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TAX STRUCTURE AND TAX COMPLIANCE

James Alm, Roy Bahl, and Matthew N. Murray*

Abstract—A model of individual tax compliance behavior, including evasion and avoidance, is developed and estimated. The model recognizes the importance of marginal income tax rates, payroll tax contributions and benefits, and the probability of detection and the penalty on unpaid taxes. Share equations for avoidance, evasion and reported income are estimated using individual-level data. The estimation results indicate that the tax base rises with higher benefits for payroll tax contributions and falls with higher marginal tax rates; the base also falls with more severe penalties and more certain detection of evasion as individuals substitute towards avoidance income.

THE methods by which individuals reduce their tax liabilities take a variety of legal and illegal forms, all of which are influenced at least in part by incentives created by the tax structure. These methods can be broadly classified as avoidance and evasion. Tax avoidance is any legal activity that lowers taxes, such as worker substitution between wage and nonwage compensation. Tax evasion is the reduction in tax liabilities by illegal means, such as underreporting income on tax returns. Despite extensive—but separate—literatures on avoidance and evasion, we know very little about the tax base response to changes in tax structure. It is the purpose of this paper to examine the role that the tax structure plays in compliance.

There are several reasons for the persistence of the compliance puzzle. Most prominent is the absence of detailed individual data that would allow a full empirical specification of all factors affecting compliance. This difficulty is most evident when searching for individual data on the evasion–compliance decision. Even when available, data have never allowed in the same work the construction of both tax and audit variables.[1]

Clearly, data availability is even more problematic when looking at the choice among evasion, avoidance, and reported income. In addition, previous work has not looked at the avoidance–evasion–compliance decision as a joint process, even though these decisions are made simultaneously.[2] Further, both strands of the literature have ignored another factor that may affect the compliance decision: the benefits that accrue from participation in payroll programs. If benefits are tied only to taxable income, then their presence gives individuals an incentive to pay taxes. In short, there has been no empirical work that analyzes the effects of tax rates, probabilities, penalties, and payroll benefits on avoidance and evasion choices of individuals.

In this paper we provide such an analysis. We first develop a theory of individual choice among the three types of compensation. We then estimate the resulting share demand equations using a unique data set, which has detailed information on the compensation paid to roughly one-quarter of the labor force in Jamaica in 1983. From these data we are able to derive measures of reported taxable income, evasion income, and avoidance income for individual workers in the formal sector. We are also able to construct measures of the marginal income tax rate, marginal payroll taxes and benefits, the probability of detection, and the penalty on evasion for individual workers. We are therefore able to estimate for the first time the responses of workers to the full range of tax structure parameters.

Section I presents the theoretical model of worker compensation choice and the empirical specification of the model. Section II discusses the Jamaican tax system. Data and variable construction are discussed in section III. Estimation results are presented in section IV. The final section summarizes the main results.

[1] For example, only Clotfelter (1983) uses micro-level measures of compliance for U.S. taxpayers. He examines the impact of the marginal tax rate on evasion, but does not include a measure of the probability of detection. On the other hand, Witte and Woodbury (1985), Dubin and Wilde (1988), and Beron, Tauchen, and Witte (1988) include the audit rate as an explanatory variable in a compliance regres-

sion, but omit the marginal tax rate; they also use data aggregated to the three-digit zip code level.

[2] For example, Goldstein and Pauly (1976), Long and Scott (1982), and Woodbury (1983) examine only the substitution between wage and nonwage compensation, while Clotfelter (1983), Witte and Woodbury (1985), Dubin and Wilde (1988), and Beron, Tauchen, and Witte (1988) look only at the reported–unreported income decision.

I. Theoretical and Empirical Specification

Each worker is assumed to have a fixed amount of total compensation $\bar{I}$ to allocate among reported (R), evasion (E), and avoidance compensation (A). Reported compensation is subject to income and payroll taxation at the combined rate t, and yields payroll benefits at the rate b. Avoidance compensation (called "allowances" in Jamaica) is not taxable under either the income or payroll tax, and is given in an in-kind form, such as entertainment, travel, or housing vouchers. Evasion is subject to an uncertain return. If caught evading with probability p, then the individual is fined at the rate f on unpaid taxes, where $f > 1$. If undetected, then evasion is neither taxed nor fined.[3]

Because allowances are in-kind compensation, the utility of the worker is assumed to be a function both of allowances and of the sum of reported and evasion compensation, net of taxes, benefits, and penalties; utility is written as $U(I, A)$, where I is net money income. If caught, net income I^C equals $[(R - tR + bR) + (E - ftE)]$, while if not caught income I^N is $[(R - tR + bR) + E]$. The individual chooses R, E, and A so as to maximize expected utility Ψ.

A slightly different formulation is useful in the empirical specification. Reported compensation R is *gross* of taxes and benefits; it is *net* reported income that enters the utility function via I^C and I^N, where net reported income equals $R(1 - t + b)$. Similarly, net evasion income equals $E(1 - ft)$ if the worker is caught and E if not caught. Denoting the net amounts of compensation by an asterisk (*), the budget constraints can be written in a way that makes clear how net R^*, E^*, and A^* depend upon the state of the world. These constraints are

$$\bar{I} = R + E + A = \left(\frac{1}{1 - t + b}\right)R^*$$
$$+ \left(\frac{1}{1 - ft}\right)E^* + A^* \quad (1)$$

$$\bar{I} = R + E + A = \left(\frac{1}{1 - t + b}\right)R^*$$
$$+ E^* + A^*, \quad (2)$$

where equation (1) is the constraint if the worker is caught evading and equation (2) is the constraint if not caught.

Equations (1) and (2) allow a convenient interpretation. Consider the "price" of each type of compensation, or the amount of gross compensation of each type that must be spent to obtain one dollar of net compensation. These prices are defined by the expressions attached to R^*, E^*, and A^*. For example, a worker must allocate $1/(1 - t + b)$ to gross reported compensation in order to receive one dollar of net reported income in either state of the world; that is, if the worker pays taxes of 45% and receives benefits of 5% on gross reported income, then he must spend $1.67 on gross R to get $1 of net R^*. The price P_R of net compensation is therefore $1/(1 - t + b)$. Note that this formulation yields the intuitive result that either an increase in the tax rate or a reduction in the benefit rate increases the cost of reported income. Because P_R is the same in equations (1) and (2), the expected price of reported income $\tilde{P}_R$ is independent of the state of the world, where the expected price is the price in each state weighted by the probability of the state.[4] Similarly, the price of avoidance compensation P_A is unity in both states of the world because A is not taxed; its expected price $\tilde{P}_A$ is also unity and state independent. Unlike P_A and P_R, the price of evasion P_E depends upon the state of world. If the individual is caught evading, then $1/(1 - ft)$ must be spent on gross evasion to receive one dollar of net evasion; if not caught, then the price is one. The expected price of evasion $\tilde{P}_E$ therefore equals $p[1/(1 - ft)] + (1 - p)$, so that an increase in p, f, or t increases the cost of evasion.

The problem facing the worker is, then, one of portfolio compensation choice:

$$\underset{\{R, E, A\}}{\text{Max}} \ \Psi = pU(I^C, A) + (1 - p)U(I^N, A)$$
$$(3)$$

where I^C and I^N are defined above and $\bar{I} = R + E + A$.[5] Individual optimization generates first-

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[3] The tax, benefit, and fine rates are assumed to be proportional and the probability of detection is assumed to be exogenous in order to simplify the exposition. The empirical specification, however, recognizes fully that in fact these are nonlinear functions that vary with the levels of the arguments.

[4] Note, however, that the progressive rate structure of the Jamaican income tax implies that $\tilde{P}_R$ is state dependent in the empirical specification.

[5] The formulation in equation (3) implicitly assumes that hours of work, and thus total compensation, are fixed and predetermined, so that the behavioral responses are confined to portfolio reallocations among R, E, and A. Also, the firm

order conditions that contain the components of the prices, and that can also be solved for the optimal choices of R, A, and E. These demand equations can be represented by equations for the share of total income taken by each type of gross compensation, where the shares depend upon expected prices, total income, and various control variables. Assuming that these variables enter linearly, the share equations are

$$S_i = \alpha_t + \sum \beta_{ij} \ln \tilde{P}_j + \sum \phi_{ik} X_k,$$
$$i, j = R, E, A \text{ and } k = 1, \ldots, K \quad (4)$$

where S_t is the proportion of total compensation $\bar{I}$ that is allocated to gross compensation type i; α_i, β_{tj}, and ϕ_{ik} are parameters that characterize the workers' preferences; $\tilde{P}_j$ is the expected price of income type j normalized by income; and X_k represents the control variables.[6] It is these share equations that are estimated.

II. The Structure of the Jamaican Income Tax[7]

The Government of Jamaica relies heavily upon the individual income tax. In fiscal year 1983/84, income tax collections were .28.9% of total government revenues and 7.6% of national income. Over 90% of these revenues are collected from employer withholding of taxes on employee wages under the Pay-As-You-Earn (PAYE) system. The remaining revenues come from individuals who must file a return upon which taxes on other sources of income are paid.

In theory, the Jamaican individual income tax is broad-based with only interest income exempt, and the rate structure is high and progressive.[8] In practice, the base and progressivity are substantially reduced. Taxpayers may receive up to sixteen credits for purposes such as participation in savings and insurance programs, employment of household helpers, and personal and family credits. A more substantial narrowing of the base is due to the provision of nontaxable allowances to employees. Another loophole is the preferential treatment of income earned from overtime activities, with all overtime taxed at the lowest marginal rate of 30%. Finally, the base is narrowed by outright evasion via underreporting of taxable income and nonfiling of income tax returns.

Five separate payroll taxes, payable by both workers and firms, are also levied on approximately the same base as the individual income tax. Of these five programs, three provide benefits to individuals that are related to their contributions: the National Insurance Scheme (NIS) gives disability and old-age benefits, the National Housing Trust (NHT) provides various housing subsidies, and the Civil Service Family Benefits Scheme (CSFBS) is a pension program for government workers. For these three programs nonpayment of payroll taxes implies the loss of future benefits. The other two programs—the Education Tax and the Human Employment and Resource Training (HEART) Trust Fund—are taxes and provide no benefits. The combined (employee plus employer) marginal tax rate in each program is constant, varying from 2% for the Education Tax to 5% for the NIS and NHT; the tax rates for the HEART Fund and the CSFBS are 3% and 4%, respectively. In total, payroll tax revenues are roughly half of the revenues from the income tax.

III. Data and Variable Construction

A. Data

Estimation of the share equations requires measures of gross reported, avoidance, and evasion compensation for individual taxpayers. The presence of a unique data set for Jamaica makes it possible to construct these measures at the individual level.

The Revenue Board of the Government of Jamaica requested in summer 1984 that all Jamaican firms in the PAYE sector provide information on compensation for each employee in 1983. The government's request was not binding.

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is assumed to equate the value of the marginal product of labor to gross labor expense $\bar{I}$ for each worker; the firm is therefore concerned only with the total compensation of each worker. Finally, the model assumes that the firm responds passively to worker preferences for the various types of compensation. Although this assumption is not ideal and is relaxed in the empirical model, it is commonly used. See, for example, Goldstein and Pauly (1976), Long and Scott (1982), and Woodbury (1983). See Cowell (1985) for a survey of the theoretical literature on tax evasion.

[6] These share equations are similar to those derived from the transcendental logarithmic indirect utility function, where independent variables enter linearly and prices are normalized by income. See, for example, Woodbury (1983).

[7] The discussion here is of the system before a comprehensive reform in 1986.

[8] The rate structure is 30% on the first J$7,000 of income; 40% on J$7,001 to J$10,000; 45% on J$10,001 to J$12,000; 50% on J$12,001 to J$14,000; and 57.5% on income in excess of J$14,000.

However, firms were told that failure to respond could lead to government examination of their records, so that there was some incentive to comply and to ensure that information reported in the Survey was consistent with information reported on various tax forms. By January 1985, 1,345 firms had reported information for 69,724 workers (or 25% of the formal PAYE labor force), at which point the government stopped compiling the data. Although the Revenue Board Survey is nonrandom, its distribution of taxpayers and their characteristics (income, taxes, and credits) is not statistically different from that of earlier, random samples of taxpayers.

The government was concerned about the growth in untaxed forms of compensation, and the Survey was intended to provide information on the extent of this practice. Each firm gave information for each of its employees on taxable cash compensation and nontaxable in-kind compensation; they also reported taxes withheld and total tax credits. Although the Survey allows specific firms to be identified, all individual information is anonymous. It was initially believed that the Survey provided estimates only of what are called here reported income and allowance income. However, detailed examination of these data revealed numerous instances in which there were serious discrepancies—shortfalls in most cases—between taxes actually withheld and the statutory liability implied by tax credits and income. Only 8% of the taxpayers in the Survey had no discrepancy; tax withholding shortfalls were identified for 66% of those in the Survey, while the remaining 26% were overpayers. As we discuss in more detail below, we believe that there is convincing evidence that the discrepancies are most likely due to intentional efforts to defraud the tax authorities via tax evasion; that is, we believe that cash compensation consists of reported plus evasion compensation. The Survey therefore has micro-level information on allowance, reported, and evasion income. We have taken allowances as the measure of A; the Survey's measure of cash compensation has been decomposed into estimates of R and E.

Because of the central role that these withholding discrepancies play in the estimation, it is important that our interpretation of them be understood. This may be most easily explained by describing the process by which we, working on a tax reform study in conjunction with personnel

from the Revenue Board, analyzed the discrepancies. The discovery of the withholding errors threw into question the entire Jamaican withholding system, and much effort was made to discover the likely explanation for the mistakes. The initial reaction was that the discrepancies were simply random mistakes by the employer or the Income Tax Department. This explanation is plausible for some of the errors. The withholding system in Jamaica is complicated, and the calculations for each individual are generally made by hand. The potential for error is substantial, and it is unlikely that the Income Tax Department would detect such errors.

However, government officials concluded that this explanation was very unlikely. One reason is that the withholding errors do not exhibit a random pattern. If random, the errors should fall equally on the side of underpayment and overpayment; instead, there is a much higher frequency of underreporting than of overreporting. Of course, a poorly written tax code could produce such nonrandomness. However, if it is tax code complexity that generates the discrepancies, then these discrepancies should be largely independent of the level of taxpayer income, tax bracket, credits, and the like. Probit analysis of the existence/nonexistence of the discrepancies as a function of these variables indicated that the discrepancies are in fact systematic, suggesting an intent to defraud the authorities.[9] Results from an earlier, random sample of PAYE taxpayers who filed returns provided further evidence of intent. These earlier data indicated that only 11% of the sample filed a return in order to pay

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[9] Probit maximum likelihood estimation of a tax discrepancy equation yields (with t-statistics in parentheses):

$$DISC = -1.261 + 8.164\ MTR + 4.2*10^{-5}\ INCOME$$
$$\quad\ \ (10.48)\quad\ (3.84)\quad\quad\quad (9.40)$$
$$-\ 3.039\ PEN - 14.443\ PROB + 1.364\ NB$$
$$\quad (2.10)\quad\quad\quad (9.48)\quad\quad\quad (1.53)$$
$$-\ 0.116\ SIZE2 - 0.246\ SIZE3$$
$$\quad (2.16)\quad\quad\quad (4.48)$$
$$-\ 0.094\ SIZE4 + 0.363\ PUBLIC$$
$$\quad (1.57)\quad\quad\quad (7.88)$$
$$N = 10,000;\ -2*\text{log of likelihood ratio} = 2578.1$$

where $DISC$ indicates the presence or absence of tax withholding shortfalls; MTR is the marginal income tax rate on gross compensation; $INCOME$ is gross compensation; PEN and $PROB$ are the penalty function and probability of detection, respectively, as developed in the text; and NB represents net marginal payroll tax benefits on gross income. The remaining variables are zero-one dummies to control for firm size and sector of employment.

additional taxes; the remaining 89% filed to receive a refund. This finding suggested that the 26% of the individuals in the Revenue Board Survey who had too much withheld will file for refunds, while the 66% of the Survey who underpaid will simply enjoy the benefits of an illegally reduced tax liability.

Another possible explanation for the discrepancies was that the apparent errors in withholding could in fact represent correct tax liabilities, if the taxpayer occupation was in sales, leading to large business-related expenses. However, Jamaican experts agreed that underpayment was far too prevalent and far too large for business expenses to be a plausible explanation.

A third possible explanation for the withholding discrepancies was that the errors reflected preferential taxation of legitimate overtime income. Since overtime is taxable at the lowest marginal tax rate of 30%, even if nonovertime income is subject to a higher tax rate, the existence of widespread overtime could therefore lead to numerous tax shortfalls.

It is in fact likely that some individuals in the Survey received some compensation for legitimate overtime. However, government officials became convinced that legitimate overtime cannot explain the vast bulk of the errors. First, legitimate overtime activity should have been present prior to the introduction of preferential treatment for overtime in 1983; however, information from prior years indicated that overtime did not seem to be used. Second, the pattern of discrepancies by income class seemed wildly inconsistent with the overtime explanation. If the discrepancies were in fact attributable to legitimate overtime, then such imputed "overtime" would have to account for over 60% of total income for those who earned more than J$30,000, over 20% of income for those in the J$20,000 to J$30,000 category, roughly 10% for those in the J$10,000 to J$20,000 class, and virtually 0% for those making less than J$10,000; 40% of "overtime" would have to accrue to the 15% of the Survey who earned more than J$30,000; and on average "overtime" would have to equal more than J$6,000 for those earning more than J$30,000.[10]

Revenue Board personnel thought that this pattern of "overtime" income was completely implausible. Third, nearly half of the Survey received some amount of imputed "overtime"; although there are no official government statistics on overtime, the presence of widespread overtime in a country with an official unemployment rate of 27% in 1983 was questioned by Jamaican officials. Finally, and most importantly, government personnel records indicate that the vast majority of public sector employees who earn more than J$10,000 are salaried workers, ineligible for overtime income. Nevertheless, imputed "overtime" was pervasive among this group, more common than among comparable private sector workers, with an astonishing 94% receiving some "overtime." All of this "overtime" is necessarily illegal. "Overtime" was also pervasive among private sector workers, and Jamaican tax experts believed that legitimate overtime was unlikely for private sector employees in upper income classes. For these reasons, government officials concluded that "overtime," even if present, must be largely income that was illegally taxed at a lower than required rate.

The most convincing reason for the discrepancies is therefore outright evasion. Of course, it is logical to ask what incentive an employer would have to accede to employee requests for underwithholding; if anything, a firm has an incentive to overwithhold, since it can retain the overwithheld taxes for itself. The answer is simple, and is analogous in part to arguments for employer provision of fringe benefits: for a given total compensation cost to the firm, the employer can provide greater net compensation to the worker. The employer faces virtually no risk in this practice, since by law it is the employee who will be prosecuted if detected.[11]

In sum, close examination of the Survey suggested several alternative explanations for the withholding discrepancies: random error, busi-

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[10] Overtime income is not reported to the Income Tax Department, nor is it reported on the Survey. It is imputed here by calculating the amount of compensation that would have to have been received as overtime to yield an income tax liability consistent with that reported in the Survey.

[11] It remains possible that the discrepancies are in fact due to overtime. However, as long as overtime is not truly legitimate—and Jamaican experts think this certain—then there is an element of evasion that is present in overtime, an element that depends upon the same factors that determine what we call evasion. The worker must therefore still choose among reported, evasion, and avoidance compensation, where evasion is now measured as imputed overtime income, and the prices are slightly altered to reflect this change. As discussed below, this specification has been estimated, and the results are unaffected.

ness expenses for salespeople, legitimate over-time income, illegitimate overtime income, and outright evasion. There is no way to know for certain the exact reason for the discrepancies, and it is likely that all five sources of error play a role. However, Government of Jamaica personnel with whom we worked concluded, and we concurred, that the dominant reason for the discrepancies was evasion.

Cash compensation in the Survey therefore includes both reported income and evasion compensation. Cash compensation has been decomposed accordingly by calculating the amount of income that would have to have been reported to yield a tax liability consistent with the income and tax credit information provided in the Survey. This estimate is our empirical measure of reported income. Subtracting this estimate of reported income from cash compensation in the Survey then yields our measure of evasion income.[12] The estimated amounts of E, R, and A are reported by statutory income class in table 1.

B. Variable Specification

1. Dependent Variables:· The dependent variables in the three share demand equations are the proportion of total compensation allocated to gross reported income (S_R), gross allowances (S_A), and gross evasion income (S_E). Since the Survey data are net of some firm and taxpayer specific payroll taxes, it is necessary to gross-up these figures to reflect the standard assumption that labor bears the full burden of employee and employer shares of the various payroll taxes.[13]

2. Independent Variables: There are five components of the "price" terms for reported and evasion compensation. The first component is the marginal income tax rate on declared income. The specification of the rate reflects the possibility that taxation of an additional dollar of reported income may yield no increased income tax liability if the taxpayer has sufficient tax credits. To remove the problem of endogeneity of the marginal tax rate, the rate is also calculated on the basis of total compensation.[14] This procedure is followed for the other components as well.

The marginal penalty rate f affects both the price of evasion income and the price of reported income.[15] In Jamaican practice, a uniform penalty of 50% with no interest charge is imposed on all delinquent income taxes, so that f equals 1.5. However, although f is the same for all taxpayers, the marginal penalty term in the price of evasion varies across taxpayers because the penalty is imposed on evaded taxes; the marginal penalty term equals f times the marginal tax rate on gross (or true) compensation. Surprisingly, f also affects the price of R. If evasion is detected, then the individual may be pushed into a higher tax bracket in the progressive Jamaican tax structure. There is therefore an additional penalty that enters the price of reported income that equals f times the difference between the marginal tax rate on reported plus evasion compensation and that on reported income only. This penalty term is generated from the first-order conditions of the model, and also varies across taxpayers.

The third component of the prices includes the marginal payroll tax rates for both the employee and employer shares of the programs. These payroll tax rates are assumed to apply to both forms of cash compensation (R and E) because the Survey provides no information on payroll taxes withheld at source (unlike the income tax). It is

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[12] To illustrate, consider an individual whose Survey information shows cash compensation of J$7,000, tax credits of J$1,000, and income taxes withheld of J$500. There is clearly a discrepancy between actual taxes withheld (or J$500) and the true tax liability as suggested by the Survey data (or J$1,100 = .3*J$7,000–J$1,000). To calculate the amount of reported income R, solve for reported income from the relationship: .3*R − J$1,000 = J$500. This suggests a value of reported income of J$5,000. Imputed evasion income is then found by subtracting reported income from J$7,000, so that evasion income E is J$2,000. It may appear that the calculation of evasion requires the assumption that credit information is correct. However, this is not the case; that is, the estimate of E is unchanged even if it is assumed that evasion occurs via overstating of credits rather than underreporting of income. For example, assume for the above taxpayer that taxes withheld of J$500 are correct. Then credits would have to equal J$1,600 (not J$1,000) for taxes withheld to equal J$500, since taxes on J$7,000 are J$2,100. At a marginal tax rate of 30%, the overstating of credits by J$600 is worth J$2,000 (or J$600/.3), which is identical to the above estimate of evasion.

[13] Alternative incidence assumptions have been used in the construction of the variables and in the estimation, with no significant effects on the results.

[14] For example, a taxpayer with R = J$9,000, E = J$2,000, and A = J$4,000 has total compensation of J$15,000. The "first-dollar marginal tax rate" is calculated on $\bar{I} = R + E + A$, and equals 57.5%.

[15] This is explicit in the derivation of the prices when the progressive Jamaica tax structure is introduced formally. The precise forms of the prices and their derivation are available upon request.

TABLE 1.—DISTRIBUTION OF EVASION INCOME, REPORTED INCOME, AND ALLOWANCE INCOME
(DOLLAR AMOUNTS IN THOUSANDS OF JAMAICAN DOLLARS)

Income Class[a]	Number of Taxpayers	Evasion Income		Reported Income		Allowance Income		Total Compensation	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Under J$ 2,000	7,385	J$ 0.0	0.0	J$ 7,500.0	1.4	J$ 535.1	0.7	J$ 8,035.1	1.2
2,001–4,000	9,072	458.7	2.2	26,781.0	4.9	1,805.1	2.2	29,044.8	4.5
4,001–6,000	9,370	779.2	3.8	47,332.0	8.6	3,620.5	4.4	51,731.7	8.0
6,001–8,000	10,778	1,795.2	8.7	74,600.0	13.6	6,435.9	7.9	82,831.1	12.7
8,001–10,000	12,242	3,271.0	15.9	109,698.0	20.0	10,743.8	13.1	123,712.8	19.0
10,001–12,000	10,242	3,262.6	15.9	108,307.0	19.8	11,045.6	13.5	122,615.2	18.9
12,001–14,000	4,163	1,643.2	8.0	52,145.0	9.5	8,624.2	10.5	62,412.4	9.6
14,001–16,000	2,313	1,397.7	6.8	32,997.0	6.0	7,773.5	9.5	42,168.2	6.5
16,001–18,000	1,065	827.2	4.0	17,201.0	3.1	5,045.4	6.2	23,073.6	3.5
18,001–20,000	796	802.0	3.9	14,277.0	2.6	4,656.4	5.7	19,735.4	3.0
20,001–25,000	880	1,357.1	6.6	18,096.0	3.3	7,539.7	9.2	26,942.8	4.2
25,001–30,000	487	1,070.5	5.2	12,190.0	2.2	4,801.1	5.9	18,061.6	2.8
30,001–50,000	632	1,811.4	8.8	21,195.0	3.9	7,576.5	9.2	30,582.9	4.7
Over J$50,000	99	2,055.3	10.0	5,309.0	1.0	1,708.7	2.1	9,073.0	1.4
Total	69,724	J$20,531.1	100.0	J$547,628.0	99.9	J$81,911.5	100.1	J$650,070.6	100.0

[a] Based upon taxable income as reported in the Revenue Board Survey.

thus impossible to determine the degree of compliance with the payroll tax programs.[16]

The fourth component of the prices is the marginal payroll tax benefit function. The NIS, the NHT, and the CSFBS payroll programs provide contribution-related benefits. For these programs, it is possible to specify a marginal benefit function that reflects the institutional features of the appropriate plan. Payroll benefits equal the additional benefits that accrue from earning and paying payroll taxes on an additional dollar of compensation.[17]

The final price component is the probability of detection. The measure used here is arrived at indirectly. We assume that the subjective views that determine the individual's perceived probability of detection are derived from the experience of those audited in Jamaica. This probability is calculated as the product of the probability of being audited and the probability of detecting evasion given that an audit has occurred. The first probability is a closely guarded secret of the Income Tax Department. It is estimated by dividing the total number of returns that were examined by the Department over the period 1980 to 1982 by the total number of filers. Based on recent work in which the probability of audit is shown to be endogenous, the second conditional probability is a predicted one, estimated by applying a probit model to a sample of audited individ-

ual tax returns for 1980 to 1982.[18] These data are detailed line-by-line audits of 148 tax returns. The conditional probability of detection given an audit is estimated using this sample of audited returns, and then predicted for those in the Survey as a function of the reported values for tax credits, income, and the marginal tax rate.[19]

These various components are combined in terms that measure the prices of R, E, and A. The prices are similar to those discussed earlier, but reflect the nonlinear functions of the Jamaican tax structure.

While the firm has not been modeled as an active participant in the compensation choice process, it is important empirically to recognize variations in the willingness or ability of firms or sectors to supply various types of compensation. A dummy variable is included for the sector of employment, public versus private. Dummy variables are also included to capture the effects of

[16] Note that this assumption on payroll tax withholding does not affect the estimates of compensation shares, and has only a minor effect on their prices.
[17] The benefit calculations are available upon request.

[18] Beron, Tauchen, and Witte (1988) and Dubin and Wilde (1988) discuss the issues surrounding the appropriate specification of an audit equation, and apply this technique using aggregate data for the United States.
[19] The probit maximum likelihood estimation results are (t-statistics are in parentheses):

$$AUDIT = \underset{(3.12)}{0.89} + \underset{(1.93)}{3.0*10^{-5}\,INCOME} + \underset{(2.06)}{0.61\,MTR}$$
$$- \underset{(1.59)}{2.4*10^{-3}\,CREDIT}$$

$N = 148$; $-2*$log of likelihood ratio $= 284.65$

where $AUDIT$ indicates whether or not the audited return was found to have discrepancies; $INCOME$ is the value of gross income; MTR is the marginal tax rate; and $CREDIT$ is the value of tax credits.

firm size, where firm size is measured in terms of the number of employees; larger firms typically pay higher wages and provide more extensive nonwage compensation. Unfortunately, the Survey does not include any information on characteristics that might reflect individual preferences, and the individual anonymity in the Survey does not allow its matching with other sources.

3. *Estimation Technique:*[20] Estimation of the share equations poses several problems. As is well known, the three share equations can be estimated by dropping one equation and estimating the remaining two equations as a system. However, due to the high frequency of censored dependent variables across the shares—34% of the observations have a zero evasion share, 44% have a zero avoidance share, and 22% have a unity wage share—the usual normal error assumption of the system framework will be violated, and parameter estimates will be biased and inconsistent. Alternatively, a technique such as Tobit maximum likelihood estimation, which addresses the censoring problem, could be used. Unfortunately, neither the theoretical foundation nor the econometric software for the estimation of a system of censored equations with cross-equation restrictions has been developed to date.[21] We are thus faced with a choice between two imperfect estimation methods. Either we estimate the system with appropriate cross-equation restrictions but ignore the censoring problem; or we recognize the censoring problem, appeal to the consistency of single equation Tobit, but ignore the cross-equation restrictions. We have chosen to make use of both methods. Fortunately, the results are quite similar, and so we report only the Tobit estimates.[22]

IV. Estimation Results

Tobit maximum likelihood coefficient estimates for the three share equations are reported in

table 2. Estimates are provided for the entire subsample, as well as its public sector and private sector components.

The own-price coefficients possess the proper sign and (with the exception of the own-price of reported compensation in the public sector subsample, β_{RR}) are statistically significant. The cross-price coefficients exhibit symmetry in the signs, a result that is largely consistent across samples and is encouraging in the absence of explicit cross-equation restrictions. The signs of the cross-prices β_{EA} and β_{AE} indicate that evasion and avoidance compensation are substitutes, and reflects the fact that both are effective vehicles for reduction in tax liability. This result poses a serious dilemma for policymakers. For example, an increase in the penalty or the probability of detection increases the price of evasion compensation and (ignoring for the moment the impact on reported compensation) causes a portfolio reallocation that leads to the substitution of A income for E income. Therefore, better enforcement will not necessarily increase the tax base if there are loopholes in the system that can be exploited by evaders.

Reported and avoidance compensation are also substitutes. Increases in marginal tax rates or reductions in payroll tax benefits increase the price of R, and cause individuals to choose more A. Here, policy choices are easier: tax rates can be reduced or payroll tax benefits increased, leading to a direct increase in the reported tax base (own-price effect) and a reduction in avoidance activities (cross-price effect).

Somewhat surprisingly, β_{ER} and β_{RE} indicate that evasion and reported compensation are complements. Higher prices for reported (or evasion) compensation induce a portfolio reallocation that reduces the evasion (or reported) compensation share. Still, these responses are plausible. If, say, a reduction in the marginal tax rate lowers the price of R, then E may increase because the lower tax rate also lowers $\tilde{P}_E$. Similarly, an increase in the price of evasion may lower both S_E and S_R, as individuals substitute into avoidance activity. Finally, because higher penalties directly raise the price of evasion and, due to tax progressivity, raise the price of reported income as well, these compensation shares may move in a similar direction.

Taken in their entirety, the estimated price coefficients suggest a complicated behavioral re-

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[20] The entire Revenue Board Survey is not used in estimating the model due to the computational cost. The estimation results are based upon a 10,000 observation random subsample of 4,982 public and 5,018 private sector workers. The estimation results for different subsamples are very similar to those presented below.

[21] Some of the difficulties are explored in Amemiya (1974) and Huang, Sloan, and Adamache (1987).

[22] We have also estimated a specification in which evasion is measured as imputed overtime income, with reported income and prices recalculated accordingly. The elasticity of reported income with respect to each of the various policy parameters is largely the same.

TABLE 2.—TOBIT ESTIMATION RESULTS

Parameter		Coefficient Estimates		
Symbol	Definition	Survey Subsample	Private Sector	Public Sector
β_{EE}	Own-price of evasion	−1.2744[a]	−0.9030[a]	−2.6676[a]
		(0.2646)	(0.3028)	(0.5760)
β_{EA}	Avoidance income cross-price; evasion share	1.2689[a]	0.8892[a]	2.5361[a]
		(0.2554)	(0.2956)	(0.5455)
β_{ER}	Reported income cross-price; evasion share	−1.0296[a]	−0.9931[a]	−0.7605[a]
		(0.0968)	(0.1214)	(0.1621)
β_{AE}	Evasion income cross-price; avoidance share	2.2319[a]	0.4262	12.4711[a]
		(0.2584)	(0.2976)	(0.5791)
β_{AA}	Own-price of avoidance	−3.8091[a]	−1.9637[a]	−13.3816[a]
		(0.2476)	(0.2880)	(0.5489)
β_{AR}	Reported income cross-price; avoidance share	1.3190[a]	1.2603[a]	0.4763[a]
		(0.0898)	(0.1163)	(0.1515)
β_{RE}	Evasion income cross-price; reported share	−2.2574[a]	−0.3243	−10.7878[a]
		(0.2528)	(0.2859)	(0.5586)
β_{RA}	Avoidance income cross-price; reported share	3.4515[a]	1.5738[a]	11.2714[a]
		(0.2416)	(0.2759)	(0.5279)
β_{RR}	Own-price of reported income	−0.6147[a]	−0.6388[a]	0.2430
		(0.0851)	(0.1081)	(0.1449)
ϕ_{E1}	Firm size control; evasion share	−0.0444	−0.0532	0.0191
		(0.0457)	(0.0475)	(0.2311)
ϕ_{E2}	Firm size control; evasion share	0.0163	0.0460	−0.0517
		(0.0461)	(0.0493)	(0.2255)
ϕ_{E3}	Firm size control; evasion share	−0.0156	−0.2483[a]	0.1981
		(0.0493)	(0.0595)	(0.2230)
ϕ_{E4}	Public sector dummy; evasion share	−0.0244	—	—
		(0.0324)		
ϕ_{A1}	Firm size control; avoidance share	0.1871[a]	0.1884[a]	−0.7175[a]
		(0.0502)	(0.0531)	(0.2298)
ϕ_{A2}	Firm size control; avoidance share	0.2253[a]	0.2956[a]	−0.8838[a]
		(0.0501)	(0.0540)	(0.2228)
ϕ_{A3}	Firm size control; avoidance share	0.4408[a]	0.2145[a]	−0.4760[a]
		(0.0530)	(0.0631)	(0.2193)
ϕ_{A4}	Public sector dummy; avoidance share	−0.1625[a]	—	—
		(0.0337)		
ϕ_{R1}	Firm size control; reported share	−0.1012[a]	−0.0637	0.5421[a]
		(0.0435)	(0.0454)	(0.2151)
ϕ_{R2}	Firm size control; reported share	−0.1648[a]	−0.1409[a]	0.6918[a]
		(0.0438)	(0.0470)	(0.2094)
ϕ_{R3}	Firm size control; reported share	−0.0939	0.0365	0.5859
		(0.0468)	(0.0563)	(0.2069)
ϕ_{R4}	Public sector dummy; reported share	0.1794[a]	—	—
		(0.0309)		
α_E	Intercept; evasion share	−8.4740[a]	−8.3435[a]	−7.2743[a]
		(0.2888)	(0.3727)	(0.4953)
α_A	Intercept; avoidance share	−3.5242[a]	−3.6797[a]	−4.3305[a]
		(0.2226)	(0.3037)	(0.4184)
α_R	Intercept; reported share	13.2761[a]	11.7570	18.4220[a]
		(0.2345)	(0.3128)	(0.4400)

Note: Coefficient estimates are reported with asymptotic standard errors in parentheses. ϕ_{i1} represents firms with 20–100 employees; ϕ_{i2} represents firms with 100–500 employees; and ϕ_{i3} represents firms with more than 500 employees.
[a] Significant at the 0.05 level.

sponse to various policy instruments. As an example, consider the behavioral response that might follow from administrative improvements that increase the probability of detecting evasion. This policy change would lead to a negative own-price effect on the evasion share. However, the cross-price effect on reported compensation would also be negative, actually implying a lower reported tax base, and the cross-price effect on avoidance would increase S_A. Clearly, this is an undesirable and unintended outcome.

The remaining estimation results pertain to two sets of control variables. Public sector workers take smaller shares of avoidance compensa-

tion and larger shares of reported compensation. The public sector may be more interested in setting an example and preventing abuse of the allowance system. There may also be less concern over abusing the allowance loophole in the private sector and thus less monitoring of worker claims for avoidance compensation.

The effect of firm size differs across sectors, a fact that cannot be isolated without decomposing the sample into public and private sectors. In general, evasion shares are independent of firm size. However, avoidance shares are positively related to firm size in the private sector and negatively related in the public sector. Perhaps larger private sector firms make more extensive use of avoidance income due to the nature of the private sector production process, while larger public sector employers may frown upon the provision of nontaxable allowances.

Although the price responses are of considerable interest, the independent effects of variations in the policy parameters embedded in these prices are of greater interest. The impacts on compliance of increases in the penalty multiplier, the probability of detection, marginal payroll tax benefits, and the marginal income tax rate can be simulated using the reported income compensation share equation. The change in the expected value of the reported income share attributable to a marginal increase in a given policy parameter is

$$\frac{\partial S_R}{\partial X_j} = F(Z)\hat{\beta}_{RR}\frac{\partial \ln \tilde{P}_R}{\partial X_j} + F(Z)\hat{\beta}_{RE}\frac{\partial \ln \tilde{P}_E}{\partial X_j}$$

$$+ F(Z)\hat{\beta}_{RA}\frac{\partial \ln \tilde{P}_A}{\partial X_j}, \qquad (5)$$

where X_j is the jth policy variable, $F(Z)$ is the cumulative distribution function of a standard normal variable evaluated at the mean of the Tobit index Z, and $\hat{\beta}_{RR}$, $\hat{\beta}_{RE}$, and $\hat{\beta}_{RA}$ are conditional Tobit coefficients (not reported). The terms $\partial \ln \tilde{P}_R/\partial X_j$, $\partial \ln \tilde{P}_E/\partial X_j$, and $\partial \ln \tilde{P}_A/\partial X_j$ are simulated numerically by calculating the change in the log of the prices resulting from a 1% increase in the relevant policy parameter.[23] The resultant changes in the reported income shares are then transformed for each individual

[23] Since avoidance is the numeraire, $\partial \ln \tilde{P}_A/\partial X_j = 0$.

observation to yield the change in the level of the declared base.

The tax base elasticities are all extremely small, which likely arises because individuals are subject to income tax withholding. The largest response stems from an increase in the marginal income tax rate, and is only -0.1898. This negative own-price response on the reported compensation share does not appear to be large enough to be a major concern to policymakers. The other elasticities are even smaller: the penalty elasticity is -0.0810; the payroll benefits elasticity is 0.0708; and the probability elasticity is essentially zero (-0.0048). Note again that an increase in either the penalty multiplier or the probability of detection has the undesirable effect of slightly lowering the reported tax base.

These results suggest a number of important policy lessons. First, because the elasticities are very small, large discretionary changes in policy are necessary to induce a significant impact on the tax base. Second, individuals are less influenced by the expected penalties associated with evasion than with the rewards from lower income tax rates. Clearly, they do not perceive the enforcement regime as a significant deterrent to tax evasion. Third, the interrelationships among compensation types indicate that policy cannot be used in isolation to influence the choice of one compensation type unless the implications for other forms of compensation are identified. Finally, the major lesson is that comprehensive reform of the rate, base, and administration of the income tax is necessary to improve compliance. For example, a large reduction in the marginal income tax rate will result in a net revenue reduction because the direct revenue loss from lower rates is not offset by the base expansion resulting from lower rewards for evasion and avoidance. Consequently, the best way to ensure that structural rate and base changes have the desired effect on compliance is to introduce simultaneously changes in the entire system.

V. Conclusions

The decision to comply—or not to comply—with the individual income tax depends fundamentally upon the incentives introduced by the tax system. The results presented here suggest that individuals respond to these incentives in

choosing whether to pay, avoid, or evade taxes; that is, incentives matter, and individuals will increase their tax compliance if tax rates are lowered or if payroll benefits are increased, while they will actually comply less if more severe penalties are imposed or if detection becomes more certain. However, these responses are generally quite small. Thus, if structural reform is to be used to combat evasion and avoidance, major changes may be necessary to elicit a significant response from taxpayers, and the impacts of reform on all compensation types must be carefully identified to achieve the desired results.

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