Informal Taxation (Web Appendix)

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1 Appendix A: Data

1.1 Survey Data

As described in the text, the data used in this paper stems from household surveys from 10 countries around the world, which were selected because they included questions on payments to local public good provision. Since each of the surveys is somewhat different in terms of sampling and questionnaire design, this section briefly describes each of these surveys one by one, including details on the informal tax question, sampling design, and the definition of a community used for community fixed effects. Since the derivation of VAT tax rates is somewhat more involved, Section 2 separately discusses the construction of implied VAT rates in each country in more detail.

In constructing the data, we use several normalizations to standardize the data. To standardize units of time (e.g, for labor contributions) between surveys, we assume that each "day" worked is equivalent to 6 hours worked, and that there are 260 working days per year. When including "village" fixed effects, we use the smallest geographic unit available in the data. When the smallest geographic unit includes both urban and rural areas, we interact the geographic unit with an urban/rural dummy, so that each "village" is entirely rural or entirely urban. We convert all local currency units to 2000 PPP dollars after obtaining the exchange rate by dividing each country's GDP in local currency units for that year by the GDP in PPP constant 2000 international dollars. This data is available in the World Bank World Development Indicators.

All our surveys (with exception of Ethiopia) provide a household level weight variable to account for the sampling procedure. We used these weights in calculating the descriptive statistics (Table 3), as well as in all our regression analysis.

1.1.1 Albania

We use the Albanian Living Standards Measurement Survey, conducted in mid-2005 by the Living Standards Unit of Albania's National Statistical Institute, with the technical assistance of the World Bank. This survey is the fourth round of a series of LSMS, which began in 1996. The survey covers 3,840 households in urban and rural areas and is nationally representative.

Our estimation of payments is based on questions 12 and 13 of the Social Capital module of the household questionnaire. These questions ask about the payment of the entire household and cover "participation in any activities, in which people come together to do some work for the benefit of community." Conditional on a positive response to this question, the following question asks about "how many times in the past year" the household has participated in such activities. Each "time" was counted as a working day.

Communities are defined as villages, which are subgroups of districts and municipalities.

1.1.2 Ethiopia

We use the Ethiopia Rural Household Survey, which covers 1,507 rural households. This survey was been conducted by the International Food Policy Research Institute in 1997 as the fourth round of the series of household surveys started in 1989.

We examine questions from the Community Work section of the household questionnaire. The first question asks whether the "household engaged in community work in the last 12 months." The following question inquires about "how many days the household engaged in community work." The survey documentation notes that "... these data are not nationally representative. However, they can be considered broadly representative of households in non-pastoralist farming systems as of 1994."

Communities are defined as peasant associations, which are subgroups of regions and woredas (subdistricts).

1.1.3 Guatemala

We use the Guatemala Living Standards Survey (Encuesta Nacional Sobre Condiciones de Vida), which covers 8,940 household in rural as well as urban areas. This nationally representative survey was conducted in 2000 by the Guatemalan National Statistics Institute, with the technical and financial assistance of the World Bank and the Inter-American Development Bank.

We used question II.A.1.l, which asks whether households "participate in the collective construction of community works (roads, schools, etc)." Two other questions, II.A.1.h and IX.E.3, which asked respectively about cash or in-kind donations and the amount of hours contributed per household, were not used. The decision to exclude those is due to the ambiguity of the former and the fact that the recall period of the latter was only one day.

Communities are defined as sectors, which are subgroups of regions, departments, and municipios.

1.1.4 Indonesia

We use Wave I of the Indonesian Health and Education Service Survey, which was conducted by Gadjah Mada University and the World Bank as a baseline survey for the evaluation of the PNPM-Generasi program (see Olken, Onishi and Wong 2008). The survey was conducted in June – August 2007, and took place in rural areas of 5 provinces in Indonesia. 12,000 households were interviewed, spread over approximately 2,400 villages. Because the survey followed the placement of the PNPM-Generasi program (and associated control areas), the 20% richest districts in each province are not included.

We designed short modules on informal taxation administered to households and to village heads. The module began by asking "Has there been community activities in repair/ cleaning/ maintenance/ construction of village/neighborhood infrastructure and facilities during the last 12 months?" If yes, the household was asked if they participated in the activities, and if so, what type of activity (road/bridge, schools, water/sanitation systems, irrigation systems, or religious/cemetery projects). Households were then asked how many total person-hours the household contributed as well as total cash and materials payments over the previous 12 months. Finally, both households and village heads were asked a series of questions about who decides how much each household should contribution and the sanctions for non-contribution; these questions are described in detail in the text.

Communities are defined as villages, which are subgroups of provinces, districts, and subdistricts.

1.1.5 Nigeria

We examine the 2004 Nigerian Living Standards Survey. This nationally representative survey is a continuation of the series of National Integrated Surveys of Households conducted since 1981 by Federal Office of Statistics of Nigeria. The survey collected data on 19,158 households from September 2003 to August 2004.

We use questions four and five of section eight, Social Capital and Community Participation. These questions asked "Do you or any member of your household participate in community program(s)?" and, if yes, "Which of the following programs do you or a member of your household participate in?" We include in our estimation participation in the following categories: "construction of community school," "maintenance of community roads and bridges," and participation "in community development project." While the survey does not specify a recall period for these questions, the instructions to the interviewer specify a recall period of 1 year for the previous question regarding "Coping Mechanisms in times of need." We therefore take the recall period as 1 year.

Communities are defined as the urban or rural subsections of unique rics, which are subgroups of states.

1.1.6 Nicaragua

We use data from the second Nicaraguan LSMS, "Encuesta Nacional de Hogares sobre Medición de Niveles de Vida." They survey was conducted in 1998 by the National Institute for Statistics and the Census of Nicaragua with technical assistance from the World Bank. It covers 4,209 households in both urban and rural areas of all 15 departments and two autonomous regions, and is nationally representative

Question 57 of the household survey asks about household payments to construction and/or improvement of public facilities, such as schools, health centers, etc. The question also asks the respondent to indicate what "the contribution of this household was/were," allowing us to separate labor and monetary payments. Note, however, that question 57 is conditional on a question 55, which asks households whether they were beneficiaries of any construction or improvement projects. Thus, our estimation is a lower-bound for the real proportion of household payments, since households who do not receive benefits might also contribute.

Communities are defined as segementos, which are subgroups of departamentos, municipios, and areas de supervision.

1.1.7 Panama

The 2003 Panama Living Standards Survey, Encuesta de Niveles de Vida, provides data from 6,363 households in rural and urban areas, and is nationally representative. It was designed and conducted by the Panamanian Ministry of Economy and Finance with the assistance of the World Bank.

Questions 2.A.1.a and 2.A.1.e ask households whether they have participated in works to benefit their or other communities (roads, schools, etc.) and whether they have donated money or goods for community works over the past 12 months.

Communities are defined as corregimientos, which are subgroups of regions, provinces, and districts.

1.1.8 Philippines

We use the baseline survey of the KALAHI-CIDSS project for the Philippines (see Chase and Holmemo 2005). It was conducted by the World Bank by the Asia-Pacific Policy Center as a baseline for the evaluation of the KALAHI program, and covers 2,401 households. Due to the goals of the project, these households were selected only from rural areas of the 42 poorest provinces in the country, although each of the three geographical areas of the Philippines are represented.

Question 1a, part E of the household survey asks whether households participate in community projects: "Over the past six months, did you or any member of your family participate in any bayanihan in the barangay?" If yes, question 1ai asks for the three main activities and 1aiii provides a measure of the total time contributed to these three (per hours) for the period of the six months preceding the administration of the survey. We used a ratio of 6 hours per working day to convert the data to a daily measure. For our measure of participation, we included activities related to public cleaning, beautification, repair, construction, and other infrastructure work.

Communities are defines as barangays, which are subgroups of provinces and municipalities.

1.1.9 Vietnam

The 2002 Vietnam LSMS survey is nationally representative and covers 29,532 households in both rural and urban areas. The survey was conducted by the General Statistical Office of Vietnam with technical assistance from the World Bank.

Question 3.18 of the household survey asks: "Have you contributed any public working days?" If yes, labor quantity information is provided in question 3.19: "In the past 12 months how many public working days without pay did you contribute?"

Information on monetary donations is found in question 6.b.3.1.402, which asks whether contributions were made in the last 12 months to public labor, and question 6.b.3.2.402 which asks the monetary value given in the last 12 months.

Communities are defined as communes/towns, which are subgroups of provinces/cities and districts.

1.1.10 Zambia

The 1998 Zambia Living Conditions Monitoring Survey is nationally representative and covers 16,710 rural and urban households. The survey was conducted by the Central Statistical Office of Zambia.

Question 13.3 asks whether certain community projects (building/rehabilitations of school, health facility, roads, etc.) took place in the previous five years. If yes, question 13.18 of the household survey asks: "Did any member of your household participate in provision of materials, labour, management, or funds to the project?" Respondents can specify which of these categories they contributed, if any.

Communities are defined as centralities, which are subgroups of provinces, districts, census supervisory areas, standard enumeration areas, and stratum.

1.2 Construction of formal taxation variables

We construct formal taxation payments for all countries for which we have data on the quantity of informal tax payments: Albania, Ethiopia, Indonesia, and the Philippines. We consider both direct

tax payments by households, as well as indirect payments in the form of consumption taxes.

1.2.1 Direct taxes

To capture direct tax payments, we use all available questions in household surveys that measure taxation directly, either as part of household expenditure or as part of non-farm business expenditures. Appendix Table 1 (below) shows all these variables and their questions and recall periods. We use the listed recall periods to normalize taxes to an annual basis.

1.2.2 Indirect taxes

The tax structure of each country was investigated to determine the sources of indirect taxation for households. To maintain comparable construction of the variable across countries, we estimate indirect taxes as total value-added tax (VAT) combined with excise taxes paid on fuel, tobacco, and alcohol. Note that this measure does not include tariffs on imports and exports, which are a non-trivial component of indirect formal taxation in developing countries.

We construct the VAT base to include household expenditures unrelated to health, food, or education, as these categories are usually VAT exempt. Even to the extent that food is subject to VAT, since food purchases are predominantly in the informal sector, they are likely to be de facto exempt from VAT in our sample countries. Tobacco, alcohol, and fuel expenditures are considered separately due to their special rates of taxation.

The Ethiopian and Vietnamese surveys record the value of purchased alcohol separately from the value of alcohol self-produced or received as a gift. In these cases, we include only the value of purchased alcohol for tax consideration.

For each expenditure category, we calculate tax paid as follows:

$$Taxes = \frac{Tax\ Rate}{1 + Tax\ Rate} * Expenditure$$

The following sections report the details of the tax rates used in VAT calculations. The sources are shown in Appendix Table 2, and the recall periods for the corresponding questions are shown in Appendix Table 3.

Albania: The VAT and the tobacco excise tax were defined at 20% and 60%, respectively (see Table 2 below for relevant sources). Excise tax was defined at 50% for beer and varied from 16-100% for other types of alcohol. The excise tax on fuel ranged from 50-90% for the most important sources. Using this information, we chose the categorical tax rates for VAT (20%), tobacco (60%), alcohol (50%), and fuel (80%).

Ethiopia: The tobacco and alcohol excise taxes were set officially at 50% and 75%, respectively. A sales tax, rather than a VAT, was defined ranging from 5-15% by type of good or service. The majority of the goods included in our VAT base fell into the upper sales tax category and the only fuel source found to be tax exempt was kerosene. As such, we defined the categorical tax rates for VAT (15%), tobacco (75%), alcohol (50%), and fuel (15%).

Indonesia: The VAT was set at 10% and no fuel tax was charged. Tobacco was subject to an 8.4% VAT, an ad valorem tax ranging from 4-40% by type and production scale, and a specific tax ranging from 0-2%. The World Bank estimated the tobacco tax share as 30% of total retail price in 1999. Alcohol was charged VAT, excise tax, and luxury sales tax. The luxury sales tax was

40% for types of alcohol below 52 proof and 75% for those above. The excise tax on alcohol varied based on proof as well. Taking this information into account, we defined the categorical tax rates for VAT (10%), tobacco (30%), alcohol (75%), and fuel (0%).

Philippines: The VAT was defined at 10% and was included in addition to excise tax for alcohol, tobacco, and fuel. While the tobacco excise tax varied by product type, the World Bank estimated the tobacco tax share as 63% of average retail price in 1999. The excise taxes on fuel and alcohol varied, respectively, by product type and by product type, price, and proof. Taking these facts into consideration, we chose the categorical tax rates for VAT (10%), tobacco (63%), alcohol (50%), and fuel (25%).

Vietnam: The fuel excise tax was defined at 10% and there were three categories of VAT at 5, 10, and 15%, with the majority of VAT base goods falling into the middle category. The tobacco excise tax varied based on product type and was set at 25, 45, or 65%. The World Bank estimated the tobacco tax share as 36% of average retail price in 1999. The alcohol excise tax varied by product type and proof. With this information, we defined the categorical tax rates for VAT (10%), tobacco (36%), alcohol (35%), and fuel (10%).

Table A1: Questions used in total direct tax estimation

	Year		Recall Period
Albania	2005	"Taxes and insurance" reported in non-farm business "Other Taxes (vehicle, radio and TV, etc)" reported in expenditure	1 month 12 Months
Ethiopia	1997	"Taxes and Levies" reported in expenditure	4 Months
Indonesia	2007	"Land and house tax; Vehicle tax; Income tax; Other taxes" reported in expenditure	12 months
Philippines	2003	"Taxes (income tax, real estate tax, car registration, etc.)" reported in expenditure	6 Months
Vietnam	2002	"All kinds of taxes (excluding production tax)" reported in expenditure	12 Months

Table A2: Sources for VAT and excise tax rates

Albania	Law No. 7928/1995; Law No. 8437/1998
Ethiopia	Proclamation No.68/1993; Proclamation No. 77/1997
Indonesia	Law No. 17/2000; Jakarta Post/July 19.2004; Tobacco Economics in Indonesia/2008; The Tobacco Source Book, Ministry of Health Republic of Indonesia/2004;
Philippines	Republic Act No. 8424/1997; World Bank Vietnam Tobacco Country Brief/1999
Vietnam	Law No. 2/1997/QH9; World Bank Vietnam Tobacco Country Brief/1999

Table A3: Recall periods for indirect tax questions

	VAT base	Tobacco	Alcohol	Fuel
Albania	30 days	30 days	30 days	30 days
Ethiopia	4 months	4 months	1 week	1 month
Indonesia	12 months	1 week	1 week	12 months
Philippines	6 months	3 days	3 days	1 month
Vietnam	12 months	12 months	12 months	12 months

1.3 Dropping of Outliers

We drop observations for which any of the following three are true: (a) the reported total household days of labor contributed in the last year exceeds 50% of total possible yearly household working days (defined as 250 multiplied by the number of workers in the household); (b) the total monetized value of reported household days of labor contributed in the last year exceeds 50% of total yearly household expenditure; (c) the total reported value of yearly direct taxes exceeds total yearly household expenditure.

These restrictions affect only the data from Indonesia (0.22% dropped), Ethiopia (1.98% dropped), and Vietnam (0.01% dropped).

1.4 Wage Prediction and Household Expenditure Measure

To predict wages, we first approximate monthly household income per worker as annual household expenditure divided by 12 and the number of workers in the household. (We follow the standard convention of using household expenditure as a proxy for household income.) We then regress the household monthly wage rate on each individual's education, age, and age squared interacted with a female dummy, an urban dummy, and a female x urban dummy. We then divide by the number of working days in a month, which we define as 21.7, to get a measure of the household daily wage rate. $21.7 \simeq (365.25/12)^*(5/7)$, where 5/7 adjusts the wage rate for working days per week. We repeat this prediction separately for each country.

We use equivalent household expenditure as our household income measure when examining the distributional implications of informal taxation. Since household expenditure includes direct and indirect taxes, it is conceptually a "pre-tax" measure. To be consistent, one might also want to add back income lost as a result of informal tax payments. Since our measure of the household wage rate is likely to be noisy, we do not make this adjustment.

Following Deaton (1997), we define equivalent expenditure as

$$\frac{household\ expenditure}{(adults + \alpha_1 children + \alpha_2 infants)^{\theta}}$$

Infants are defined as those aged 0-4; children are defined as those aged 5 to 14. Combining Deaton's estimates of total child costs and Olken (2005)'s estimates of household economies of scale, we set $\alpha_1 = 0.6$ and $\alpha_2 = 0.5$ and $\theta = 0.85$.

1.5 References

Chase, Robert S and Camilla Holmemo, "Community Driven Development and Social Capital: Designing a Baseline Survey in the Philippines," World Bank Report #32405-PH, 2005.

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2 Appendix B: An Optimal Tax Model of Informal Taxation

The stylized facts we observe are remarkably consistent across countries. This appendix develops a simple framework for thinking about informal taxation that does not require non-standard preferences, government corruption, or market failures in labor or credit markets, but instead treats informal taxation as one possible solution to an optimal tax problem, with asymmetric information and screening. We treat the local government as the unit of observation and abstract from the existence of a central government.

In our model, local governments face a standard problem: financing local public goods in a social welfare maximizing way. We consider three sources of departure from the first best. As in standard taxation models, governments face information constraints about true earnings ability. Our model adds two additional constraints: governments may face constraints on their ability to enforce the desired tax schedule, and they may also face constraints on labor taxes, since individuals can shirk on required labor payments. These information and enforcement constraints limit the degree to which the government can achieve redistribution in financing the public good.

We model formal and informal taxes as having different constraint parameters arising from differences in their tax technologies. In the informal system, enforcement happens through social sanctions rather than through courts. This means that the informal system must use less severe punishments than the formal system, i.e., social sanctions instead of jail time. However, the informal tax system can use information that does not meet the burden of proof required in court (i.e., information that is observable but not verifiable), so it effectively has better information than the formal tax system. [1]

We demonstrate that informal taxation may be the optimal solution to the government's constrained maximization problem and show that the model's predictions are consistent with the observed patterns of informal tax prevalence. We also show that the predictions of the model match the stylized facts on the distribution and form of informal tax payments.

Modeling these payments as the equilibrium of a screening mechanism differs from the literature on voluntary contributions to public goods, which often models contributions driven by a personal desire to affect the level of the public good (e.g., Olson 1965), a warm-glow from donations (e.g., Andreoni 1990), or to signal wealth to others (e.g., Glazer and Konrad 1996). others have modeled private provision of public goods in a collective action framework (e.g., Bagnoli and Lipman 1999, Bergstrom, et al. 1986). Masclet, et al. (2003) and Falk et al. (2005) have emphasized the role of social sanctions as a mechanism through which the free rider problem can be overcome, and Fehr and Gachter (2000) show experimentally that cooperators are willing to punish free-riders even if this is costly for them and even if they cannot expect future benefits from their punishment activities.[2] To the best of our knowledge, little work has focused on formally modeling informal tax mechanisms specifically. An exception is Wilson (1992), who argues that cooperation in a repeated prisoner's dilemma game may be sustainable in the context of *harambee* programs in Kenya.

[1] Another possible constraint on redistribution is exit from the local community. Exit would affect both formal and informal taxes in the same way, so for simplicity, we do not consider the issue of exit here. In practice, mobility is often low in developing countries (Bardhan 2002). Abramitzky (2008) explores the issue of exit as a constraint on redistribution in a different context, that of Israeli kibbutzim.

[2] On the empirical side, the lower public good provision in ethnically diverse communities has been explained using the theory of social sanctions: Miguel and Gugerty (2005) argue that social sanctions are harder to enforce between different ethnic groups, which explains the lower contributions to public goods in diverse communities. Alesina et al. (1999) also show empirically that more diverse communities have lower public good provision.

This section proceeds as follows. We begin by setting up the general social planner's maximization problem as a two-type screening model with enforcement and information constraints and discuss characteristics of the general solution. We then introduce informal and formal taxation in the context of this model by varying the enforcement and information constraints. Finally, we discuss the implications of the model for the empirics of informal taxation.

2.1 Model

2.1.1 Setup

Suppose that there are N individuals. A fraction α of the individuals have wage w_H and a fraction $1-\alpha$ have wage w_L where $w_L < w_H$. We assume that w is private information and that each individual has an endowment of time 1 which they spend working. Since we are primarily interested in the tradeoff between enforcement and information, we model all behavioral responses coming through an evasion decision rather than through a labor supply decision. This assumption seems plausible in the contexts we are studying, and also allows us to capture the idea that local communities may have information on earnings ability rather than just earnings. Each individual's wealth is therefore equal to his wage rate. There are no savings, so individuals consume their entire wealth after paying any taxes.

Each individual i can potentially consume two goods, the private good (w_i) and the public good (g). If the public good is provided, all individuals consume it and $g = 1$; if it is not provided, then $g = 0$. We assume that utility over the private good is concave and that the utility from the private and public good are separable, i.e.

$$U = u(w_i) + \theta g$$

where u is concave and θ indicates the value from consuming the public good. We assume that u has the property that the coefficient of relative risk aversion is greater than 1 (i.e., $\frac{-wu''(w)}{u'(w)} > 1$).[3]

The public good costs G to produce, and once produced is both non-rival and non-excludable. G is determined exogenously.[4] For the public good to be provided, total government revenue R must be greater than or equal to G. We assume that providing the public good is efficient, so that the first-best involves providing the public good.

We assume that the goal of the government is to finance the public good in a way that maximizes social welfare. Taxes cannot be negative; in other words, redistribution occurs only through progressive payments toward the public good.[5]

[3] This assumption guarantees a single-crossing property which is necessary to allow screening using labor taxes (λ), discussed in more detail below. To see this, note that

$$\frac{\partial^2 U}{\partial \lambda \partial w} = -wu''(w) - u'(w)$$

If $\frac{-wu''(w)}{u'(w)} > 1$, then $\frac{\partial^2 U}{\partial \lambda \partial w} > 0$, so that the marginal utility cost of an extra hour worked is strictly increasing in wealth.

[4] We focus here on the decisions made by local government trying to raised a fixed amount of revenue to finance a public good, abstracting from intergovernmental transfers and endogenous public good size.

[5] In a system where a large share of payments take the form of in-kind unskilled labor, positive net transfers (i.e., net receipt of unskilled labor) could be difficult to implement. In addition, we can observe only payments (either zero or positive) to the public good in the data. General transfer payments, if any, may occur through a different mechanism. In this respect, we can think of informal taxation as somewhat analagous to a property tax system (a tax levied to finance a set of goods) that may exist in addition to a traditional income tax and transfer system.

Taxes can potentially be levied in two forms: money and labor. Define τ_H and τ_L as the monetary payments from the high and low type. Define λ_H and λ_L as the labor payments from the high and low type, defined as a share of each type's total time budget. After-tax income for type i is then $w_i(1-\lambda_i)-\tau_i$.

We assume that λ_i is publicly valued at the low type wage rate w_L, i.e., λ is always used for low-skill tasks. This implies that labor by the high type is inefficient, since it is valued at the opportunity cost w_H by the high type but valued at w_L in the government budget constraint. As we show below, this asymmetry in the value of labor means that the government can use labor as a screening device.[6]

We assume that the social planner faces three types of constraints in designing the optimal allocation. First, there is the *enforcement constraint*: if a given type fails to pay his required taxes, the planner can impose a utility punishment up to a maximum of P. This punishment P enters the planner's problem as an IR constraint. Second, there is the *hidden income constraint*: by paying a utility cost D, a high type can hide his income and pretend to be a low type. Third, there is the *shirking constraint*: by paying a utility cost S, the type who is supposed to do the higher amount of work in labor can shirk and do only the lowest amount of labor required of any type (denoted $\underline{\lambda}$).[7] The hidden income and shirking constraints enter the planner's problem as IC constraints. Together, the triplet of costs, (P, D, S), is what we refer to as the technology of the tax system. We will model informal vs. formal taxation as having different tax system technologies.

2.1.2 Planner's problem and characteristics of the solution

Faced with a given tax technology (P, D, S), the social planner's problem is to maximize social welfare subject to the enforcement (IR), hidden income (IC), and shirking (IC) constraints, i.e., he solves:

$$\max_{(\tau_i,\lambda_i)} \alpha\left(u\left(w_H\left(1-\lambda_H\right)-\tau_H\right)\right)+(1-\alpha)\left(u\left(w_L\left(1-\lambda_L\right)-\tau_L\right)\right)+\theta \tag{1}$$

subject to the enforcement constraints (IR):

$$u\left(w_H\right)-P \leq u\left(w_H\left(1-\lambda_H\right)-\tau_H\right) \tag{EC$_H$}$$
$$u\left(w_L\right)-P \leq u\left(w_L\left(1-\lambda_L\right)-\tau_L\right) \tag{EC$_L$}$$

hidden income constraints (IC):

$$u\left(w_H\left(1-\lambda_L\right)-\tau_L\right)-D \leq u\left(w_H\left(1-\lambda_H\right)-\tau_H\right) \tag{HI$_H$}$$
$$u\left(w_L\left(1-\lambda_H\right)-\tau_H\right)-D \leq u\left(w_L\left(1-\lambda_L\right)-\tau_L\right) \tag{HI$_L$}$$

shirking constraints (IC):

$$u\left(w_H\left(1-\underline{\lambda}\right)-\tau_H\right)-S \leq u\left(w_H\left(1-\lambda_H\right)-\tau_H\right) \tag{SC$_H$}$$
$$u\left(w_L\left(1-\underline{\lambda}\right)-\tau_L\right)-S \leq u\left(w_L\left(1-\lambda_L\right)-\tau_L\right) \tag{SC$_L$}$$

[6] While use of labor as a screening device has been considered in the design of income maintenance programs (e.g., **?**), it has not, to the best of our knowledge, been considered in the context of raising revenue.

[7] Note that hiding income allows the high type to pretend to be the low type and pay the labor and money taxes required by the low type, whereas shirking allows each type to do the minimum amount of required labor without affecting the monetary taxes.

the government budget constraint:

$$\alpha\left(\tau_H + w_L\lambda_H\right) + (1-\alpha)\left(\tau_L + w_L\lambda_L\right) = \frac{G}{N}$$

and non-negativity constraints:

$$\tau_i \geq 0,\ \lambda_i \geq 0\ \forall i$$

Note that in the first best (when no constraints bind), the planner will set taxes so that the after-tax marginal utilities are equal for the two types; if the non-negativity constraint binds, the optimum in the first-best will be to set $\tau_L^* = 0$ and $\tau_H^* = \frac{G}{\alpha N}$.

Several comments are worth making about the general solution to this problem. We first examine the form of tax payments of each type and then discuss the distributional implications.

Remark 1 *The high type will always pay in money, not in labor.*

Proof. Suppose that, at the optimum payment level, $\lambda_H > 0$.

(i) Suppose SC_L does not bind.

Let the payment of the high type change to the new levels $\lambda_H^* = \lambda_H - \epsilon$ and $\tau_H^* = \tau_H + w_L\epsilon$, for some small $\epsilon > 0$. At these new payment levels, the shirking constraint for both types would still hold.

For HI_H :

$u\left(w_H\left(1-\lambda_L\right) - \tau_L\right) - D \leq u\left(w_H\left(1-\lambda_H\right) - \tau_H\right) \leq u\left(w_H\left(1-\lambda_H\right) - \tau_H + (w_H - w_L)\epsilon\right) = u\left(w_H\left(1-\lambda_H^*\right) - \tau_H^*\right) \implies HI_H$ still holds for λ_H^* and τ_H^*.

For EC_H : $u\left(w_H\right) - P \leq u\left(w_H\left(1-\lambda_H\right) - \tau_H\right) \leq u\left(w_H\left(1-\lambda_H^*\right) - \tau_H^*\right) \implies EC_H$ still holds for λ_H^* and τ_H^*.

HI_L, EC_L, the government budget constraint and the low type's utility are unaffected by the changes in the high type's payments.

The high type's utility now becomes:

$u\left(w_H\left(1-\lambda_H^*\right) - \tau_H^*\right) = u\left(w_H\left(1-\lambda_H\right) - \tau_H + \epsilon(w_H - w_L)\right) > u(w_H\left(1-\lambda_H\right) - \tau_H)$. Thus, the high type can be made strictly better off without violating any of the constraints.

(ii) Suppose SC_L binds.

This implies $\lambda_L > 0$. Let the payments of the two types change such that, for some small $\epsilon > 0$, $\lambda_L^* = \lambda_L - \epsilon, \lambda_H^* = \lambda_H - \epsilon, \tau_L^* = \tau_L + w_L\epsilon$ and $\tau_H^* = \tau_H + w_L\epsilon$.

Decreasing λ_L and λ_H by ϵ and increasing τ_L by ϵ would not change the low type's income or the SC_L constraint. So SC_L will still hold.

We next check that SC_H is still satisfied at the new payment levels.

At the previous allocation, $S \geq u\left(w_H\left(1-\lambda_L\right) - \tau_H\right) - u\left(w_H\left(1-\lambda_H\right) - \tau_H\right)$. At the new allocation, income in both utility terms is increased by $\epsilon(w_H - w_L) > 0$. Since the utility function is concave, this change will decrease the right-hand side of the inequality, so SC_H will still be satisfied.

As above, HI_H, $E\dot{C}_H$, HI_L, and EC_L will continue to hold at the new payment levels. The government budget constraint and the low type's utility are unaffected by the changes in payments.

As before, the high type's utility now becomes:

$u\left(w_H\left(1-\lambda_H^*\right) - \tau_H^*\right) = u\left(w_H\left(1-\lambda_H\right) - \tau_H + \epsilon(w_H - w_L)\right) > u(w_H\left(1-\lambda_H\right) - \tau_H)$, so the high type can be made strictly better off without violating any of the constraints.

Thus, in both (i) and (ii), $\forall \lambda_H > 0$,social welfare can be increased without violating any of the constraints $\implies$ at the optimum level of payments, $\lambda_H = 0$. ■

The fact that the high type always pays in money, not labor, is the equivalent of the "no distortion at the top" result from the optimal tax literature (Mirrlees 1971). Note that this is not simply a productive efficiency result; as we discuss below, it can be optimal to have low types make inefficient payments in labor, but it will never be optimal to have the highest type do so.

The shirking constraint determines the degree to which labor can be used as a screening device and therefore the form of payment of the low type:

Remark 2 *As the utility cost of shirking* (S) *increases, the low type's taxes will weakly shift towards taxes in labor, i.e.,* $\frac{\partial\left(\frac{w_L\lambda_L}{w_L\lambda_L+\tau_L}\right)}{\partial S} \geq 0$*, with the inequality strict whenever* EC_H *does not bind and* $\tau_L > 0$*.*

Proof. Notice that the non-negativity constraint and the fact that $\lambda_H = 0$ at the optimum (Remark 1) imply $\underline{\lambda} = 0$ and SC_H is slack.

Assume that there exists an allocation $\lambda_L \geq 0$, $\tau_L > 0, \tau_H \geq 0$ such that the constraints are satisfied and the public good is provided. Thus, $S \geq u\left(w_L - \tau_L\right) - u\left(w_L\left(1-\lambda_L\right) - \tau_L\right)$.

Let $S^* = S + \Delta S$, $\Delta S > 0$. Thus, $S^* > u\left(w_L - \tau_L\right) - u\left(w_L\left(1-\lambda_L\right) - \tau_L\right)$ and SC_L is slack.

For some small $\epsilon > 0$, let $\tau_L^* = \tau_L - w_L\epsilon$ and $\lambda_L^* = \lambda_L + \epsilon$. At these new payment levels SC_H and SC_L would still be satisfied.

Since $u\left(w_L\left(1-\lambda_L^*\right) - \tau_L^*\right) = u\left(w_L\left(1-\lambda_L\right) - \tau_L\right)$, HI_L and EC_L are unchanged. EC_H is also unchanged.

However,

$u\left(w_H\left(1-\lambda_L^*\right) - \tau_L^*\right) - D = u\left(w_H\left(1-\lambda_L\right) - \tau_L - \epsilon(w_H - w_L)\right) - D < u\left(w_H\left(1-\lambda_L\right) - \tau_L\right) \leq u\left(w_H\left(1-\lambda_H\right) - \tau_H\right) \implies HI_H$ is slack $\forall D \geq 0$. Thus, HI_H would be satisfied for higher values of τ_H. This is because it would now cost the high type more in foregone income if he were to deviate to the low type's tax package.

Since $u\left(w_H\left(1-\lambda_H\right) - \tau_H\right) > u(w_L(1-\lambda_L^*) - \tau_L^*)$ and the utility function is concave,

$u'\left(w_H\left(1-\lambda_H\right) - \tau_H\right) < u'(w_L(1-\lambda_L^*) - \tau_L^*)$.

Therefore, if EC_H is not binding at τ_H, $\exists \delta > 0$ such that increasing τ_H by δ/α and decreasing τ_L by $\delta/(1-\alpha)$ will still satisfy HI_H and improve social welfare. If EC_H binds at τ_H, then the change in the low type's tax mix (and the resulting slackness of HI_H) does not allow for a change in τ_H.Therefore, the total tax payments and the utilities of the two types will be unaffected.

Hence, as S^* increases, it is weakly optimal to decrease τ_L. Therefore, $\exists S_0 > 0$ such that $\forall S \geq S_0$ setting $\tau_L = 0$ can weakly increase social welfare. In this case, it is weakly better for the low type to pay only in labor and not in money, if his optimal total tax payment is positive. ■

Since an hour of the low type's labor is publicly valued at the low type's outside wage rate, having the low type pay in labor does not affect the government budget constraint. It does, however, allow for screening by affecting the high type's hidden income constraint: it would now cost the high type more in foregone income if he were to deviate to the low type's tax package and pay labor instead of money. As long as EC_H is slack (in other words, as long as it is possible to increase the tax payment of the high type without violating his IR constraint), then shifting the low type toward labor will allow the planner to improve social welfare.

If the shirking constraint for the low type does bind (from Remark 1, we know that $\underline{\lambda} = 0$ at the optimum), then there are limits to the degree to which labor can be used as a screening device.

In this case, τ_L could be positive, and the inability to screen using labor could reduce the overall progressivity of the tax system or make it no longer optimal to provide the public good. Note that if instead the required labor was high skilled (could only be provided by the high type), there would be no screening benefit from labor taxes. One implication is that such projects are less likely to take place.

We next examine the distribution of payments:

Remark 3 *As long as the planner has some information (either $D > 0$ or $S > 0$) and $P > u(w_H) - u\left(w_H - \frac{G}{N}\right)$, then if the public good is provided, total payments will be strictly increasing in household expenditure, i.e., it will always be the case that $\tau_H + w_H\lambda_H > \tau_L + w_L\lambda_L$.*

Proof. First assume the social planner maximizes social welfare when $\tau_H + w_H\lambda_H < \tau_L + w_L\lambda_L$. Now consider the allocation $\tau_H = \tau_L = \frac{G}{N}$. If the constraints for the low type were satisfied at the previous allocation, they will still be satisfied at the new allocation. HI_H and SC_H will be satisfied for $D = 0$ and $S = 0$, and EC_H will be satisfied as long as $P \geq u(w_H) - u\left(w_H - \frac{G}{N}\right)$. Since $w_H > w_L$ and the utility function is concave, the new allocation will result in a social welfare improvement.

Now assume the social planner maximizes social welfare when $\tau_H + w_H\lambda_H = \tau_L + w_L\lambda_L$.

(i) Suppose $S = 0$.

From Remark 1, we know that $\lambda_H = 0$ and therefore $\underline{\lambda} = 0$. $S = 0$ and the government budget constraint then imply that $\lambda_L = 0$ and $\tau_H = \tau_L = \frac{G}{N}$. At this allocation, HI_H will be satisfied at $D = 0$ and is therefore slack $\forall D > 0$. If the condition given in the remark holds (i.e., $P > u(w_H) - u\left(w_H - \frac{G}{N}\right)$), then EC_H will also be slack.

Then $\exists \epsilon > 0$ such that HI_H and EC_H are still satisfied for $\tau_H^* = \tau_H + \epsilon/\alpha$ and $\tau_L^* = \tau_L - \epsilon/(1-\alpha)$. This change in τ_H and τ_L leaves the government budget constraint unchanged. If the constraints for the low type were satisfied at (τ_H, τ_L), they will still be satisfied at (τ_H^*, τ_L^*).

Since the utility function is concave, $u'\left(w_H - \frac{G}{N}\right) < u'\left(w_L - \frac{G}{N}\right)$. Therefore, increasing τ_H by ϵ/α and decreasing τ_L by $\epsilon/(1-\alpha)$ will improve social welfare.

(ii) Suppose $D = 0$.

From Remark 1, we know that $\lambda_H = 0$ and therefore $\underline{\lambda} = 0$, so SC_H is slack. If $D = 0$, HI_H can be rewritten as

$$u(w_H - \tau_H) \geq u(w_H(1 - \lambda_L) - \tau_L)$$

HI_H will be slack for the allocation given ($\tau_H = \tau_L + w_L\lambda_L$) as long as $\lambda_L > 0$. As above, if $P > u(w_H) - u\left(w_H - \frac{G}{N}\right)$, then EC_H will also be slack.

If the allocation given has $\lambda_L > 0$, then we can achieve a social welfare improvement by increasing τ_H and reducing τ_L as in case (i) above.

Now suppose the allocation given has $\lambda_L = 0$. SC_L will then be binding at $S = 0$ and slack for $\forall S > 0$. Then, $\exists \eta > 0$ such that we can set $\lambda_L^* = \eta$ and $\tau_L^* = \tau_L - w_L\eta$ and SC_L will still be satisfied. This change does not affect the total tax payment of the low type, the government budget constraint or HI_L. We can then achieve a social welfare improvement by increasing τ_H and reducing τ_L as in case (i) above. ■

Thus as long as the government has any information and sufficient ability to enforce, the tax

system will be redistributive – i.e., the high type will pay more in taxes than the low type.[8] This result comes directly from the fact that the planner is maximizing social welfare and the marginal utility of income is higher for the low type. The difference in tax payments between the two types is weakly increasing in the wage gap between the two types.

The fact that the high type pays more does not necessarily imply that the tax system will be progressive – i.e., it does not imply that the high type will pay more in taxes as a share of income than the low type. In fact, whether the tax system is progressive or regressive is theoretically ambiguous and depends on the parameters of the model.

It is also important to note that while the utility costs (P, D, S) represent a social loss, none of these costs should be borne in equilibrium. Efficiency costs relative to the first best instead take two forms. First, the public good may not be provided whereas it will always be provided in the first best. This may occur if the government cannot satisfy the enforcement and information constraints and still meet its budget constraint or if redistribution is limited enough that providing the public good actually reduces social welfare. Second, in a multiple type case, it may be optimal for the government to require inefficient labor payments from individuals whose wage rate exceeds the unskilled wage rate, since those labor payments serve as a screening device for higher wage types. We discuss extensions to the multiple type case in more detail below.

2.1.3 Formal vs. informal taxes

We model formal and informal taxation as having different technology triplets. Formal taxes are thus represented by the triplet (P_F, D_F, S_F) whereas informal taxes are represented by the triplet (P_I, D_I, S_I). We assume that $P_F \geq P_I$ – i.e., the punishments that can be imposed by the courts, *conditional on detecting non-compliance*, are at least as great as the punishments that can be imposed informally through social sanctions.[9] By using the formal legal system, the social planner can in theory levy an unlimited punishment if the individual does not meet his required payments (for example, through imprisonment); in the informal tax system, there are likely to be limits on the sanctions that can be imposed for non-payment. We can think of the costs of evading income (D) or evading labor taxes (S) as inversely related to the information the community needs to impose punishment. A conviction in the formal legal system is likely to require a higher level of proof than a community needs to impose informal punishments, which implies that $D_F \leq D_I$ and $S_F \leq S_I$. The choice between formal and informal taxation thus entails a trade-off between enforcement (P) and information (D and S).

Considering a limiting case may be useful for intuition. As $P_F \to \infty$ and $D_I \to \infty$, formal taxes are limited by the IC constraints (hidden income and shirking) whereas informal taxes are limited by IR constraints (punishments). Note that there are two potential sources of informational advantage

[8] We monetize labor payments by the high type using the high type's wage rate, since this measure is most relevant for considering the distribution of tax burdens.

[9] Note that social sanctions must be levied by individual community members, not by the social planner directly. However, we can think of the social planner as coordinating the community on a particular equilibrium by choosing the schedule of social sanctions to be implemented by the community. If each individual in the community's cost of enforcing a social sanction on someone else is less than the cost of receiving a social sanction themselves, there is an equilibrium where everyone in the community enforces the social sanction on non tax payers, as well as enforces the social sanction on anyone who deviates and does not enforce a social sanction when they are supposed to do so. Perroni and Scharf (2007) note that *any* tax schedule must ultimately be sustained by the collective willingness of the group to enforce the schedule, and Fehr and Gachter (2000) discuss the willingness of individuals to punish free riders even if such punishments are costly.

in the informal system: communities effectively have more information about true earnings ability and they are better able to monitor labor payments. Either of these advantages is sufficient to generate the result that informal taxation may be preferable to formal taxation; we believe both are relevant in explaining the observed stylized facts, as we discuss below.

2.2 The informal tax framework and the stylized facts

2.2.1 The choice between formal and informal taxes

It is straightforward to see that loosening any of the constraints faced by the local government will weakly allow it to achieve higher social welfare. This framework therefore suggests that informal taxation is likely to result in a social welfare improvement relative to formal taxation when: (1) the ability of the community to levy social sanctions (P_I) is high; (2) there is more available information about incomes informally than formally ($D_F < D_I$); and (3) the ability to monitor labor payments informally is greater than the ability to monitor formally ($S_F < S_I$).

The prevalence of informal taxation throughout our sample of developing countries, particularly in rural areas, is consistent with the existing evidence that informal insurance and credit markets may function more effectively in rural areas, where information is better and villagers are better able to levy informal sanctions for default (Townsend 1995, Besley and Coate 1995, Banerjee and Newman 1998, Ghatak 1999). The ability to verify income legally may also be more difficult in developing countries, since many individuals work in or can easily shift into the informal sector.[10] Unsurprisingly, informal taxation mechanisms are not generally observed in developed countries, where it is harder to hide income and where social sanctions may be less effective.

Our model has considered the choice between formal and informal taxation made by a given local government. Even within developing countries, information and social enforcement are likely to be effective within small communities. This is consistent with the observation that informal taxes tend to be levied at local levels, rather than by higher levels of government.

The framework also clarifies why labor payments are more commonly observed in informal taxation systems rather than in formal tax systems. Although labor payments are always desirable as a screening device, they are also likely to be hard to verify legally. Therefore, the community can more easily make use of labor payments as a screening device through the informal system. Note that labor taxes are sometimes implemented through the formal tax schedule. Systems of corvee labor, for example, were common at one time in Europe and elsewhere, and mandatory labor taxes still exist in some countries, such as Vietnam. It may be that in at least some of these contexts, local landlords or officials did not have to meet the burden of proof required by a court in order to punish non-compliers, resulting in a high S_F.[11]

2.2.2 The distribution and form of informal taxes

The informal tax model makes a number of predictions about the distribution and form of informal tax payments. As discussed above, the framework suggests that informal tax payments should be

[10] Similarly, while landholding may be legally verifiable in theory, land taxes in developing countries have also proven difficult to implement in practice (Burgess and Stern 1993).

[11] A number of studies have documented substantial absenteeism in sectors such as health and education in developing countries (e.g., Banerjee and Duflo 2006), which suggests that the effectiveness of formal public works projects may be constrained by shirking as well.

increasing with household expenditures. We find that the elasticity of total payment with respect to household expenditure is positive in all countries (shown in Table 6), consistent with the prediction of the model. Moreover, in the simple two-type case, it will be optimal for the public good to be financed solely by the high types if income inequality is sufficiently high and the planner has the ability to satisfy the high type's IR and hidden income IC constraints. The data is also consistent with this prediction: we observe significantly positive participation gradients in the majority of sample countries (Table 6).

In our simple framework, we have focused on the local government making a choice between formal and informal taxes. In practice, the optimal solution may involve the government levying both types of taxes. The observation that formal direct taxes are generally more progressive than informal taxes could result from local governments levying formal taxes until D binds. While such a formal tax system could be progressive, once D binds, a marginal expansion of the formal tax system could then only be achieved by a (very regressive) poll tax. The local government might instead choose to expand financing through informal taxes, where some degree of redistribution can be achieved by making use of the higher information (D and S) available informally. The fact that formal direct taxes tend to be very small (Figure 1) is consistent with the idea that local governments are constrained in their ability to levy formal taxes, i.e., D may be binding.[12]

Our framework also rationalizes the prevalence of labor payments observed in the data. In the first best case, the government will be indifferent between having the low type pay in labor versus money. In our framework, the government will always prefer to have the low type pay in labor if the shirking constraint does not bind, since doing so allows the government to extract greater payments from those with (unobservably) higher income. If the shirking constraint does bind, the low type may make payments in both money and labor, consistent with what we observe in the data (Table 3, Panel B). Conversely, high types should pay in money rather than in labor, which is what we observe in almost all countries (Table 8).

2.3 Extensions to multiple types

This section discusses two extensions of the model. First, we consider the case where the low type's wage is above the unskilled wage rate, so that having the low type pay in labor imposes social costs. Second, we consider what happens when we introduce more than two types into the model. Together, these two extensions allow the model to closely match all of the stylized facts demonstrated above.

First, consider the case when both the high and low wages are above the unskilled wage rate. Specifically, suppose that a fraction α of the population earns wage w_H and a fraction $1-\alpha$ earns wage w_M, where $w_H > w_M$. The labor payments of each type are valued by the government at wage rate w_L, where $w_L < w_M$. The enforcement, hidden income and shirking constraints are the same as above, with the difference that the low skilled type is now receiving wage w_M and paying taxes $\lambda_M w_M + \tau_M$. In this case, the general pattern of the equilibrium – with the high type paying more in total and the high type never paying labor taxes – still holds, i.e.:

Remark 4 *Even if $w_M > w_L$, $\lambda_H = 0$ and $\tau_H > \tau_M + w_M \lambda_M$ under conditions analogous to those given in Remarks 1 and 3.*

[12] By contrast, indirect formal taxes (VAT) are large, but these tend to be levied by state and national governments and could be administratively difficult to administer at the local level.

Proof. We denote the low type's income and tax payments by the subscript M, to differentiate them from the notation for the unskilled wage rate at which government values labor, w_L.The fact that at the optimum level of payments $\lambda_H = 0$ can be shown using a proof similar to the one used for Remark 1 with the additional condition that if SC_M does not bind, then it must be the case that $D > u(w_M(1-\lambda_H) - \tau_H) - u(w_M(1-\lambda_M) - \tau_M)$ in order for HI_M to be satisfied.

To show that the tax payments are strictly increasing in income, the proof is similar to the one used to prove Remark 3. ■

The key difference if $w_M > w_L$ is that using labor as a screening device now has real social costs, so it affects the attractiveness of using labor as a screening device. Nevertheless, we show with a numerical example that it is still possible to obtain similar equilibria, i.e.:

Remark 5 *Even if $w_M > w_L$, it is still possible to obtain an equilibrium where the high type pays only in money and the low type pays only in labor.*

Example 1 *Let $U(y_i, g) = \ln(y_i) + \theta g$, where $y_i = w_i(1-\lambda_i) - \tau_i$. We take $w_H = 9$, $w_M = 4, w_L = 3.5, \alpha = 1/3, P = 1, D = \ln(10/7), S = \ln(3/2)$, $G/N = 2$ and $\theta = 2$.*

In the first best, when no constraints bind, the optimal solution would involve $\tau_H = 16/3$ and $\tau_M = 1/3$.The social planner would not use any labor taxes since both individuals' labor is publicly valued at a lower rate than their outside wage.

If we introduce the enforcement, hidden income and shirking constraints, then the hidden income constraint for the high type would not be satisfied at the first-best values of τ_H and τ_M. Thus, labor would have to be used as a screening device to make the low type's tax mix less attractive to the high type. By requiring the low type to pay some taxes in labor, the high type's utility cost of switching to the low type's tax mix is increased since the high type values his labor at a higher wage rate than the government. However, the introduction of labor payments also increases the low type's total tax payment, since his labor is also valued at a lower rate than his outside wage. Thus, P, D and S must be high enough so that the constraints hold even after these changes in the tax mix.

In this example, after switching the low type's payment to labor instead of money, the hidden income constraint for the high type will be satisfied with equality. Solving the constrained maximization numerically, at the optimal level, $\tau_H^* = 4.26$, $\lambda_H^* = 0$ and $\tau_M^* = 0, \lambda_M^* \simeq 0.25$. The total tax payment for the low type increases to $w_M \lambda_M \simeq 1$, reflecting the need to use the low type's payment as a screening device. One can check, for example, that welfare under this scenario is greater than, for example, setting $\tau_H = \tau_L$, or setting $\lambda_L = 0$ and setting τ_H and τ_L such HI_H binds.

Note that we can always guarantee that it will continue to be optimal to provide the public good by setting θ high enough.

The model thus provides a potential explanation for labor payments made by those with an opportunity cost above the unskilled wage rate, despite the fact that these in-kind payments are inefficient.

Second, we examine the case when there are three types in the model. With three types, we can simultaneously consider participation gradients (i.e., does the household pay anything at all) and the quantity paid conditional on participating. With a numerical example we can show the following possibility result:

Remark 6 *If there are multiple types and if the cost of hiding income increases with the amount of income hidden, it is possible to get both a positive participation gradient and a positive income gradient conditional on participating.*

Example 2 *As in the previous example, let* $U(y_i, g) = \ln(y_i) + \theta g$, *where* $y_i = w_i(1 - \lambda_i) - \tau_i$. *Assume there are three types of individuals in the community: high-skilled, medium-skilled and low-skilled, each representing a share* $\alpha = 1/3$ *of the population. We take* $w_H = 11$, $w_M = 5, w_L = 4.5$, $G/N = 2$ *and* $\theta = 2$.*Let* D_{ij} *denote the utility cost for individual of type* i *to hide income and pretend to be of type* j. *Assume the punishment and utility cost of shirking* P *and* S *are identical for all types. We let* $P = 1$, $S = \ln(3/2)$, $D_{HM} = D_{MH} = \ln(1.45)$, $D_{HL} = D_{LH} = \ln(1.9)$, $D_{ML} = D_{LM} = \ln(1.3)$. *Notice that the cost of hiding income is increasing with the amount hidden in such a way that switching to the medium type's tax rates is always more attractive for the high type than switching to the low type's tax rates.*

In the first best case, when no constraints bind, the optimal allocation involves $\tau_H = 6, \tau_M = 0$, $\tau_L = 0$ *and no labor payments. This allocation reflects the large difference in income between the high type and the other two types. However, at this allocation, the hidden income constraint would not hold for the high type, who would have an incentive to switch to be the medium type's schedule. Therefore, the constrained maximization problem will use labor payments as a method of making the medium type's payment less attractive to the high type. (In this example, the large gap between the high and medium wages makes increasing the medium type's labor payments preferable to increasing his monetary payments.)*

Solving the constrained maximization problem numerically yields $\tau_H = 5$, $\tau_M = 0$, $\lambda_M = 0.214$, $\tau_L = 0$ *and* $\lambda_L = 0$. *In this example, we obtain a case in which the lowest type is not required to pay anything, the medium-skilled type is required to supply labor, and the high-skilled type only pays in money.*

Note that we can always guarantee that it will continue to be optimal to provide the public good by setting θ *high enough.*

This example provides parameter values for which the pattern outlined in the above remark will hold at the optimal solution. Moreover, in this numerical example, it is also be optimal for the middle type, whose wage rate is greater than the unskilled wage rate, to pay in the form of labor, since these payments serve as a screening device. We have thus provided an example that encompasses many of the stylized facts: a positive participation gradient, a positive income gradient conditional on paying, prevalent labor payments, a steeper gradient on money payments than on labor payments, and labor payments by those whose incomes are greater than the unskilled wage rate.

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