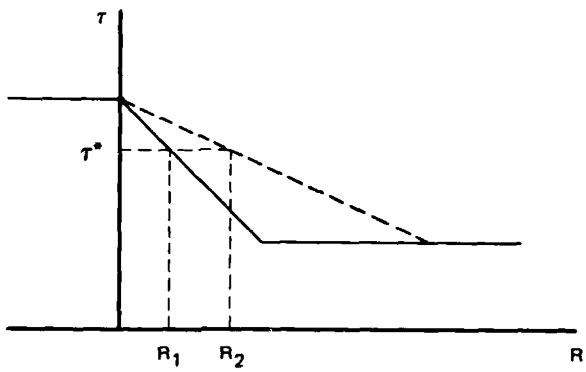

FIG. 3a: Δ SLOPE, Δ MAXRES

A change in the slope affects not only the average balance of the firms on the sloped section of the schedule but also the distribution of firms among the three regions of the tax schedule. Obviously, a shift like the one shown in figure III-3a will affect the percentage of firms that pay MINTAX (net subsidy firms), because the change affects the reserve-ratio range over which MINTAX is applicable, but this shift also affects the average percent of firms with negative reserve ratios. For the type of change shown in figure 3a, there are more firms with negative reserve ratios, the steeper the tax schedule. Since the average balance of firms is smaller with the steeper tax schedule, any given negative shock in employment is more likely to send the firm into the negative region. The opposite effect occurs for the type of change shown in figure III-3b: the steeper schedule raises average balances and increases the probability of a firm being pushed into the net surplus region of the tax schedule. The shift in firm distribution caused by a shift in tax schedules is most obvious in the case of the tax schedule change, shown in figure III-3d, where an increase

[1]The tax schedules may provide incentives for employers to adjust their employment patterns. For papers on this topic see: Frank Brechling (1977a), Martin Feldstein (1978), Robert Topel and Fines Welch (1979).

in MAXRES decreases the range over which MINTAX is applicable but increases the average percent of firms at MINTAX.

The distribution of firms is important in understanding the behavior of state fund balances over time for two reasons: First, the ratio of net-surplus to net-deficit firms affects the long-term trend in the balance. Net-surplus firms must offset net-deficit firms (including decreased firms) for the fund balance to be stable. Second, the distribution of firms affects the responsiveness of the system. If most firms are on the flat portions of the schedule (at MAXTAX or MINTAX), then there will be a sluggish reaction to generalized employment declines; tax rates will rise slowly to make up for benefit outflows, and the fund will decline more precipitously than if fewer firms had been in flat regions.[1]

The importance of keeping the firm distribution in mind is illustrated by the tax schedule change depicted in figure III-3a. When the slope is made flatter, more firms, on average, are on the sloped portion of the schedule. This has two offsetting effects. For the firms on the flatter slope, a general employment decline would mean a smaller immediate increase in taxes, but there would be fewer firms in the flat regions where there is no response of tax rates to changing reserve ratios. Thus, the two tax schedules in figure III-3c can not be ranked in terms of responsiveness using only the difference between slopes.

Simulating Alternate Economic Parameters

Table III-4 reports aggregrate statistics from simulations where the base-case tax parameters are simulated with alternate economic parameters. Changing the mean of the turnover rate has a significant impact on the number of firms at MINTAX. With no turnover, almost all firms have benefit charges equal to less than one percent of taxable payroll; thus, the fund increases steadily. When the mean turnover rate increases from .05 to .10, there are very few net subsidy firms; the fund decreases steadily.

Changing the standard deviation of the employment shock distribution affects the fund balance for two reasons. First, even with a mean change of zero across firms, an increase in the standard deviation of annual shocks decreases the fund balance because positive changes in employment do not balance negative changes in employment. Since the average tax rate is approximately 2 percent,

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[1]A quick response (increase in tax rates) may be good in terms of maintaining positive fund balances but bad in terms of countercylical power of the fund. This tradeoff is discussed in the subsequent section "Evaluation UI Tax Systems: Tradeoffs and Improvements."

a new employee in a growing firm generates about \$80 (.02 x \$4000) in taxes, but one employee less in a declining firm generates \$800 in benefits. Since positive shocks do not balance negative shocks, an increase in the standard deviation of employment shocks increases the imbalance. An increase in the standard deviation of employment shocks also increases the probability that firms go out of business and leave the system with a negative balance.

TABLE III-4

SIMULATION RESULTS - CHANGES IN ECONOMIC PARAMETERS (3)

(three year average used in reserve ratio)

Simulation type	Mean balance	Average % of firms R<0	Average % of firms at MINTAX	Trend in balance
Δq_i (turnover rate)				
μ σ				
0 0	6.66M	01.1	91.5	Increasing
.10 .05	1.29	04.4	07.7	Decreasing
$\Delta f(y)$ (salary distribution)				
σ=4K, μ= 8	2.30	03.1	36.1	Stable
9	2.31	03.0	36.1	Stable
11	2.32	03.0	36.2	Stable
12	2.32	03.0	36.2	Stable
ΔN (annual employment change)				
μ=0 σ = 0	4.90	00.0	51.3	Increasing
1	3.26	00.3	42.7	Increasing
10	1.45	07.9	20.3	Decreasing
15	.92	11.2	13.2	Decreasing

Simulating Employment Cycles

Another simulation exercise was to introduce shocks or cycles into the system by changing the mean of the annual employment shock distribution ($\mu(\Delta N)$). The mean was changed in two ways: a negative shock of 20 employees per firm (and 20 percent of current employment) was introduced in the 50th and 70th years; employment was increased in each of the two subsequent years by 10 employees (and by 10 percent). The second type of employment shock was to let

$$\mu(\Delta N) = \alpha \sin \frac{t2\pi}{c}$$

where

α = amplitude of the cycle

c = length of the cycle.

Each of these experiments supported the speculation made earlier that the distribution of firms among the three regions of the tax schedule is an important determinant of the sensitivity of the fund balance to employment shocks.

Figure III-4 compares the path of the balance for the base case with a 20 percent shock in the 50th year for two different wage bases ($\tilde{w}$ = \$6000 and \$3200). The simulation with the \$6000 wage base has a higher average balance than the simulation with the \$3200 wage base, and the \$6000 balance is growing while the \$3200 balance is declining. The \$6000 simulation is much more sensitive to the same shock; the initial decline in the balance is greater and the balance takes much longer to return to its pre-shock levels.

The system with the higher wage base is more sensitive to shocks, because it has more firms on the flat portion of the tax schedule. The average percent of firms on the flat regions can be obtained by adding the two columns (R<0, at MINTAX) in table III-3. The average is 57.3 for the \$6000 wage base and 31.4 for the \$3200 wage base. When the shock hits, most of the firms in the \$6000 simulation do not experience an immediate change in tax rates; benefits go up but tax rates do not. This kind of simulation exercise makes it clear that a high balance is not necessarily a protection against getting into trouble when a recession hits. Any evaluation of the adequacy of a fund should also take into account the distribution of firms along the schedule. The industrial distribution in a state is one determinant of the firm distribution; construction firms are frequently at MAXTAX, while those in the finance industries are frequently at MINTAX. Thus, if we compare two states, each with the same balance and each subject to the same economic shock, the state with a higher concentration of its industry in finance and construction would have a bigger drop in its fund balance when the employment shock hits.

The simulations where employment shocks follow a sine wave demonstrate the interaction between employment shocks and the distribution of firms by reserve ratio. Table III-5 lists the results from six of these simulations, two different cycles, three amplitudes each. These simulations illustrate two relationships that held for all the sine wave simulations:

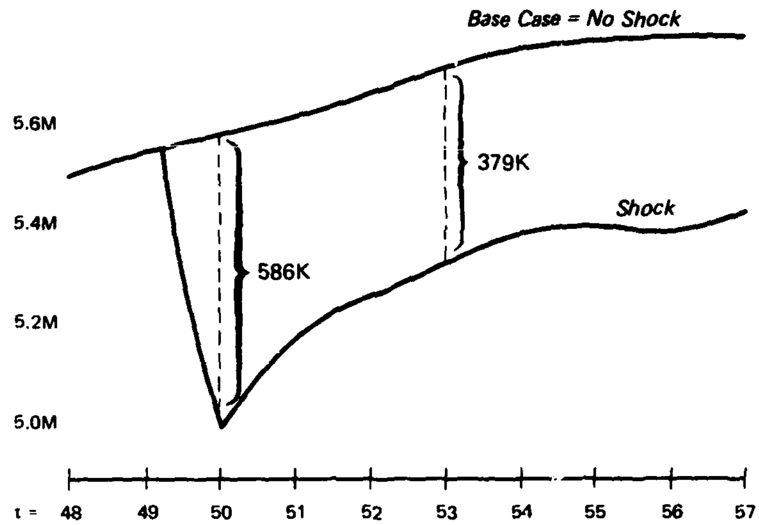

FIG. III-4a: $\widehat{W}$ = 6000

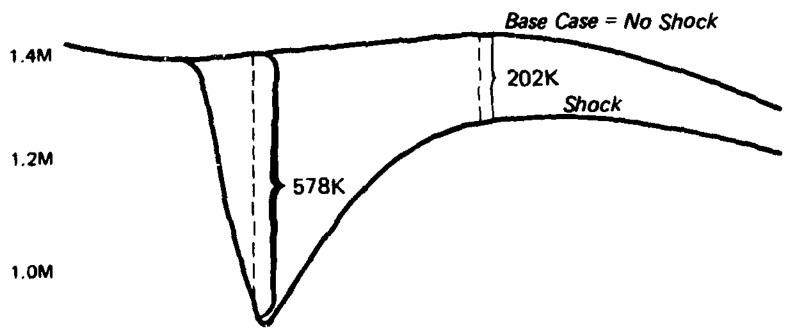

FIG. III-4b: $\widehat{W}$ = 3200

1. An increase in the amplitude of the cycle decreases the average fund balance.

2. An increase in the frequency (a decrease in the number of years between cycle peaks) decreases the average balance.

TABLE III-5

SIMULATION RESULTS

$$\mu(\Delta N) = \sin \frac{t2\pi}{c}$$

(all other parameters equal to base-case parameters)

Simulation type	Mean balance	Average % of firms with R < 0	Trend in balance
c = 6 yrs.			
α = 2	2.36 M	02.4	Stable
10	1.80	04.4	Declining
20	1.22	08.4	Declines rapidly, goes below zero at t = 96
c = 3 yrs.			
α = 2	2.30	02.9	Stable
10	1.52	05.4	Declining
20	.87	10.4	Declines rapidly, goes below zero at t = 84

Both an increase in amplitude and an increase in frequency increases the probability that a firm will have a negative balance and, hence, be at MAXTAX. An increase in α increases the probability that a firm will become a net deficit firm, and an increase in frequency increases the probability that it will stay a net deficit firm. The speed at which the fund balance declines is directly related to the number of firms with reserve ratios less than zero.

Table III-6 lists the fund balance and the percent of firms with negative balances in each year for the simulation where $\mu(\Delta N) = 10 \sin \frac{t2\pi}{6}$, the second simulation listed in table III-5. The balance recovers quite quickly from each shock, but the long-term trend in the balance declines as more firms enter and stay in the region of the tax schedule where balances are negative.

These simulations imply that the tax parameters that yield long-term stability of the fund balance are a function of the type of economic fluctuations that a state experiences. One way a state with frequent or strong economic fluctuations can compensate for the resulting disequilibrium balance in the firm distribution is to raise MAXTAX.

Regression Analysis of Aggregate Data

The macro model simulations are based on the following relationship:

$$TAX_t = \tau_t \cdot \tilde{W}_t$$

where the aggregate tax rate (τ_t) is predicted as a function of reserve ratios by either of two equations:

$$\tau_t = a_0 + a_1 R_{t-1} + a_2 R_{t-2} + a_3 \tau_{t-1} \qquad \text{(III-1)}$$

or the more restricted form

$$\Delta\tau_t = b_0 + b_1 \Delta R_{t-1} \qquad \text{(III-2)}$$

The coefficients are estimated from the state data provided in the Handbook of Unemployment Insurance Financial Data 1938-1976.

The results from the stylized-state simulation model were aggregated to conform to the data in the Handbook and the macro model equations were re-estimated with the data from the stylized-state simulation.

These regressions were run for two purposes. First, they provide a link between the two simulation models. If we know how changes in the tax parameters affect the coefficients of the reserve ratio in the τ equations, then we can resimulate balances for actual states

TABLE III-6

RESERVE-RATIO SIMULATION WITH SINE WAVE EMPLOYMENT SHOCK

$$\mu(\Delta N) = 10 \sin \frac{t2\pi}{6}$$

(all other parameters equal to base-case parameters)

t	Fraction of firms with R<0	Balance
1	0.0000	619046.10
2	0.0000	1607014.85
3	0.0000	2645316.33
4	0.0000	2538266.40
5	0.0000	2223369.34
6	0.0000	2004321.59
7	0.0000	2031331.65
8	0.0000	2151193.17
9	0.0000	2246417.19
10	0.0000	2243331.87
11	0.0000	2014877.36
12	0.0000	1341234.39
13	0.0000	1955355.64
14	0.0000	2103632.63
15	0.0000	2220106.44
16	0.0000	2266559.99
17	0.0000	1990759.58
18	0.0000	1770733.25
19	0.0000	1923654.49
20	0.0000	2086911.45
21	0.0000	2193676.32
22	0.0000	2237462.40
23	0.0000	1998348.91
24	0.0000	1832229.98
25	0.0000	1951783.96
26	0.0000	2106409.97
27	0.0000	2227834.00
28	0.0000	2287113.33
29	0.0000	1991342.50
30	0.0000	1317335.20
31	0.0000	1932631.45
32	0.0000	2088509.89
33	0.0000	2208506.75
34	0.0000	2261423.85
35	0.0000	1998980.62
36	0.0000	1793492.27
37	0.0000	1339102.46
38	0.0000	2046354.12
39	0.0000	2163670.58
40	0.0000	2182224.80
41	0.0000	1933461.17
42	0.0000	1724857.99
43	0.0400	1795854.56
44	0.0600	1962015.05
45	0.0000	2035872.79
46	0.0000	2098422.90
47	0.0000	1379177.82
48	0.0400	1592691.25
49	0.1000	1788542.65
50	0.0800	1745228.86
51	0.0000	2070426.43
52	0.0000	2103603.00
53	0.0200	1906033.12
54	0.0500	1577177.12
55	0.1500	1755151.15
56	0.0300	1382950.32
57	0.0500	1990988.62
58	0.0400	2031601.51
59	0.0400	1777032.38
60	0.0400	1604393.26
61	0.0900	1712139.16
62	0.1000	1834579.83
63	0.0600	1948989.53
64	0.0200	1952954.50
65	0.0200	1564432.60
66	0.1400	1467015.54
67	0.1500	1532299.07
68	0.1200	1570160.64
69	0.0800	1786197.35
70	0.0600	1784889.60
71	0.0400	1578912.19
72	0.1000	1376417.00
73	0.1500	1493983.49
74	0.1400	1530423.19
75	0.0800	1742104.67
76	0.0600	1733524.78
77	0.0600	1470136.27
78	0.1200	1306630.97
79	0.1200	1389525.47
80	0.0600	1531269.92
81	0.0400	1649031.03
82	0.0400	1691608.43
83	0.0400	1427651.62
84	0.1600	1194223.96
85	0.1400	1285004.22
86	0.1000	1435920.93
87	0.0800	1553418.99
88	0.0800	1593403.93
89	0.0200	1364344.31
90	0.1800	1148354.17
91	0.1200	1243247.91
92	0.1400	1379040.26
93	0.1400	1483762.79
94	0.1000	1505515.13
95	0.0600	1233703.32
96	0.1600	1030704.12
97	0.1200	1099754.24
98	0.0800	1234211.23
99	0.0400	1337376.34
100	0.0400	1339869.69

for different tax schedules. It is difficult to determine exactly what the tax schedules are for all periods in a state history, and tax schedules may not change enough to allow estimation of the separate effects of each tax parameter change. The stylized-state simulation provides a way to link actual state simulations to hypothetical tax schedules.

The coefficients of the reserve ratio in the tax rate equations also indicate how responsive a system is, how fast the tax rate reacts to a change in the reserve ratio. The higher (in absolute value) is the coefficient of the reserve ratio, the more quickly the system reacts.

When equation (III-1) was estimated, a_1 was always equal in absolute value to a_2 and opposite in sign. Since a_3 was not far below 1 in most instances, equation (III-2) seems to be the appropriate functional form. A more responsive tax system is associated with a bigger (in absolute value) b_1.

The regression results show that the responsiveness of the tax system is a function of the slope of the tax schedule and the distribution of firms along the schedule. The system is more responsive if it has a steeper slope and if more firms are on the sloped portion of the schedule. Table III-7 lists the b_1 coefficient from nine different equations, estimated from nine different simulations--five for different slopes, four for different wages bases. The other parameters in the simulation are equal to the base-case parameters.

TABLE III-7

REGRESSIONS FROM SIMULATIONS

b_1 = response coefficient, where b_1 is the coefficient in the regression equation

$$\Delta\tau_t = b_0 + b_1 \Delta R_{t-1}$$

Slope (with ΔMAXRES)	$-b_1$	$\tilde{W}$	$-b_1$
-.2	.09	3200	.21
-.3	.14	4000	.19
-.4	.21	5000	.10
-.5	.29	6000	.06
-.6	.35		

The response coefficient is a positive function of the slope. We noted earlier that an increase in the slope has two potentially offsetting effects: the firms on the sloped portion are made more responsive, but a higher fraction of firms move to the flat regions of the schedule where the tax rate does not change at all. The regressions results show that, at least for the tax schedule changes shown here, the first effect dominates; average tax rates go up more quickly when balances decline in a tax system with a steeply sloped tax schedule.

The regression results confirm the observation made earlier that a system with a high wage base is less responsive than a system with a low wage base, because a higher wage base means that more firms are on the flat portions of the tax schedule.

Single-Year Taxable Payroll Simulations

Table III-8 reports aggregate statistics from some of the simulations where the reserve ratio is calculated using a single, lagged year of taxable payroll or:

$$R(1) = BAL_{t-1,i} \Big/ \tilde{W}_{t-1,i}$$

The effects of tax parameter changes were the same for the two methods of calculating the reserve ratio; the average balance, the distribution of firms, and the trend in the balance changed in the same direction for each change in the tax parameters.

The single-year tax systems are more countercyclical than the systems that use mean taxable payroll. In single-year states, the denominator of the reserve-ratio fraction goes down faster than in states that use mean taxable payroll. Since tax rates respond more slowly in single-year states, balances decline more quickly in a recession in single-year states and rebound faster in a boom.

Table III-9 compares the response to a shock for R(1) and R(3) tax systems. The mean of employment shocks was changed from zero to [-20%, +10%, +10%] in years [50, 51, 52], respectively. Columns [illegible] and 6 in table III-8 compare the base-case and shock simulations for both types of reserve-ratio systems. The R(1) system shows a larger decline in the balance than R(3) system.

Note, however, that the mean balance for all the parameters listed in table III-8 is the same for the R(1) and R(3) systems (see table III-3). The R(1) system may show more pronounced reactions to shocks, but when the mean employment shock is zero, the pronounced positive and negative deviations offset each other so that the mean stays the same.

TABLE III-8

SIMULATION RESULTS
R(1)
(single year used in reserve ratio)

Simulation type		Mean balance	Average % of firms R<0	Average % of firms at MINTAX	Trend in balance
Base case		2.31M	02.0	35.5	Stable
$\tilde{W}$	3200	1.34	05.2	25.1	Declining
	5000	3.78	01.4	45.2	Increasing
	6000	5.47	00.7	55.3	Increasing
Slope, MAXTAX see Fig. III-3b					
.3	.04	2.00	04.4	31.9	Stable
.5	.06	2.62	02.1	39.2	Stable
MAXRES, MINTAX see Fig. III-3c					
.1250	.000	1.41	03.1	00.7	Declining
.1130	.0050	1.45	03.1	10.6	Declining
.0880	.0150	4.16	02.8	51.8	Increasing
MAXRES, MAXTAX see Fig. III-3d					
.075	.04	1.80	05.0	34.6	Stable
.125	.06	2.82	01.6	36.5	Stable

TABLE III-9

COMPARISON OF R(1) AND R(3)
RESPONSE TO A SHOCK

		Balance ($M)					
		Single year R(1)			Three year R(3)		
Year	Shock $\mu(\Delta N)$ (%)	(1) Base case	(2) Shock	(3) Diff. (1)-(2)	(4) Base case	(5) Shock	(6) Diff. (4)-(5)
1949	0	2.411	2.411	0	2.406	2.406	0
1950	-20	2.418	1.830	.578	2.413	1.834	.579
1951	+10	2.436	1.992	.444	2.433	2.034	.399
1952	+10	2.446	2.113	.334	2.445	2.172	.272
1953	0	2.473	2.188	.286	2.471	2.199	.272
1954	0	2.458	2.200	.258	2.453	2.199	.253
1955	0	2.445	2.203	.242	2.438	2.197	.241
1956	0	2.415	2.181	.234	2.410	2.181	.229
1957	0	2.421	2.192	.228	2.420	2.194	.227

SIMULATING OTHER TAX SYSTEMS

One of the few requirements that the federal government imposes on the states is that the tax system be experience rated, meaning that the tax on each employer be related to the benefits that former or laid-off employees collect. Employers who are responsible for many benefit charges should pay a higher tax rate than employers who rarely send employees into a UI office.

The simulation results presented thus far have been based on the reserve-ratio (RR) measure of experience rating, by far the most common type. We have also simulated the two other major types of tax systems--benefit ratio (BR) and benefit-wage ratio (BWR).[1]

The Benefit-Ratio System

As of January 7, 1980, nine states used the benefit ratio formula to determine tax rates for covered employers. The tax rate is a function of the ratio of benefits charged in the most recent three years to taxable payroll in the most recent three years.

The benefit-ratio simulation uses all the equations from the reserve-ratio simulation except for two substitutions.[2] The reserve-ratio equation is replaced by the benefit-ratio equation,

$$BR_{ti} = \sum_{j=t-3}^{t-1} BEN_{ji} \Big/ \sum_{j=t-3}^{t-1} \tilde{W}_{ji}$$

and the tax rate equations are changed to

$$\begin{aligned} \tau_{ti} &= BR_{ti} \text{ if } MINTAX \le BR_{ti} \le MAXTAX \\ &= MAXTAX \text{ if } BR_{ti} > MAXTAX \\ &= MINTAX \text{ if } BR_{ti} < MINTAX \end{aligned}$$

[1]There is a fourth system, payroll decline, where an employer's experience is measured by the year-to-year or quarter-to-quarter proportional decline in payroll. Currently, only three states make some use of this formula, and they all combine payroll decline with some variant of the other three systems.

[2]The equations for all three simulations are reproduced in the appendix to this section along with the base-case yearly balance for all four types of experience rating.

This system has a shorter memory than the reserve-ratio system. The reserve-ratio system keeps track of the benefits charged and taxes paid over the firm's entire history. If a firm has a large decline in employment, the benefits will eventually either be paid back, or the firm will remain at the highest tax rate (MAXTAX). Similarly, taxes in excess of benefits will send the firms to MINTAX until the firm's balance is lowered. Only the last three years count in the benefit-ratio system; firms can be at MINTAX even if their balance is negative or at MAXTAX even if they have paid more benefits than taxes.

<u>The Benefit-Wage-Ratio System</u>

Currently, five states use the benefit-wage-ratio system. In these states, each firm is assigned an experience factor which is the ratio of wages of employees who collect benefits (benefit wages) to wages of all employees, both over the last three years. This firm experience factor is multiplied by a state factor to determine the benefit wage ratio. The state factor is the ratio of total benefit payments to total benefit wages in the state in the last three years. Basically, if a firm was responsible for X percent of benefit wages over the last three years, its taxes will equal X percent of the total benefits paid in the state. The replacement equations in the benefit-wage-ratio simulation are:

$$BENW_{ti} = \sum_{j=t-3}^{t-1} [q_i \cdot N_{ji} + (\Delta N^-)_{ji}] \cdot \frac{\tilde{W}_{ji}}{N_{ji}}$$

$$EXPF_{ti} = BENW_{ti} \sum_{j=t-3}^{t-1} \tilde{W}_{ji}$$

$$BENWST_t = \sum_{i=0}^{50} BENW_{ti}$$

$$TBEN_t = \sum_{i=0}^{50} BEN_{ti}$$

$$SF_t = \left(\sum_{j=t-3}^{t-1} TBEN_j \right) \Bigg/ BENWST_t$$

$$BWR_{ti} = (EXPF_{ti}) \cdot SF_t$$

$$\begin{aligned} \tau_{ti} &= BWR_{ti} \text{ if } MINTAX \leq BR_{ti} \leq MAXTAX \\ &= MAXTAX \text{ if } BWR_{ti} > MAXTAX \\ &= MINTAX \text{ if } BWR_{ti} < MINTAX \end{aligned}$$

where

$BENW_{ti}$ = wages paid to employees of firm i who collect benefits in period t

$EXPF_{ti}$ = experience factor of firm i in period t

$BENWST_t$ = total benefit wages for state during period t

$TBEN_t$ = total benefits paid in state during period t

SF_t = state factor during period t

BWR_{ti} = benefit wage ratio for firm i during period t

Like the benefit-ratio system, the benefit-wage-ratio system has a relatively short-term memory; only the last three years experience are used to calculate tax rates. This weakens the link between a firm's benefit charges and its tax payments, since a large change in the firm's employment pattern appears for only three years in the tax calculation.

The big difference between the benefit-wage-ratio system and the other two systems is that benefits do not appear at all in the calculation of the tax rate. If some firms rehire their laid-off workers quickly, they will not reduce their tax liability, because the tax rate in the BWR system depends on only the incidence of unemployment, not the duration. In all three simulations, we have assumed that the average dollar amount of benefits collected by unemployed workers ($\bar{B}$) is the same for each firm. In the RR system and the BR system, this assumption does not have a large impact on the fund balance or the distribution of firms among the net-deficit, breakeven, and net-subsidy firms. In these two systems, if a firm has a higher average benefit per claimant, its tax rate will be higher than the rate for a firm with a low average benefit per person. In the RR and BR simulations, the inclusion of firm-specific $\bar{B}$ would have much the same effect as the already-included, firm-specific turnover rate (q_i). In the benefit-wage-ratio system, however, the inclusion of a firm-specific $\bar{B}$ would significantly alter the distribution of net-deficit and net-subsidy firms and, hence, the fund balance. Firms with a long layoff period, other things constant, would be more likely to be net-deficit firms than firms with a short layoff period. The fact that the BWR simulation does not include a firm-specific $\bar{B}$ should be kept in mind when the three simulation results are compared.

Simulation Results

Table III-10 reports aggregate statistics from the benefit-ratio and benefit-wage-ratio simulations. In order to compare the three types of systems, these simulations have as many parameters as possible in common with the base case for the reserve-ratio simulation. Each firm in each simulation has the same employment pattern. All the other economic parameters are the same. The average benefit is the same. Each base-case simulation has the same minimum and maximum tax rate. The simulations for the four wage bases given in table III-10 should be compared to the base-case, Δw simulation results reported in table III-3.

As noted before, there is no correspondence in these two systems between the balance (cumulative taxes minus benefits) and the current tax rate of the firm. In table III-3, every firm at MAXTAX had a negative reserve ratio (RR<0) and every firm at MINTAX had a reserve ratio greater than MAXRES (RR>.1 in the base case). Although the reserve ratio (balance) is not used in BR and BWR states, we can still calculate it for any firm:

$$R(3)_{ti} = BAL_{t-1,\ i} \Bigg/ \frac{1}{3} \sum_{j=t-3}^{t-1} \tilde{W}_{ji} .$$

Table III-10 reports both the average percent of firms at MAXTAX and MINTAX and the percent of firms that would be at MAXTAX (R(3)<0) and MINTAX (R(3)>.1) under the reserve ratio system.

Holding the wage base constant, the aggregate statistics for the benefit-ratio system and the benefit-wage-ratio system are very similar. We note again, however, that the major difference between the systems has been assumed away in these simulations. Benefit wages are proportional to benefits, so it is not surprising that the two simulations look alike. We will show later that individual firms with identical employment paths have different balances (different tax payments) under the two systems, but the aggregation of the firms makes the two systems look quite similar.

TABLE III-10

BENEFIT-RATIO AND BENEFIT WAGE RATIO SIMULATIONS

BENEFIT RATIO

Simulation type	Mean balance	Average % of firms: At MAXTAX (0.5)	At MINTAX (.01)	R<0	R>.1	Trend in balance
Wage Base						
3200	1.88M	10.6	17.4	04.0	51.7	Stable
4000	2.96	08.6	24.8	02.3	65.9	Increasing
5000	4.50	07.5	34.1	01.6	80.3	Increasing
6000	6.26	06.8	44.0	01.1	86.6	Increasing

BENEFIT-WAGE-RATIO

Simulation type	Mean balance	Average % of firms: At MAXTAX (0.5)	At MINTAX (.01)	R<0	R>.1	Trend in balance
Wage Base						
3200	1.97M	10.7	18.7	03.8	57.9	Stable
4000	3.08	08.6	26.3	02.3	73.4	Increasing
5000	4.66	07.5	35.6	01.7	85.8	Increasing
6000	6.45	06.8	44.8	01.0	91.3	Increasing

Both the BR and BWR systems have higher average balances than the RR system. Since the benefit outflows are exactly the same for each simulation, the average tax rate must be higher for the BR and BWR systems. Thus, a lower wage base supports the benefit outflows; the RR system was stable with a $4000 wage base, the BR and BWR stabilize at a $3200 wage base.

The higher average tax rate for the BR and BWR systems is reflected in the distributions of firms along the tax schedule under each system. Both systems have more firms at MAXTAX and fewer firms at MINTAX than the RR system. As a result, fewer firms have a cumulative negative balance (R(3)<0) and more firms have a balance that would have qualified them for MINTAX under the reserve-ratio system.

The relationship between the average balance for the three systems, holding as many parameters as possible constant, is a function of the economic parameters.

Although the BWR and BR systems had a higher average balance than the R(3) system for most of the economic parameters that we investigated, this relationship need not always hold. Figures III-5 through III-9 show how five different firms would be taxes under the three systems. These firms have different employment patterns and different turnover rates (q_i's). The balance for each of the five firms is shown under the three types of tax systems. The firm would frequently have the highest average balance under the BWR system (figures III-5, III-6, and III-7), but not always (figures III-8 and III-9). Similarly, the firm would frequently have the lowest average balance under the reserve-ratio system (see figures III-6 and III-8), but again, this is not a general result. The behavior of the fund balance will depend on the distribution of employment patterns and turnover rates.[1] More work needs to be done to clarify the relationship between the three systems.

CONCLUSIONS

This paper describes a simulation model of UI fund balances. The model was developed to show how balances would differ under different tax parameters so that we could rank tax systems using

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[1]Strictly speaking, we can not say that if all firms looked like those in figures III-5, III-6, and III-7 that the BRW would have a higher average balance, because the tax rate in the BWR system depends on the firm's employment pattern relative to other firms (there is a state factor in the formula). The tax payments of a firm under the BWR system can only be defined if other firm's behavior is known. The firms depicted in figures III-5 through III-9 are from the base-case simulations.

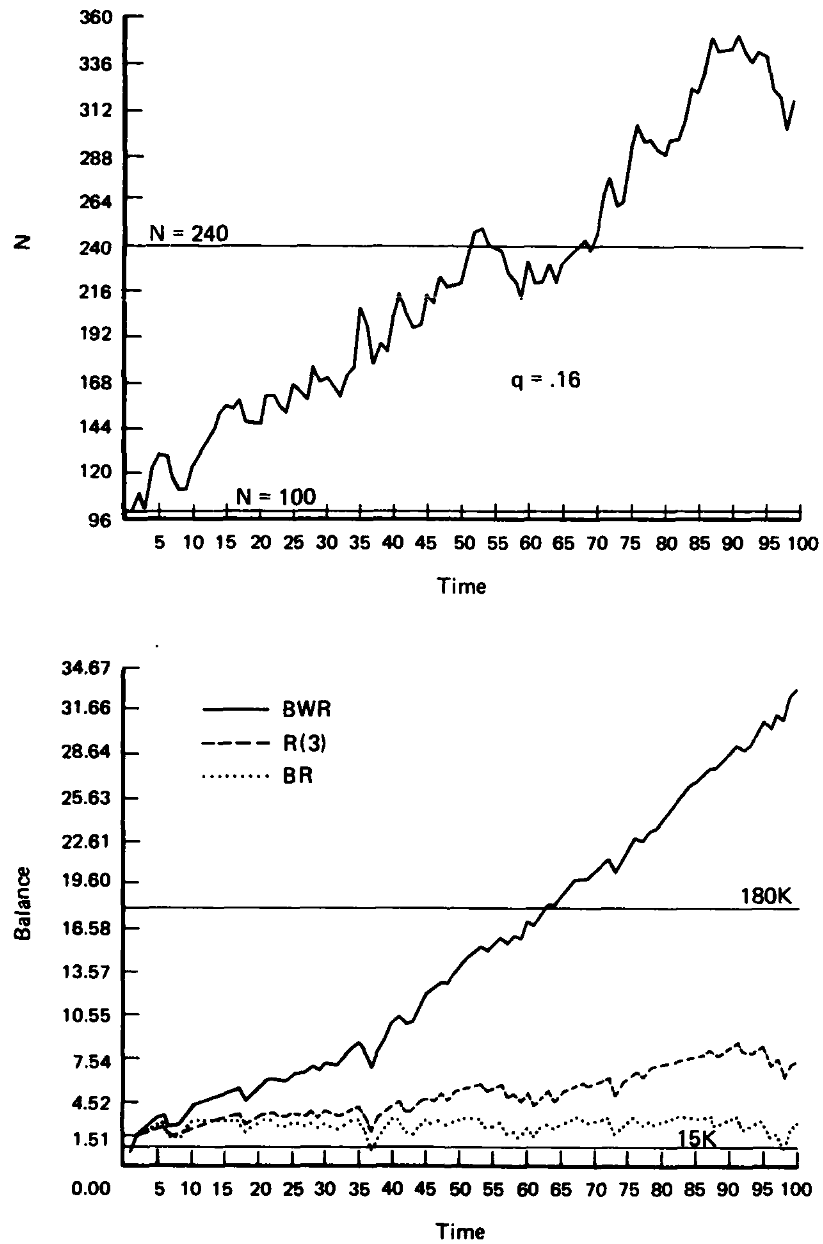

FIG. III-5: GROWING FIRM WITH HIGH TURNOVER

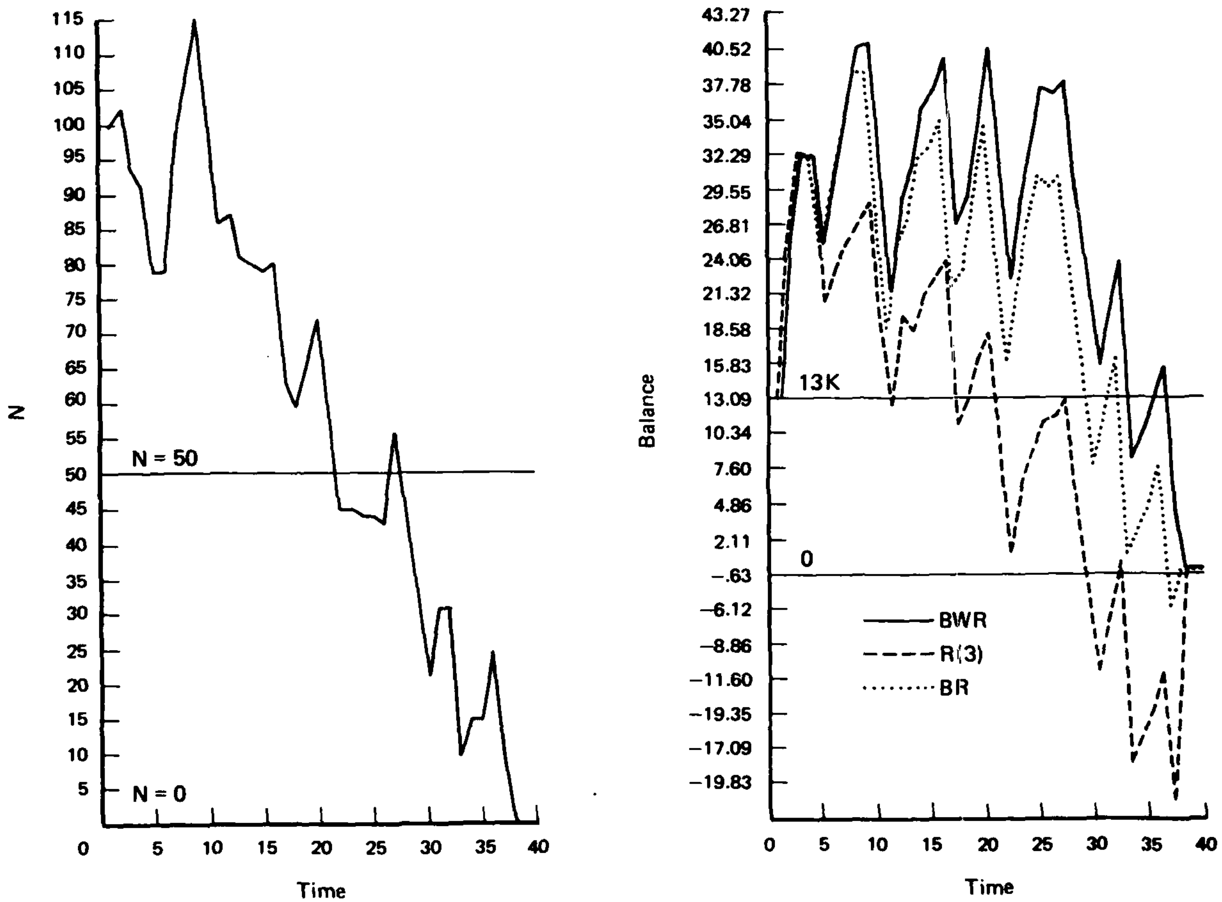

FIG. III-6: CONTRACTING FIRM WITH HIGH TURNOVER

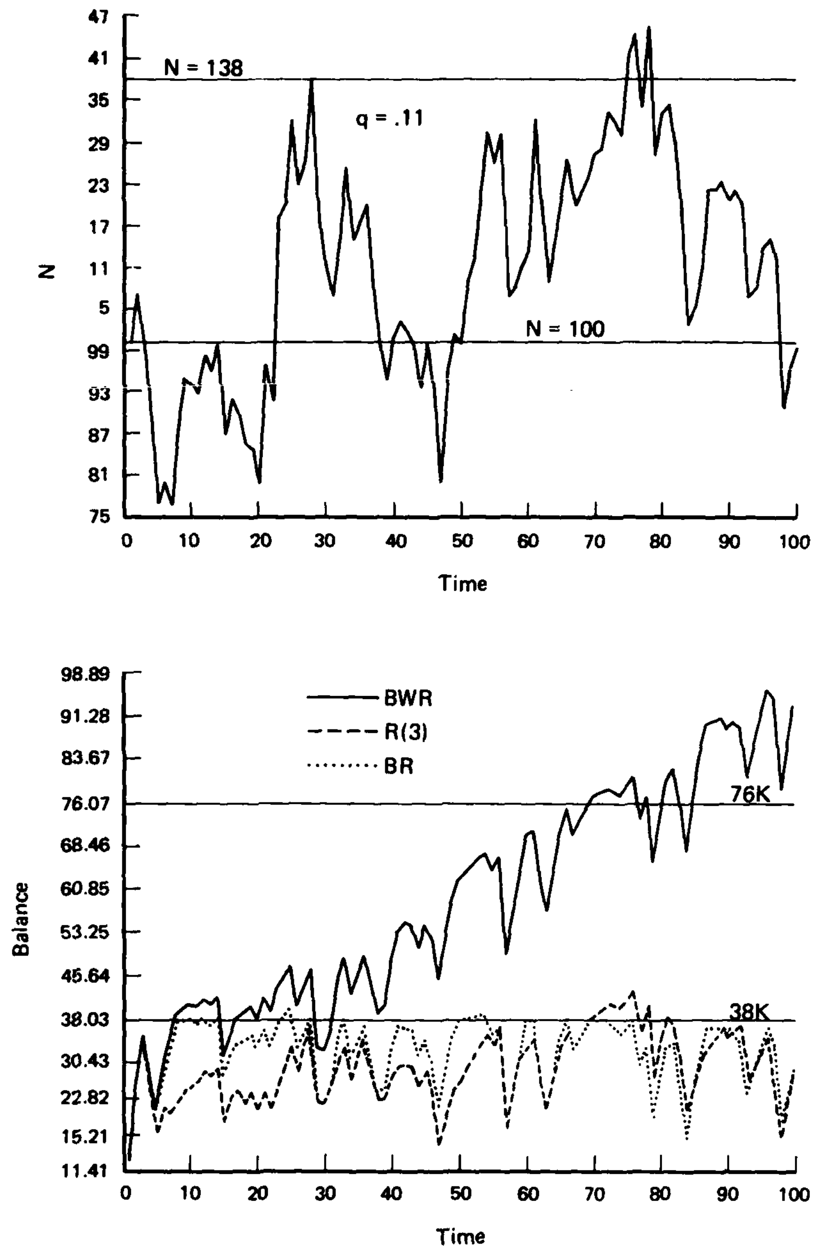

FIG. III-7: FIRM WITH TEMPORARY SPURTS IN EMPLOYMENT AND HIGH TURNOVER

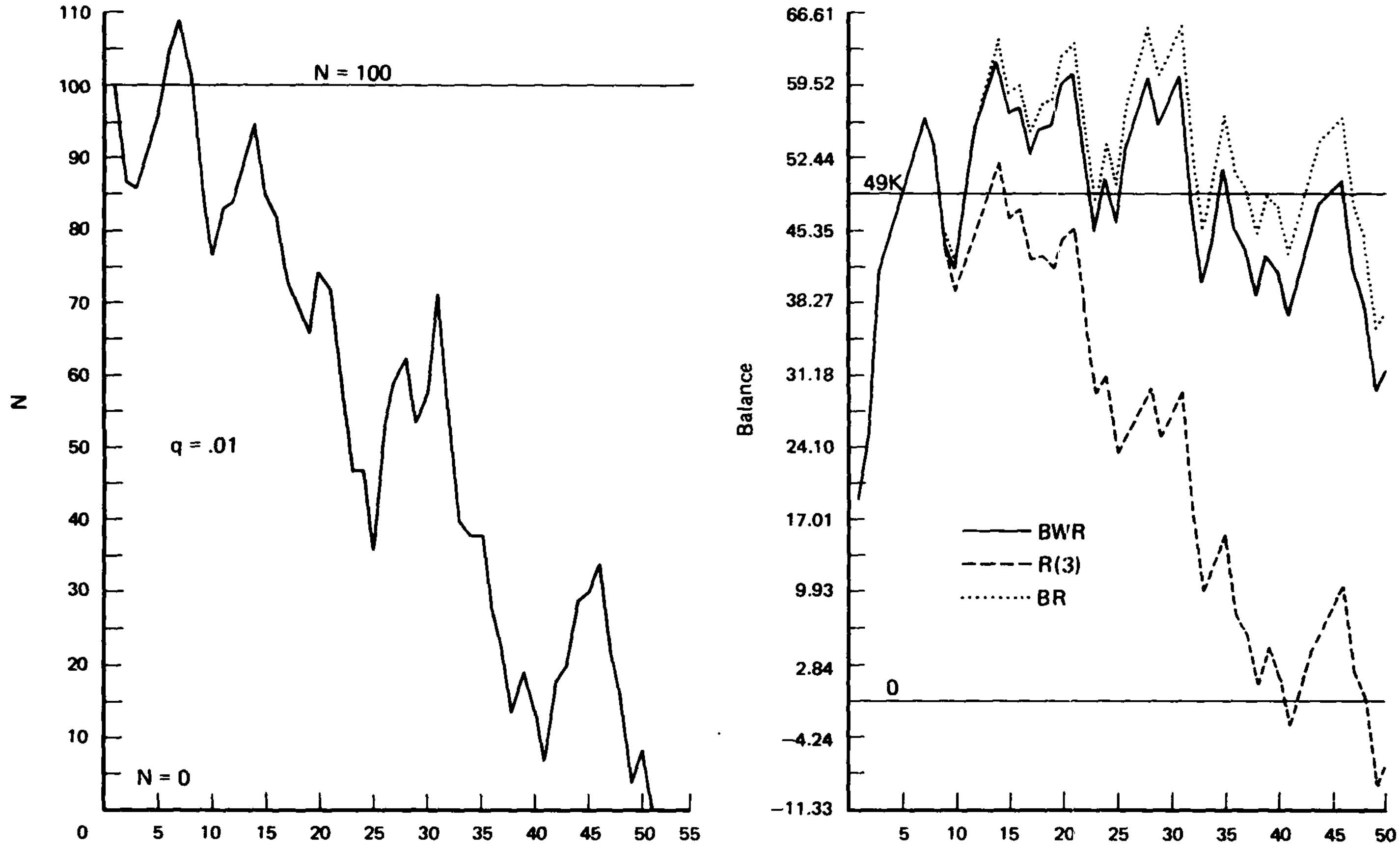

FIG. II-8: CONTRACTING FIRM WITH LOW TURNOVER

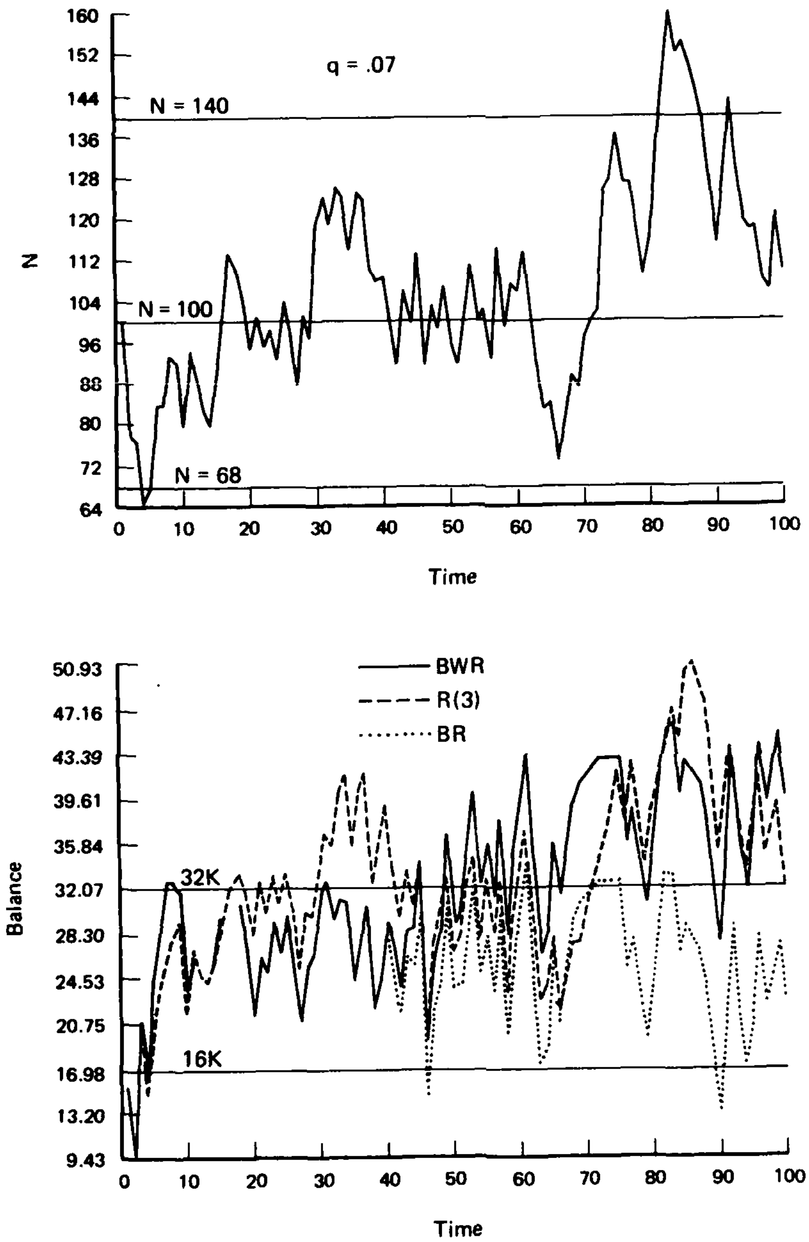

FIG. III-9: STABLE FIRM WITH AVERAGE TURNOVER

our three evaluation criteria: mean, variance, and countercyclical power. Apart from this evaluation, which is described in the next section, the simulation model provides several insights into the dynamics of the UI system that are summarized below.

Firm Distribution

Every state has a minimum and maximum tax rate. In reserve-ratio states, firms that are constrained by the maximum tax rate are responsible for more benefit charges than they pay in taxes; they are net-deficit firms. Firms at the minimum tax pay more than their share of taxes; they are net-surplus firms. The percent of firms that pay the maximum tax (deficit firms) and the percent of firms that pay the minimum tax (net-subsidy firms) are the most important determinants of the long-term trend in the fund balance and key determinants of the short-term response of the fund balance to shocks.

If a UI fund is to be in balance, deficit firms must be balanced by subsidy firms. Since firms will go out of business, generally with a debt to the UI fund, there must be many more existing net-subsidy than existing net-deficit firms. In reserve-ratio states, this means that there must be many more firms at the minimum tax rate than at the maximum tax rate. In states with other types of experience-rating, the relationship between the fund balance and the distribution of firms over the tax schedule is more complex, because the fund balance incorporates all past history of firms, while tax rates depend only on recent firm behavior. Net-surplus firms must balance net-deficit firms for the fund to be in balance, but the identification of net-deficit and net-surplus firms can not be made on the basis of current tax rates.

In all systems of experience rating, the distribution of firms that results in a fund that is in long-term equilibrium is a function of economic conditions. A state that has more frequent and deeper economic fluctuations needs more net-subsidy firms, primarily because more firms will go out of business in an economy with a high variance in employment.

The distribution of firms is also important in determining how the fund balance will react to shocks. The firms at the minimum and maximum tax rates are on the flat portions of the tax schedule; tax rates do not change when benefit charges go up or down. Thus, the more firms there are in the flat portions, the less responsive is the fund balance to employment shocks. This means that a state that has a high fraction of firms on the flat portions of the schedule, other things equal, will have a fund balance that has a higher variance and is more countercylcical than a state with more firms on the sloped portion of the tax schedule.

Determinants of the Firm Distribution

The stylized-state simulation model points out the factors that influence the distribution of firms along the tax schedule and, hence, the factors that determine the long-term trend in the fund balance and the variance in the fund balance:

1. The parameters of the tax schedule: the minimum and maximum tax rate, the slope of the schedule, the wage base, and benefit levels. The fraction of firms on the flat portions of the schedule can be reduced by increasing the maximum tax rate and decreasing the minimum tax rate. Changing the slope affects the distribution of firms by changing the average balance of firms on the sloped section. When average balances are decreased, for example, firms are more likely to end up on the flat portion (at the maximum tax rate) for any decline in employment. Increasing the wage base or decreasing benefits means that more firms will be net-subsidy firms; decreasing the wage base or increasing benefits increases the percent of net-deficit firms.

2. For any given set of tax parameters, the number of firms on the flat portion of the schedule depend on the frequency and amplitude of cycles. The percent of firms on the flat portions is a positive function of the frequency and amplitude of the cycle.

3. The distribution of firms will also depend on the industrial distribution in the state. Some industries have intrinsically high turnover and layoff rates, while others are characteristically very stable. A state with many firms on either end of the spectrum will have more firms on the flat portions of the schedule, and other things equal, the state fund balance will fluctuate more with changes in employment.

Causes of Declines in Fund Balances

Even with very large employment shocks, fund balances in our simulated model stayed positive and recovered quite quickly. Fund balances became negative only because of long-term trends due to an imbalance of taxes and benefits. This imbalance is reflected in the high proportion of deficit firms relative to surplus firms. Large and frequent shocks do eventually send the fund balance into the red, because more firms bump up against the maximum tax rate. The relatively small decline of the balances and the rapid recovery seems to point to tax parameters, rather than employment cycles as the proximate cause of negative balances. Although only a very tentative conclusion, the results of this simulation would indicate that states get into trouble not because of cycles, but because their tax inflows do not match their benefit schedules. Recessions may precipitate crises, but crises would occur eventually, even with modest employment changes.

The stylized-state simulations also point out that there are some changes in tax parameters that affect the trend in the balance, while others result in a once-and-for-all change in the level of the balance. When compared to a set of tax parameters that leads to a stable balance, an increase in the wage base, for instance, leads to a steadily increasing balance. Changing the slope of the tax schedule, on the other hand, alters the average balance, but the fund stabilizes at a new level. This means that care must be taken in choosing offsetting changes in the tax schedule if the UI fund is to be in long-term balance. An increase in benefits, for instance, can not be supported in the long run by raising tax rates for only firms on the sloped portion of the tax schedule.

Responsiveness of Fund Balances

We have called a system that quickly generates increased taxes following a large benefit outflow a responsive system. A responsive system is one with a low variance in the balance and, consequently, little countercyclical power. In general, a responsive system is one with few firms on the flat portions of the schedule and with a steep slope. The three-year average, taxable payroll, reserve-ratio system is more responsive (less countercyclical) than the single-year system and, hence, less likely to get into trouble.

APPENDIX TO PART III, SECTION 1

SIMULATION EQUATIONS
(Equations Used in All Simulations)

$$BAL_{ti} = \sum_{j=0}^{t} (TAX_{ji} - BEN_{ji}) \tag{A-1}$$

$$TAX_{ti} = \tau_{ti} \cdot \tilde{W}_{ti} \tag{A-2}$$

$$\tilde{W}_{oi} = \int_{o}^{\tilde{w}} y\ f_i(y) \cdot (1+q_i)dy \tag{A-3}$$

$$+ \int_{\tilde{w}}^{\infty} \tilde{w} \cdot f_i(y) \cdot (1+q_i)dy$$

$$\tilde{W}_{ti} = \frac{\tilde{W}_{oi}}{N_{oi}} \cdot N_{ti} \tag{A-4}$$

$$BEN_{ti} = \overline{B}((\Delta N^{-})_{ti} + q_i \cdot N_{ti}) \tag{A-5}$$

$$(\Delta N^{-})_{ti} = 0 \text{ if } N_t - N_{t-1} \geq 0$$

$$= N_{t-1} - N_t \text{ if } N_t - N_{t-1} < 0$$

$$BAL_t = BAL_{t-1} + \sum_{i=1}^{50} TAX_{ti} - \sum_{i=1}^{50} BEN_{ti} \tag{A-6}$$

$$q_i \sim N(\mu_q, \sigma_q)$$

$$N_{(t=0),i} = | N^* |$$

$$N^*_{(t=0),i} \sim N(\mu_N, \sigma_N)$$

$$y = | Y^* |$$

$$y^* \sim N(\mu_y, \sigma_y)$$

TAX RATE EQUATIONS

Reserve Ratio

$$R(3)_{ti} = BAL_{t-1,i} \Big/ \frac{1}{3} \sum_{j=t-3}^{t-1} \tilde{W}_{ji} \tag{7-RR(3)}$$

$$R(1)_{ti} = BAL_{(t-1)} \Big/ \tilde{W}_{t-1,i} \tag{7-RR(1)}$$

$$\begin{aligned} \tau_{ti} &= MAXTAX \text{ if } R < 0, \text{ or } t \leq 3 \\ &= MAXTAX - s \cdot R \text{ if } 0 \leq R \leq MAXRES \\ &= MINTAX \text{ if } R > MAXRES \end{aligned} \tag{13-RR}$$

Benefit Ratio

$$BR_{ti} = \sum_{j=t-3}^{t-1} BEN_{ji} \Big/ \sum_{j=t-3}^{t-1} \tilde{W}_{ji} \tag{7-BR}$$

$$\tau_{ti} = BR \text{ if } MINTAX \le BR \le MAXTAX \tag{13-RR}$$

$$= MAXTAX \text{ if } BR > MAXTAX \text{ or } t \le 3$$

$$= MINTAX \text{ if } BR_{ti} < MINTAX$$

<u>Benefit Wage Ratio</u>

$$BWR_{ti} = (EXPF_{ti}) \cdot SF_t \tag{7-BWR}$$

$$EXPF_{ti} = BENW_{ti} \Big/ \sum_{j=t-3}^{t-1} \tilde{\tilde{W}}_{ji} \tag{8-BWR}$$

$$BENW_{ti} = \sum_{j=t-3}^{t-1} [q_i \cdot N_{ji} + (\Delta N^-)_{ji}] \cdot \frac{\tilde{\tilde{W}}_{ji}}{N_{ji}} \tag{8-BWR}$$

$$SF_t = \left(\sum_{j=t-3}^{t-1} TBEN_j \right) \Big/ BENWST_t \tag{10-BWR}$$

$$BENWST_t = \sum_{i=0}^{50} BENW_{ti} \tag{11-BWR}$$

$$TBEN_t = \sum_{i=0}^{50} BEN_{ti} \tag{12-BWR}$$

$$\tau_{ti} = BWR_{ti} \text{ if } MINTAX \le BR_{ti} \le MAXTAX \tag{13-BWR}$$

$$= MAXTAX \text{ if } BWR_{ti} > MAXTAX \text{ or } t \le 3$$

$$= MINTAX \text{ if } BWR_{ti} < MINTAX$$

DEFINITION OF SYMBOLS

$\overline{B}$ = average dollar amount of benefits drawn per claimant per year

BAL_t = total balance in the UI fund at end of period t

BAL_{ti} = the balance of firm i at the end of period t, the sum of all past taxes minus benefit payments

BEN_{ti} = benefits charged to firm i in period t

$BENW_{ti}$ = wages paid to employees of firm i who collect benefits in period t

$BENWST_t$ = total benefit wages for state during period t

BR_{ti} = benefit ratio of firm i during period t

BWR_{ti} = benefit wage ratio for firm i during period t

$EXPF_{ti}$ = experience factor of firm i in period t

MINTAX = minimum tax rate

MAXTAX = maximum tax rate

MAXRES = lowest reserve ratio where MINTAX is effective

N_{ti} = number of positions at firm i in year t

$(\Delta N^{-})_{ti}$ = reduction in employment

q_i = turnover rate of firm i

$R(1)_{ti}$ = single-year reserve ratio of firm i during period i

$R(3)_{ti}$ = reserve ratio using three-year average taxable payroll of firm i during period t

RR = reserve-ratio system, either R(1) or R(3)

s = slope of tax schedule in reserve-ratio states

SF_t = state factor during period t

TAX_{ti} = taxes paid by firm i during period t

$TBEN_t$ = total benefits paid in state during period t

τ_{ti} = tax rate for firm i during period t

$\tilde{w}$ = taxable wage base

$\tilde{W}_{ti}$ = taxable payroll for firm i in period t

$f(y)$ = distribution of annual salaries for firm i

TABLE A-1

SIMULATED BALANCES
(Base-Case Parameters)

t	R(3)	R(1)	BR	BWR
1	819046.10	819046.10	819046.10	819046.10
2	1538355.60	1538355.80	1538359.80	1538359.80
3	2257736.16	2257736.16	2257736.16	2257736.16
4	2165928.39	2166723.84	2228631.15	2231074.42
5	2127760.46	2125027.06	2250709.56	2255198.34
6	2118843.87	2110174.76	2288662.70	2295182.57
7	2075291.31	2070136.06	2290828.85	2297419.54
8	2077419.31	2072623.22	2329419.39	2339673.61
9	2066885.40	2063456.61	2343691.85	2355916.64
10	2046033.66	2046317.01	2345121.86	2359030.61
11	2060136.07	2060078.38	2371509.15	2367018.44
12	2100899.69	2058463.78	2422194.18	2439584.40
13	2116406.71	2114055.99	2449993.48	2469810.57
14	2150101.26	2146177.90	2496902.06	2513300.03
15	2167835.52	2168389.23	2521554.12	2544715.36
16	2185293.58	2188889.23	2545992.50	2571204.66
17	2160954.71	2167810.64	2521159.69	2549798.42
18	2165113.54	2168027.16	2523558.13	2552901.51
19	2209554.48	2206510.07	2576846.07	2608003.51
20	2208171.49	2205707.39	2593181.13	2626244.89
21	2194636.90	2151640.63	2592747.34	2629300.16
22	2219739.00	2217083.13	2623740.58	2661376.58
23	2229624.62	2228506.13	2645521.07	2684997.63
24	2248641.84	2248789.06	2678548.23	2719942.27
25	2269652.34	2269444.22	2703256.42	2746430.31
26	2295267.09	2298813.97	2734752.95	2779630.73
27	2323434.17	2324918.65	2769114.97	2816443.96
28	2362653.75	2363192.29	2810422.03	2860611.84
29	2327243.93	2332448.99	2776344.99	2820001.93
30	2355094.24	2358096.96	2805300.53	2850034.10
31	2363463.82	2366040.95	2820165.89	2877159.08
32	2370936.51	2372161.06	2841533.55	2900377.32
33	2382596.68	2381600.37	2859871.08	2920821.55
34	2416256.25	2415506.21	2905717.50	2963423.39
35	2417591.07	2417956.68	2915185.05	2980144.84
36	2408067.23	2409336.35	2915180.44	2982282.39
37	2389000.98	2390207.76	2905861.35	2974429.66
38	2367083.38	2363564.55	2899214.31	2959351.98
39	2355582.64	2352576.50	2914354.87	2955744.61
40	2370034.01	2360724.56	2951320.23	3024185.39
41	2365164.33	2358056.68	2965752.44	3040247.27
42	2364314.42	2362201.26	2979057.84	3055804.35
43	2342660.39	2342291.45	2968486.41	3047072.79
44	2383343.55	2382311.74	3020382.42	3100521.79
45	2414373.28	2414482.95	3063730.88	3145345.34
46	2393493.86	2398691.21	3052856.19	3135136.41
47	2388955.59	2391330.04	3045306.35	3130468.70
48	2394791.85	2396452.83	3056163.32	3142628.14
49	2406479.18	2410836.80	3083264.32	3171526.66
50	2413425.51	2417797.27	3102973.49	3192658.99

TABLE A-1 (Cont'd)

t	R(3)	R(1)	BR	BWR
51	2433399.22	2438143.63	3131935.17	3223354.45
52	2444575.21	2446343.51	3149498.14	3242634.58
53	2470914.35	2473386.16	3153534.35	3283125.90
54	2452791.62	2458283.07	3170433.16	3274204.42
55	2438262.67	2445144.46	3162607.22	3269497.15
56	2409553.44	2415031.97	3135880.92	3244778.89
57	2420156.53	2420558.32	3159666.84	3270389.47
58	2435076.56	2441547.09	3190117.35	3303084.10
59	2433896.26	2442221.62	3199315.63	3314588.32
60	2451585.36	2456109.73	3215990.33	3337926.88
61	2466213.68	2470491.31	3237758.[illegible]	3362414.16
62	2433004.59	2442035.92	3216131.62	3344594.17
63	2442734.24	2446571.28	3229375.47	3364120.70
64	2417354.03	2422558.55	3210697.75	3351188.28
65	2399207.51	2405457.05	3212429.52	3357434.63
66	2406389.28	2410871.69	3235995.81	3384274.72
67	2379957.84	2383775.04	3230049.57	3390560.71
68	2363951.04	2368053.85	3226089.83	3380088.22
69	2365916.17	2368242.35	3241962.37	3398335.49
70	2331346.55	2333528.83	3220659.03	3382577.54
71	2354663.75	2353111.64	3254831.66	3424519.69
72	2356281.22	2358458.02	3265329.51	3444443.54
73	2389321.16	2394068.21	3315712.83	3498527.84
74	2400193.54	2411753.34	3325949.53	3513273.54
75	2405457.15	2422410.05	3328522.83	3528200.27
76	2370621.22	2389109.02	3280313.47	3475713.63
77	2376345.46	2388385.41	3279145.12	3478577.33
78	2397698.16	2403860.96	3301975.17	3504715.39
79	2383929.82	2388695.50	33[illegible]3109.45	3508739.88
80	2365080.15	2374898.18	3301487.84	3507925.33
81	2420292.34	2426910.57	3359768.69	3571448.81
82	2428712.69	2441828.06	3374736.53	3594872.51
83	2407610.50	2424992.72	3352126.83	3576698.97
84	2393354.78	2407593.09	3326812.00	3555345.27
85	2392232.60	2401551.87	3325383.09	3556803.57
86	2397595.40	2403469.78	3343262.57	3583000.17
87	2389218.44	2355077.85	3351249.50	3595900.82
88	2397592.24	2402917.56	3380383.79	3529222.52
89	2392262.24	2398615.54	3385554.73	3635572.77
90	2384031.03	2352658.17	3382020.05	3634574.74
91	2415270.59	2413493.99	3401354.33	3562247.33
92	2399281.97	2408281.09	3397306.14	3665741.35
93	2376183.00	2385025.83	3381296.74	3654709.35
94	2382383.39	2386546.50	3387167.21	3657818.14
95	2371476.25	2378055.79	3384110.77	3672634.60
96	2382399.35	2390642.29	3404373.[illegible]	3699392.15
97	2361622.89	2369066.87	3386457.30	3687496.91
98	2323837.96	2330438.28	3357800.03	3662132.20
99	2308531.83	2313721.21	3349325.41	3655615.54
100	2308061.09	2311380.70	3362688.77	3671512.93

APPENDIX TO PART III -- SECTION 2

EVALUATION UI TAX SYSTEMS: TRADEOFFS AND IMPROVEMENTS (Results from the Stylized-State Model)

We have used three criteria to evaluate UI fund balances: (1) the mean, (2) the variance, and (3) the countercyclical impulse of the fund.

The stylized-state simulation model was used to simulate 87 different tax schedules, and the three evaluation criteria were calculated for the balances produced by each schedule. We then looked for cases where one tax schedule dominated others. That is, we looked for a change in the tax schedule that would improve at least one of the three measures without worsening the other two.

The tax schedule was parameterized to conform as much as possible to the simulations from the other two models used for this project: the macro model, and the micro model. There are seven tax parameters in these simulations:

(1) $\tilde{w}$, the wage base

(2) NEGT, the tax rate paid by firms with negative reserve ratios

(3) MAXT, the highest tax rate paid by firms with positive reserve ratios

(4) MINR, the reserve ratio (highest) that payes MAXT; higher reserve ratios are on the sloped portion of the schedule

(5) SL, the amount by which the tax rate declines per unit increase in the reserve ratio

(6) MINT, the lowest tax rate

(7) MAXR, the reserve ratio (lowest) at which MINT becomes effective

The last six of these parameters describe the tax schedule, the relationship between tax rates (τ_t) and experience (the reserve ratio) that is illustrated in figure III-10.

Any five of these six ((2) through (7)) are sufficient to describe the tax schedule. It is not possible to change only one of these six parameters. At most, four parameters can be held constant while the other two vary. In the simulations reported here, we varied each of the first five parameters ((2) through (6)) of the tax schedule, each time allowing MAXR to change so as to keep the

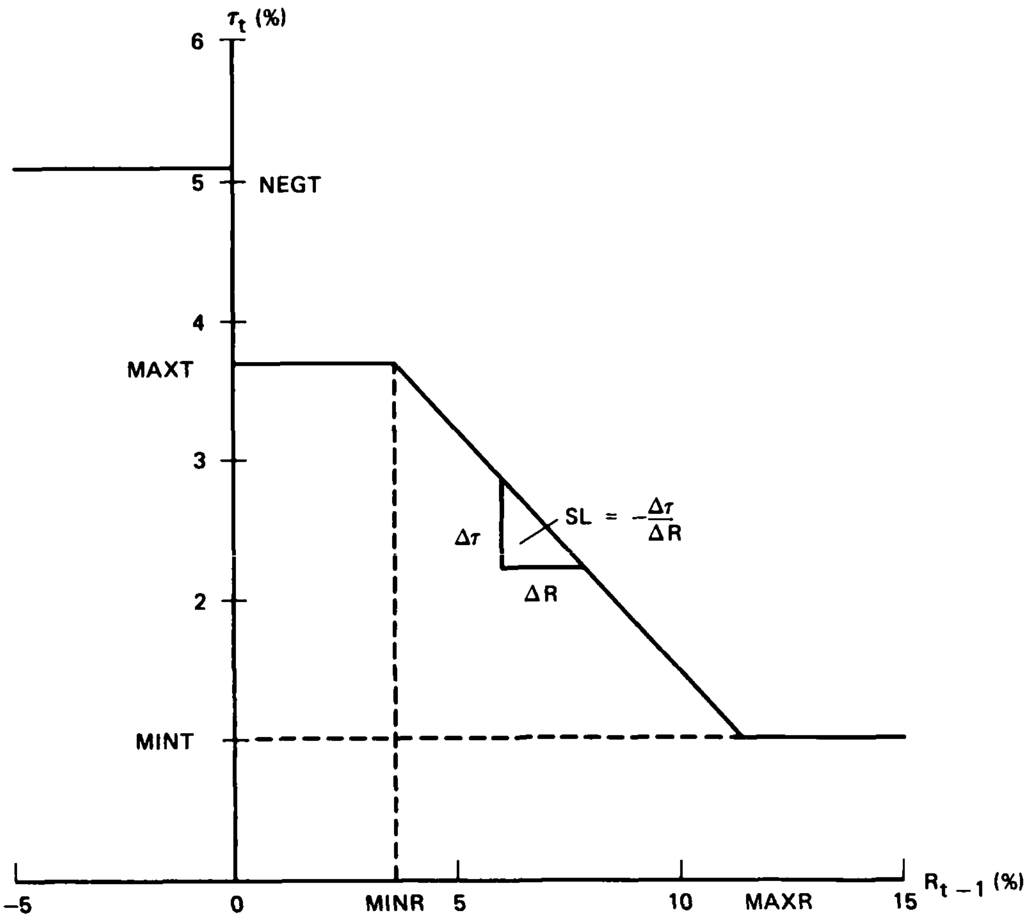

FIG. III-10: THE BASE TAX SCHEDULE

other four parameters constant. These changes in the tax schedule are illustrated in figure III-11.

In the simulations reported here, six parameters of the system's tax schedule (the wage base and the five parameters of the tax schedule) were varied around a base case. The base-case tax parameters listed in table III-11 are the same as those used by the other two simulation models. They are average tax parameters of the New Jersey tax schedule, the state that yielded the best predictions for the micro model.

The stylized-state simulation model also depends on economic parameters that determine yearly employment shocks for each firm, turnover rates, and wage distributions. These parameters are described by the mean and standard deviation of a normal distribution. The distributions used to simulate the tax schedule changes are listed in table III-11. Each of the 87 tax systems were simulated with the same yearly random draws from these distributions; the only difference between the simulations is the tax system. The economic parameters were chosen so that the base-case balance fluctuated cyclically around a stable trend; there is no secular increase or decrease in the balance simulated with the base-case parameters.

The three evaluation measures are given for each of the 87 simulations in tables III-12 through III-17. The three measures were computed as follows:

a. M = the average fund balance

$$= \frac{1}{100} \sum_{t=1}^{100} BAL_t$$

b. $\sqrt{V}$ = the square root of the variance (σ) of the fund balance

$$= \left(\frac{1}{100} \sum_{t=1}^{100} (BAL_t - M)^2 \right)^{\frac{1}{2}}$$

c. C = countercyclical measure

$$= \frac{1}{\bar{B}^2} \sum_{t=1}^{100} (TAX_t - BEN_t) \cdot (\bar{B} - BEN_t)$$

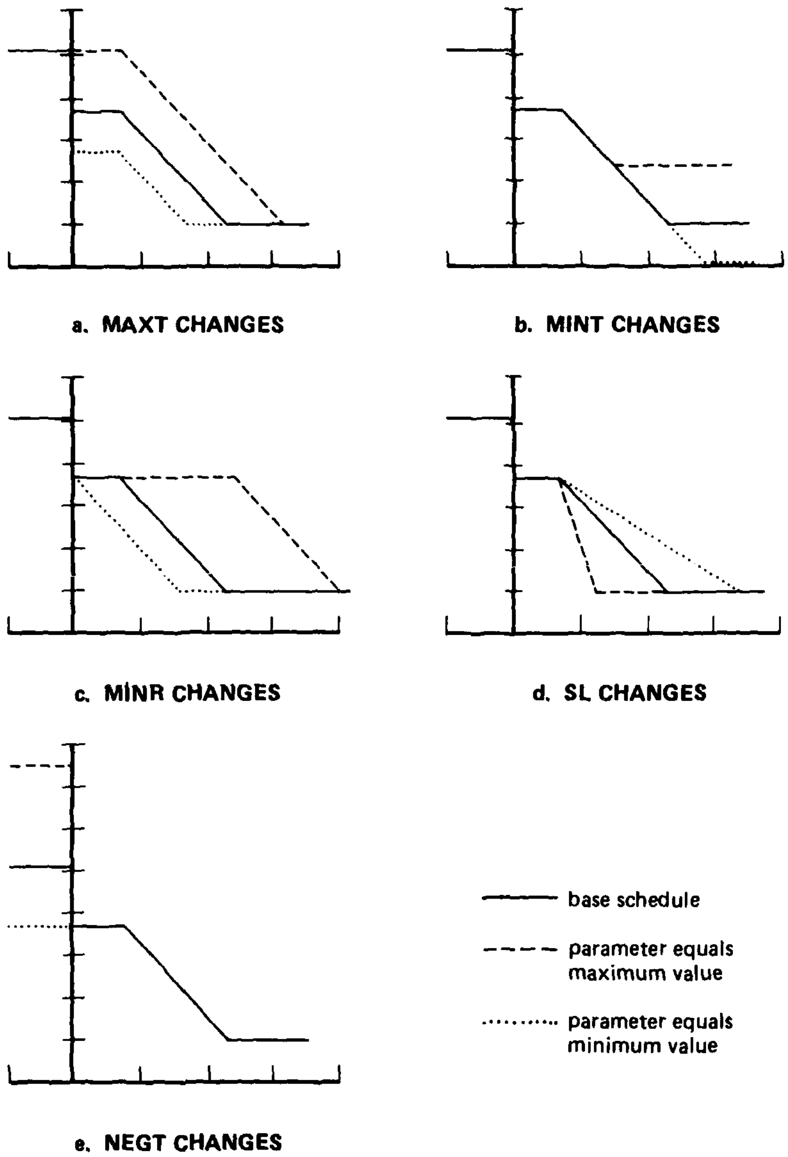

FIG. III-11: SIMULATED CHANGES IN THE BASE SCHEDULE

where

BAL_t = balance in fund at the end year t

TAX_t = total taxes paid in year t

BEN_t = total benefits paid in year t

$\bar{B}$ = average benefits

$$= \frac{1}{100} \sum_{t=1}^{100} BEN_t \quad .$$

TABLE III-11

Parameter	Base value	Range of values in the simulations	Number of simulations
$\tilde{w}$	\$4600.	\$3000. to \$12,000.	19
MAXT	.037	.027 to .051	13
MINT	.010	.000 to .024	13
MINR	.035	.00 to .12	13
SL	.3375	.20 to 1.00	9
NEGT	.051	.037 to .075	20

Base Case Economic Parameters

	μ	σ
initial firm size	100	0
annual employment change	$5 \sin(t2\pi/6)$	5
wage distribution	10K	4K
turnover rate (q_i)	.05	.05

TABLE III-12

SIMULATION RESULTS WHEN w VARIES

w	M	$\sqrt{V}$	C
3000	1053463.188	353973.201	6.458
3500	1599874.014	322582.234	6.404
4000	2170783.413	351368.309	6.375
4500	2806102.118	498520.055	6.368
5000	3515423.536	760509.578	6.362
5500	4278868.543	1097728.580	6.388
6000	5097133.809	1497556.509	6.436
6500	5956541.569	1934192.964	6.504
7000	6858395.343	2403891.719	6.612
7500	7827752.416	2934578.416	6.723
8000	8862724.454	3532180.161	6.875
8500	9957106.990	4182176.479	7.031
9000	11098424.251	4868504.102	7.219
9500	12293918.002	5604831.024	7.418
10000	13539094.775	6385977.378	7.563
10500	14805731.746	7183001.924	7.708
11000	16053909.861	7984070.611	7.843
11500	17329926.322	8807184.674	7.965
12000	18611577.239	9640872.242	8.087

TABLE III-13

SIMULATION RESULTS WHEN MAXT VARIES

MAXT	M	$\sqrt{V}$	C
0.027	2273581.827	538904.272	6.246
0.029	2411439.297	535210.089	6.249
0.031	2543897.352	534577.193	6.292
0.033	2676241.415	536096.492	6.321
0.035	2809853.390	539503.135	6.343
0.037	2943315.870	543345.281	6.363
0.039	3076323.894	547318.882	6.388
0.041	3209459.828	551750.534	6.415
0.043	3343304.715	556991.448	6.443
0.045	3476990.059	562560.853	6.469
0.047	3610740.814	568562.945	6.496
0.049	3744770.208	575126.926	6.525
0.051	3878860.810	582094.322	6.554

TABLE III-14

SIMULATION RESULTS WHEN MINT VARIES

MINT	M	$\sqrt{V}$	C
0.000	2024886.321	465481.906	6.084
0.002	2024959.107	465543.355	6.086
0.004	2028870.216	468494.144	6.132
0.006	2104814.068	471537.339	6.236
0.008	2425791.502	385989.946	6.275
0.010	2943315.870	543345.281	6.363
0.012	3692674.651	1099477.267	6.415
0.014	4618526.790	1870156.712	6.465
0.016	5701252.390	2767701.335	6.486
0.018	7024940.373	3868033.362	6.472
0.020	8520184.691	5106433.772	6.423
0.022	10172239.079	6470910.614	6.380
0.024	11938420.871	7908081.084	6.324

TABLE III-15

SIMULATION RESULTS WHEN MINR VARIES

MINR	M	$\sqrt{V}$	C
0.00	2388288.189	450813.679	7.141
0.01	2526523.272	471859.665	6.948
0.02	2676954.765	495782.260	6.737
0.03	2850416.788	525847.817	6.492
0.04	3038239.810	561776.906	6.236
0.05	3232330.624	601932.642	5.976
0.06	3429181.858	645807.596	5.716
0.07	3628178.255	693427.958	5.457
0.08	3828646.826	745324.029	5.220
0.09	4030042.036	801554.146	5.006
0.10	4230694.518	860657.996	4.801
0.11	4429838.355	923134.830	4.612
0.12	4627975.966	988072.300	4.438

TABLE III-16

SIMULATION RESULTS WHEN SL VARIES

SL	M	$\sqrt{V}$	C
0.2	3731007.457	759828.164	5.874
0.3	3086568.399	575855.469	6.270
0.4	2771356.668	509195.698	6.463
0.5	2616260.631	483156.118	6.489
0.6	2524465.064	468833.509	6.421
0.7	2463892.162	458853.948	6.297
0.8	2420817.564	451173.339	6.167
0.9	2388255.399	445399.094	6.049
1.0	2362935.821	440895.132	5.940

TABLE III-17

SIMULATION RESULTS WHEN NEGT VARIES

NEGT	M	$\sqrt{V}$	C
0.037	2933441.690	535809.444	6.339
0.039	2935846.649	537610.692	6.343
0.041	2937658.453	539004.778	6.348
0.043	2939028.810	540063.767	6.352
0.045	2940337.615	541063.632	6.356
0.047	2941409.693	541894.491	6.359
0.049	2942287.793	542549.811	6.361
0.051	2943315.870	543345.281	6.363
0.053	2943957.073	543843.554	6.367
0.055	2944531.588	544315.971	6.369
0.057	2945304.142	544935.904	6.371
0.059	2944999.315	544690.424	6.372
0.061	2945524.755	545085.995	6.370
0.063	2945749.381	545219.130	6.369
0.065	2946297.668	545657.253	6.371
0.067	2946742.694	545994.170	6.368
0.069	2947099.920	546293.588	6.367
0.071	2947524.642	546620.416	6.367
0.073	2947979.794	546982.128	6.367
0.075	2948204.785	547159.477	6.366

In order to determine the relationship between the tax parameters and evaluation measures, we estimated 18 regressions of the following form:

$$EM_k = a_{kj} + b_{kj} P_j$$

where EM_k is one of the three evaluation measures and P_j is one of the six tax parameters. The 18 b_{kj}'s from these regressions are listed in table III-18.

The regression coefficients were then used to determine how the tax parameters needed to be varied, two at a time, to keep each of the measures constant:

$$\left.\frac{dP_i}{dP_j}\right|_{EM_k} = -\frac{\partial EM_k}{\partial P_j} \Big/ \frac{\partial EM_k}{\partial P_i} = -b_{kj} \Big/ b_{ki} .$$

Next we calculated the total derivative of each measure with respect to each parameter using appropriate partials:

$$\left.\frac{dEM_k}{dP_{j,i}}\right|_{EM_\ell} = \frac{\partial EM_k}{\partial P_j} + \frac{\partial EM_k}{\partial P_i} \cdot \left.\frac{dP_i}{dP_j}\right|_{EM_\ell} .$$

The ratios of these total derivatives gives the change in any two measures, holding the third constant for the change in any of two parameters sufficient to keep the third measure constant. For instance: $\left.\frac{dV}{dC}\right|_M = \left(\left.\frac{dV}{dP_{j,i}}\right|_M\right) \Big/ \left(\left.\frac{dC}{dP_{j,i}}\right|_M\right)$ gives the change in the variance relative to the change in the countercyclical impulse for a unit change in P_j and the associated change P_i required to keep M constant.

Tables III-19, III-20, and III-21 list the results of these calculations for each measure. The bottom matrix of each table gives the change in the other two measures that result when the tax parameters are varied to keep the third measure constant. The signs of the elements in these bottom matrices (M(4), V(4), C(4)) indicate which parameter changes result in balances that dominate the base-case results. Negative signs in M(4) mean that the variance can be decreased and the countercylical impulse increased

TABLE III-18

REGRESSION COEFFICIENTS

	V.	NEGT	MAXT
M	.15762491E+04	.33582782E+08	.66760975E+08
V	.92243817E+10	.28096176E+12	.21891424E+13
C	.20800000E-03	.65751900E+00	.13021978E+02

	MINR	MINT	SL
M	.19057801E+08	.40980598E+09	-.14034454E+07
V	.19057801E+08	.20551471E+16	-.34430457E+12
C	-.23434615E+02	.14576923E+02	-.19716700E+00

TABLE III-19

TRADEOFFS BETWEEN V AND C WHEN M IS CONSTANT

MATRIX M1 $\quad M1_{ij} = -\frac{\partial M}{\partial P_j} \Big/ \frac{\partial M}{\partial P_i} = \frac{dP_i}{dP_j}\Big|_M$

V	NFST	MAXT	MINR	MINT	SL
0.	-.16293153E+03	-.32731660E+05	-.96634207E+04	-.23736555E+06	.71015611E+03
-.58847C93E-02	0.	-.19379525E+03	-.56748727E+02	-.12202860E+04	.41790623E+01
-.29601461E-04	-.50303013E-07	0.	-.28546320E+00	-.51394067E+01	.21021742E-01
-.10369764E-03	-.17621543E-01	-.35930785E+01	0.	-.21503315E+02	.73641515E-01
-.48224018E-05	-.81949034E-03	-.16290474E+00	-.46504449E-01	0.	.34246581E-02
.14091411E-02	.23528813E+00	.47569343E+02	.13579257E+02	.29193995E+03	0.

MATRIX M2 $\quad M2_{ij} = \frac{\partial V}{\partial P_j} + \frac{\partial V}{\partial P_i}\frac{dP_i}{dP_j}\Big|_M = \frac{dV^*}{dP_j}\Big|_M$.

V	NFST	MAXT	MINR	MINT	SL
0.	-.12865552E+13	-.30942578E+15	-.89056574E+14	.14232815E+15	.52066466E+13
.75710034E+10	0.	-.53664722E+14	-.15944204E+16	.17122934E+16	.82985214E+12
.91545793E+10	.20384572E+12	0.	-.62690C54E+12	.20417393E+16	-.29828455E+12
.52243777E+10	.28097614E+12	.21890757E+13	0.	.20551467E+15	-.34430317E+12
-.69636739E+09	-.14031802E+13	-.33251229E+15	-.95573466E+14	0.	.66939717E+13
.87353523E+13	.17857377E+12	-.14188200E+14	-.46753950E+13	.15546102E+16	0.

MATRIX M3 $\quad M3_{ij} = \frac{\partial C}{\partial P_j} + \frac{\partial C}{\partial P_i}\frac{dP_i}{dP_j}\Big|_M = \frac{dC}{dP_j}\Big|_M$

V	NFST	MAXT	MINR	MINT	SL
0.	.62717316E+00	.59959024E+01	-.25440644E+02	-.28555111E+02	-.49654529E-01
-.36613082E-02	0.	-.11768964E+03	-.60747981E+02	-.72778429E+03	.25506458E+01
-.17747478E-03	.55201453E+00	0.	-.27151910E+02	-.65357267E+02	.76520272E-01
.26391146E-02	.10704730E+01	.45113275E+02	0.	.51845852E+03	-.10229276E+01
.13770422E-03	.54557150E+00	.13647277E+02	-.24112507E+02	0.	-.14724602E+00
-.65618955E-04	.61033527E+00	.36424733E+01	-.26117004E+02	-.42995831E+02	0.

MATRIX M4 $\quad M4_{ij} = M3_{ij}/M2_{ij} = \frac{dV}{dC}\Big|_M$

V	NFST	MAXT	MINR	MINT	SL
0.	-.46359616E-12	-.13375967E-13	.28599369E-12	-.20062870E-12	-.79682520E-14
-.46359616E-12	0.	.21930364E-11	.38100355E-11	-.46007553E-12	.30736149E-11
-.13375967E-13	.21930364E-11	0.	.43449971E-10	-.32011255E-13	-.25673563E-12
.28599369E-12	.33100355E-11	.43449971E-10	0.	.25229290E-12	.55869836E-11
-.20061227E-12	-.46007553E-12	-.32011055E-13	.25229290E-12	0.	-.21997139E-13
-.79682520E-14	.30736148E-11	-.25673563E-12	.55849836E-11	-.21997139E-13	0.

TABLE III-20

TRADEOFFS BETWEEN M AND C WHEN V IS CONSTANT

MATRIX V1 $\quad V1_{ij} = \frac{dP_i}{dP_j}\Big|_V$

W	NEG	MAXI	MINR	MINT	SL
0.	-.30457601E+02	-.23732113E+03	-.20660248E-02	-.22275311E+06	.37329401E+02
-.32891144E-01	0.	-.77216626E+01	-.67833527E-04	-.73146861E+04	.12754499E+01
-.62136965E-02	-.12834310E+00	0.	-.37056014E-05	-.53279056E+03	.15727829E+00
-.41462129E+03	-.14742614E+03	-.11488257E+00	0.	-.10783758E+09	.18356332E+05
-.44266263E-05	-.13671172E-03	-.11651359E-02	-.42732054E-08	0.	.16753291E-03
.26781134E-01	.31602682E+00	.63581357E+01	.55351570E-06	.59689801E+04	0.

MATRIX V2 $\quad V2_{ij} = \frac{dM}{dP_j}\Big|_V$

W	NFGT	MAXI	MINR	MINT	SL
0.	.77553404E+05	.66291959E+08	.15057797E+08	-.30472654E+08	-.13776809E+07
-.98456645E+04	0.	.64146633E+08	.19057779E+08	-.20466651E+10	-.99190520E+06
-.27533423E+06	-.92326351E+07	0.	.19057220E+08	-.62264794E+11	.90966065E+07
-.92263777E+10	-.26055142E+12	-.21397075E+13	0.	-.20551467E+15	.34430317E+12
.13686411E+03	.47331077E+05	.66324450E+08	.19057798E+08	0.	-.13347844E+07
-.35623930E+05	-.84562124E+06	.57637649E+08	.19057724E+08	-.79673314E+13	0.

MATRIX V3 $\quad V3_{ij} = \frac{dC}{dP_j}\Big|_V$

W	NFGT	MAXI	MINR	MINT	SL
0.	.55115351E+00	.12772613E+02	-.23434615E+02	-.31764460E+02	-.18940330E+00
-.21277301E-01	0.	.73948512E+01	-.23434660E+02	-.47949682E+06	.60859951E+00
-.54602663E-01	-.16137644E+01	0.	-.23434729E+02	-.12210338E+05	.18509074E+01
.11342653E+05	.34549209E+05	.26919138E+07	0.	.25271321E+10	-.42337776E+06
.14257252E-03	.63552617E+00	.11006451E+02	-.23434615E+02	0.	-.19672649E+00
-.50743640E-32	.49607544E+00	.11768359E+02	-.23434626E+02	-.11623090E+04	0.

MATRIX V4 $\quad V4_{ij} = V3_{ij}/V2_{ij} = \frac{\partial M}{\partial C}\Big|_V$

W	NFGT	MAXI	MINR	MINT	SL
0.	.23624935E-05	.19556909E-06	-.12255602E-05	.10417086E-05	.14244267E-06
.23624735E-05	0.	.17314195E-06	-.12236638E-05	.23428155E-05	-.61355922E-06
.15568949E-06	.12314183E-06	0.	-.12297034E-05	.19610341E-06	.20347230E-06
-.12230562E-05	-.12256838E-05	-.12237034E-05	0.	-.12296607E-05	-.12296555E-05
.10417096E-05	.23428153E-05	.19610341E-06	-.12296602E-05	0.	.14589435E-06
.14244267E-06	-.61355922E-06	.20347230E-06	-.12216655E-05	.14588435E-06	0.

TABLE III-21

TRADEOFFS BETWEEN M AND V WHEN C IS CONSTANT

$C1_{ij} = \frac{\partial P_i}{\partial P_j}\Big|_C$

MATRIX C1

W	NEGT	MAXT	MINR	MINT	SL
0.	-.31611490E+04	-.42605651E+05	.11266642E+06	-.70081361E+05	.94701927E+03
-.31634007E-03	1.	-.17317717E+02	.35640970E+02	-.22164594E+02	.29966510E+00
-.15512936E-04	-.51493330E-01	0.	.17996202E+01	-.11194053E+01	.15141095E-01
.88757392E-05	.28037095E-01	.55667277E+00	0.	.62202528E+00	-.84136963E-02
-.14256126E-04	-.45103463E-01	-.95332811E+00	.16076517E+01	0.	.13575968E-01
.16543453E-02	.35164327E+01	.66345623E+02	-.11885668E+03	.73931880E+02	0.

$C2_{ij} = \frac{\partial M}{\partial P_j}\Big|_C$

MATRIX C2

W	AEGT	MAXT	MINR	MINT	SL
0.	-.55113501E+07	-.55953411E+08	.24171471E+09	.27130775E+09	.46987776E+06
.18700131E+04	0.	.61110090E+08	.31927031E+08	.40231012E+09	-.13027623E+07
.90597633E+03	-.31351354E+07	0.	.13920220E+09	.33507313E+09	-.39261114E+06
.21456016E+04	.87054334E+05	.77350877E+04	0.	.42156041E+09	-.15637381E+07
-.38713254E+04	-.11142227E+08	-.29553031E+09	.67788308E+09	0.	.41395774E+07
.49563345E+03	-.43644243E+07	-.25933167E+08	.10586666E+09	.39634665E+09	0.

$C3_{ij} = \frac{\partial V}{\partial P_j}\Big|_C$.

MATRIX C3

W	NEGT	MAXT	MINR	MINT	SL
0.	-.24878684E+14	-.57530739E+15	.10392781E+16	.14068059E+15	.83906553E+13
.93355020E+10	0.	-.23792254E+13	.10013769E+14	.20481183E+16	-.26003394E+12
.91874145E+10	.17942575E+12	0.	.19396440E+13	.20526964E+15	-.31115856E+12
.92243818E+13	.28049230E+12	.21691530E+13	0.	.20551471E+16	-.34430473E+12
-.20100778E+11	-.72420240E+14	-.19337320E+16	.33039608E+16	0.	.27453551E+14
.82611539E+10	-.86723465E+12	-.29550510E+16	.40922917E+14	.20294923E+16	0.

$C4_{ij} = C3_{ij}/C2_{ij} = \frac{\partial M}{\partial V}\Big|_C$.

MATRIX C4

W	AEGT	MAXT	MINR	MINT	SL
0.	.48452610E+07	.10099630E+07	.42596082E+07	.51922213E+07	.17876276E+08
.48452610E+07	0.	-.56150823E+05	.32274339E+06	.56522412E+07	.19962046E+06
.10659436E+08	-.56150423E+05	0.	.28701593E+05	.61261152E+07	.79253625E+06
.42996062E+07	.32274339E+06	.28301593E+05	0.	.40733390E+07	.72017352E+06
.51522213E+07	.56922412E+07	.61261152E+07	.40730390E+07	0.	.56319694E+07
.17876276E+09	.15962046E+06	.79253625E+06	.72017352E+06	.56319694E+07	0.

with the mean held constant by varying the two tax parameters that describe that element in the matrix.[1] Positive signs in M(4) indicate that at least one measure is made worse when tax parameters are altered; these tradeoffs could be better tax systems, but rating them requires some evaluation function that weights each of the measures.

The interpretation of the signs in V(4) and C(4) depends on whether the actual mean balance is higher or lower than the desired mean balance (M*). Although in general we cannot specify an exact M*, independent of borrowing rates and interest rates, in this case it is safe to say that the mean balance should be reduced.

The average fund balance in the base case is over 6 percent of average total wages in a year. Almost every state that has a system for automatically changing tax rates would trigger in lower rates when their balance was this high. If we know that the mean balance is greater than M*, then negative signs in V(4) and positive signs in C(4) indicate improvements over the base case.

Table III-22 lists the changes in the tax parameters that lead to balances that dominate the base-case balance. All of the improvements except one (decrease $\tilde{W}$ and decrease SL) involve one of the following:

1. decrease MINT

2. increase NEGT

3. increase MAXT

4. decrease MINR

The first three changes all make a tax system more experience rated. That is, the changes increase the tax rate of firms with low balances and decrease the tax rate of the firms with high balances. The fourth change can also be considered to be an increase in experience rating, since a decrease in MINR increases the range of reserve ratios that are on the sloped portion of the tax schedule. This means that a decrease in MINR increases the number of firms who will experience a change in tax rates when their reserve ratios change, making the system more responsive to changes in reserves.

[1] Rows in each matrix refer to the same parameters as columns, viz, row 1, $\tilde{W}$; row 2, NEGT, etc.

TABLE III-22

IMPROVEMENTS IN TAX PARAMETERS

I. Reduce Variance, Increase Countercyclical Impulse, Mean Constant

by

- decreasing MINT and
  - increasing SL[a]
  - increasing MAXT
  - increasing NEGt
  - increasing $\tilde{w}$

or

- increasing MAXT and
  - increasing SL
  - decreasing $\tilde{w}$

or

- decreasing $\tilde{w}$ and
  - increasing NEGT
  - decreasing SL

II. Decrease Mean, Increase Countercyclical Impulse, Variance Constant

by

- decreasing MINR and
  - increasing MINT
  - increasing MAXT
  - increasing NEGT
  - increasing $\tilde{w}$
  - decreasing SL

or

- increasing NEGT and
  - increasing SL

---

[a]SL is measured as a positive number, an increase means a steeper slope.

TABLE 22 (Cont'd)

III. Reduce Mean Variance, Countercyclical Impulse Constant

by

decreasing MINR and
- decreasing MINT
- increasing SL
- decreasing $\tilde{W}$
- decreasing NEGT
- decreasing MAXT

or

decreasing MINT and
- decreasing SL
- increasing MAXT
- increasing NEGT
- increasing $\tilde{W}$

or

decreasing $\tilde{W}$ and
- increasing NEGT
- increasing MAXT
- decreasing SL

or

increasing SL and
- increasing MAXT
- increasing NEGT

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PART IV

THE MACROECONOMETRIC ESTIMATION AND SIMULATION MODELS

PART IV

THE MACROECONOMETRIC ESTIMATION AND SIMULATION MODELS

INTRODUCTION

There are a number of different empirical and theoretical approaches to the problem of fund adequacy. In the previous two parts of the report two types of models based on assumed or observed microeconomic information were presented together with the appropriate simulations. In this part, by contrast, macroeconometric models will be developed, estimated, and simulated. While the macroeconometric models have the advantage of simplicity, their applicability may be limited because they do not incorporate explicitly important microeconomic features. The most important microeconomic feature seems to be the distribution of firms across the tax schedule. This distribution is very likely to vary through the business cycle and to depend crucially on the industrial composition in the state. The macroeconometric approach is thus strictly valid only if the variation in the distribution of firms across tax schedules is systematic in successive business cycles which, in turn, is likely to be the case if the industrial composition does not vary too much in the state and the time period under consideration. It is hard to know how important this shortcoming of the macroeconometric approach is. This is the reason why it has been supplemented by the two previously reported microeconomic models.

The remainder of this part of the report is structured as follows: First, the procedures and results of an initial set of estimations and simulations are described. This exercise was undertaken to obtain an overall impression of the usefulness of the macroeconometric approach. Second, a set of revised econometric models are presented. They were fitted to data of only the reserve ratio states. They incorporate explicitly the parameters of the tax structure. Third, the results of the simulation exercises with the revised models are presented. They enable us to compute the effects of changes in the parameters of the tax structure upon the three relevant variables: the average fund balance, the variance of the fund balance, and the cash-flow smoothing or countercyclical properties of the fund balance. This information is then used to determine the tradeoffs and inefficiencies that may exist among these properties of the fund balance.

INITIAL ESTIMATION AND SIMULATION

The initial econometric estimation and simulation was based on the simple identity that the aggregate tax flows for a state are the product of the aggregate taxable payroll and the average tax rate. Hence, it was decided to model, in turn, the determination of the taxable payroll and the average tax rate and then to simulate the determination of the aggregate tax flow.

The Determination of the Taxable Payroll

In two previous papers by one of the authors, references 1 and 2, the taxable payroll per man was approximated by the following formula:

$$m = \tilde{w}\left[1+q\left(1-\frac{\tilde{w}}{w}\right)\right] \qquad \text{(IV-1)}$$

where m is the taxable payroll, $\tilde{w}$ the taxable wage base, q the rate of interfirm labor turnover (excluding temporary layoffs), and w total earnings. All variables are measured at annual rates. According to this formula, the taxable payroll depends positively on q and w and nonlinearly on $\tilde{w}$, positively for low $\tilde{w}$ and negatively for sufficiently large $\tilde{w}$. Furthermore, $\tilde{w} \leq m \leq w$: at one extreme $m = \tilde{w}$ if $q = 0$ and, at the other extreme $m = \tilde{w}$ if $w = \tilde{w}$.

For the purpose of the research underlying the present report, equation (IV-1) was approximated, in the regression formulation, by a function that relates m linearly to w and q and quadratically to $\tilde{w}$. Further, since it is impossible to obtain labor turnover data by state for the period under study, the turnover rate was approximated by the umemployment rate. As is well known, the unemployment rate and quits are correlated negatively over time, and hence, the former may be a good proxy for the latter.

The regressions for the taxable payroll per employee (m) were fitted to annual time series data for the period 1947 to 1977 for 32 reserve-ratio states, 10 benefit-ratio states, 5 benefit-wage states, and 4 payroll-decline states.[1] The resulting regression coefficients are presented in table IV-1. They can be summarized as follows:

- The coefficients of annual earnings (w) are all positive and statistically highly significant.
- Most of the coefficients of the taxable wage base ($\tilde{w}$) are positive and statistically significant. Only one coefficient is negative (and insignificant) and only eight are insignificantly positive.

[1] The data are readily available see U.S. Department of Labor (1978)

TABLE IV-1

THE DETERMINANTS OF THE TAXABLE PAYROLL PER EMPLOYEE (m)
(t-ratios in parentheses)

State	Con-stant	w	$\tilde{w}$	$\tilde{w}^2$	u	R^2	D-W
	Independent Variables						
	Reserve-Ratio States						
Arizona	1466.8	0.2494	0.0770	0.000030	-36.17	.9890	1.7018
	(2.60)	(10.84)	(0.26)	(1.02)	(2.48)		
Arkansas	1255.4	0.3390	-0.1322	0.000060	-15.27	.9929	1.2524
	(2.15)	(21.39)	(0.42)	(1.54)	(1.59)		
California	-249.1	0.1242	1.0540	-0.000042	-27.44	.9957	0.6893
	(0.86)	(8.65)	(7.12)	(3.26)	(3.33)		
Colorado	575.7	0.1866	0.4798	--	-8.86	.9848	1.1601
	(4.42)	(14.96)	(8.66)	--	(0.45)		
D.C.	232.0	0.1770	0.5919	--	-38.47	.9883	0.5070
	(1.49)	(15.64)	(8.89)	--	(1.27)		
Georgia	306.3	0.2687	0.4091	0.000008	-17.27	.9944	0.6638
	(0.74)	(19.40)	(1.89)	(0.35)	(1.51)		
Hawaii	282.9	0.3694	0.3437	-0.000001	-9.40	.9996	2.4435
	(4.46)	(25.45)	(9.38)	(0.53)	(1.35)		
Idaho	570.8	0.2305	0.4095	0.000009	-6.17	.9983	1.4961
	(2.34)	(15.68)	(3.62)	(1.01)	(0.56)		
Indiana	741.3	0.1427	0.4982	--	2.78	.9912	0.8275
	(8.81)	(18.39)	(14.08)	--	(0.35)		
Iowa	547.3	0.1576	0.4765	0.000012	-14.52	.9962	0.4681
	(2.04)	(17.93)	(3.44)	(0.77)	(0.97)		
Kansas	388.0	0.1633	0.5812	--	-19.64	.9930	0.5206
	(4.29)	(17.98)	(16.30)	--	(1.61)		
Kentucky	402.4	0.2077	0.4958	--	-2.56	.9874	0.6335
	(2.89)	(14.71)	(8.49)	--	(0.34)		
Louisiana	638.7	0.2347	0.4283	--	-54.66	.9764	1.2801
	(3.05)	(13.59)	(5.35)	--	(2.49)		
Maine	328.6	0.2196	0.5484	--	-16.78	.9929	0.4601
	(3.58)	(19.58)	(13.53)	--	(2.89)		

TABLE IV-1 (Cont'd)

State	Con-stant	w	$\tilde{w}$	$\tilde{w}^2$	u	R^2	D-W
	Independent Variables						
	Reserve-Ratio States						
Massachusetts	-2499.4	0.1641	2.2041	-0.000227	-17.42	.9892	0.4510
	(2.33)	(9.71)	(3.63)	(2.58)	(1.73)		
Michigan	307.4	0.1161	0.7638	-0.000015	-5.92	.9971	1.0615
	(0.87)	(10.05)	(4.22)	(0.81)	(1.41)		
Missouri	-1646.5	0.1273	1.7492	-0.000144	-36.48	.9505	1.5740
	(0.38)	(5.34)	(0.73)	(0.44)	(1.28)		
Nebraska	1062.5	0.2238	0.1990	--	52.42	.9830	0.9851
	(8.92)	(17.70)	(4.05)	--	(2.34)		
Nevada	-470.4	0.2051	1.0820	-0.000050	-47.36	.9969	1.2676
	(1.34)	(15.01)	(6.18)	(3.04)	(4.62)		
New Hampshire	331.7	0.1954	0.5759	--	-24.41	.9935	1.0378
	(3.67)	(15.46)	(13.32)	--	(4.00)		
New Jersey	615.6	0.1588	0.5032	0.000009	-9.85	.9959	1.1796
	(1.74)	(12.93)	(2.68)	(0.44)	(1.20)		
New Mexico	247.7	0.2957	0.4743	--	-58.51	.9488	1.2666
	(0.94)	(8.19)	(3.94)	--	(1.43)		
New York	616.0	0.1386	0.5929	--	-32.29	.9889	0.5582
	(5.23)	(13.98)	(11.04)	--	(2.95)		
North Carolina	321.5	0.2619	0.4647	--	-21.88	.9878	0.5311
	(2.18	(15.71)	(7.27)		(1.85)		
North Dakota	-764.7	0.2002	1.1195	-0.000093	38.10	.9745	2.1296
	(0.35)	(8.03)	(0.91)	(0.55)	(1.70)		
Ohio	433.3	0.1270	0.6254	--	-8.60	.9896	0.5060
	(4.15)	(14.29	(14.11)	--	(1.03)		
Rhode Island	-1248.2	0.2459	1.3823	-0.000132	2.34	.9909	1.6561
	(1.94)	(15.66)	(4.18)	(3.03)	(0.38)		
South Carolina	946.9	0.2468	0.1872	0.000040	-56.75	.9917	0.6624
	(0.66)	(17.65)	(0.24)	(0.37)	(3.87)		
South Dakota	340.2	0.1887	0.4922	--	37.39	.9827	1.2706
	(2.57)	(12.08)	(9.75)	--	(1.40)		

TABLE IV-1 (Cont'd)

State	Con-stant	w	$\tilde{w}$	$\tilde{w}^2$	u	R^2	D-W
	Independent Variables						
Reserve-Ratio States							
Tennessee	-650.6	0.2234	1.2034	-0.000111	-35.88	.9885	1.770
	(0.31)	(10.50)	(1.06)	(0.73)	(3.37)		
West Virginia	-1968.1	0.1626	1.9690	-0.000196	-9.62	.9920	0.9527
	(2.09)	(12.34)	(3.70)	(2.56)	(1.71)		
Wisconsin	342.4	0.1643	0.6263	-0.000010	-22.27	.9905	1.6994
	(0.62)	(6.82)	(2.15)	(0.35)	(1.40)		
Benefit-Ratio States							
Connecticut	1252.0	0.1527	0.1981	0.000044	-18.01	.9953	1.1151
	(3.27)	(10.93)	(0.98)	(2.12)	(2.32)		
Florida	382.8	0.2591	0.4415	--	-12.59	.9903	0.6187
	(2.96)	(19.59)	(7.84)	--	(0.85)		
Maryland	446.0	0.1788	0.5138	--	-11.71	.9848	0.5245
	(3.06)	(13.72)	(8.25)	--	(0.98)		
Minnesota	282.2	0.1700	0.5811	-0.000003	-4.31	.9972	0.3540
	(1.43)	(12.81)	(6.67)	(0.40)	(0.30)		
Mississippi	513.2	0.3220	0.3250	--	-22.39	.9890	0.5098
	(3.47)	(17.74)	(5.35)	--	(2.01)		
Oregon	262.8	0.1494	0.7361	-0.000012	-13.40	.9990	0.7538
	(2.17)	(19.28)	(12.59)	(2.49)	(2.75)		
Pennsylvania	-2892.6	0.1513	2.4114	-0.000253	1.66	.9912	0.4468
	(2.36)	(8.98)	(3.54)	(2.70)	(0.19)		
Texas	269.9	0.2068	0.5345	--	-8.93	.9945	0.5263
	(2.85)	(24.44)	(14.26)	--	(0.66)		
Vermont	928.3	0.2389	0.2753	0.000022	-32.25	.9942	0.9595
	(2.23)	(13.31)	(1.28)	(1.03)	(4.44)		
Wyoming	-741.6	0.2180	1.0548	-0.000062	16.75	.9974	1.3631
	(0.88)	(24.27)	(2.22)	(0.93)	(1.86)		

- The coefficients of the $\tilde{w}^2$ terms are not uniformly strong. Seventeen have negative signs of which ten are significant by conventional standards. There are only two positive significant coefficients. Furthermore, multicollinearity between $\tilde{w}$ and $\tilde{w}^2$ prevented the determination of both coefficients in quite a few states.

- The coefficients of the insured unemployment rate (u) are predominantly negative. Eighteen are negative and significant at conventional levels, another twenty-four are negative and insignificant. Nine coefficients are positive, but only two significantly so. This evidence is consistent with our hypothesis that the unemployment rate may be a proxy for the quit rate. The quit rate should have a positive influence on the taxable payroll and be correlated negatively with the unemployment rate. Hence, a negative association between the taxable payroll and the unemployment rate is predicted by the theory and this prediction is supported by the evidence in table IV-1.

- The overall goodness of fit, as measured by the R^2's, is very good. On the other hand, the Durbin-Watson statistics indicate that there remains a significant amount of positive autocorrelation in the residuals.

To sum up: For the majority of states the simple model of the determination of the taxable payroll seems to work quite well. To be sure, there are exceptional states and, in many cases, the residuals are autocorrelated. These problems deserve further investigation.

The Determination of the Average Tax Rate

In the initial estimation, a simple approach to determination of the average tax rate was adopted. In brief, it was hypothesized that the average tax rate can be determined simply by the state's total reserve ratio:

$$\tau_t = \alpha + \beta R_{t-1} \tag{IV-2}$$

where τ_t is the average tax rate and R_{t-1} stands for the aggregate (lagged) reserve ratio. In the econometric analysis, various versions of equation (IV-2) were tried. It turned out that the first difference specification of equation (IV-2) had the most attractive statistical features. Hence, the regression equation

$$\tau_t - \tau_{t-1} = \hat{\alpha} + \hat{\beta}(R_{t-1} - R_{t-2}) \tag{IV-3}$$

was fitted to annual time series for the period 1948 to 1977 for all states (including D.C.). The resulting regression coefficients are presented in table IV-2. The main features of these coefficients can be summarized as follows:

- The estimates of the constant ($\hat{\alpha}$) are predominantly negative but not very significant. Only nine negative coefficients have a t-ratio in excess of 1.5. This represents some weak evidence of a negative time trend in the average tax rate τ_t.

- The coefficients of the $(R_{t-1}-R_{t-2})$ variable are all negative, and all but two have a t-ratio of 1.5 or more. The two states with insignificant coefficients are both payroll-decline states. The percentage distribution of the coefficients are presented in table IV-3. The unweighted mean of the coefficients for all coefficients is .2366. They tend to be marginally higher in benefit-wage-ratio states and marginally lower in payroll-decline states. In view of the small number of coefficients, however, not too much emphasis ought to be placed on these differences.

- The overall goodness of fit, as measured by the R^2's, range from a low of 0.019 to a high of 0.85. Their unweighted mean is approximately 0.46. They tend to be higher in benefit-wage-ratio and reserve-ratio states and lowest in payroll-decline states. But these differences should not be overemphasized. The R^2's are not as high as is common in time series regressions. The reason for the relatively low R^2's is that both the tax (τ_t) and the reserve ratio (R_{t-1}) were transformed into first differences. Such transformations usually reduce the R^2's.

- The Durbin-Watson statistics indicate that there is no autocorrelation in the residuals for most equations. This absence of autocorrelation is also attributable to the first difference transformations.

To sum up: The first simple approach to the estimation of the average tax rate consisted of regressing the change in the tax rate on the change in the lagged aggregate reserve ratio. The results look fairly satisfactory for most states. But there are some states for which further refinement of the estimation equation seem called for.

TABLE IV-2

THE DETERMINATION OF THE AVERAGE TAX RATE
(t-ratios in parentheses)

State	Constant Independent Variables	$(R_{t-1}-R_{t-2})$ Reserve-Ratio	R^2 States	D-W
Arizona	-0.000265 (0.56)	-0.151531 (2.94)	0.2575	2.0119
Arkansas	-0.000431 (2.36)	-0.199582 (8.80)	0.7558	1.6162
California	-0.000444 (1.05)	-0.312014 (6.89)	0.6552	2.4727
Colorado	-0.001097 (1.36)	-0.430594 (3.91)	0.3800	1.4432
D.C.	-0.000398 (0.91)	-0.253240 (5.09)	0.5093	2.5261
Georgia	-0.000203 (1.06)	-0.147790 (6.23)	0.6080	1.6479
Hawaii	-0.000451 (1.06)	-0.312487 (5.63)	0.5593	1.8938
Idaho	-0.000262 (0.52)	-0.114281 (1.65)	0.1021	2.0911
Indiana	-0.000062 (0.30)	-0.205138 (7.57)	0.6962	1.9854
Iowa	-0.001666 (3.84)	-0.506624 (7.40)	0.6865	1.2705
Kansas	0.000136 (0.48)	-0.152637 (3.28)	0.3007	1.4452
Kentucky	-0.000707 (1.70)	-0.277944 (5.75)	0.5695	2.5332
Louisiana	-0.000520 (1.02)	-0.260833 (2.97)	0.2603	1.9515
Maine	-0.000202 (0.51)	-0.219858 (5.30)	0.5291	2.1060

TABLE IV-2 (Cont'd)

State	Constant	$(R_{t-1}-R_{t-2})$ Reserve-Ratio	R^2 States	D-W
	Independent Variables			
Massachusetts	0.000328 (0.73)	-0.259219 (6.38)	0.6009	1.8758
Michigan	0.000164 (0.26)	-0.195836 (4.80)	0.4608	2.1057
Missouri	-0.000826 (1.71)	-0.387799 (5.77)	0.5711	2.6857
Nebraska	-0.001554 (4.44)	-0.670037 (11.67)	0.8501	1.8658
Nevada	-0.000433 (0.74)	-0.204772 (2.89)	0.2506	2.1123
New Hampshire	-0.000450 (1.45)	-0.263762 (7.10)	0.6686	1.4724
New Jersey	0.000470 (0.97)	-0.066332 (1.64)	0.0976	2.0191
New Mexico	-0.000692 (2.41)	-0.221772 (4.23)	0.4169	2.3576
New York	-0.000156 (0.28)	-0.268107 (4.81)	0.4614	1.6405
North Carolina	-0.000251 (0.64)	-0.116171 (2.47)	0.1957	2.3233
North Dakota	-0.000014 (0.03)	-0.223313 (2.35)	0.1805	1.7048
Ohio	-0.000176 (0.35)	-0.271342 (6.54)	0.6309	1.9505
Rhode Island	0.000097 (0.23)	-0.107368 (3.27)	0.2990	2.5509
South Carolina	-0.000294 (1.18)	-0.263930 (9.25)	0.7600	1.6928
South Dakota	-0.000579 (2.24)	-0.214826 (4.16)	0.4095	1.6584

TABLE IV-2 (Cont'd)

State	Constant	$(R_{t-1}-R_{t-2})$	R^2	D-W
	Independent Variables			
Reserve-Ratio States				
Tennessee	-0.000012	-0.077359	0.2873	1.9500
	(0.08)	(3.30)		
West Virginia	-0.000271	-0.324552	0.4869	2.0693
	(0.43)	(4.87)		
Wisconsin	0.000380	-0.140706	0.3809	1.8332
	(1.31)	(4.08)		
Benefit-Ratio States				
Connecticut	0.000081	-0.098345	0.3371	1.4868
	(0.18)	(3.57)		
Florida	-0.000575	-0.362002	0.6289	1.2527
	(1.48)	(6.51)		
Maryland	-0.000224	-0.299357	0.4604	1.2100
	(0.32)	(4.62)		
Minnesota	0.000114	-0.116652	0.2049	1.9593
	(0.32)	(2.54)		
Mississippi	-0.000423	-0.222637	0.2733	1.1680
	(0.73)	(3.07)		
Oregon	-0.000189	-0.255114	0.5755	1.7635
	(0.43)	(5.82)		
Pennsylvania	-0.000031	-0.201479	0.4139	2.1862
	(0.04)	(4.20)		
Texas	-0.000674	-0.287130	0.3915	1.4946
	(2.33)	(4.01)		
Vermont	-0.000190	-0.108120	0.1873	1.6091
	(0.30)	(2.40)		
Wyoming	0.000180	-0.283640	0.5044	1.4771
	(0.37)	(5.04)		

TABLE IV-2 (Cont'd)

State	Constant	$(R_{t-1}-R_{t-2})$	R^2	D-W
	Independent Variables			
Benefit-Wage Ratio States				
Alabama	-0.000289 (0.82)	-0.300285 (7.46)	0.6903	1.6847
Delaware	0.000245 (0.34)	-0.167717 (2.78)	0.2363	1.3449
Illinois	-0.000588 (0.85)	-0.330085 (5.40)	0.5380	1.5140
Oklahoma	-0.000679 (1.59)	-0.439838 (5.64)	0.5601	1.6070
Virginia	-0.000611 (1.46)	-0.359021 (5.61)	0.5575	2.1283
Payroll-Decline States				
Arkansas	0.000703 (1.31)	-0.041259 (1.02)	0.0398	1.7441
Montana	-0.000501 (0.85)	-0.209298 (3.25)	0.2808	1.6734
Utah	0.000145 (0.34)	-0.047771 (0.69)	0.0187	3.0296
Washington	-0.000458 (0.75)	-0.115827 (2.91)	0.2532	2.7104

TABLE IV-3

PERCENTAGE DISTRIBUTION OF THE $\hat{\beta}$ COEFFICIENTS

$-\hat{\beta}$	All 51 Coefficients	32 Coefficients RR states[a]	10 Coefficients BR states[a]	5 Coefficients BWR states[a]	4 Coefficients PD states[a]
0 - 0.1	11.77	6.24	10.00	--	50.00
0.1 - 0.2	23.53	28.13	20.00	20.00	25.00
0.2 - 0.3	47.06	43.75	60.00	--	25.00
0.3 - 0.4	11.77	12.50	10.00	60.00	--
0.4 - 0.5	1.96	3.13	--	20.00	--
0.5 - 0.6	1.96	3.13	--	--	--
0.6 - 0.7	1.96	3.13	--	--	--
Unweighted mean	.2366	.2444	.2234	.3194	.1035

[a]RR - Reserve Ratio
BR - Benefit Ratio
BWR - Benefit Wage Ratio
PD - Payroll Decline

The Initial Simulations

The next step in the initial analysis consisted of the simulation of the fund balance for the period 1950 to 1977, using some actual historical data series. The simulation model, that was used, can be expressed formally as follows:

$$\hat{B}_t = \hat{B}_{t-1} + \tau_t m_t N_t - BEN_t + \hat{I}_t \tag{IV-4}$$

$$m_t = m(\tilde{w}_t, w_t, u_t) \tag{IV-5}$$

$$\hat{R}_t = \hat{B}_t / \overline{m_t N_t} \tag{IV-6}$$

$$\hat{\tau}_t = \hat{\tau}_{t-1} + \hat{\alpha} + \hat{\beta}(R_{t-1} - R_{t-2}) \tag{IV-7}$$

$$\hat{I}_t = \hat{B}_t \; I_t / B_t \tag{IV-8}$$

where $\hat{B}$ stands for the predicted fund balance, B for the actual fund balance, N for the number of covered employees, BEN for the amount of total benefits charged to the state fund, $\hat{I}$ for the computed interest earned on the fund, I for the actual interest earned and $\overline{mN}$ for an appropriate moving average of the taxable payroll. The remaining variables have already been defined.

Since mN represents the amount of total taxes credited to the fund, equation (IV-4) states that the change in the predicted fund balance ($\hat{B}_t - \hat{B}_{t-1}$) equals the difference between tax and interest inflows ($\hat{I} + \tau mN$) and benefit outflows (BEN). Equation (IV-6) defines the reserve ratio, and according to equation (IV-8), the computed interest is equal to the product of the computed balance and the actual interest rate.

The following variables were taken as exogenous in the simulations and set equal to their actual historical values: the level of employment (N), the level of benefits (BEN), the taxable wage base ($\tilde{W}$), annual earnings (w), the insured unemployment rate (u), actual interest paid (I), and the actual balance (B). Furthermore, the starting values for the predicted balance and tax rate were equal to the appropriate actual values.

It should be pointed out that the lagged terms in equations (IV-4) and (IV-7) are the predicted and not the actual balance and tax rate. This means differences between actual and predicted fund balances tend to cumulate rather than be corrected in every year. Consequently, the simulations can be used for quite strong tests of our model and its two components.

It seems that there is no ideal simple measure of the "goodness of fit" of the balances predicted by the simulations. Two types of measures come to mind readily. The first measures absolute and the second proportionate differences between $\hat{B}$ and B. Measures of absolute differences are not scalefree and, hence, make interstate comparisons difficult because some states have much larger balances than other. Measures of proportionate differences, on the other hand, have the shortcoming that they become very large and, hence unreliable, when the denominator approaches zero as B and $\hat{B}$ tend to do.

Table IV-4 contains measures of both the absolute and the proportionate differences between $\hat{B}$ and B. The first is simply the mean difference between $\hat{B}$ and B or:

$$\text{Mean Difference} = \frac{1}{n} \sum_{t=1}^{n} (\hat{B}_t - B) \qquad \text{(IV-9)}$$

The mean difference thus measures the dollar amount by which the simulations, on average, over or under predicts the actual fund balance. The second measure is similar to the coefficient of variation. It is the root mean squared difference between $\hat{B}$ and B divided by the mean of B(RMSD):

$$\text{RMSD} = \frac{1}{n} \sqrt{\sum_{t=1}^{n} (\hat{B}_t - B_t)^2} \Bigg/ \frac{1}{n} \sum_{t=1}^{n} B_t \qquad \text{(IV-10)}$$

Examination of the two measures in table IV-4 lead to the following conclusions:

- As a rule, the predicted fund balance ($\hat{B}$) has the same cyclical pattern over time as the actual balance (B).
- Typically, the fund balance predicted by the simulations exceeds the actual fund balance. The average difference between $\hat{B}$ and B is negative in only twelve of the 51 states.

TABLE IV-4

SUMMARY STATISTICS OF DIFFERENCES BETWEEN
ACTUAL AND SIMULATED FUND BALANCES

State	Mean Difference Between $\hat{B}$ and B ($000)	Root Mean Squared Difference Divided by $\bar{B}$
	Reserve-Ratio States	
Arizona	11,239	.22140
Arkansas	7,761	.24910
California	108,555	.14670
Colorado	19,586	.35181
D.C.	-9,139	.21546
Georgia	6,437	.05193
Hawaii	7,741	.46288
Idaho	1,302	.06697
Indiana	40,065	.19354
Iowa	74	.06181
Kansas	26,862	.35246
Kentucky	20,413	.17035
Louisiana	15,390	.15018
Maine	9,998	.39202
Massachusetts	-56,500	.32322
Michigan	72,953	.32620
Missouri	8,151	.07565
Nebraska	239	.07983
Nevada	3,456	.21959

TABLE IV-4 (Cont'd)

State	Mean Difference Between $\hat{B}$ and B ($000)	Root Mean Squared Difference Divided by $\bar{B}$
	Reserve-Ratio States	
New Hampshire	582	.13551
New Jersey	28,931	.25653
New Mexico	3,442	.11427
New York	-297,533	.29168
North Carolina	60,104	.26796
North Dakota	5,367	.52994
Ohio	109,608	.25248
Rhode Island	7,101	.31601
South Carolina	-1,030	.08461
South Dakota	-1,158	.11339
Tennessee	22,866	.23248
West Virginia	-744	.10365
Wisconsin	53,497	.32452
	Benefit-Ratio States	
Connecticut	-67,684	.59359
Florida	30,038	.24007
Maryland	6,397	.30782
Minnesota	63,539	1.16426
Mississippi	26,353	.51736
Oregon	19,104	.26062
Pennsylvania	-198,280	.73963
Texas	19,120	.12596

TABLE IV-4 (Cont'd)

State	Mean Difference Between $\hat{B}$ and B ($000)	Root Mean Squared Difference Divided by $\bar{B}$
	Benefit-Ratio States	
Vermont	-564	.30812
Wyoming	3,613	.29382
	Benefit-Wage-Ratio States	
Alabama	13,819	.24875
Delaware	-1,299	.41877
Illinois	-48,705	.25657
Oklahoma	13,062	.31919
Virginia	-3,135	.13605
	Payroll-Decline States	
Alaska	8,168	.65746
Montana	5,571	.32761
Utah	615	.05904
Washington	-15,349	.21669

- In the initial years the predicted and actual fund balances are usually quite close. Deviations then occur and they are not, as a rule, offset in later years. This indicates that early errors are carried over to later years. Such a carryover could be avoided by using the actual lagged balance (B_{t-1}) in lieu of the predicted one ($\hat{B}_{t-1}$) in equation (IV-4). Such an adjustment would probably improve the short-term predictive power of the simulation models.

- The proportionate root mean squared difference between $\hat{B}$ and B varies from 0.05 to 1.16 and has an unweighted mean of 0.28. In reserve-ratio states, however, this ratio tends to be lower (with a mean of 0.22) than in the other states (with a mean of 0.38).

To sum up: The initial simulation was designed to determine whether the estimated coefficients of the regression equations for the taxable payroll and for the average tax rate sufficiently reliable to yield predicted fund balances that were reasonably close to actual fund balances. For this purpose, employment, benefits the taxable wage base, annual earnings, the unemployment rate, and the interest rate were set equal to their actual historical values. The results indicate that the simulated fund balances have very similar time paths but tend to exceed the actual balances. While improvements in the predicted fund balances are desirable, we proceeded on the assumption that the macroeconometric approach could be used to examine in detail the effects of changes in the parameters of the tax structure.

REVISED ESTIMATION AND SIMULATION

The initial estimation and simulation was designed to gain an overall impression of the suitability of the macroeconometric approach to simulation and forecasting. The initial estimation, however, is not sufficient to answer a set of questions about the relationships between the parameters of the tax strucutre and the level and time path of the fund balance. These questions are addressed in this and the ensuing sections.

Changes in the Specification of the Model

Equation (IV-1) and its econometric counterpart contain explicitly an important parameter of the tax structure, namely the taxable wage base ($\tilde{W}$). Different assumptions about the level of $\tilde{W}$ can be made and the resulting paths of the fund balances can be simulated and compared. By this method the likely effects of changing $\tilde{W}$ can be ascertained. Hence, there is no need to revise the equation for the taxable payroll.

All the other parameters of the tax structure, however, have a primary effect on the tax rate and therefore are reflected by the values of $\hat{\alpha}$ and $\hat{\beta}$ in equation (IV-3). The nature of the relationship between the parameters of the tax structure and the coefficients $\hat{\alpha}$ and $\hat{\beta}$ needs to be determined. Various attempts were made to this by regressing $\hat{\alpha}$ and $\hat{\beta}$ across states against the average values of the tax parameters. But none of the results were very satisfactory. Hence, it was decided to adopt an alternative approach which can be explained briefly as follows.

Let there be k tax parameters which are denoted by $P_i (i=1...k)$. Further, let α and β in equation (IV-2) be linear functions of these parameters.

$$\alpha = \gamma_0 + \sum_{i=1}^{k} \gamma_i P_i \qquad \text{(IV-11)}$$

$$\beta = \delta_0 + \sum_{i=1}^{k} \delta_i P_i \qquad \text{(IV-12)}$$

Equation (IV-2) can then be rewritten as:

$$\tau_t = \gamma_0 + \sum_{i=1}^{k} \gamma_i P_i + \delta_0 R_{t-1} + \left(\sum_{i=1}^{k} \delta_i P_i \right) R_{t-1} \qquad \text{(IV-13)}$$

where, as before, τ and R stand for the average tax rate and aggregate reserve ratio, respectively. According to equation (IV-13) the relationships between the parameters of the tax structure and the coefficients α and β can be ascertained indirectly by regressing the average tax rate (τ) against the tax parameters, the aggregate reserve ratio, and the products of the reserve ratio and the tax parameters.

Equation (IV-13) was fitted to pooled cross-section and time series data. The time series were annual for the period 1962-1977. The states were 30 reserve-ratio states for which adequate data were available. The total number of observations was 483.

The following parameters of the tax structure were used as independent variables in the estimation of equation (IV-13): (i) NEGTAX which is the tax rate which applies to firms with negative balances, (ii) MAXTAX which applies to firms with low positive balances, (iii) SLOPE which is the average gradient $\frac{d\tau}{dR_{t-1}}$ of the sloped part of the tax schedule, (iv) MINRES which is the reserve ratio of the schedule starts, and (v) MINTAX which is the minimum tax paid by employers with relatively large reserve ratios. These five parameters are necessary and sufficient for a full description of the typical tax schedule in reserve-ratio states. In a first set of regressions, equation (IV-13) was fitted to the time series data of each state separately. The estimated coefficients were then grouped by size and each size group was given the same dummy variable in the overall regression. As a result the overall regression has 58 independent variables.

In view of the large number of coefficients and the difficulties of interpretation, let us simply state verbally the main results of the regression analysis:

- The unadjusted R^2 is 0.912 and the Durbin-Watson statistic is 0.97. Further, 40 of the 48 regression coefficients have t-ratios in excess of 2, many of them substantially so. Thus, while the overall fit of the regression is good, there is evidence of significant positive autocorrelation in the residuals. Moreover, inspection of the residuals suggests that the autocorrelation occurs not between states but within states between years.

- NEGTAX tends to have a negative effect on α and a positive one on β (which is negative), so that a rise in NEGTAX tends to reduce and to flatten the line between τ and R_{t-1}. This result is counterintuitive. Furthermore, the signs are reversed when the state dummies are omitted.

- MAXTAX has a strong positive effect on α and a strong negative one on β, so that a rise in MAXTAX tends to raise and to make steeper the line between τ_t and R_{t-1}. This is a plausible result.

- SLOPE (defined as a negative number) has a positive effect on α and a negative one on β, so that a rise in SLOPE tends to raise and to make steeper the line between τ_t and R_{t-1}. This result is also somewhat counterintuitive.

- MINRES has a strong positive effect on α and a strong negative one on β, so that a rise in MINRES raises and makes steeper the line between τ_t and R_{t-1}.

- MINTAX has a positive impact on α and a mixed one on β, so that a rise in MINTAX raises the line between τ and R_{t-1} and may make it either steeper or flatter.

The above summary suggests that the tax parameters typically affect α and β in opposite directions, so that the line between τ_t and R_{t-1} rises and becomes steeper and vice versa.

The Revised Simulations

In order to be able to discover inefficiencies in the system and to determine tradeoffs among policy objectives, it is necessary to discover the relationships between the parameters of the tax structure and the level and time path of the fund balance. This was done by varying the parameters, one by one, and then by simulating the model and tracing out the resulting fund balance.

The revised simulation model is very similar to the initial one. The only substantive difference consists of the substitution of equation (IV-13) for equation (IV-7), so that the parameters of the tax structure now have a direct impact on the tax rate and, hence, on the fund balance. The simulation period now is 1962 to 1977 and, as before, the level of employment (N), annual earnings (w), the unemployment rate (u), and the interest rate are treated as exogenous and fixed at their historical values.

The first simulation run consisted of a "base case" for which all the parameters were fixed at their historical mean levels. Then the parameters were changed, one at a time, over quite a large range. Summary statistics were computed from the resulting simulated fund balance, and the response of these statistics to the ceteris paribus changes in the tax parameters were estimated. The coefficients measuring these responses are the input to the calculations of inefficiences and tradeoffs to be discussed in the ensuring section.

INEFFICIENCIES AND TRADEOFFS

In order to be able to tell whether a particular parameter change "improves" the fund balance, we must first determine what constitutes our improvement. Hence, the desirable properties of the fund balance are discussed first. Thereafter, the empirical results are presented.

Desirable Properties of the Fund Balance

In accordance with the arguments presented in part I of this report, we postulate a collective utility function which has three determinants: the mean balance, the probability of becoming insolvent, and the amount of cash-flow smoothing.

- An increase in the mean balance, holding the other two arguments constant, reduces collective utility because the resources could have been used for productive purposes.

- An increase in the probability of becoming insolvent, other things equal, reduces collective utility because it forces certain changes on the state. The probability of becoming insolvent, in turn, is determined by the mean and variance (and possibly higher moments) of the fund balance. The higher the mean and the lower the variance the less likely it is that a state becomes insolvent. Hence, through this argument alone, a rise in the mean and a reduction in the variance raise the collective utility.

- The amount of cash-flow smoothing (or the extent of countercyclical phasing) of the tax payments has a positive effect on collective utility. The lower the proportion of total taxes firms have to pay in recessions and the higher the proportion payable in booms the better is the tax system.

Since the probability of becoming insolvent depends on the mean and variance, the collective utility function can be written formally as follows:

$$U = U(M, Pr(M,V), C) \qquad \text{(IV-14)}$$

where M stands for the mean, V for the variance, and C for the amount of cash-flow smoothing. The total impact of M is now ambiguous because $\frac{dU}{dM} = \frac{\partial U}{\partial M} + \frac{\partial U}{\partial Pr} \frac{\partial Pr}{\partial M}$ and all three partial derivatives are negative. We postulate that for negative and possibly small positive mean balance $\frac{dU}{dM}$ is positive while for large mean balances $\frac{dU}{dM}$ is negative. Hence, there exists an optimum mean balance M*. Further, the impact of V on U is negative and that of C on U is positive.

Suppose now that $M^* < M$ and that a particular parameter change reduced M and V and raises C. Then this parameter change unambiguously raises collective utility and should, therefore, be implemented. We call this a gross inefficiency in the system.

Gross inefficiencies, however, are likely to be rare. Let us, therefore, turn to net inefficiencies. Suppose that $M^* < M$ and that a particular parameter change reduces all three arguments, M, V, and C. This parameter change is no longer unambiguously desirable. We can now, however, change a second parameter, so as to offset the influence of the first on, say C, and then compute $\left.\frac{dM}{dV}\right|_{C=\overline{C}}$ and if this derivative is positive then the appropriate changes in the two parameters can reduce both M and V while leaving C unaffected.

The above relationships can be derived formally as follows. Consider any two parameters P_i and P_j and let M, V, and C be functions of these two parameters.

Total differentiation then yields:

$$dM = \frac{\partial M}{\partial P_i} dP_i + \frac{\partial M}{\partial P_j} dP_j \tag{IV-15}$$

$$dV = \frac{\partial V}{\partial P_i} dP_i + \frac{\partial V}{\partial P_j} dP_j \tag{IV-16}$$

$$dC = \frac{\partial C}{\partial P_i} dP_i + \frac{\partial C}{\partial P_j} dP_j \tag{IV-17}$$

Next let us postulate that P_i and P_j should be changed so as to leave C constant, then

$$\frac{dP_i}{dP_j} = - \frac{\partial C}{\partial P_j} \bigg/ \frac{\partial C}{\partial P_i} \tag{IV-18}$$

By dividing equation (IV-15) by equation (IV-16) and after substitution for $\frac{dP_i}{dP_j}$ we obtain:

$$\left.\frac{dM}{dV}\right|_{C=\overline{C}} = \frac{- \frac{\partial M}{\partial P_i} \frac{\partial C}{\partial P_j} \bigg/ \frac{\partial C}{\partial P_i} + \frac{\partial M}{\partial P_j}}{- \frac{\partial V}{\partial P_i} \frac{\partial C}{\partial P_j} \bigg/ \frac{\partial C}{\partial P_i} + \frac{\partial V}{\partial P_j}} \tag{IV-19}$$

These conditional derivatives can be computed for any pair of parameters in three different spaces, namely $\left.\frac{dM}{dV}\right|_{C=\overline{C}}$, $\left.\frac{dV}{dC}\right|_{M=\overline{M}}$ and $\left.\frac{dM}{dC}\right|_{V=\overline{V}}$. The signs of these derivatives indicate net efficiencies or inefficiencies according to table IV-5.

TABLE IV-5

NET INEFFICIENCIES AND EFFICIENCIES AND THE SIGNS OF THE CONDITIONAL DERIVATIVES

Derivative	M in Relation to M*	Net Inefficiency	Net Efficiency
$\left.\frac{dV}{dM}\right\|_{C=\overline{C}}$	M*<M	+	-
	M*>M	-	+
$\left.\frac{dC}{dM}\right\|_{V=\overline{V}}$	M*<M	-	+
	M*>M	+	-
$\left.\frac{dV}{dC}\right\|_{M=\overline{M}}$		-	+

The empirical task can now be stated clearly: It consists of discovering gross and net inefficiencies which may exist in the unemployment insurance fund balances of various states.

Empirical Evidence on Inefficiencies and Tradeoffs

The summary statistics of the fund balances which, in accordance with the discussion in the previous section, needed to be computed are the mean, the variance, and the measure of cash-flow smoothing or countercyclical impact. The mean and variance need no further elaboration. Various measures of cash-flow smoothing have been considered. As explained in part V of this report, the following measure seems to have desirable properties:

$$C = \frac{1}{n} \sum_{t=1}^{n} (T_t - B_t)(\overline{B} - B_t) \qquad \text{(IV-20)}$$

where T_t stands for total taxes collected, B_t for total benefits paid, and $\bar{B}$ for the mean level of benefits ($\bar{B}$ may also be interpreted as the trend level of benefits). When firms have laid off a large number of workers, then $(\bar{B}-B) < 0$ and good cash-flow smoothing implies that $(T_t-B_t) < 0$, so that the product $(T_t-B_t)(\bar{B}-B_t)$ is positive. Similarly, when there are few layoffs, then $(\bar{B}-B_t) > 0$ and good cash-flow smoothing implies that $(T_t-B_t) > 0$, so that $(T_t-B_t)(\bar{B}-B_t)$ is again positive. Thus, the larger is the cash-flow smoothing measure C, the more cash-flow smoothing takes place.

As has already been mentioned, the fund balance was simulated on the assumption that all but one of the six tax parameters ($\tilde{W}$, NECTAX, MAXTAX, SLOPE, $\overline{\text{MINRES}}$, and MINTAX) were at their historical mean levels, and one parameter was allowed to take on different values over a realistic range. For each simulation run, the mean (M), variance (V), and cash-flow smoothing measure (C) of the fund balance were computed. Then these measures were regressed on the parameter, so that the regression coefficients can be regarded as approximations to $\frac{\partial M}{\partial P_i}$, $\frac{\partial V}{\partial P_i}$ and $\frac{\partial C}{\partial P_i}$ (i=1...6). The signs of these regression coefficients are presented in table IV-6. There were thirty reserve ratio states for which all the relevant data were available. The numbers in table IV-6 refer to the numbers of states which had the indicated sign in the appropriate relationship.

Let us interpret the sign patterns in table IV-6 in terms of the definition of gross inefficiencies presented earlier. Two regimes must be distinguished. In the first, $M^*<M$ and then a gross inefficiency is said to exist when a parameter change reduced M and V and raises C. This means that two sign patterns emerge: - - + for a rise in the parameter and + + - for a reduction in the parameters. In the second regmine, $M^*>M$ and then a gross inefficiency is said to exist when a parameter change raises M and C and reduces V. Hence, there are two further sign patterns + - + for a rise in the parameter and - + - for a fall in the parameter. Inspection of table IV-6 indicates that none of the four sign patterns is dominant. This impression is supported by detailed examination of the sign patterns for individual states. The results are summarized in table IV-7. Lines 1 through 6 refer to the first regime when $M^*<M$ and lines 7 through 10 to the second regime when $M^*>M$. The following points emerge from an examination of the evidence in tables IV-6 and IV-7:

- There are no widespread gross inefficiencies in the unemployment insurance financing mechanisms.

- There are virtually no gross inefficiencies under the second regime when M*>M.

- In relatively small number of states, there appear to be gross inefficiencies if the first regime (M*<M) is assumed.

- It is interesting to note that the states with gross inefficiencies under the first regime do not appear to be random drawings from the total pool of reserve-ratio states. Thus, SD appears five times, NE and ND four times, and IN, KS, AZ, LA, WV, and AR each three times.

TABLE IV-6

SIGNS OF THE RELATIONSHIPS BETWEEN TAX PARAMETERS AND PROPERTIES OF FUND BALANCE

Tax parameter	Properties of fund balance: Mean		Variance		Cash-flow smoothing	
	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.
$\tilde{w}$	26	4[a]	28	2	22	8
NEGTAX	12	18	24	6	29	1
MAXTAX	28	2	11	19	0	30
SLOPE	18	12	8	22	5	25
MINRES	21	9	6	24	0	30
MINTAX	24	6	14	16	6	24

[a]These negative coefficients are caused by nonlinearities and ought to be ignored.

Let us now turn to an examination of net inefficiencies. As mentioned before, net inefficiencies exist when pairwise changes in the tax parameters improve the fund balance in two respects while leaving the third respect unchanged. Since there are six tax parameters, there are 15 possible pairwise changes.

TABLE IV-7

SPECIFIC GROSS INEFFICIENCIES

Parameter change	Sign pattern	Number of states	States
1. Decline in $\tilde{W}$	+ + -	5	CO, IN, MA, OH, SD
2. Rise in NEGTAX	- - +	6	IN, KS, NE, ND, OH, SD
3. Decline in MAXTAX	+ + -	11	AZ, CO, IN, KS, KY, LA, NE, NC, ND, SD, WV
4. Rise in SLOPE[a]	- - +	4	AR, NE, NM, SD
5. Fall in MINR	+ + -	6	AZ, AR, KS, LA, ND, WV
6. Fall in MINTAX	+ + -	8	AZ, AR, LA, NE, NM, ND, SD, WV
7. Rise in $\tilde{W}$	+ - +	1	HI
8. Fall in $\tilde{W}$[b]	- + -	4	MO, ND, TN, WV
9. Fall in MAXTAX	- + -	1	SC
10. Fall in SLOPE[a]	- + -	1	ME

[a] SLOPE is measured as a positive number. A rise in slope means that the tax schedule get steeper over the relevant range.

[b] This result is based on the four negative coefficients in the $\tilde{W}$-M relationship as mentioned under table 6, they are unreliable.

The outcome of each pairwise change in parameters can be described by three signs. The first sign refers to the direction in which the two parameters are changed: $\left.\frac{dP_i}{dP_j}\right|_{X_k=\overline{X}_k}$ where X_k stands for the fund measure that is held constant (either M, V, or C). The second sign refers to the impact of P_j on X namely $\left.\frac{dX_i}{dP_j}\right|_{X_k=\overline{X}_k}$.

Finally, the third sign refers to the conditional derivative $\left.\frac{dX_i}{dX_j}\right|_{X_k=\overline{X}_k}$. Suppose, for instance, that the first regime applies so that M*<M and that we are holding C constant. Then all sign patterns for which the last sign is negative $\left.\frac{dM}{dV}\right|_{C=\overline{C}} < 0$ represent an efficient tradeoff between M and V. The inefficient sign patterns can be interpreted as follows:

+ + +: a decrease in both P_i and P_j reduces both M and V

− + +: a decrease in P_j and an increase in P_i reduce both M and V

− − +: an increase in P_j and a decrease in P_i reduce both M and V

+ − +: an increase in both P_i and P_j reduces both M and V.

Similar sign patterns can be derived for the relationship between M and C as well as V and C.

The frequencies of sign patterns that resulted from the research are presented in tables IV-8, IV-9, and IV-10 for the M-V, the M-C and the V-C relationships, respectively. The following general but tentative conclusions can be drawn from an examination of tables IV-8, IV-9, and IV-10.

- There are no specific inefficiencies which apply to a large majority of states. The largest frequency of a sign pattern that might imply an inefficiency is 17, and there are only 17 frequencies of 10 and above of sign patterns that might imply inefficiencies.

- If it is assumed that the actual mean balance is <u>below</u> the optimal mean balance (M*>M) in all states, then the evidence suggesting inefficiencies is very weak because all the relevant frequencies are below 10.

- If it is assumed that the actual mean balance is <u>above</u> the optimal mean balance (M*<M) in all states, then there is some evidence suggesting inefficiencies. Each parameter participates in five pairwise parameter changes, and the direction of change to improve the properties of the fund balance need not be the same in the five pairwise changes. When only frequencies of ten and above are considered, however, the numbers in tables IV-8 and IV-9 suggest that

TABLE IV-8

FREQUENCY OF SIGN PATTERNS IN THE M-V RELATIONSHIP HOLDING C CONSTANT

Sign Pattern	$P_i = \tilde{W}$					P_i = NEGTAX				P_i = MAXTAX			P_i = MINRES		P_i = MINTAX	
	P_j					P_j				P_j			P_j		P_j	
	NEGTAX	MAXTAX	MINRES	MINTAX	SLOPE	MAXTAX	MINRES	MINTAX	SLOPE	MINRES	MINTAX	SLOPE	MINTAX	SLOPE	SLOPE	
+ + +	5	12	13	10	5	13	9	10	1	0	5	11	4	9	8	If M*<M decrease P_i and P_j If M*>M then efficient
− + +	1	1	1	4	0	1	1	3	7	3	6	1	10	1	1	If M*<M increase P_i decrease P_j If M&>M then efficient
− − +	13	4	4	5	12	0	0	0	3	17	9	5	5	5	11	If M*<M decrease P_i increase P_j If M*>M then efficient
+ − +	1	0	0	0	0	6	8	7	6	0	0	2	0	3	2	If M*<M increase P_i and P_j If M*>M then efficient
− − −	5	0	0	1	4	0	0	0	3	6	6	5	7	5	3	If M*<M then efficient If M*>M increase P_i decrease P_j
+ + −	0	9	8	6	4	4	4	3	0	0	1	4	2	5	5	If M*<M then efficient If M*>M increase P_i and P_j
+ − −	4	1	1	2	4	5	7	6	4	0	0	2	0	2	0	If M*<M then efficient If M*>M decrease P_i and P_j
− + −	1	3	3	2	1	1	1	1	6	4	3	0	2	0	0	If M*<M then efficient If M*>M decrease P_i increase P_j

TABLE IV-9

FREQUENCY OF SIGN PATTERNS IN THE M-C RELATIONSHIP HOLDING V CONSTANT

Sign Pattern	$P_i = \tilde{W}$, P_j: NEGTAX	MAXTAX	MINRES	MINTAX	SLOPE	P_i = NEGTAX, P_j: MAXTAX	MINRES	MINTAX	SLOPE	P_i = MAXTAX, P_j: MINRES	MINTAX	SLOPE	P_i = MINRES, P_j: MINTAX	SLOPE	P_i = MINTAX, P_j: SLOPE	
+ + +	2	7	7	6	2	4	3	3	0	1	1	5	3	5	5	If M*<M then efficient If M*>M increase P_i and P_j
− + +	5	2	1	4	9	0	1	2	6	5	3	0	2	0	1	If M*<M then efficient If M*>M decrease P_i increase P_j
− − +	6	2	2	2	6	0	0	0	2	7	7	4	8	5	3	If M*<M then efficient If M*>M increase P_i decrease P_j
+ − +	3	2	3	1	5	8	8	6	5	0	0	1	0	1	1	If M*<M then efficient If M*>M decrease P_i and P_j
− − −	11	0	0	0	4	0	0	0	1	7	6	5	5	6	11	If M*<M decrease P_i increase P_j If M*>M then efficient
+ + −	0	9	16	9	2	8	9	4	0	7	11	14	9	11	7	If M*<M decrease P_i and P_j If M*>M then efficient
+ − −	3	0	0	0	1	2	4	5	7	0	0	0	0	1	1	If M*<M increase P_i and P_j If M*>M then efficient
− + −	0	8	1	8	1	8	5	10	9	3	2	1	3	1	1	If M*<M increase P_i decrease P_j If M*>M then efficient

TABLE IV-10

FREQUENCY OF SIGN PATTERNS IN THE V-C RELATIONSHIP HOLDING M CONSTANT

Sign Pattern	$P_i = \hat{w}$					P_i = NEGTAX				P_i = MAXTAX			P_i = MINRES		P_i = MINTAX	
	P_j					P_j				P_j			P_j		P_j	
	NEGTAX	MAXTAX	MINRES	MINTAX	SLOPE	MAXTAX	MINRES	MINTAX	SLOPE	MINRES	MINTAX	SLOPE	MINTAX	SLOPE	SLOPE	
+ + +	18	0	0	1	7	5	2	9	10	0	0	0	0	0	2	Efficient
− + +	6	0	0	1	6	0	0	0	2	8	14	15	9	13	14	Efficient
− − +	0	22	16	16	6	11	11	14	15	9	9	1	9	1	1	Efficient
+ − +	0	5	10	7	4	13	16	7	2	10	7	12	11	14	8	Efficient
− − −	4	0	0	1	5	0	0	0	0	0	0	0	0	0	2	Decrease P_i increase P_j
+ + −	1	3	4	3	2	1	0	0	0	0	0	1	0	0	0	Decrease P_i and P_j
+ − −	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2	Increase P_i and P_j
− + −	1	0	0	1	0	0	0	0	1	3	0	1	1	1	1	Increase P_i decrease P_j

the taxable wage base ($\tilde{w}$), the maximum tax for positive balances (MAXTAX), and the minimum tax (MINTAX) should all be lowered in all relevant pairwise changes if the variance, the mean balance, and the cash-flow smoothing measure are to be reduced.

- While the evidence in tables IV-8 and IV-9 can be interpreted appropriately only when an assumption is made about the relative magnitude of M* and M, the same is not true of the frequencies in table IV-10 for which M is held constant. The numbers in table 10 suggest very strongly, however, that there are no inefficiencies in V-C space.

The evidence presented in this section thus suggests that substantial gross and net inefficiencies are likely to exist only if the actual typically exceeds the optimal mean fund balance. If that were true, then $\tilde{w}$, MAXTAX, and MINTAX ought to be reduced. It should be remembered, however, that even if M*>M inefficiencies exist only in relatively few states.

CONCLUSIONS

Two basic questions have been addressed in the research underlying this part of the report. First, is the macroeconometric approach suitable for forecasting and simulation purposes? Second, is there any evidence of substantial inefficiencies in the unemployment insurance financing systems?

The answer to the first question is a tentative yes. It would appear that the macroeconometric approach can be used for simulation and especially for relatively short-term forecasting.

The answers to the second question has to be fairly qualified. Certainly inefficiencies are rare and can be discerned only when it is assumed that the actual mean fund balance typically exceeds the optimal mean fund balance.

The analysis of inefficiencies has led to one important implication for policy: There does not appear to be a specific parameter [illegible]ange which would unambiguously improve the properties of the fund [illegible]ances in all or even a majority of states. States differ signi[illegible]ly in their economic environments, as well as the structure [illegible] tax systems, so that particular inefficiencies are ob[illegible] some but not in other states. A general implementation [illegible]lar parameter change is, therefore, highly likely to be [illegible]

[illegible]ems arise in connection with interstate differ[illegible] optimal mean fund balance (M*) is very likely to [illegible] state, and this reduces further the generality [illegible]ommendations. Second, in the case of efficient choice frontiers, the properties of the fund balance can usually be improved but only if we have some knowledge of the parameters of the collective utility function. These parameters are also likely to vary substantially from state to state, and hence, a general implementation of specific parameter changes is again likely to be inappropriate.

In view of the heterogeneity of our results, it seems that only fairly general policy recommendations are justified. They may consist of exhortations to states to ensure that their fund balances have desirable properites or of incentives by the Federal government to induce states to change their tax systems in certain ways. These incentives might be built into the Federal lending policies, so that prolonged and substantial borrowing by states is penalized heavily.

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PART V

MEASURING THE COUNTERCYCLICAL IMPACT OF UI TAX SYSTEMS

PART V

MEASURING THE COUNTERCYCLICAL IMPACT OF UI TAX SYSTEMS[1]

BACKGROUND

The countercyclical impact of UI has always been viewed as an important attribute of the program. UI pumps money into the economy in a downturn automatically, independent of the legislative arena where lags often turn countercyclical intentions into procyclical programs. Moreover, UI puts money where it is needed, into the hands of the unemployed. Because it maintains spending power, UI helps prevent the kind of contagious unemployment that is a central feature of Keynesian models of the economy.

It is certainly not clear that the UI program does prevent unemployment through its countercyclical impact.[2] It is clear, however, that benefit payments are greater than taxes during recessions and that taxes exceed benefits during booms. Thus, UI fund balances decline during recessions and increase during booms. We have assumed in this study that this is a desirable feature; other things being equal, a superior UI system raises its taxes during a boom rather than in a recession.

MEASURING COUNTERCYCLICAL POWER

To evaluate different tax systems, we need a measure of the degree to which tax payments are countercyclical. Previous studies have looked at tax rates or taxes over the cycle in order to make a judgment whether the system is countercyclical.[3] Typically, taxes or tax rates were correlated with some measure of the cycle (e.g., unemployment rates or benefit payments). The system was judged to be countercyclical according to whether or not the correlation coefficient had the appropriate sign.

For this project, we need more than the ability to determine whether or not a UI system is countercyclical; we need a rank ordering of different systems.

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[1]Dr. John Berning, from The Institute of Naval Studies, helped in the design of the countercyclical measure described here.
[2]For a discussion of the countercyclical impact of UI see K. Classen (1977).
[3]For a review of previous studies, see Joseph Becker and Daniel Hamermesh (1977).

The correlation coefficient, a function of the fit of the least squares line between taxes (or tax rates) and the cycle measure, does not provide a good rank ordering. The correlation coefficient does not depend on the slope of the line, which, in this case, measures on the amount that taxes go up when unemployment goes down. The regression coefficient, another candidate, does not weight goodness-of-fit. We want a measure that gives weight to both goodness-of-fit and slope. The measure of countercyclical power (C) that we have used in this paper is:

$$C = \sum_t (T_t - B_t)(\bar{B} - B_t)$$

where

T_t = taxes collected during period t

B_t = benefits paid during period t

$\bar{B}$ = the average yearly amount of benefits paid during the timespan for which the measure is being calculated.

Tax system A is measured as more countercyclical than tax system B if C(A) is larger than C(B).

The measure sums products of two factors, one for the size of the countercyclical impulse (T_t-B_t) and the other for the timing $(\bar{B}-B_t)$. The first factor measures how much money is being pumped into or drawn out of the economy. When $T_t>B_t$, the UI program is drawing funds out of the rest of the economy. Conversely, when $T_t<B_t$, money is flowing from the UI program to the rest of the economy. The second factor $(\bar{B}-B_t)$ puts a weight on each yearly impulse according to the cyclical position of the economy. If benefit schedules are constant, then $\bar{B}>B_t$ in a boom and $B<B_t$ in a recession. Thus, C for any year (C_t) will be positive

if $(T_t-B_t) > 0$ and $(\bar{B}-B_t) > 0$

or $(T_t-B_t) < 0$ and $(\bar{B}-B_t) < 0$

The C is positive (good) if money is withdrawn from the economy during a boom or money is pumped in during a recession.

Conversely, C_t is negative

if $(T_t - B_t) < 0$ and $(\bar{B} - B_t) > 0$

or $(T_t - B_t) > 0$ and $(\bar{B} - B_t) < 0$.

Any system that takes money out of the economy in a recession or adds money in a boom gets a poor rating $(C<0)$. The absolute value of C is a function of the size of the dollar flow and the amplitude of the cycle.

The properties of the countercyclical function can be illustrated by considering a few classes of tax systems.

1. $T_t = B_t$
   This system sets taxes equal to benefits each year. The balance is the same every year; no money flows into or out of the rest of the economy. $C = 0$.

2. $T_t = \bar{B}$
   Taxes are the same every year. If benefits fluctuate from year to year, then

   $$C = \sum_t (\bar{B} - B_t)^2 \text{ and } C > 0.$$

3. $\bar{B} - B_t = \sin t$
   $T_t - B_t = k(\sin t + c)$
   Here, the cycle is represented as a sine wave. The countercyclical nature of the tax system will depend on k (the amplitude of the impulse) and c (the timing) and the number of periods over which the measure is calculated.

$$C = \sum_{0}^{t} (T_t - B_t)(\bar{B} - B_t)$$

$$= \int_0^t k \sin(t+c) \sin t \, dt$$

$$= \int_0^t k \frac{1}{2} (\cos(c) - \cos(2t+c))dt$$

$$= \frac{k}{2} \cos(c) \cdot t \Big|_0^t - \frac{k}{4} \sin(2t+c) \Big|_0^t$$

$$= \frac{kt}{2} \cos(c) - \frac{k}{4} \sin(2t+c) + \frac{k}{4} \sin(c) \quad .$$

For an integral number of periods ($t = n\pi$)

$$C = \frac{kn\pi}{2} \cos c$$

$$\frac{dC}{dc} = - \frac{kn\pi}{2} \sin c$$

$$\frac{d^2C}{dc^2} = - \frac{kn\pi}{2} \cos c \quad .$$

Thus, C reaches a maximum of $\frac{kt}{2}$ when $c = 0$ since $dC/dc = 0$, $d^2C/d^2c < 0$. The net tax flow into the economy is highest when benefits are lowest. This case is illustrated in figure V-1.

C reaches a minimum when $c = \pi$. In this case, illustrated in figure V-2, taxes reach a peak in a recession.

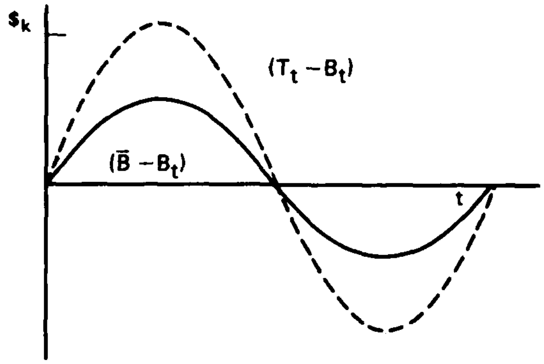

FIG. V-1

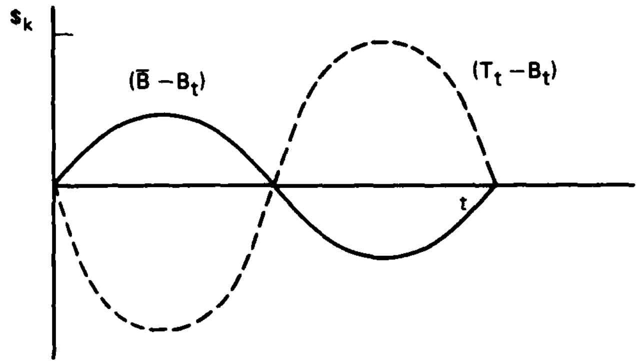

FIG. V-2

MODIFICATIONS AND CROSS-STATE COMPARISONS

In this paper, we have used the above countercyclical measure to evaluate fund balances that have been simulated with different tax schedules. In each comparison, the benefit payments are the same, only the tax flows differ. Our C measure is not suitable as is for cross-state comparisons because benefit payments differ across states. Our C measure would give a better ranking to a big state, other things equal, and it does not account for changes in coverage and benefit levels.[1] High benefits need

[1]For simulations within a state, we assume that changes in coverage and benefit levels will affect the absolute value of C, not the ranking over tax schedules. We used ($\bar{B}$-B_t) because we wanted to use the same countercyclical measure for all three simulation models, and the stylized-state model does not yield an unambiguously defined unemployment rate.

not be associated with a recession; they may be associated with legislative changes in the benefit schedule.

In order to make cross-state comparisons, we made the following adjustments in C:

1. $(T_t - B_t)$ was divided by $\overline{B}$ to account for differences in the size of the state.

2. Unemployment rates were substituted for benefit payments as a measure of the cycle. Unemployment rates were adjusted for changes in the composition of the labor force to make some correction for alleged increases in the natural rate of unemployment.

Thus, the adjusted (for cross-state comparison) countercyclical measure C(2) is

$$C(2) = \sum_t \left(\frac{T_t - B_t}{\overline{B}} \right) (\overline{U}^* - U^*_t)$$

$$U^*_j = \frac{U^*_{us}}{U_{us}} \cdot U_j$$

where

U^*_j = adjusted unemployment rate in state j

U^*_{us} = adjusted unemployment for United States as a whole[1]

U_{us} = insured unemployment rate for U.S. as a whole (<u>Handbook</u>, p. 174, Col. 31)

U_j = insured unemployment rate for state j (<u>Handbook</u>, Col. 31).

The value of C(2), using historical values of taxes and benefits, for 1947 through 1976 is given in table V-1 for each state. All dollar values have been converted to constant dollars using the CPI. The best state is Michigan, which during these years was a reserve-ratio state. Utah, the worst state, used the payroll decline method of experience rating.

[1]From Wachter and Wachter (1978).

TABLE V-1

COUNTERCYCLICAL MEASURES BY STATE 1947-1976

STATE	C(2)
AL	3.9426
AK	10.7562
AZ	8.2444
AR	4.9159
CA	2.4590
CO	4.1814
CT	14.5427
DE	5.9918
DC	4.0042
FL	3.7676
GA	10.8458
HI	2.5828
ID	0.2023
IL	6.5865
IN	10.0941
IA	3.3508
KS	5.2214
KY	7.8206
LA	3.2318
ME	5.6503
MD	4.5667
MA	4.0859
MI	20.2801
MN	2.9782
MS	10.2843
MO	2.6762
MT	5.5874
NE	2.3669
NV	3.1162
NH	14.0085
NJ	2.2763
NM	5.9482
NY	0.3798
NC	10.1493
ND	2.3677
OH	12.6183
OK	0.2212
OR	6.1094
PA	9.7537
RI	11.6089
SC	12.4667
SD	0.9468
TN	8.8149
TX	2.3922
UT	-0.1340
VT	9.8970
VA	5.5325
WA	13.4534
WV	12.6329
WI	5.3288
WY	6.8247

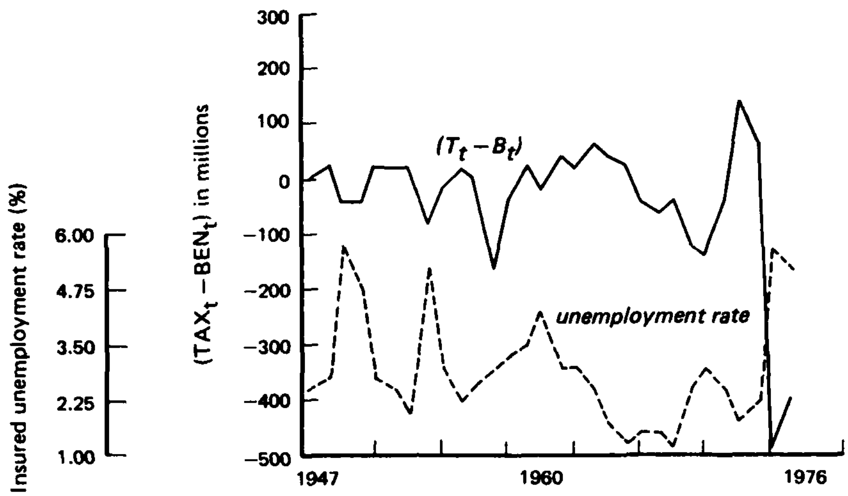

FIG. V-3: ILLINOIS

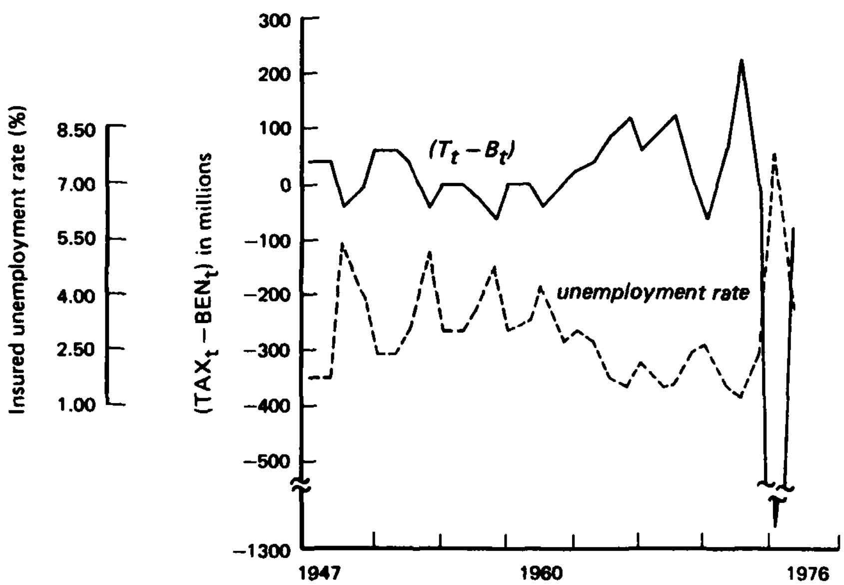

FIG. V-4: SOUTH CAROLINA

There are four major types of experience ratings currently in use[1]

1. Reserve Ratio (1) where the last year's taxable payroll is used to calculate the tax rate.

2. Reserve Ratio (3) where the tax rate is a function of the average taxable payroll over the last three years.

3. Benefit Ratio.

4. Benefit Wage Ratio.

The states were grouped by type of experience rating. Nine states could not be classified, because they use a combination of systems, or because they changed systems over the period (1947-1976). The average value of C(2) by type of experience rating for the remaining states is given in table V-2. The single-year, reserve-ratio states have the highest (best) score, while the benefit-wage-ratio states have the lowest score.

TABLE V-2

COUNTERCYCLICAL MEASURE BY TYPE OF EXPERIENCE RATING

	Number of States[a]	C(2)
Reserve Ratio (single year payroll)	5	10.195
Benefit Ratio	7	6.954
Reserve Ratio (3 year average payroll)	25	5.676
Benefit Wage Ratio	5	4.455

[a]Nine states could not be classified by any single type of experience rating.

[1]The payroll-decline method is no longer used exclusively by any state.

All four systems of experience rating base the tax rate in period t (τ_t) on some measure of benefit experience (MBE) relative to payrolls (PAY):

$$\tau_t = MBE/PAY$$

All systems of experience rating, except the single-year, reserve ratio, use an average of three or more years of payroll in the tax rate calculation. The single-year, reserve-ratio system uses only the last year's payroll. Thus, in a year following a payroll decline, when benefit payments are high, the single-year, reserve-ratio system will have a smaller increase in tax rates, other things equal, than the other three types of systems. This slow response of the tax rates to changing economic conditions means that ($T_t - B_t$) the first term in our C measure will be larger on average in single-year, reserve-ratio states than in states with other types of experience rating.

Figures 3 and 4 show the tax and benefit patterns and the insured unemployment rates in two states with different types of experience rating. South Carolina, a single-year, reserve-ratio state, has the seventh highest C measure among all states but an average C measure for single-year states. Illinois ranks twentieth among all states, but it has the highest C among the benefit-wage-ratio states. The graphs show why South Carolina gets a higher C (12.47) than Illinois (6.57). In South Carolina, the peaks in ($T_t - B_t$) have the same timing and relative amplitude as the troughs in unemployment. This mirror-image pattern is not so apparent in Illinois, especially in the sixties.

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