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Roy W. Bahl
Georgia State University, rbahl@gsu.edu

Richard Hawkins
Georgia State University

Robert E. Moore
Georgia State University, rmoore@gsu.edu

David Sjoquist
Georgia State University, sjoquist@gsu.edu

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USING MICROSIMULATION MODELS FOR REVENUE FORECASTING IN DEVELOPING COUNTRIES

Roy Bahl, Richard Hawkins,
Robert E. Moore and David L. Sjoquist
Policy Research Center
College of Business Administration
Georgia State University
Atlanta, Georgia 30303-3083

ABSTRACT

The use of microsimulation models for revenue forecasting in developing countries is addressed and contrasted to some of the alternative forecasting techniques. Given the problems of many of the alternative techniques, microsimulation models are often found to be the preferred revenue estimation method. The microsimulation revenue estimation is illustrated with data for the Jamaican personal income tax. Details for the example related to the data requirements, problems, and the necessary assumptions for obtaining revenue estimates are discussed and several alternate tax policy changes are simulated and presented.

INTRODUCTION

This paper is concerned with the use of microsimulation models in forecasting tax revenue in developing countries. More specifically, the paper focuses on forecasting personal income tax revenues under alternative tax reform policy proposals. Government officials need reasonably accurate forecasts of how the adoption of alternative rate and base structures will affect tax revenue and the distribution of tax burdens, not only for the year in which the reform is adopted, but for two or three out years as well. Microsimulation models provide a vehicle for generating such forecasts, and are arguably preferable to the alternatives.

In this paper we describe how tax simulation models work and the advantages and disadvantages of relying on them for forecasts. We illustrate their use from a recent application of the technique to tax reform proposals in Jamaica.

MICROSIMULATION MODELS

Microsimulation models are exercises in microeconomics generally designed to estimate the effects across individual economic agents (taxpayers, firms, workers, program participants, etc.) resulting from policy or exogenous changes. Microeconomic simulation models grew out of the work of Orcutt[(1)] and Orcutt, Greenberger, and Rivlin[(2)] and in the last three decades their use has expanded and their complexity has increased.

In their simplest form, microeconomic simulation models consist first of a data base that contains observations at the micro level of some important sector of the economy, e.g., actual and potential taxpayers. Depending upon the model, the observations might be individuals, households, firms, etc. The second component of the model is a set of instructions as to how the data base will be manipulated as a result of some policy change. For example, the data base might consist of information on taxpayers, including sources of income, expenditures by type (deductions), and other relevant information. The rules are a set of statements used to calculate the tax liability for each unit in the data base. By altering the rule statements, the tax liability for alternative tax policies can be calculated and compared, and it is thus possible to determine the differences in the level of revenue, as well as the distribution of revenue. An example of a microeconomic simulation model for analyzing tax policy is the MERGE file developed at the Brookings Institution.(3) The MERGE file combines data on individual income tax returns with data from the Current Population Survey, yielding a data base that can be used to study alternative tax policy proposals.

The simulation model described above is simply a "tax calculator". In other words, given the data base, the model uses the proposed tax rules to calculate tax liability. The model assumes no behavioral reaction to the change in tax policy. Thus, changes in the deductibility of certain expenditures are assumed to have no effect on the level of these expenditures. Thus, the second step in the development of microeconomic simulation models was to incorporate behavioral responses into the model. Several papers that incorporate behavioral responses are contained in Feldstein.(4) One of the principal difficulties in incorporating behavioral responses is the availability of estimates of how agents respond to changes in policy designs. For example, in order to include the effect of changes in tax rates on labor supply, it is necessary to have estimates of the elasticity of labor supply. While there are a substantial number of studies that estimate such elasticities, there is little agreement on their magnitudes. For other behavioral responses, estimates may not exist. In developing countries, the paucity of estimates is even worse, so that it is generally necessary to fall back on estimates from developed countries, although the assumption that the value of elasticities from a developed country are the same in a developing country is a demanding one. This lack of appropriate elasticity estimates for Jamaica makes it unreliable to include behavior responses in the microsimulation in this paper.

Microeconomic simulation models have two major advantages over alternatives. First, they are able to provide information concerning policy changes that other techniques are less equipped to provide. For example, these models can provide information on the distributional effects of proposed policy changes, i.e, who gains and who loses, as well as the aggregate effect, e.g., the change in tax revenue. Second, these models allow for the estimation of the effect of very detailed changes in program structure. Typical forecasting techniques rely upon aggregate relationships, while microeconomic simulation models determine the aggregate by building up from the individual micro units.

REVENUE FORECASTING IN DEVELOPING COUNTRIES

Revenue forecasting is a difficult exercise in developing countries because of the absence of data, because of the short supply of officials with the skill to set up and maintain a system, and because developing countries are often beset by major economic problems and an almost continuous stream of discretionary changes to accommodate these problems. The issue is even more difficult in the context of tax reform, i.e., predicting the response of the economy to a new set of tax rules and the ability of the administration to collect a new tax.

The result is that many, if not most, less-developed countries (LDCs) do very little by way of revenue forecasting beyond that required for the one-year budget cycle. In some cases, medium-term forecasts have been developed, but even in these cases, the results do not always find their way into the official fiscal planning process. Predicting the impact of policy changes is not done well in most LDCs. When a new tax is proposed, the Minister presents a budget speech in which an aggregate estimate of the amount to be gained from new taxes is reported. The techniques used to generate these forecasts are not always specified, but tend to be the same procedures that are used in the ordinary revenue forecasts.

Traditional Approaches

There are four approaches that are typically used to forecast revenues in developing countries. These are judgmental or impressionistic, extrapolation, econometric and deterministic.[(5)] There are instances, that we can identify, where each of these has been used to estimate the normal growth in revenues and to estimate the impact of alternative reforms.

The judgmental approach is the most common. In this case, the ministry may simply seek a consensus about what is the most likely outcome for revenues next year, based on expert judgement. Often the basic data are studied, but there is no formal approach to organizing these data to come to an estimate. The advantage to the judgmental approach is that the "experts" may be quite expert indeed and, based on years of experience with the system, can come close to hitting the mark with some combination of study of the data and intuition.

There are major drawbacks to the judgmental approach. First, its longevity is limited to the time of service of the expert, and it is difficult for him to pass on his "secrets" to successors. Second, expert judgement is better at forecasting when there are not big changes in the economic environment, i.e., changes with which the expert has not had experience. The situation in developing countries is one where big changes in the economic environment are more the rule than the exception. Third, judgmental forecasts do not let government planners "learn" about what is driving the system, i.e., what are the determinants of the revenue growth and shortfalls?

Finally, judgmental forecasts are especially weak in forecasting the revenue effects of discretionary changes. These are changes with which the "expert" may not have had an experience, and intuition oftentimes will fail when the change is complicated. For example, the revenue consequence of removing a particular tax expenditure in favor of instituting a new rate structure.

Extrapolation is another common approach. This involves simply projecting the trend from the recent past into the future, i.e., if real revenues have grown at an average annual rate of five percent over the past seven years, the assumption is made that they likely will grow at five percent per year over the next three. The advantage of extrapolation is that it is simple to do and it is understandable. Where it is used, it is mostly taken as a "first" estimate and adjustments are made using judgement.

The disadvantage with extrapolation is that the recent past is almost never a smooth trend in developing countries, and the assumption that the future performance of the economy will be a simple extension of past years is not likely to be true. It also assumes that any discretionary changes in the tax system -- rate changes, base changes, administrative improvements -- in the historical period will be repeated in the future. Extrapolation is not at all useful in the evaluation of proposed changes in the tax system that depart from the changes of the recent past.

Econometric approaches base revenue forecasts on some assumption about a behavioral relationship between the yield of a tax and the underlying factors that drive the growth in its base. For example, personal income taxes are a function of the growth in national income and in the employed labor force; and import duty revenue are responsive to exchange rate adjustments, national income and other local factors that drive the demand for imports. The analysis in developing countries is usually simple because relatively few data points are available, reasonable forecast values for the independent variables are often not available, and disaggregated information on the dependent variable are sometimes not available.

Econometric models are not usually suitable for projecting the revenue impacts of alternative rate and base structures because the models are too aggregated. For example, one might have a personal income tax equation, but not a model that would take into account each component of personal income, or one that would allow an estimate of the amount of taxes paid in each rate bracket.

Deterministic forecasts involve projecting the components of an identity. For example, automobile license revenues would be forecasted by first projecting the number of automobiles of various types to be licensed and then multiplying this by the applicable license fee per vehicle. The trick is in forecasting the tax base, and this is generally done with some fixed ratio approach, e.g., cigarettes, bottles of beer, or numbers of automobiles are thought to show a steady relationship with income, population, urban population, or some other such variable.

This approach is used most effectively in the case of specific taxes, i.e., in cases where the tax rate is not ad valorem. Since specific excises are an important revenue source in most developing countries, and physical assessment is not uncommon even for some ad valorem taxes, deterministic forecasting has considerable merit. Another advantage is that it is easily used and is understandable. Deterministic approaches are in effect a first cousin of the microsimulation model approach which is the subject of this paper.

There are some common problems that plague all of these approaches.(6) One major problem is that in many countries it may be difficult to obtain a time-series of tax revenue data. For example, Martinez(7) in his analysis of the Ecuadorian personal income tax had detailed data only through 1979 while the tax reforms were being considered for 1985. It is not uncommon for only a few years of consistent data to be available, and this may rule out the econometric approach.

A related problem is that of separating increases in revenue resulting from discretionary changes in tax rates or bases, from the automatic changes in tax bases. It is the latter that one wants to forecast; but if there have been changes in the tax structure, these will be reflected in the time-series data. This issue also arises if there have been administrative changes that lead to increased or reduced enforcement. If one forecasts with such an "uncleaned" series, he implicitly assumes that the revenue growth in the future will benefit from (be burdened by) the same discretionary changes that occurred in the past. This is obviously a heroic assumption that few analysts should be willing to make. Thus, in order to forecast tax revenue using trend forecasting, it is necessary to "clean" the data. One could use dummy variables to control for the discretionary changes, but this technique is not particularly satisfactory. The other method is to calculate an adjustment to the tax revenue series based upon the amount of revenue that would have been collected under the current tax structure rather than the one that existed in that particular year. This is no easy task, although Bahl[8] discusses several methods for cleaning tax revenue data. Finally, if the forecast is being made to analyze the effect on revenue from a structural change, the problem emerges that the proposed system is different from the present system and historical data are simply not useful.

Microsimulation modeling avoids all three of these problems. First, microsimulation does not require historical data series; it is sufficient to use data for one time period. However, the amount of data required for that one year is substantial because of the level of detail needed. This is especially true if the purpose of the exercise is to predict tax revenues from a change in tax structure. In order to correctly model detailed structural changes, it is necessary to have sufficient detail for each observation, e.g., each tax unit, either individual or firm. Second, microsimulation is not hampered by changes in administrative structure, and in fact is essentially designed for considering structural changes. Third, since the technique does not rely on historic data, it is not necessary to "clean" the data for past discretionary changes in the tax structure. Forecasting with a microsimulation model, however, does require a set of growth assumptions. For example, to forecast the outyear revenue effect of structural changes to a payroll tax requires assumptions about the growth in wage rates and the labor force. Developing these growth assumptions, i.e., these forecasts, may require a historic data series.

When the forecast is being made in the presence of a proposed structural change, forecasting with a microsimulation model offers an important advantage over other forecasting techniques. Consideration of the proposed structural change should be based not only on the revenue growth but also on the effect on the distribution of tax burden. Neither judgment, extrapolation, nor econometric models can add anything to our understanding of how the distribution of tax burdens will be effective. Microsimulation models, however, can be used to generate estimates of the distributional consequences of the structural change.

Microsimulation models do have a number of drawbacks, and their usefulness depends on whether these can be overcome or accommodated. Perhaps the most important is the data requirements. The basic data must be drawn from a sample of tax returns, and these returns must be combined with other data. Consider a change in the income tax. While it might seem that tax returns are the obvious source of data, in fact it may be necessary to rely on other data sources as well. If the nature of the reform lies outside the current tax return data, it would be necessary to supplement the tax return data. For example, it may be proposed to tax a particular source of income that is currently not taxed. Infomation on this income type would have to come from a data source other than the tax return file. In developing the data for the simulation model, it is important to bear this in mind if the use of the simulation model is to extend beyond a one-time consideration of a specific and known tax reform proposal.[9]

Another major drawback is that it is normally assumed that there is no behavioral response to tax changes. If the model is being used to forecast revenue growth in an environment of a new tax structure, then ignoring any behavioral response will undoubtedly lead to errors in the forecast. To incorporate behavioral responses, however, is to magnify the complexity of the model immensely. Furthermore, as noted above, information on the nature and magnitude of the reaction to a change in the tax structure is not easy to come by in developing countries.

Related to this is the distributional question. In the typical simulation model the incidence of the tax is not considered in any formal way. The distributional question is usually addressed, not by considering economic incidence -- in particular the differential incidence -- but rather by the impact incidence. In other words, the change in the taxes paid as a result of the change in the tax structure is assumed to be borne by the taxpayer, no shifting of the tax change is considered. This, of course, is a serious limitation to the use of simulation models. To address the question of incidence and welfare loss researchers have turned to computable general equilibrium models.[10] Computable General Equilibrium (CGE) models are an interesting and important development in modeling policy changes; however a discussion of CGE models is outside the scope of interest of this paper.

Microsimulation models yield only a point estimate of the revenue yield, while trend forecasting and causal forecasting techniques also yield interval estimates with an associated confidence level. There are several reasons why the forecast is probabilistic, for example, the underlying growth assumptions are probabilistic. Without the confidence level we are unable to say anything about the relative accuracy of the forecast. However, it should be pointed out that most revenue forecasts in developing countries, irrespective of the method they use, present only point estimates.

THE JAMAICAN INCOME TAX

We turn now to the application of microsimulation to proposed changes in the Jamaican income tax. We first provide a brief description of the Jamaican income tax and the policy setting.

Jamaica adopted a major reform of its personal income tax in 1986-1987.[11] The reform proved to be quite revenue productive, and was generally accepted by the population. By 1990, however, a deficit position of the central government brought pressure to increase revenues through discretionary adjustments in the tax system. The individual income tax, a major revenue producer (about 20 percent of total tax revenue) was targeted for revision.

The question for research was to estimate the revenue yield and distribution of tax burdens that would result from alternative changes in the income tax structure. To answer the policy questions, a microsimulation model was constructed -- relying primarily on tax return data -- and the revenue and distributional effects of alternative reforms were estimated and projected for a three year period.

In theory and by law, all income in Jamaica is subject to tax. In practice, capital gains, most income earned by the self employed and certain employer provided perquisites are not taxed. There is a standard deduction of J$10,400 (about US$570) and a flat tax rate of 33 1/3 percent. This simplified system was the result of the 1986-1987 reform.

The projection exercise was called on to answer three questions. If the government choose any one of several options for altering the structure of the tax, what would be the effect on the revenue yield, the distribution of tax burdens and the income elasticity of the income tax. The objective was to make these estimates over a three year time frame.

THE UNBALANCED STRATIFIED SAMPLE, WEIGHTS AND ADJUSTMENTS

We turn now to the data collection phase and describe the sampling procedures used. This discussion also serves to indicate the problems with data availability in developing countries.

The sampling design was formulated to assure accurate representation for particular sub-groups, at minimum costs. We sought data on employees; however, a master list of employees did not exist. Therefore, it was necessary to first draw a sample of firms and then sample employees from the selected firms. We were concerned that a simple random sample of firms had a high probability of not sampling larger firms, which we thought paid higher than average salaries. Therefore, we drew a stratified random sample of firms. Using six firm-size categories, we then randomly selected employees from each firm in the sample.

We obtained a list of firms from the Statistical Institute of Jamaica (STATIN), however, the list did not contain all firms operating in Jamaica.[12] STATIN believed that nearly all large firms were represented, but that the list of smaller firms was an incomplete listing. It was necessary to generate a separate list of public agencies, including statutory bodies, government agencies, and public enterprises.

In order to collect information on the self employed, another sample was drawn. Using the individual (self-employed) income tax returns, a random sample of 601 filers was drawn. The information available from the returns, however, was not useful.[13]

Based upon the sample selection procedures, we calculated weights for each employee. The original weights were based on the information available at the time of the sample design. However, after the initial weights were constructed, additional information was obtained that suggested that it would be appropriate and necessary to re-calculate the weights.

The master file from which we drew the sample did not contain any firms in agriculture and only one firm in mining, which was not chosen as part of the sample. Furthermore, the number of firms in the master list were updated after the data were collected. We already knew that the number of small firms was understated in the master list. We also found that our master list of public sector agencies was not accurate. In order to assure that the data base accurately reflects the entire unknown population of employees, we made a number of re-calibrations of the weights and other adjustments to the data.(14)

Table 1 presents information on the final distribution of employees by firm categories, where the numbers of employees are the weighted values.

Table 2 presents the income distribution of employees in our sample, again based on weighted values.

Based on comparisons with other data sources and on conversations with Jamaican government officials, it appears that the weighted data reasonably reflect the actual population of employees.

GROWTH ASSUMPTIONS

Data collected on employees were for 1988. Thus, to forecast the effects of tax policy changes into the future, it was necessary to project the 1988 data into future time periods. To

TABLE 1

Employees by Firm Category

Firm Category	Number of Employees in Category	Percent of Employees in Category
Private		
0 - 9 employees	68,946	19.8
10 - 24 employees	48,401	13.9
25 - 49 employees	30,294	8.7
50 - 99 employees	17,411	5.0
100 - 199 employees	13,928	4.0
200 or more employees	60,241	17.3
Mining	6,268	1.8
Public Enterprise	26,812	7.7
Government	75,910	21.8
Total	348,211	100.0

perform these projections, assumptions were made regarding the growth of the labor force and the rate of compensation.

The first dimension, growth of the labor force, was relatively simple to capture. An index for the growth of the labor force in the central government and not in the central government (private firms and public enterprises) was constructed based on the best available information, as provided by the Jamaican Revenue Board.

TABLE 2

Income Distribution

Income Class	Number of Employees in Each Income Class	Percent of Employees in Each Income Class
$0 - 2,000	7,310	2.1
$2,001 - 3,000	5,983	1.7
$3,001 - 4,000	4,337	1.2
$4,001 - 6,000	14,750	4.2
$6,001 - 8,000	25,004	7.2
$8,001 - 10,000	20,712	5.9
$10,001 - 15,000	51,339	14.7
$15,001 - 20,000	52,724	15.1
$20,001 - 30,000	64,166	18.4
$30,001 - 50,000	62,844	18.0
Over $50,000	39,042	11.2
Total	348,211	100.0

The second dimension, compensation growth was more complex, due to the Administrative Reform Measures that affected the rate of compensation of government employees. This necessitated the construction of separate compensation growth indices by income level of government sector employees in 1988. For the non-central government, the assumptions regarding compensation growth was based on conversations with officials at the Jamaican Revenue Board.(15)

PAYE TAX POLICY SIMULATIONS

A computational tax model was written to simulate the effects of various tax policy options. The model uses the current or proposed tax rules to calculate tax liability at the level of the individual taxpayer. With this microsimulation we are able to forecast the PAYE tax revenue (total) and the effective tax rate in each of 11 income classes. Additionally, this model reports the number of taxpayers with increased, decreased, and no change in liability under a proposed rule change. The model also tallies the number of taxpayers with zero liability under the baseline and under the proposed tax rule change. None of the extrapolation, judgmental or econometric approaches could have yielded these results.

The baseline for comparison purposes is the PAYE tax rules that apply for 1990. In summary, these include: a standard deduction of $10,400; a PAYE tax rate of 33 1/3 percent; and the provision of certain non-taxable perquisites. The policy options to reform the tax were selected in consultation with officials of the Revenue Board. Each policy option is described below in terms of its deviation from the baseline case.

1. Increase the standard deduction to J$12,000 and raise the tax rate to 3 percent.

2. Increase the standard deduction to J$12,000; lower the tax rate to 30 percent; and bring all non-taxable perquisites into the tax base.

3. Increase the standard deduction to J$14,352 and leave the tax rate structure intact.

Annual PAYE tax revenue, the effective tax rate for both the base and for each option, and the number of individuals with increased, reduced, or no change in liability were forecasted for

1991 to 1993. Subsets of these data for the three tax policy simulations are reported in Tables 3 through 5.

As an illustration of the results of the simulations, consider policy option #3 (Table 5), increasing the standard deduction to J$14,352. With no change in the standard deduction, PAYE tax revenue would be J$1,772.8 million in 1991 and J$2,210.3 million in 1992. The increase in the standard deduction to J$14,352 in 1991, retroactive to January 1, 1991, would reduce PAYE revenue to J$1,463.8, or by J$308.9 million, in 1991 and to J$1,871.9 million, or by J$338.5 million in 1992.

Part 2 of the simulation analysis contains the burden analysis for 1991. With no change in the standard deduction it is clear that the PAYE tax is very progressive. Increasing the standard deduction reduces the effective tax rate by both a larger absolute and relative amount for lower income individuals than for higher income. For example, for the J$15,001-20,000 income class, the effective tax rate falls by 7.05 percentage points for a 61.6 percent reduction. Part 3 shows that 136,994 employees would have zero tax liability compared to 90,405 in the Baseline. This change represents 18.1 percent of the employees who had positive tax liability in the Baseline.

It is important to again note that these simulations do not incorporate behavioral responses to the proposed policy changes. The most important behavioral response that one would want to incorporate would be the labor supply response to changes in the net wage. Accurate labor supply elasticities would be necessary to model this response. A priori, not even the sign of the labor supply elasticity can be known, much less its magnitude. The general lack of information about the elasticities adds an additional degree of potential error to he accuracy of these projections. However, incorporating arbitrary behavioral responses would arguably result in greater inaccuracy than including none at all.

TABLE 3
Tax Policy Simulation #1

DESCRIPTION: Raise the Tax Rate to 35 Percent and Increase the Standard Deduction to J$12000

1. Revenue Impact:

	1991	1992	1993
Baseline Projection	1,772,760,164	2,210,336,425	2,736,620,594
Simulation	1,727,833,996	2,172,162,115	2,715,077,328
Difference	(44,926,168)	(38,174,310)	(21,543,266)

2. Tax Burden Impact (1991):

Income Class	Number	Baseline Effective Tax Rate	Simulation Effective Tax Rate	Difference in Effective Tax Rate
$0-2,000	7,310	0.0000	0.0000	0.0000
$2,001-3,000	5,983	0.0000	0.0000	0.0000
$3,001-4,000	4,337	0.0000	0.0000	0.0000
$4,001-6,000	14,750	0.0000	0.0000	0.0000
$6,001-8,000	25,004	0.0000	0.0000	0.0000
$8,001-10,000	20,712	0.0000	0.0000	0.0000
$10,001-15,000	51,339	0.0410	0.0154	(0.0256)
$15,001-20,000	52,724	0.1144	0.0894	(0.0251)
$20,001-30,000	64,166	0.1618	0.1469	(0.0148)
$30,001-50,000	62,844	0.2053	0.2012	(0.0040)
Over $50,000	39,042	0.2553	0.2621	0.0068
TOTAL	348,211			

3. Number of Taxpayers in 1991 with:

(a) Increased Liability	27,401
(b) Reduced Liability	205,154
(c) Zero Liability: Baseline	90,405
(d) Zero Liability: Simulation	111,467
(e) No Change	116,452

TABLE 4
Tax Policy Simulation #2

DESCRIPTION: Decrease the Tax Rate to 30 Percent
Increase the Standard Deduction to J$12000
and Tax All Allowances

1. Revenue Impact:

	1991	1992	1993
Baseline Projection	1,772,760,164	2,210,336,425	2,736,620,594
Simulation	1,673,991,760	2,090,206,952	2,596,978,623
Difference	(98,768,404)	(120,129,473)	(139,641,971)

2. Tax Burden Impact (1991):

Income Class	Number	Baseline Effective Tax Rate	Simulation Effective Tax Rate	Difference in Effective Tax Rate
$0-2,000	7,310	0.0000	0.0000	0.0000
$2,001-3,000	5,983	0.0000	0.0000	0.0000
$3,001-4,000	4,337	0.0000	0.0000	0.0000
$4,001-6,000	14,750	0.0000	0.0000	0.0000
$6,001-8,000	25,004	0.0000	0.0000	0.0000
$8,001-10,000	20,712	0.0000	0.0000	0.0000
$10,001-15,000	51,339	0.0410	0.0162	(0.0248)
$15,001-20,000	52,724	0.1144	0.0867	(0.0277)
$20,001-30,000	64,166	0.1618	0.1426	(0.0192)
$30,001-50,000	62,844	0.2053	0.1982	(0.0071)
Over $50,000	39,042	0.2553	0.2513	(0.0040)
TOTAL	348,211			

3. Number of Taxpayers in 1991 with:

(a) Increased Liability	48,071
(b) Reduced Liability	207,782
(c) Zero Liability: Baseline	90,405
(d) Zero Liability: Simulation	104,147
(e) No Change	93,155

TABLE 5

Tax Policy Simulation #3

DESCRIPTION: Increase the Standard Deduction to J$14352

1. Revenue Impact:

	1991	1992	1993
Baseline Projection	1,772,760,164	2,210,336,425	2,736,620,594
Simulation	1,463,824,417	1,871,863,720	2,370,831,548
Difference	(308,935,747)	(338,472,705)	(365,789,046)

2. Tax Burden Impact (1991):

Income Class	Number	Baseline Effective Tax Rate	Simulation Effective Tax Rate	Difference in Effective Tax Rate
$0-2,000	7,310	0.0000	0.0000	0.0000
$2,001-3,000	5,983	0.0000	0.0000	0.0000
$3,001-4,000	4,337	0.0000	0.0000	0.0000
$4,001-6,000	14,750	0.0000	0.0000	0.0000
$6,001-8,000	25,004	0.0000	0.0000	0.0000
$8,001-10,000	20,712	0.0000	0.0000	0.0000
$10,001-15,000	51,339	0.0410	0.0001	(0.0409)
$15,001-20,000	52,724	0.1144	0.0439	(0.0705)
$20,001-30,000	64,166	0.1618	0.1081	(0.0536)
$30,001-50,000	62,844	0.2053	0.1712	(0.0340)
Over $50,000	39,042	0.2553	0.2406	(0.0147)
TOTAL	348,211			

3. Number of Taxpayers in 1991 with:

(a) Increased Liability	0
(b) Reduced Liability	257,528
(c) Zero Liability: Baseline	90,405
(d) Zero Liability: Simulation	136,994
(e) No Change	90,681

A unique aspect of this microsimulation is that it can be used with a range of growth assumptions to forecast a range of possible outcomes under a given policy option when growth prospects are uncertain. While growth assumptions can be incorporated and changed in other forecast methods, the other methods fail to capture the differential impact of the growth assumptions on different income classes.

Tables 6 and 7 below illustrate the implications for policy option #3 when the growth rate assumption is changed. For Table 5, the assumption of 15% compensation growth was utilized. Table 6 shows the results with an assumed 10% growth rate of compensation, while Table 7 shows the results for a 20% growth rate. Tables 6 and 7 provide a worst case and best case bracket for policy option #3.

The simulations in Tables 5, 6, and 7 also provide the information needed to calculate the compensation elasticity of PAYE tax revenue. This elasticity indicates the responsiveness of PAYE revenue to changes in compensation and is defined by the ratio of the percentage change in PAYE revenue to the percentage change in the total compensation. Using Tables 6 and 5, with total compensation growth rates of 10% and 15%, respectively, over 1990, the elasticity is 1.73. Using Tables 5 and 7, with total compensation growth rates of 15% and 20%, respectively, the elasticity is 2.43.

It is of interest to note that for an economy with a flat rate income tax and no standard deduction, the compensation elasticity of income tax revenue would be 1. Also, for an economy with a flat rate tax and a fixed standard deduction (as is simulated in Tables 5 through 7) the elasticity will eventually tend to 1 from above with increasingly larger increases in compensation. The fact that our elasticity is increasing rather than declining (toward 1) indicates that compensation growth rates of greater than 20% would be necessary to bring the bulk of the taxable population into

TABLE 6
Tax Policy Simulation #3A

DESCRIPTION: Increase the Standard Deduction to J$14352, With A Jamaican Compensation Growth Rate of 10%

1. Revenue Impact:

	1991
Baseline Projection	1,772,760,164
Simulation	1,357,285,627
Difference	(415,474,537)

2. Tax Burden Impact (1991):

Income Class	Number	Baseline Effective Tax Rate	Simulation Effective Tax Rate	Difference in Effective Tax Rate
$0-2,000	7,310	0.0000	0.0000	0.0000
$2,001-3,000	5,983	0.0000	0.0000	0.0000
$3,001-4,000	4,337	0.0000	0.0000	0.0000
$4,001-6,000	14,750	0.0000	0.0000	0.0000
$6,001-8,000	25,004	0.0000	0.0000	0.0000
$8,001-10,000	20,712	0.0000	0.0000	0.0000
$10,001-15,000	51,339	0.0410	0.0001	(0.0409)
$15,001-20,000	52,724	0.1144	0.0417	(0.0727)
$20,001-30,000	64,166	0.1618	0.1091	(0.0527)
$30,001-50,000	62,844	0.2053	0.1704	(0.0349)
Over $50,000	39,042	0.2553	0.2409	(0.0144)
TOTAL	348,211			

3. Number of Taxpayers in 1991 with:

(a) Increased Liability	0
(b) Reduced Liability	254,071
(c) Zero Liability: Baseline	90,405
(d) Zero Liability: Simulation	142,636
(e) No Change	94,139

TABLE 7
Tax Policy Simulation #3B

DESCRIPTION: Increase the Standard Deduction to J$14352, With A Jamaican Compensation Growth Rate of 20%

1. Revenue Impact: 1991

	1991
Baseline Projection	1,772,760,164
Simulation	1,618,726,099
Difference	(154,034,065)

2. Tax Burden Impact (1991):

Income Class	Number	Baseline Effective Tax Rate	Simulation Effective Tax Rate	Difference in Effective Tax Rate
$0-2,000	7,310	0.0000	0.0000	0.0000
$2,001-3,000	5,983	0.0000	0.0000	0.0000
$3,001-4,000	4,337	0.0000	0.0000	0.0000
$4,001-6,000	14,750	0.0000	0.0000	0.0000
$6,001-8,000	25,004	0.0000	0.0000	0.0000
$8,001-10,000	20,712	0.0000	0.0000	0.0000
$10,001-15,000	51,339	0.0410	0.0001	(0.0409)
$15,001-20,000	52,724	0.1144	0.0434	(0.0711)
$20,001-30,000	64,166	0.1618	0.1069	(0.0548)
$30,001-50,000	62,844	0.2053	0.1732	(0.0321)
Over $50,000	39,042	0.2553	0.2401	(0.0152)
TOTAL	348,211			

3. Number of Taxpayers in 1991 with:

(a) Increased Liability	0
(b) Reduced Liability	267,897
(c) Zero Liability: Baseline	90,405
(d) Zero Liability: Simulation	130,460
(e) No Change	85,099

the taxable income classes. As a point of contrast to the microsimulation which we perform here, a very simple projection can be made based on past relationships. For example, we use a simple regression equation to estimate a relationship between Gross Domestic Product (GDP) and PAYE receipts and then to project revenue. The advantage of this approach is that the data requirement is minimal. The disadvantage is that there is no possibility of forecasting differences in PAYE revenue that would result from different policy structures. Furthermore, with this approach it is not possible to look at the tax burden at the micro level.

Using data from 1970-1987 we estimated the following equation:

$$PAYE_t = \underset{(10.03)}{-19.44} + \underset{(0.001)}{0.044}\ GDP_t$$

The adjusted R^2 = .9820; standard errors are in parentheses. From this estimated equation we can project PAYE revenue into 1988-1990 using actual GDP data and into 1991-1993 using projected GDP growth.

Table 8 gives the comparison of the projected PAYE from the model above, the estimated PAYE from the microsimulation (baseline case), and the actual PAYE collected for available years.

The lower projections for PAYE from the linear model compared to the estimated PAYE from the microsimulation can be attributed, in part, to the fact that the linear projection fails to capture the higher average effective tax rate that occurs as compensation grows. This is especially the case where, as with the baseline simulation, the standard deduction is not indexed. The inflation-induced income growth makes bracket creep particularly severe when the standard deduction is not indexed. This bracket creep can cause large one time increases in the tax revenue as a particularly dense part of the distribution becomes taxable for the

TABLE 8

Comparison of Alternative Forecasts of PAYE
(in Millions of J$)

Year	Actual PAYE	Estimated PAYE	Projected PAYE
1988	766.07	---	813.53
1989	941.19	---	972.01
1990	1,156.58	---	1,124.02
1991	---	1,772.76	1,295.54
1992	---	2,210.34	1,515.47
1993	---	2,736.62	1,781.01

Source: Actual PAYE from the Revenue Board of Jamaica for fiscal year.
Estimated PAYE from Microsimulation.
Projected PAYE projection from linear model.

first time. This appears to be the case, for example, when comparing the 1990 Actual PAYE to the 1991 Estimated PAYE in Table 8, where a 53.9% increase is projected. This may also be an indication of the appropriateness of increasing the standard deduction.

CONCLUSIONS

There are many ways of forecasting tax revenue and predicting the effects of a structural change on a tax. Microsimulation models are a very powerful tool for performing such calculations with many advantages over alternative methods. However, it is not without difficulties. In particular, the data requirements can be severe and the difficulty of incorporating behavioral responses is limiting. Over all, the microsimulation approach is generally superior to the alternatives.

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12. We had considered using the list of employers who file an annual form, referred to as the P-35 form, that indicates the amount of individual income tax withhold for each employee in the firm. This was the basis of the sample drawn for an earlier study conducted by Syracuse University. However, it was discovered through inspection that about half of the firms did not file this form.

13. With the simplified structure (flat rate, no deductions) of the Jamaican income tax, it is necessary only for the self-employed to file an individual return. Employed workers' tax information is filed by their employers. Given the generally lower income levels, lack of enforcement, and tax avoidance, the tax collected from the self-employed is minimal. The returns filed were frequently incomplete.

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15. Details of the growth assumptions are available in Bahl, Hawkins, Moore, and Sjoquist, "Analysis of Jamaican Income Taxes and Allowances."