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# Mobility, Competition, and the Distributional Effects of Tax Evasion

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## Abstract

The standard assumption underlying the incidence of tax evasion is that the beneficiaries are those who successfully evade their taxes. However, this assumption is likely to be incorrect or at least incomplete. Those who benefit from tax evasion are not necessarily the individuals actually engaging in evasion; indeed, these participants may not benefit at all. In many situations tax evasion is similar to a "tax advantage" generated by the tax laws. If there is any advantage at all, we would expect replication and competition (if possible) to work toward the elimination of this advantage. Put differently, a general equilibrium process of adjustment should occur through changes in the relative prices of both commodities and factors of production as resources move into and out of the relevant activities, and these changes should tend to eliminate (or at least reduce) the tax advantage of tax evasion. In this paper we analyze these incidence effects, using a computable general equilibrium model of an economy with a formal (and taxed) sector and an informal (and untaxed) sector. We incorporate the element of uncertainty in an individual's decision to evade. Importantly, we also allow for varying degrees of mobility via competition/entry across sectors in the economy in order to examine how much of the tax advantage is retained by the initial evaders and how much is shifted via factor and commodity price changes stemming from mobility. Our simulation results show that the evading household's post-evasion welfare is only 0.7-3.4 percent higher than the post-tax welfare if it had fully complied with taxes. Further, the evading household keeps 75.3-83.2 percent of this initial increase in welfare, while 16.8-24.7 percent of this initial gain is competed away as a result of mobility that reflects competition and entry into the informal sector. The compliant household's welfare increases by 58.8-106.5 percent with competition and entry in the informal sector. Consequently, the evading household benefits only marginally from successful evasion, and this advantage diminishes with mobility via competition/entry in the informal sector.

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## I. Introduction

The standard approach to the analysis of tax evasion assumes that an individual weighs the expected utility of successful evasion with the risky prospect of detection and punishment (Allingham and Sandmo, 1972). The implicit assumption here is that the successful evader keeps the evaded income in its entirety, so that the beneficiaries of evasion are those who successfully evade their taxes. However, this assumption is likely to be incorrect or least incomplete. Those who benefit from tax evasion are not necessarily the individuals actually engaging in evasion; indeed, these participants may not benefit at all. In many situations tax evasion can be viewed as a "tax advantage" generated by the tax laws (Martinez-Vazquez, 1996). If there is any advantage at all, we would expect replication and competition via the mobility of factors and products to work toward the elimination of this advantage. Put differently, a general equilibrium process of adjustment should occur through changes in the relative prices of both commodities and factors of production as resources move into and out of the relevant activities, and these changes should tend to eliminate (or reduce) the tax advantage of tax evasion. These types of general equilibrium effects are not typically considered in the standard approach to tax evasion.

This omission considerably weakens the relevance of the standard approach, at least in its conclusions about the distributional effects of tax evasion. For example, if it is simpler to hide capital income as opposed to labor income, then the standard approach concludes that (successful) evasion will make the tax system less progressive; if lower-income groups can evade taxes more easily, the conclusion is that evasion will make the tax system more progressive (Skinner and Slemrod, 1986). However, these types of inferences may not be correct, if the advantage of evading gets capitalized or competed away by market adjustments. An obvious case in point is tax evasion by domestic help, such as house cleaners, baby sitters, and yard care workers. Tax evasion in this case may actually

benefit the higher-income households hiring these services since they can pay lower prices for their services. However, these types of adjustments have not typically been considered in most previous work on the distributional effects of tax evasion.

In this paper we analyze the incidence effects of these adjustment processes, using a computable general equilibrium (CGE) model of an economy with a formal (and taxed) sector and an informal (and untaxed) sector. We incorporate the element of uncertainty in an individual's decision to evade. Importantly, we also allow for varying degrees of mobility via competition and/or entry across sectors in the economy in order to examine how much of the initial tax advantage is retained by the initial evaders and how much is shifted via factor and commodity price changes stemming from factor and product mobility. Our simulation results show that the evading household's post-evasion welfare is only 0.7-3.4 percent higher than the post-tax welfare if it had fully complied with taxes. Further the evading household keeps 75.3-83.2 percent of this initial increase in welfare, while 16.8-24.7 percent of this initial gain is competed away as a result of mobility that reflects competition and entry into the informal sector. The compliant household's welfare increases by 58.8-106.5 percent with competition and entry in the informal sector. Consequently, the evading household benefits only marginally from successful evasion, and this advantage diminishes with mobility via competition/entry in the informal sector.

In the following sections, we first present a brief overview of significant previous research on tax evasion incidence, highlighting some of the gaps in the literature. We then develop a CGE model tailored to mirror a "typical" small closed and developing economy. We then present the data used in this paper and discuss our simulation results. The final section concludes.

## II. Related Research

In their seminal work, Allingham and Sandmo (1972) consider the case of an individual's decision to evade income taxes. In their portfolio approach to tax evasion, individuals compare the expected utility of being detected and paying a penalty on tax evasion, to the expected utility from being able to keep the evaded income. The incidence of tax evasion in this formulation is simple: the successful individual evader benefits exclusively by keeping the evaded income in its entirety. However, this approach ignores market forces that work toward the elimination of the tax advantage created by evasion opportunities via changes in both commodity and factor prices, as products and resources flow into and out of affected activities. These forces can only adequately be analyzed in a general equilibrium framework.

Several studies have utilized such a general equilibrium approach. Watson (1985) analyses a model with two labor markets with differing evasion possibilities, in order to examine changes in various tax parameters on evasion and labor market equilibrium. A distinction between markets could arise if, say, employers in only one market are subject to withholding requirements that could prevent their employees from successfully underreporting their income. He argues that the interaction between evasion and labor market equilibrium is crucial to the understanding of the ultimate effect of tax parameter changes on evasion and equilibrium in the labor market. His analysis of both proportional and progressive taxation reveals that the gains that might accrue to those who are better able to avoid detection are partially eliminated by wage declines in markets in which evasion is possible, so that market forces tend to eliminate the value of any advantage created by the presence of evasion opportunities.

In perhaps the most complete analysis of these types of general equilibrium effects, Kesselman (1989) develops an intersectoral general equilibrium model of income tax evasion. Qualitative and quantitative assessments of the effects of tax rate changes on

evasion activity, relative output prices, and real tax revenues yield an array of findings. For example, higher tax rates drive resources out of the compliant sector into the evading sector, if government consumes goods from both the evading and compliant sectors in the same pattern as households and if higher tax rates do not affect evasion costs. However, if government purchases are biased toward output of the compliant sector and if higher tax rates also raise the evasion costs for individuals via, say, the structure of penalties for the apprehended evaders, then higher tax rates may actually lower tax evasion. Of more relevance for our work here, the inducement toward more or less evasion requires changes in the relative prices of outputs from both the evading and compliant sectors, which suggests that the gains from evasion may be shifted from the evaders to the consumers of their output via lower prices; that is, the evaders may bear most of the evasion costs, but the marginal evader may not gain from evasion. Finally, the effects of evasion on the marginal revenue response to tax rate changes depend on consumers' elasticity of substitution between sectoral outputs.

Both Watson (1985) and Kesselman (1989) utilize a general equilibrium approach and thus account for the effects of evasion on the labor market equilibrium. However, neither considers the uncertainty of returns in an individual's decision to evade.

This limitation is addressed by Thalmann (1992), who studies the impact of factor taxes on employment in two production sectors, the "reported" and the "unreported" sectors. In his general equilibrium framework, taxes are evaded when resources relocate from the "reported" sector to the "unreported" sector. The unreported sector differs from the reported sector, but only to the extent that unreported activities are not reported to the tax authority and therefore are not taxed. He also uses a novel approach of relegating the uncertainty of returns associated with tax evasion to the budget constraint rather than follow the usual expected utility approach.

Thalmann's (1992) analysis gives rise to several results that are noteworthy. First, the dependence of the expected penalty on the tax rate and on the extent of evasion renders ambiguous the response of labor supply to the unreported sector when there is an increase in the labor income tax. This ambiguity occurs because the higher tax also raises the expected penalty for evasion, so that the general equilibrium effect of the higher tax on employment in the unreported sector is indeterminate if the labor supply response also is indeterminate. Second, a lower wage rate implies higher capital income, which reduces the total supply of labor by the representative household, consequently leading to a shift to the less labor-intensive reported sector. Third, participation of any agent in the unreported sector, be it the worker, firm, or capital owner, does not depend solely on their legally due tax payments. Even when firms have no direct incentive to escape to the unreported sector, some firms still employ capital and labor that try to avoid taxes, since these factors will be offered at a discount; that is, factor holders surrender part of the savings from tax evasion as a way of "bribing" firms to offer them employment "off the books".

These studies have added considerably to our understanding of the general equilibrium adjustments that occur in the presence of tax evasion.[1] Even so, this work does not address fully the main issues surrounding the distributional effects of tax evasion. There is no study that has explicitly incorporated the general features that we believe a model must have in order to capture these effects.

What are these general features? As argued by Martinez-Vazquez (1996), there are several desirable features for models of evasion incidence.

First, the model should be able to capture the potential general equilibrium effects of tax evasion. These general equilibrium effects induce changes in the relative prices both of

[1] See also Alm (1985), who examines the welfare cost of taxes that drive resources from the taxed or above-ground sector to the untaxed or underground sector.

factors of production and of goods and services, brought about by market equilibrium forces. If there is a tax advantage in terms of expected factor income or firms' expected profits, the (potential) mobility of resources will lead to the necessary price adjustments until this advantage is eliminated.

Second, the model should incorporate the element of uncertainty in an individual's decision to evade in at least one sector of the economy. This uncertainty may reflect simply the element of tax evasion as an opportunity facing the individual; more broadly, it may reflect the possibility that at some point the individual may be subject to taxation. The presence of uncertainty is an essential characteristic of tax evasion incidence, and allows the excess burdens of evasion associated with uncertainty to be accounted for in the model.

Third, the model should allow for varying degrees of competition or entry across sectors in the economy, including those in which tax evasion is prevalent. This includes mobility of factors, such as labor in the case of income tax evasion; it also includes firm entry in several sectors, as in the case of sales tax or corporate income tax evasion. The element of mobility is critical to an understanding of how much of the tax advantage may be retained by the initial evaders and how much is shifted elsewhere via factor and commodity price changes.[2]

A complete analysis of the incidence of tax evasion therefore requires the consideration of these general equilibrium effects, in a setting in which uncertainty is present and in which mobility across sectors can vary.[3] At one extreme, with no entry or competition, those participating in evasion activities are the final beneficiaries, as the standard approach predicts. However, at the other extreme, with perfect competition and

[2] There are several other features that would be desirable in a complete model. For example, it would be desirable to allow for differences in preferences among individuals so that different groups may benefit differently from changes in relative prices. It would also be desirable to incorporate any the externality effects that evaders may impose on others.

[3] Any advantage from tax evasion may also be dissipated by direct means, such as bribes to corrupt officials (Shaw and Whalley, 1990).

completely free entry, tax evaders (even if successful) may hardly benefit at all because any initial benefit from the absence of taxation is eroded via entry and competition.

The failure to consider these adjustments can lead to a variety of mistakes. As one example, Skinner and Slemrod (1985) argue that, if labor income is more likely to be generated in the untaxed sector than capital income, then the existence of tax evasion makes the tax system more progressive. However, if the advantages realized by workers get capitalized or competed away by market processes, then this conclusion is incorrect. The failure to tax, say, domestic help may actually benefit higher-income households who hire these services because entry into domestic help means that the households pay lower prices for the domestic services. Similarly, immigrant or undocumented workers working in, say, the garment industry may not benefit from their failure to pay taxes. Instead, with entry it is rather the buyers of garments who benefit from lower prices of the various commodities that are produced.

A second example is demonstrated by Persson and Wissen (1984), who analyze the relationship between the true distribution of income, or income on which no taxes are paid, and the distribution of officially reported income. Given the differences between the two, they correctly conclude that government policies aimed at reducing the inequality in the distribution of reported income could be counterproductive in terms of actual income distributions. However, they also implicitly assume that the incidence of tax evasion is simple and direct: evaders benefit exclusively and fully from their failure to pay taxes. If the incidence of evasion is more indirect and more complicated, then the government might stop redistribution efforts based on the belief that certain groups are already benefiting from tax evasion, when actually they are not.

Empirical studies of the distribution, of tax burdens provide a third, and perhaps the most important, example of the use of naive assumptions about the incidence of evasion. It

is a traditional exercise in public finance to examine the progressivity or regressivity of a particular tax system, and the study of the overall incidence of new proposals for tax reform is almost always part of the background work accompanying the reform. Frequently, findings of vertical and horizontal incidence are adjusted to take into account the impact of existing evasion, such as in the case of professionals or unskilled workers employed in the informal sector of the economy. These adjustments are made under the assumption that the evading groups benefit exclusively and in full from the assumed tax evasion. Indeed, Alm, Bahl, and Murray (1991) conduct this type of analysis for Jamaica, in which they generate estimates of the amount of tax evasion that occurs via underreporting of income and nonfiling of income tax returns, in order to derive estimates of the "true" burden of taxation in Jamaica. However, they assume that tax evaders retain all benefits from their evasion. Of course, in many cases this implicit assumption is incorrect, and the resulting estimates of the "true" burden of taxation are therefore misleading.

The key phenomenon that any model should explain is to extent to which any advantage of tax evasion gets capitalized or competed away via price changes, including the identification of gainers and losers from this process. A complete model of incidence should also allow us to reach a wide variety of conclusions. As noted above, at one extreme we might have the case in which there is "no shifting" at all because, for example, there is no mobility or no free entry. In this case, successful evaders keep all unpaid taxes in their entirety, and there are no changes in relative prices of factors of production or commodities as a result of the evasion activity itself.[4] At the other extreme we might have the case in which the tax advantage gets "fully shifted" elsewhere because entry is unrestricted and the

[4] Limits to entry may reflect the fact that buyers prefer to buy from reputable merchants with products under warranty. Limits to entry may also come from risk aversion, higher costs for concealing taxes, fear of stigma, or even the need to show some degree of compliant behavior to conceal other taxes due from the authorities. See Kesselman (1989).

supply response is large enough to compete away any residual tax advantage. This could happen if, for example, there is a very elastic supply of potential taxpayers who may have no choice but to work in the untaxed or informal sector, such as the presence of unskilled laborers in a developing economy with limited opportunities for employment, or the existence of undocumented workers in a developed economy who also have limited opportunities. In these cases, it is unlikely that these workers would be able to keep any benefit from working in an informal sector. Instead, the likely beneficiaries are buyers of the goods and services produced in the informal sector.[5]

We utilize these guidelines to develop a framework for analyzing the incidence of tax evasion via a static CGE model. The static CGE model has the advantage that it emphasizes the interaction among different industries and/or sectors, and so allows for product and factor mobility in response to changes in returns.

## III. A Static Computable General Equilibrium Model[6]

The CGE model depicts a small closed economy with two broadly defined sectors, composed of an aboveground or taxed sector that produces output X and an underground or tax evading sector, whose output (Y) is a substitute for taxed output. We make several main assumptions:

- There are two consumers, a POOR evading (informal) household and a RICH conforming (formal) household.
- Spending and income of the government (GOVT) are disaggregated from that of the consumers, so that the government is treated as a separate consumer that collects taxes in order to provide a public good called "public administration".
- Labor is variable in supply, with a standard labor-leisure choice, and is imperfectly mobile across sectors.[7]

[5] A special case here is one in which the commodities are consumed exclusively by higher income groups.
[6] The full algebraic representation of the CGE model used in this paper is presented in the Appendix.

- Capital is fixed in total supply, imperfectly homogenous, and imperfectly mobile across sectors.[8]

- Labor and capital holders declare their activity in the aboveground sector (sector X) and comply with registration and tax laws.

- Unreported sector productive activity (sector Y) is hidden from the authorities and thus escapes taxation. However, firms in this sector are constrained by concealment requirements.[9]

- The RICH consumer holds portfolios only in the formal or aboveground sector, while the POOR consumer only operates or works in the underground sector.[10]

Also, producers are assumed to maximize profits taking prices as given, and consumers are assumed to maximize utility subject to a budget constraint that depends upon the value of their endowments. These assumptions imply that producers earn only normal profits and that consumers cannot increase consumption of all goods.

**Household Consumption and Labor Decisions**

The RICH and POOR consumers allocate their time to labor in the formal and informal sectors, respectively, and to leisure according to the following utility maximization problem:

$$[1] \qquad U = \text{Max } U^i\left(C_j^i, H^i - L_x^i - L_y^i\right); i = 1,2 \;\&\; j = x, y$$

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[7] For a Cobb-Douglas function with an elasticity of substitution between consumption and leisure equal to one, labor supply is completely inelastic with respect to the wage rate. However, when the elasticity of substitution is greater than one, an increase in the wage rate will generate an increase in labor supply, and an elasticity of substitution less than one will mean that labor supply falls with an increase in the wage rate, leading to a "backward bending" supply curve. As discussed later, we allow for multiple values of the elasticity of substitution in our sensitivity analysis.

[8] Alm (1985) argues that the presence of risk premia on factor returns in the underground sector will prevent complete equalization of net factor returns, even with complete mobility. It is important to note that it is factor returns adjusted for any such differentials that are equalized by mobility. To the extent that the pattern of risk premia is not affected by the presence of these taxes, the results remain unchanged.

[9] For instance, firms in the underground sector may opt to produce less than the profiting maximizing level of output to avoid detection in the evasion of sales taxes.

[10] As an extension, we allow the RICH or compliant household to hold portfolios in both the formal and informal sectors via the supply of labor to both these sectors. This is necessary to capture the changes in net-of-tax returns to factors of production, especially labor, when the compliant household decides to allocate some labor to the informal sector.

subject to

$$[2] \qquad \sum_{j=1}^{2} P_j C_j^i \le (1-t) w_x L_x^i + \left[1 - P^{ti}\left(a^t, L_y^i, t\right)\right] w_y L_y^i + K^i,$$

where

$C_j$ is the consumption of the commodity produced by both sectors[11]

$P_j$ is the price of good *j,* ( $j = x, y$ )

$H^i$ is individual *i*'s total time endowment

$L_x^i$ and $L_y^i$ are labor allocated to sectors X and Y, and $w_x$ and $w_y$ are the corresponding real wage rates

Labor and capital income taxes are proportional to gross income at rate *t*

$P^{ti}(\cdot)$ is individual *i*'s expected tax-plus-penalty rate (or expected penalty), and is a general function of labor supplied in sector Y, the tax rate *t,* and the enforcement parameter $a^t$

$K^i$ is individual *i*'s capital income.

Note that wages need not be equal for a consumer to be active in both sectors. Labor and capital income are taxed in the aboveground sector, while unreported activity in sector Y entails the risk of detection and taxation at a penalty rate above the regular tax rate, as captured by $P^{ti}(\cdot)$.

The $P^{ti}(\cdot)$ function merits some elaboration. Following Thalmann (1992), we model the uncertainty associated with the tax evaders' returns via first-order certainty equivalence around unreported income. Uncertainty is usually modeled by writing the optimization problem in expected utility. However, this approach has the disadvantage that it rapidly becomes intractable when the representative consumer has more choices than simply underreporting fixed income. Thalmann (1992) argues that an alternative hypothesis is to use first-order certainty equivalence around the unreported income. The actual income from the unreported labor is $\left[1 - P^{ti} + e\right] w_y L_y^i$, where *e* is a zero-expectation stochastic

[11] The elasticity of substitution between goods X and Y in final demand is assumed to be 1. The informal sector good is, however, tainted by the lack certain attributes like return service, warranty, and after-sales-service otherwise enjoyed by consumers of the formal sector good X.

variable. He shows that the solution of the maximization of expected utility is the same (to the first-order condition in *e*) as the solution to the problem in [1] and [2], where *e* is replaced by its expected value. The expected penalty in this case is the product of the probability of detection and the tax-plus-penalty rate charged on unreported income, and it increases at an increasing rate with enforcement parameters ( $a^t$ ) such as the frequency of audits and the penalty coefficient on regular tax rates, with the unreported volume of activity, and with the regular tax rate.

**Firm's Production Decisions**

Following Kehoe and Kehoe (1994), we assume that both goods have production functions that combine intermediate inputs in fixed proportions, and labor and capital with substitution possibilities governed by a Cobb-Douglas production function of the form $\beta k_m^{\alpha} l_m^{1-\alpha}$. Stated differently, goods are produced according to a nested Leontief–Cobb Douglas technology, where intermediate inputs and aggregate value-added enter at the top level.[12] Value-added represents a Cobb-Douglas aggregation of labor and capital. The general form of the total production function of good *m* is;

$$[3] \qquad q_m = \min\left(v_{xm}/a_{xm}, v_{ym}/a_{ym}, \beta k_m^{\alpha} l_m^{1-\alpha}\right), m = x, y.$$

where

$v_{jm}$ is the intermediate input of good *j* used in the production of good *m*
$a_{jm}$ is the amount of good *j* required to produce one unit of good *m*
$a_{jm}$, $\beta_m$ and $\alpha_m$ are parameters to be calibrated.

It is reasonable to expect that not every good is used in the production of every other good. This is corrected by dropping the corresponding entry from the production function.

[12] The labor/capital elasticity in value-added is assumed to be 1, while the elasticity of substitution between intermediate inputs is assumed to be zero. Our choice of both the Cobb-Douglas structure for value-added and the Leontief intermediate input demand is standard in applied general equilibrium modeling.

Producers are assumed to minimize costs and to earn zero after-tax profits. Given that this assumption implies that producers never waste inputs, the production function can be rewritten as:

$$[4] \qquad q_m = v_{xm} / a_{xm} = v_{ym} / a_{ym} = \beta_m k_m^{\alpha} l_m^{1-\alpha} .$$

Cost minimization further implies that $k_m$ and $l_m$ solve the problem:

$$[5] \qquad \min w_m l_m + r_m k_m$$

subject to

$$[6] \qquad \beta_m k_m^{\alpha} l_m^{1-\alpha} \geq q_m ,$$

where $w_m$ is the wage rate and $r_m$ is the capital rental rate. The assumption of zero after-tax profits implies that:

$$[7] \qquad (1-\tau_m) P_m q_m - \sum_{j=1}^{2} P_j a_{jm} q_m - w l_m - r k_m = 0, m = x, y,$$

where $\tau_m$ is the indirect tax rate on the sales of good *m*.

**Equilibrium Conditions**

Mathiesen (1985) demonstrates that an Arrow-Debreu general economic equilibrium model can be formulated and solved as a complementarity problem. This problem can be depicted in terms of three sets of "central variables": ***p*** is a non-negative *n*-vector of commodity prices including all final goods, intermediate goods, and primary factors of production; ***y*** is a non-negative *m*-vector of activity levels for constant returns to scale production sectors in the economy; and ***M*** is an *h*-vector of income levels, one for each "household" in the model, including any government entities. Equilibrium in these variables satisfies a system of three classes of nonlinear inequalities: zero profit, market clearance, and income balance. Consider each condition.

***Zero Profit.*** The first class of constraints requires that in equilibrium no producer earns an "excess" profit; that is, the value of inputs per unit activity must be equal to or greater than the value of outputs. This can be written in compact form as:

[8] $Cost_i(p) \geq \text{Re}venue_i(p).$ $\perp y_i$

The corresponding complementary variable for a zero profit condition is output $y_i$. All else constant, if output prices increase for commodity *i*, then production activity increases until marginal cost equals marginal revenue.

***Market Clearance.*** The second class of equilibrium conditions is that, at equilibrium prices and activity levels, the supply of any commodity must balance or exceed excess demand by consumers and producers. This condition can be expressed as:

[9] $y_i \geq \sum_i POOR_i + RICH_i + GOVT_i$ . $\perp p_i$

Inequality [9] refers to produced commodities; a similar constraint holds for endowed goods such as labor and capital. The corresponding dual or complementary variable is the price $p_i$ (e.g., the price of both commodities and factors of production). Prices adjust until supply equals demand for a given commodity or factor.

***Income Balance.*** The third condition is that in equilibrium the value of each agent's income must equal the value of factor endowments, or:

[10] $\sum_i M_i \geq w\overline{L} + p_K \overline{K}$ ,

for POOR, RICH, and GOVT. Since we always work with utility functions that exhibit non-satiation, Walras' law always holds. In other words, complementary slackness, though not imposed as an equilibrium condition by itself, is a feature of the equilibrium allocation. This means that in equilibrium any production activity that is operated makes zero profit, while any production activity that earns a negative net return is idle. Similarly, any

commodity that commands a positive price has a balance between aggregate supply and demand, and any commodity in excess supply has an equilibrium price of zero.

## IV. Data and Model Calibration

This section describes our model calibration, procedures. We start with the Social Accounting Matrix (SAM), constructed under the assumption that the consumers and/or producers in the formal sector meet their tax obligations while their counterparts in the informal sector fully evade taxes (e.g., full compliance in the formal sector and tax evasion in the informal sector.) Our data do not represent any particular country, but have been constructed to reflect sectoral compositions in a "typical" developing country. Table 1 presents a list of variable definitions, while Tables 2, 3, and 4 show the data for the basic two-good, two-factor, and two-consumer closed economy models considered here.

### Salient Features of the SAMs

Table 2 summaries the salient features of the social accounting matrices used here. These SAMs are constructed based on assumptions about the structure and size both of the formal and informal sectors and of the POOR and RICH households. We assume that the formal sector is more capital-intensive compared to the informal sector and that the formal sector is more efficient relative to the informal sector. We also assume that the informal sector utilizes part of the formal sector output (in addition to inputs of labor and capital) as an intermediate input in its production process, while the formal sector utilizes only capital and labor inputs in production.[13] Finally, we assume that the POOR household's endowment is less than that of the RICH household; specifically, we assume that the POOR

[13] An example of formal sector intermediate inputs used in the informal sector is a sweat shop producing handbags or wallets that utilize leather and thread from the formal sector.

households' endowment is 33 percent of the endowment enjoyed by the RICH household, and we verify the robustness of our counterfactual results by changing this proportion to 25 and 50 percent.[14]

It is important to note that, although it is feasible to use various parameters to reflect the input and output choices that are consistent with these assumptions, the choice of our input and output values is dictated by the need to maintain the internal consistency of our social accounting matrices or to preserve the zero profit, market clearing, and income balance conditions. Table 3 presents the data for the basic two-good, two-factor, and two-consumer closed economy models, in which it is assumed that there is full compliance in the formal sector and tax evasion in the informal sector; Table 4 allows for some evasion in the formal sector as well as in the informal sector. We now turn to a description of these data, focusing for the moment on Table 3.

**Taxes**

In the economy represented in Table 3, we assume that no taxes are levied in the benchmark equilibrium. Two tax treatments are introduced as counterfactual exercises:

- There are commodity and income taxes in both sectors (e.g., there full compliance in both sectors)
- There are commodity and income taxes in the formal sector but these taxes are imposed at zero rates in the informal sector (e.g., there is full compliance in the formal sector and complete tax evasion in the informal sector).

**Input/Output Data**

[14] Though the informal sector is present in all countries, the size of the informal sector in developing countries at times rivals that of the formal sector. The unweighted average of the shadow economy as a share of the official GDP in 2002/03 was 43.2 percent in developing nations and 40.1 percent in East and Central European and former Soviet countries. For OECD countries, the unweighted average was 16.3 percent. See Schneider (2005).

The input data are presented in the form of a balanced matrix, in which the entries represent the value of economic transactions in a given period, typically one year. The rectangular SAM format follows a sign convention wherein supplies or receipts are represented by positive numbers and demands or payments are represented by negative numbers. Internal consistency of a rectangular SAM implies that row sums and column sums are zero. With this interpretation, a *row* sum is zero if the total amount of commodity flowing into the economy equals the total amount of commodity flowing out of the economy. This represents is market clearance, and one such condition applies for each commodity in the model. Columns in this matrix correspond to production sectors or consumers. A *production sector column* sum is zero if the value of outputs equals the cost of inputs. A *consumer column* is balanced if the sum of primary factor sales equals the value of final demands. Zero column sums thus indicate zero profits (product exhaustion) or consumer income balance.

In the SAM shown in Table 3, we have one row for every market (traded commodity). There are four markets, for goods X and Y and for factors L and K. Again, there are two types of columns in a rectangular SAM, corresponding to production sectors and consumers. There are two production sectors (X and Y) and three consumers (POOR, RICH, and GOVT).

The numbers in the SAM are values, or prices multiplied by quantities. A commonly followed practice is to choose units so that the prices of as many activities as possible are initially equal to unity. However, in the presence of taxes, both consumer and producer prices generally cannot equal one.

**Production Sectors**

In Table 3, we assume that 110 units of output are produced in sector X using 50 units of labor and 60 units of capital. These units are chosen to reflect the assumptions that production in sector X is more efficient and capital-intensive relative to production in sector Y. We also assume that sector X (the aboveground sector) does not utilize intermediate inputs from sector Y (the underground sector). Sector Y produces 100 units of output using 30 units of intermediate inputs from sector X, 30 units of labor, and 40 units of capital. These input/output choices are made to emphasize the fact that sector Y is less efficient and labor-intensive in production compared to sector X. The input/output parameterization adopted here is intended to highlight two things: more efficient and more capital-intensive production in formal sector X relative to informal sector Y. While it is possible to use diverse parameters to reflect these input and output choices, the choice of our input and output units is dictated by the need to maintain the internal consistency of our social accounting matrices or to preserve the zero profit, market clearing, and income balance conditions.

**Consumers' Endowments and Labor Supply**

We assume in Table 3 that the POOR consumer is endowed with 40 units of labor and 10 units of capital, while the RICH consumer is endowed with 60 units of labor and 90 units of capital. These choices reflect the assumption that the POOR consumer's total endowment is one-third of the RICH consumer's total endowment.

Table 3 also shows the labor supply choices of the three consumers (POOR, RICH, and GOVT). We allow a standard labor-leisure choice, in which labor chooses between leisure and labor supply with leisure entering into the workers utility function.[15] We assume

[15] In our formulation, we introduce additional activities TCONSP and TCONSR, which transform leisure (at price PL) into labor supplied by the POOR and RICH households (at prices PLSP and PLSR, respectively).

that the POOR consumer owns 40 units of leisure, supplies 30 in the benchmark, and retains 10 as leisure; the RICH consumer is assumed to own 60 units of leisure, supplies 50 in the benchmark, and retains 10 as leisure. In the presence of tax evasion, taxes are applied to both labor and capital supplied to the formal sector, and the leisure margin is untaxed. These units are chosen to emphasize the fact that the POOR consumer supplies less labor in the benchmark and thus enjoys more leisure compared to the RICH consumer. Specifically, the POOR household supplies 75 percent of the total leisure endowment and retains 25 percent as leisure. The RICH household supplies 83 percent of the total leisure endowment in the benchmark, and consumes the remaining 17 percent as leisure. Informal sector economic activity traditionally includes such activities as small plot-farming, street marketing, and other low-volume activities (Light, 2004), and as such it is reasonable to assume that the POOR consumer enjoys more leisure compared to the RICH consumer.

**Consumer Utility Functions**

The consumer's utility function is represented as a production activity, so that utility is a good that is produced from commodity inputs, including factor inputs such as leisure. The utility goods (PWP and PWR) are purchased using the consumer's endowments, which also reflect the income constraint. For example, in Table 3 the POOR consumer demands 50 units of utility good PWP and receives 10 and 40 units of income from the endowments of labor and capital, respectively, to make this purchase.

The activity level in sectors WP and WR (denoting the utility functions of POOR and RICH consumers, respectively) can also be interpreted as a Hicksian welfare index, the equivalent variation. Utility for the POOR consumer (WP=50 units) is "produced" using 15 units of good X and 35 units of good Y. Similarly, the RICH consumer's utility (WR=150 units) is produced using 85 units of good X and 65 units of good Y. We assume that the

POOR consumer's utility is intensive in the informal sector goods, while the RICH consumer's utility is intensive in the formal sector goods.

**Government**

The government (GOVT) is also considered as a separate consumer, which collects or demands tax revenues to provide a government good referred to as "public administration". Since no taxes are imposed and/or collected in the benchmark, the level of government activity is thus implicitly assumed to be zero in the benchmark. We assume that the government is the only consumer of this good, and consequently the RICH and POOR households do not enjoy any welfare from "public administration". Put differently, the government good does not enter the household utility functions, but increased government activity (or increased provision of the government good) increases the demand for labor and capital, so that the households earn wages and rents working for the government. We assume that production of the government good is labor-intensive. The government good is produced using formal sector labor ( $L_F$ ) and capital ( $K$ ) with substitution possibilities governed by a Cobb-Douglas production function, or $G = L_F^{\alpha_F} K^{\beta}$, in which constant returns to scale imply that $\alpha_F + \beta = 1$.

**Tax Evasion in the Formal (or Aboveground) Sector**

The rectangular SAM presented in Table 3 assumes that consumers and/or producers in the aboveground sector completely fulfill their tax obligations, which is equivalent to assuming that tax evasion takes place only in the underground sector Y. However, individuals who earn their income in the aboveground sector may be able to evade part of

their due tax payments. Thus, analysis of the gains and/or losses from tax evasion requires modeling the compliance choices of workers in the aboveground sector.

One way of modeling this aspect is to adjust the returns to labor in the aboveground sector along the same lines as suggested by Thalman (1992), yielding a budget constraint of:

$$[11] \quad \sum_{j=1}^{2} P_j C_j^i \leq \left[1 - t - P^{ti}\left(a^t, L_x^i, t\right)\right] w_x L_x^i + \left[1 - P^{ti}\left(a^t, L_y^i, t\right)\right] w_y L_y^i + K^i .$$

Other relevant equations can also be adjusted accordingly so as to compute the equilibrium outcome. Table 4 presents the rectangular SAM that depicts evasion in both the formal and informal sectors. The consumption and production choices in Table 4 are similar to those in Table 3, except that the RICH consumer now allocates only 80 percent of the labor supply (40 units) to the formal sector and the rest (10 units) is allocated to the informal sector.[16]

**Production/Consumption Functions and Elasticities**

We adopt constant elasticity of substitution (CES) functions for producers and consumers because these functions are globally regular and can be defined by their zero, first, and second order properties. This implies that the location (price and quantity), slope (marginal rate of substitution), and curvature (convexity) completely characterize the function (Light, 2004).

We choose elasticities based largely on past studies and conventions (Light, 2004). Specifically, we make the following elasticity assumptions:

- Labor/capital elasticity in value-added = 1
- Elasticity of substitution between intermediate inputs = 0

[16] We assume that the RICH consumer allocates only a fraction of labor supply to the informal sector, with the majority of the labor being supplied to the formal sector. Although there are various ways of modeling this labor supply decision, we assume that 40 units (80 percent of RICH household's labor supply) are allocated to the formal sector and 10 units (20 percent of the RICH household's labor supply) are allocated to the informal sector, so as to maintain the internal consistency of the SAM and also preserve the zero profit, market clearing, and income balance conditions of our CGE model in Table 4.

- Elasticity of substitution between goods X and Y in final demand = 1
- Labor-leisure elasticity = 1
- Elasticity of substitutions (ESUB) between leisure and consumption = 2.

Value-added in production represents a Cobb-Douglas aggregation of labor and capital, hence the labor/capital elasticity in value-added is 1. The choice for the Leontief intermediate input demand is standard in CGE modeling. Finally, unity is chosen to be the elasticity between labor and leisure, and 2 is the default elasticity between leisure and consumption. The choice for the elasticity between leisure and consumption is motivated by the need to model perfect competition in the informal sector of the economy.

**Consumer Welfare Changes**

A widely used measure of welfare change is how much income the consumer would require, when faced with base case prices, to achieve the same level of utility as in the simulation, or the equivalent variation. We use this measure of consumer welfare change to compare the welfare gains and/or losses accruing to the POOR and RICH households.

**Sensitivity Analyses**

Various sensitivity analyses are performed to verify the consistency and robustness of our results. One set examines the assumptions about the relative endowment of the POOR household. As one variation here, we assume that the total endowment of the POOR household is only 25 percent of the endowment enjoyed by RICH household; in another, we assume that the POOR household's total endowment is 50 percent of the RICH household's total endowment. The SAMs in Tables 3 and 4 are adjusted accordingly.[17]

[17] For example, with full compliance in the formal sector and a POOR household endowment of 25 percent of a RICH household endowment, the SAM becomes:

Another set changes the expected penalty rates in these different scenarios. Still another set varies the elasticity assumptions, especially the elasticity of substitution between leisure and consumption, in order to examine the impact of different degrees of mobility between the sectors upon our results. A final set changes the tax rates on consumption and income. As discussed later, our main results are largely unaffected.

## V. Counterfactuals and Simulations

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| | Production Sectors | | | | | | Consumers | |
|---|---|---|---|---|---|---|---|---|
| Markets | X | Y | WP | WR | TCONSP | TCONSR | POOR | RICH |
| PX | 155 | -30 | -5 | -120 | | | | |
| PY | | 100 | -35 | -65 | | | | |
| PWP | | | 50 | | | | -50 | |
| PWR | | | | 200 | | | | -200 |
| PLSP | | -30 | | | 30 | | | |
| PLSR | -70 | | | | | 70 | | |
| PL | | | -10 | -15 | -30 | -70 | 40 | 85 |
| PK | -85 | -40 | | | | | 10 | 115 |

Here the POOR consumer has a total endowment of 40 units of labor in the benchmark, supplies 75 percent of this labor endowment (30 units) to be used in the production process, and retains 25 percent (10 units) as leisure. The RICH household has a total endowment of 85 units of labor in the benchmark, supplies 82 percent of this labor endowment (70 units) to the production process, and retains 18 percent (15 units) as leisure. We maintain the assumption that the relatively inefficient nature of production in the informal sector Y implies that the POOR household is able to devote a higher percentage of the labor endowment to leisure compared to the RICH household. The output units in also reflect the fact that production is more efficient and capital-intensive in the formal sector relative to the informal sector. With partial compliance in the formal sector and a POOR household endowment of 25 percent of a RICH household endowment, the SAM becomes:

| | Production Sectors | | | | | | Consumers | |
|---|---|---|---|---|---|---|---|---|
| Markets | X | Y | WP | WR | TCONSP | TCONSR | POOR | RICH |
| PX | 155 | -30 | -5 | -120 | | | | |
| PY | | 100 | -35 | -65 | | | | |
| PWP | | | 50 | | | | -50 | |
| PWR | | | | 200 | | | | -200 |
| PLSP | | -30 | | | 30 | | | |
| PLSR | -56 | -14 | | | | 70 | | |
| PL | | | -10 | -15 | -30 | -70 | 40 | 85 |
| PK | -99 | -26 | | | | | 10 | 115 |

Now the RICH consumer allocates 80 percent of the labor endowment (56 units) to the formal sector and the rest (14 units) to the informal sector. Similar adjustments are made to the SAMs for a POOR household endowment of 50 percent of a RICH household endowment under full or partial compliance.

Analysis of the impact of a change in government policy proceeds via the comparative statics methodology. The model is constructed so that its equilibrium replicates the benchmark data. Simulation of the policy change then follows by altering the relevant policy parameters (say, a change in the ad valorem tax rate on good *m*, or $\tau_m$) and calculating the new equilibrium. In the base case equilibrium, prices $P_m$, the wage *w,* and the capital rental rate *r* are all calibrated to equal one. The model is then used to evaluate the impact of changes in government policy on the welfare of the POOR and RICH households, on consumption, and on the prices of produced goods and factors of production. Our model allows for varying degrees of mobility into and out of the informal sector, mainly by varying the elasticity of substitution between leisure and consumption, in order to measure how much of the tax advantage is retained by the initial evaders and how much is competed away via factor and commodity prices changes. The main purpose of our counterfactual exercises is to compare the initial to the post-evasion/post-tax equilibria, under the various scenarios (especially full compliance in the formal sector/full evasion in the informal sector, and partial compliance in the formal sector/full evasion in the informal sector); that is, how much of the gain from tax evasion is retained by the evading household and how much is dissipated via general equilibrium adjustments in prices? A discussion of our simulation results follows.

**Full Compliance in the Formal Sector and Tax Evasion in the Informal Sector**

We first analyze the general equilibrium effects of full compliance in the formal sector and full evasion of taxes in the informal sector, using the benchmark data presented in Table 3. We levy an ad-valorem commodity tax at a 10 percent rate and an income tax at a proportional rate of 25 percent. All counterfactual results incorporate an equal-yield tax

constraint in the formal sector and a labor-leisure choice in both the formal and informal sectors.

Table 5 presents a summary of the general equilibrium effects resulting from the evasion of commodity and income taxes in the informal sector. Using changes in consumer welfare as an overall indicator of the gains and/or losses from tax evasion, the top part of Table 5 indicates that the POOR household benefits from evasion but only somewhat, and that this advantage declines with entry into the informal sector. Specifically, Table 5 shows that the POOR household retains 78.2 percent of the initial 2.4 percent increase in its welfare, while 21.8 percent of this initial gain in welfare is wiped away as a result of entry into the informal sector.[18] The RICH household's welfare initially falls by 0.64 percent, but mobility reduces this loss to only -0.02 percent, which represents a 96.9 percent increase in welfare for the RICH household arising from mobility into the informal sector. The increase in the RICH households' commodity X-intensive welfare is mainly attributed to a reduction in the tax-inclusive price of commodity X as mobility into the informal sector occurs.

Table 5 also shows that the tax-inclusive price of commodity X falls by 8.6 percent with mobility into the informal sector, while the commodity price of good Y increases by 9.8 percent. The POOR household's welfare is intensive in commodity Y, and so an increase in the commodity price of good Y reduces the POOR households' welfare. Further, mobility increases the amount of labor supplied by the POOR and RICH households by 59.8 percent and 122.6 percent, respectively, leading to a reduction in their net-of-tax wages by 13.4 percent and 184.0 percent, respectively.

Increasing the expected penalty rate only alters the size of these changes and not their direction. The lower part of Table 5 shows that with increased expected penalty rates

[18] The "initial" gain or loss refers to the percentage change between the post-evasion and post-tax welfare.

the initial increase in the POOR household's welfare is only 1.08 percent. Now the POOR household keeps just 76.8 percent of this increase in welfare, while 23.2 percent is competed away with mobility, and the RICH household experiences a 112.0 percent increase in welfare with mobility. Increased expected penalty rates for evasion (and increased entry/competition into the informal sector) therefore work toward the elimination of the differences in factor prices, commodity prices, and consumer welfare in the formal and informal sectors.

**Partial Compliance in the Formal Sector and Tax Evasion in the Informal Sector**

Recall that we also allow for the possibility of evasion in the formal sector using the SAM in Table 4. The RICH household allocates labor between the formal and informal sectors by comparing the statutory tax rate with the expected penalty for evasion, respectively (or the relative wages in these two sectors). All counterfactual results again incorporate an equal-yield tax constraint in the formal sector and a labor-leisure choice in both formal and informal sectors. The results are presented in Table 6.

The effects on commodity prices, price of capital, and welfare for both the POOR and RICH household mimic those in Table 5. For example, the POOR household retains 77.2 percent of the initial 2.8 percent increase in its welfare, while 22.7 percent of this initial gain in welfare is eliminated as a result of mobility into the informal sector. The RICH household's welfare initially falls by 0.76 percent, but mobility reduces this loss to only -0.05 percent, representing a 106.5 percent increase in welfare for the RICH household. However, although the amount of labor supplied by RICH household increases by 233.1 percent (which is 110.5 percentage points higher than in Table 5), the results in Table 6 indicate that the net-of-tax wage for the RICH household falls by 126.8 percent (or 57.2 percentage points less than in Table 5). This result occurs because, with tax evasion

now possible in the formal sector, some of the RICH household labor is now supplied to the informal sector, which mitigates the reduction in the net-of-tax wage for the RICH household but which also exacerbates the reduction in the net-of-tax wage for the POOR household.

**Sensitivity Analysis**

Some additional sensitivity analyses are based on alternative SAMs, in which the endowments of POOR and RICH households are adjusted. Overall, the sensitivity results show that variations in the proportion of the POOR household's endowment to that of the RICH household does not affect our results in any significant way. For example, in Tables 7 and 8 the POOR household's endowment is 25 percent of the RICH household's endowment. The results in Table 7 (with full compliance in the formal sector) indicate that the POOR household's post-evasion welfare is only 3.01 percent higher than the post-tax welfare if it had fully complied with taxes. Further, the POOR household keeps 77.1 percent of this initial increase in welfare, while 22.9 percent of this initial gain is competed away as a result of mobility into the informal sector. The RICH household's welfare initially falls by 0.58 percent, but mobility results in a 0.01 percent increase in the RICH households' welfare, representing a gain of 101.7 percent. The increase in the RICH household's commodity X-intensive welfare is due to a reduction in the tax-inclusive price of commodity X as mobility into the informal sector occurs. Increasing the expected penalty rate for evasion does not alter these general results.

Similarly, the results in Table 8 (with partial compliance in the formal sector) shows that the tax-inclusive price of commodity X falls by 8.5 percent with mobility, while the commodity price of good Y increases by 10.3 percent. The POOR household's welfare is intensive in commodity Y, and an increase in the price of commodity Y leads to a reduction

in the POOR household's welfare. Further, increased competition from the informal sector leads to an increase in the amount of labor supplied in the informal and formal sectors by 61.8 percent and 159.6 percent, respectively, leading to a reduction in the net-of-tax wages by 15.1 percent and 112.9 percent, respectively. As with our earlier results, the POOR household benefits only marginally from tax evasion, and this advantage diminishes with entry and competition in the informal sector. Increasing the expected penalty rate for evasion does not change these conclusions.

The results when we assume that the POOR households' endowment is 50 percent of the RICH households' endowment are also consistent with the results in Tables 5 to 8. Similarly, other sensitivity results for variations in the elasticity of substitution between leisure and consumption and for different levels of the commodity and income tax rates are very similar to the results that we report.[19]

## VI. Conclusions

Distributional conclusions drawn from the standard approach to tax evasion are unsatisfactory because this approach ignores the fact that tax evasion is much like a "tax advantage" in the law, so that replication and competition should work toward the elimination of this advantage. This process of adjustment will take place through changes in the relative prices of both commodities and factors of production, as mobility occurs into and out of the relevant sectors. The standard approach takes only a partial equilibrium perspective, and does not capture these general equilibrium mobility effects.

Our approach addresses this limitation by utilizing a CGE model to analyze the incidence of tax evasion. We assume that there are two broadly defined sectors of the

[19] All results are available upon request.

economy, the formal (or taxed) and the informal (or untaxed) sectors. We adapt our model and specifications to characterize the circumstances of a "typical" developing country.

The counterfactual experiments indicate that the tax evader does not benefit exclusively from evasion. Indeed, our results indicate that any "tax advantage" from evasion diminishes with mobility into the informal sector, as well as with an increase in the expected penalty associated with tax evasion. The evading household benefits but only somewhat from tax evasion, and this advantage shrinks significantly with mobility. Additionally, both the net-of-tax wage for informal sector labor and the consumer price of the informal sector output decline with tax-evasion-induced mobility.

In short, the gains from evasion are shifted at least in part from the evaders to the consumers of their output via lower prices, as general equilibrium mobility effects work via relative price and productivity changes to eliminate the incentive for workers to enter the informal sector beyond some margin. As more workers enter the underground sector, their production pushes down the relative price of the informal sector output and consequently the hourly returns of working in there; the movement of workers between the sectors also changes the relative productivity of workers in each sector as capital also moves between the sectors. In equilibrium, therefore, the marginal entrant to the informal sector has the gains from evading taxes offset by the relative price and productivity effects.[20]

[20] There could also be changes in the "psychic costs" associated with working in the informal sector. Psychic costs reflect the distaste that individuals experience when working in each sector, which includes innate preferences for each type of work as well as the possible loss of status and fear of apprehension associated with working in the underground sector (Kesselman, 1989).

**Appendix**

The RICH and POOR consumers allocate their time to labor in the formal and informal sectors, respectively, and to leisure according to the following utility maximization problem:

$$[A1] \quad U = \text{Max } U^i\left(C_j^i, H^i - L_x^i - L_y^i\right); i = 1,2 \;\&\; j = x, y$$

subject to

$$[A2] \quad \sum_{j=1}^{2} P_j C_j^i \le (1-t) w_x L_x^i + \left[1 - P^{ti}\left(a^t, L_y^i, t\right)\right] w_y L_y^i + K^i$$

where the utility function is assumed to take the CES form, or

$$u\left(c_j^i, l\right) = \left\{\sum_{j=1}^{2} \theta_j^i \left(c_j^i\right)^{1-1/\sigma} + \left(1 - \sum_{j=1}^{2} \theta_j^i\right)\left(l^i\right)^{1-1/\sigma}\right\}^{\sigma/(\sigma-1)}; i = 1,2; j = x, y.$$

Using calculus to solve the consumer's maximization problem given in [1] and [2] above, we have:[21]

$$[A3] \quad C_j^i = \frac{\theta_j^i \left\{(1-t) w_x L_x^i + \left[1 - P^{ti}\left(a^t, L_y^i, t\right)\right] w_y L_y^i + K^i\right\}}{P_j}; \; i = 1, 2; j = x, y.$$

where $\theta_j^i$ are non-negative parameters.

Equilibrium is specified by listing values of all the endogenous variables in the model: a price for each of the produced goods $\hat{P}_m$, a level of consumption for each good $\hat{C}_m$, wage rates $\hat{w}_m$, capital rental rates $\hat{r}_m$ and a production plan for each of the produced goods $\left(\hat{q}_m, \hat{v}_{xm}, \hat{v}_{ym}, \hat{k}_m, \hat{l}_m\right)$. Equilibrium must therefore satisfy the following properties:

- The consumption vector $\left(\hat{c}_x, \hat{c}_y\right)$ solves the utility maximization problem subject to the budget constraint.
- The production plan $\left(\hat{q}_m, \hat{v}_{xm}, \hat{v}_{ym}, \hat{k}_m, \hat{l}_m\right)$ minimizes costs subject to the feasibility constraints and earns zero after-tax profits.
- Supply equals demand for each produced good, or:

[21] For a Cobb-Douglas utility function, the utility maximization problem depicted by equations [A1] and [A2] yields the following demand function *c* for consumer *i*: $c^i = \theta^i I / p$, where $\theta^i$ are non-negative parameters, I is the representative consumer's disposable income, and $p$ is the consumer price. Equation [A3] is obtained by replacing *I* with the consumers' disposable income shown in the budget constraint in equation [A2].

[A4] $\hat{q}_m = \hat{c}_j + \sum_{m=1}^{2} \hat{v}_{jm}$ , for $j = m$ = x, y.

- Supply equals demand in each factor market:

[A5] $\bar{l} = \sum_{m=1}^{2} \hat{l}_m, m = x, y.$

[A6] $\bar{k} = \sum_{m=1}^{2} \hat{k}_m, m = x, y.$

- Total government revenues equal total tax receipts under full tax compliance:

[A7] $\hat{T} = t\left(\hat{w}\bar{l} + \hat{r}\bar{k}\right) + \sum_{m=1}^{2} \tau_m \hat{P}_m \hat{q}_m, m = x, y.$

Imposing the condition that supply equals demand for each produced good, we have:

[A8] $q_m = \frac{\theta_m I^i}{P_m} + \sum_{m=1}^{2} \hat{v}_{jm}; j = m = x, y; i = 1,2.$

[A9] $P_m = \frac{\theta_m I^i}{q_m - \sum_{m=1}^{2} \hat{v}_{jm}}; j = m = x, y; i = 1,2,$

where

$$I^i = (1-t)w_x L_x^i + \left[1 - P^{ti}\left(a^t, L_y^i, t\right)\right]w_y L_y^i + K^i.$$

Further, the first order conditions from the consumer optimization yield the condition:

[A10] $(1-t)w_x = \left[1 - P^{ti}\left(a^t, L_y, t\right) - P_y^{\ ti}\left(a^t, L_y, t\right)L_y\right]w_y$

where

$$P_y^{ti} = \frac{\partial P^{ti}(\cdot)}{\partial L_y}, \text{ for } i=1, 2.$$

Consumers allocate labor to the informal sector Y until their wage net of the expected penalty (including the marginal change in the expected penalty that is attributable to the change in $L_y$) is equal to the wage in sector X net of taxes.

**Table 1.** ***List of Variable Definitions***

| | |
|---|---|
| X | Activity level for formal or taxed sector X |
| Y | Activity level for informal or untaxed sector Y |
| TX | Ad-valorem tax rate for X sector inputs |
| TY | Ad-valorem tax rate for Y sector inputs |
| TXI | Proportional tax rate on X sector inputs |
| TYI | Proportional tax rate on Y sector inputs |
| POOR | Evading (informal) household |
| RICH | Conforming (formal) household |
| WP | Hicksian welfare function for informal (POOR) household |
| WR | Hicksian welfare function for formal (RICH) household |
| G | Government activity level, equal to zero in benchmark |
| TCONSR | Labor supply for formal (RICH) household |
| TCONSP | Labor supply for informal (POOR) household |
| PX | Price index for commodity X |
| PY | Price index for commodity Y |
| PL | Price index for primary factor L |
| PK | Price index for primary factor K |
| PWP | Price index for POOR household welfare |
| PWR | Price index for RICH household welfare |
| PG | Price index for the government good (e.g., cost of administration) |
| PLSP | Price index for POOR household labor supply |
| PLSR | Price index for RICH household labor supply |
| GOVT | Government (e.g., tax collector) |
| ESUB | Elasticity of substitution between leisure and consumption |

**Table 2.** ***Social Accounting Matrix: Summary of Salient Features***

| **Markets** | **Production Sectors (Sector X, Sector Y)** | **Consumers' Endowment (POOR, RICH)** |
|---|---|---|
| Good X | o X is more capital-intensive<br>o Y is more labor-intensive | o POOR has 25 percent of RICHs' endowment |
| Good Y | o X uses only inputs of capital and labor<br>o Y uses K and L inputs plus intermediate inputs from sector X | o POOR has 33 percent of RICHs' endowment |
| Capital (K) | o POORs' welfare is commodity Y-intensive<br>o RICHs' welfare is commodity X-intensive | |
| Labor (L) | o POOR enjoys more leisure compared to RICH | o POOR has 50 percent of RICHs' endowment |

*Note*. The actual values in the Social Accounting Matrix reflect three internal consistency conditions: zero profit, market clearing, and income balance.

**Table 3.** ***Social Accounting Matrix: Labor-leisure Choice and Intermediate Inputs in Production with Full Compliance in the Formal Sector and Full Evasion in the Informal Sector and with the POOR Household's Endowment 33 Percent of the RICH Household's Endowment***

| | Production Sectors | | | | | | Consumers | |
|---|---|---|---|---|---|---|---|---|
| **Markets** | **X** | **Y** | **WP** | **WR** | **TCONSP** | **TCONSR** | **POOR** | **RICH** |
| PX | 110 | -30 | -5 | -75 | | | | |
| PY | | 100 | -35 | -65 | | | | |
| PWP | | | 50 | | | | -50 | |
| PWR | | | | 150 | | | | -150 |
| PLSP | | -30 | | | 30 | | | |
| PLSR | -50 | | | | | 50 | | |
| PL | | | -10 | -10 | -30 | -50 | 40 | 60 |
| PK | -60 | -40 | | | | | 10 | 90 |

**Table 4.** ***Social Accounting Matrix: Labor-leisure Choice and Intermediate Inputs in Production with Partial Compliance in the Formal Sector and Tax Evasion in the Informal Sector and with the POOR Household's Endowment 33 Percent of the RICH Household's Endowment***

| | Production Sectors | | | | | | Consumers | |
|---|---|---|---|---|---|---|---|---|
| **Markets** | **X** | **Y** | **WP** | **WR** | **TCONSP** | **TCONSR** | **POOR** | **RICH** |
| PX | 110 | -30 | -5 | -75 | | | | |
| PY | | 100 | -35 | -65 | | | | |
| PWP | | | 50 | | | | -50 | |
| PWR | | | | 150 | | | | -150 |
| PLSP | | -30 | | | 30 | | | |
| PLSR | -40 | -10 | | | | 50 | | |
| PL | | | -10 | -10 | -30 | -50 | 40 | 60 |
| PK | -70 | -30 | | | | | 10 | 90 |

**Table 5.** ***Summary of General Equilibrium Effects with Full Compliance in the Formal Sector and Full Evasion of Consumption and Income Taxes in the Informal Sector and with the POOR Household's Endowment 33 Percent of RICH Household's Endowment***

| **Statutory ad valorem commodity tax = 0.1, Statutory proportional income tax rate = 0.25 Expected penalty rate (commodity taxes) = 0.07, Expected penalty rate (income taxes) = 0.2** | | | | |
|---|---|---|---|---|
| | **POOR Household** | | **RICH Household** | |
| | **Magnitude (%)** | **Percent change (%)** | **Magnitude (%)** | **Percent change (%)** |
| Initial Post-Evasion Welfare | 2.43 | | -0.64 | |
| Final Post-Evasion Welfare | 1.90 | -21.8 | -0.02 | 96.9 |
| Initial Price of Good X | 5.99 | | 5.99 | |
| Final Price of Good X | 5.47 | -8.6 | 5.47 | -8.6 |
| Initial Price of Good Y | -6.30 | | -6.30 | |
| Final Price of Good Y | -5.68 | 9.8 | -5.68 | 9.8 |
| Initial Post-Evasion Rental Rate | -0.89 | | -0.89 | |
| Final Post-Evasion Rental Rate | 2.36 | 365.1 | 2.36 | 365.1 |
| Initial Post-Evasion Net Wage | -4.02 | | 0.50 | |
| Final Post-Evasion Net Wage | -4.56 | -13.4 | -0.87 | -184.0 |
| Initial Post-Evasion Labor Supply | 6.43 | | -2.74 | |
| Final Post-Evasion Labor Supply | 10.28 | 59.8 | 0.62 | 122.6 |
| **Statutory ad valorem commodity tax = 0.1, Statutory proportional income tax rate = 0.25 Expected penalty rate (commodity taxes) = 0.095, Expected penalty rate (income taxes) = 0.225** | | | | |
| Initial Post-Evasion Welfare | 1.08 | | -0.25 | |
| Final Post-Evasion Welfare | 0.83 | -23.2 | 0.03 | 112.0 |
| Initial Price of Good X | 2.56 | | 2.56 | |
| Final Price of Good X | 2.32 | -9.4 | 2.32 | -9.4 |
| Initial Price of Good Y | -2.79 | | -2.79 | |
| Final Price of Good Y | -2.49 | 10.8 | -2.49 | 10.8 |
| Initial Post-Evasion Rental Rate | -0.37 | | -0.37 | |
| Final Post-Evasion Rental Rate | 1.13 | 405.4 | 1.13 | 405.4 |
| Initial Post-Evasion Net Wage | -0.99 | | 0.60 | |
| Final Post-Evasion Net Wage | -1.24 | -25.2 | -0.36 | -160.0 |
| Initial Post-Evasion Labor Supply | 2.80 | | -1.18 | |
| Final Post-Evasion Labor Supply | 4.47 | 59.6 | 0.36 | 130.5 |

*Note*. "Initial" refers to the outcome with limited competition and/or entry in the informal sector. "Final" refers to the outcome with increased competition and/or entry in the informal sector. "Magnitude" is the percentage difference between the post-evasion and post-tax outcome if both POOR and RICH households complied with taxes. "Percent change" refers to the percentage change between the magnitude for the "initial" and "final" outcome.

**Table 6.** ***Summary of General Equilibrium Effects with Partial Compliance in the Formal Sector and Full Evasion of Consumption and Income Taxes in the Informal Sector and with the POOR Household's Endowment 33 Percent of the RICH Household's Endowment***

| **Statutory ad valorem commodity tax = 0.1, Statutory proportional income tax rate = 0.25 Expected penalty rate (commodity taxes) = 0.07, Expected penalty rate (income taxes) = 0.2** | | | | |
|---|---|---|---|---|
| | **POOR Household** | | **RICH Household** | |
| | **Magnitude (%)** | **Percent change (%)** | **Magnitude (%)** | **Percent change (%)** |
| Initial Post-Evasion Welfare | 2.81 | | -0.76 | |
| Final Post-Evasion Welfare | 2.17 | -22.7 | 0.05 | 106.5 |
| Initial Price of Good X | 6.24 | | 6.24 | |
| Final Price of Good X | 5.83 | -6.5 | 5.83 | -6.5 |
| Initial Price of Good Y | -6.65 | | -6.65 | |
| Final Price of Good Y | -6.11 | 8.1 | -6.11 | 8.1 |
| Initial Post-Evasion Rental Rate | -1.68 | | -1.68 | |
| Final Post-Evasion Rental Rate | 2.18 | 229.7 | 2.18 | 229.7 |
| Initial Post-Evasion Net Wage | -3.37 | | -0.67 | |
| Final Post-Evasion Net Wage | -4.20 | -24.6 | -1.52 | -126.8 |
| Initial Post-Evasion Labor Supply | 6.02 | | -2.05 | |
| Final Post-Evasion Labor Supply | 10.90 | 81.0 | 2.73 | 233.1 |
| **Statutory ad valorem commodity tax = 0.1, Statutory proportional income tax rate = 0.25 Expected penalty rate (commodity taxes) = 0.095, Expected penalty rate (income taxes) = 0.225** | | | | |
| Initial Post-Evasion Welfare | 1.23 | | -0.29 | |
| Final Post-Evasion Welfare | 0.93 | -24.3 | 0.07 | 124.1 |
| Initial Price of Good X | 2.64 | | 2.64 | |
| Final Price of Good X | 2.45 | -7.1 | 2.45 | -7.1 |
| Initial Price of Good Y | -2.93 | | -2.93 | |
| Final Price of Good Y | -2.66 | 9.2 | -2.66 | 9.2 |
| Initial Post-Evasion Rental Rate | -0.67 | | -0.67 | |
| Final Post-Evasion Rental Rate | 1.07 | 259.7 | 1.07 | 259.7 |
| Initial Post-Evasion Net Wage | -0.69 | | -0.24 | |
| Final Post-Evasion Net Wage | -1.08 | -81.9 | -0.62 | -158.3 |
| Initial Post-Evasion Labor Supply | 2.62 | | -0.88 | |
| Final Post-Evasion Labor Supply | 4.72 | 80.1 | 1.28 | 245.5 |

*Note*. "Initial" refers to the outcome with limited competition and/or entry in the informal sector. "Final" refers to the outcome with increased competition and/or entry in the informal sector. "Magnitude" is the percentage difference between the post-evasion and post-tax outcome if both POOR and RICH households complied with taxes. "Percent change" refers to the percentage change between the magnitude for the "initial" and "final" outcome.

**Table 7.** ***Summary of the General Equilibrium Effects with Full Compliance in the Formal Sector and Full Evasion of Consumption and Income Taxes in the Informal Sector and with the POOR Household's Endowment 25 percent of the RICH Household's Endowment***

| **Statutory ad valorem commodity tax = 0.1, Statutory proportional income tax rate = 0.25 Expected penalty rate (commodity taxes) = 0.07, Expected penalty rate (income taxes) = 0.2** | | | | |
|---|---|---|---|---|
| | **POOR Household** | | **RICH Household** | |
| | **Magnitude (%)** | **Percent change (%)** | **Magnitude (%)** | **Percent change (%)** |
| Initial Post-Evasion Welfare | 3.01 | | -0.58 | |
| Final Post-Evasion Welfare | 2.32 | -22.9 | 0.01 | 101.7 |
| Initial Price of Good X | 4.10 | | 4.10 | |
| Final Price of Good X | 3.75 | -8.5 | 3.75 | -8.5 |
| Initial Price of Good Y | -6.89 | | -6.89 | |
| Final Price of Good Y | -6.18 | 10.3 | -6.18 | 10.3 |
| Initial Post-Evasion Rental Rate | -0.82 | | -0.82 | |
| Final Post-Evasion Rental Rate | 2.56 | 412.1 | 2.56 | 412.1 |
| Initial Post-Evasion Net Wage | -3.89 | | -0.54 | |
| Final Post-Evasion Net Wage | -4.48 | -15.1 | -1.15 | -112.9 |
| Initial Post-Evasion Labor Supply | 7.27 | | -2.13 | |
| Final Post-Evasion Labor Supply | 11.77 | 61.8 | 1.27 | 159.6 |
| **Statutory ad valorem commodity tax = 0.1, Statutory proportional income tax rate = 0.25 Expected penalty rate (commodity taxes) = 0.095, Expected penalty rate (income taxes) = 0.225** | | | | |
| Initial Post-Evasion Welfare | 1.31 | | -0.23 | |
| Final Post-Evasion Welfare | 0.99 | -24.4 | 0.05 | 121.7 |
| Initial Price of Good X | 1.75 | | 1.75 | |
| Final Price of Good X | 1.59 | -9.1 | 1.59 | -9.1 |
| Initial Price of Good Y | -3.05 | | -3.05 | |
| Final Price of Good Y | -2.71 | -11.2 | -2.71 | -11.2 |
| Initial Post-Evasion Rental Rate | -0.33 | | -0.33 | |
| Final Post-Evasion Rental Rate | 1.21 | 466.7 | 1.21 | 466.7 |
| Initial Post-Evasion Net Wage | -0.94 | | -0.17 | |
| Final Post-Evasion Net Wage | -1.20 | -27.6 | -0.48 | -182.3 |
| Initial Post-Evasion Labor Supply | 3.14 | | -0.91 | |
| Final Post-Evasion Labor Supply | 5.08 | 61.7 | 0.64 | 170.3 |

*Note*. "Initial" refers to the outcome with limited competition and/or entry in the informal sector. "Final" refers to the outcome with increased competition and/or entry in the informal sector. "Magnitude" is the percentage difference between the post-evasion and post-tax outcome if both POOR and RICH households complied with taxes. "Percent change" refers to the percentage change between the magnitude for the "initial" and "final" outcome.

**Table 8.** ***Summary of the General Equilibrium Effects with Partial Compliance in the Formal Sector and Full Evasion of Consumption and Income Taxes in the Informal Sector and with the POOR Household's Endowment 25 percent of the RICH Household's Endowment***

| **Statutory ad valorem commodity tax = 0.1, Statutory proportional income tax rate = 0.25 Expected penalty rate (commodity taxes) = 0.07, Expected penalty rate (income taxes) = 0.2** | | | | |
|---|---|---|---|---|
| | **POOR Household** | | **RICH Household** | |
| | **Magnitude (%)** | **Percent change (%)** | **Magnitude (%)** | **Percent change (%)** |
| Initial Post-Evasion Welfare | 3.40 | | -0.69 | |
| Final Post-Evasion Welfare | 2.56 | -24.7 | 0.15 | 87.5 |
| Initial Price of Good X | 4.19 | | 4.19 | |
| Final Price of Good X | 4.03 | -3.8 | 4.03 | -3.8 |
| Initial Price of Good Y | -7.23 | | -7.23 | |
| Final Price of Good Y | -6.76 | 6.5 | -6.76 | 6.5 |
| Initial Post-Evasion Rental Rate | -1.91 | | -1.91 | |
| Final Post-Evasion Rental Rate | 2.32 | 221.4 | 2.32 | 221.4 |
| Initial Post-Evasion Net Wage | -3.03 | | -0.31 | |
| Final Post-Evasion Net Wage | -3.95 | -30.3 | -1.25 | -75.2 |
| Initial Post-Evasion Labor Supply | 6.84 | | -1.44 | |
| Final Post-Evasion Labor Supply | 12.89 | 88.4 | 3.79 | 363.1 |
| **Statutory ad valorem commodity tax = 0.1, Statutory proportional income tax rate = 0.25 Expected penalty rate (commodity taxes) = 0.095, Expected penalty rate (income taxes) = 0.225** | | | | |
| Initial Post-Evasion Welfare | 1.46 | | -0.26 | |
| Final Post-Evasion Welfare | 1.07 | -26.7 | 0.11 | 142.3 |
| Initial Price of Good X | 1.77 | | 1.77 | |
| Final Price of Good X | 1.70 | -3.9 | 1.70 | -3.9 |
| Initial Price of Good Y | -3.18 | | -3.18 | |
| Final Price of Good Y | -2.94 | 7.5 | -2.94 | 7.5 |
| Initial Post-Evasion Rental Rate | -0.77 | | -0.77 | |
| Final Post-Evasion Rental Rate | 1.13 | 246.7 | 1.13 | 246.7 |
| Initial Post-Evasion Net Wage | -0.55 | | -0.19 | |
| Final Post-Evasion Net Wage | -0.96 | -42.7 | -0.51 | -168.4 |
| Initial Post-Evasion Labor Supply | 2.94 | | -0.61 | |
| Final Post-Evasion Labor Supply | 5.51 | 87.4 | 1.73 | 383.6 |

*Note*. "Initial" refers to the outcome with limited competition and/or entry in the informal sector. "Final" refers to the outcome with increased competition and/or entry in the informal sector. "Magnitude" is the percentage difference between the post-evasion and post-tax outcome if both POOR and RICH households complied with taxes. "Percent change" refers to the percentage change between the magnitude for the "initial" and "final" outcome.

**References**


Allingham, Michael G. and Agnar Sandmo (1972). Income Tax Evasion: A Theoretical Analysis. *Journal of Public Economics, 1* (4), 323-338.

Alm, James (1985). The Welfare Cost of the Underground Economy. *Economic Inquiry, 23* (2), 243-263.

Alm, James, Roy Bahl, and Matthew N. Murray (1991). Tax Base Erosion in Developing Countries. *Economic Development and Cultural Change, 39* (4), 849-872.

Kehoe, Patrick J. and Timothy J. Kehoe (1994). A Primer on Static Applied General Equilibrium Models. *Journal of Public Economics, 22* (1), 1-26.

Kehoe, Timothy J. and Jaime Serra-Puche (1983). A Computational General Equilibrium Model with Endogenous Unemployment. *Journal of Public Economics, 38* (2), 137-182.

Kesselman, Jonathan R. (1989). Income Tax Evasion: An Intersectoral Analysis. *Journal of Public Economics, 38* (2), 137-182.

Light, Miles (2004). Taxation and Economic Efficiency in Jamaica. International Studies Program Working Paper, Andrew Young School of Policy Studies, Georgia State University, Atlanta, GA.

Martinez-Vazquez, Jorge (1996). Who Benefits from Tax Evasion? The Incidence of Tax Evasion. *Public Economics Review 1* (2), 105-135.

Mathiesen, Lars (1985). Computation of Economic Equilibria by a Sequence of Linear Complementarity Problems. *Mathematical Programming Study, 23* (2), 144-162.

Persson, Mats and Pehr Wissen (1984). Redistributional Aspects of Tax Evasion. *Scandinavian Journal of Economics, 86* (2), 131-149.

Schneider, Friedrich (2005). Shadow Economies around the world: What do we really know? *European Journal of Political Economy, 21* (3), 598-642.

Shah, Anwar and Whalley, John (1990). An Alternative View of Tax Incidence Analysis for Developing Countries. NBER Working Paper. Boston, MA.

Skinner, Jonathan and JoelSlemrod (1986). An Economic Perspective on Tax Evasion. *National Tax Journal, 38* (1), 345-353.

Thalmann, Philippe (1992). Factor Taxes and Evasion in General Equilibrium. *Regional Science and Urban Economics, 22* (2), 259-283.

Watson, Harry (1985). Tax Evasion and Labor Markets. *Journal of Public Economics 27* (2), 231-246.