ADELAIDE UNIVERSITY
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Working Paper 01-3
January 2001

SCHOOL OF ECONOMICS
Adelaide University
SA 5005 AUSTRALIA

ISSN 1444-8866

ABSTRACT

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How does the presence of corruption affect the optimal mix between consumption and income taxation? In this paper we examine this issue using a simple neoclassical growth model, with a self-seeking and corrupt public sector. We find that the optimal tax mix in a corrupt economy is one that relies more heavily upon consumption taxes than on income taxes, relative to an economy without corruption. Our model also allows us to investigate the effect of corruption on the optimal size of government, and our results indicate that the optimal size of government balances the wishes of the corrupt public sector for a larger government, and so greater opportunities for corruption, with those in the private sector who prefer a smaller government. Not surprisingly, the optimal size of government is smaller in an economy with corruption than in one without corruption.

Classification: H21, O17, O40

Keywords: Endogenous Growth, Corruption, Taxation

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I. Introduction

Governments have a natural monopoly over the provision of many publicly provided goods and services, such as property rights, law and order, and contract enforcement, and a selfless and impartial government official would provide these services efficiently, at their marginal cost. However, it has long been recognized that public officials are often self-seeking, and such officials may abuse their public position for personal gain. These actions include such behavior as demanding bribes to issue a license, awarding contracts in exchange for money, extending subsidies to industrialists who make contributions, stealing from the public treasury, and selling government-owned commodities at black-market prices. In their entirety, these actions can be characterized as abusing public office for private gain, or "corruption" (Shleifer and Vishney, 1993).

The idea of self-seeking government agents, particularly those who provide public services through public bureaus, is hardly new.[1] The typical bureaucrat is assumed to face a set of possible actions, to have personal preferences among the outcomes of the possible actions, and to choose the action within the possible set that he or she most prefers. Corruption can often result, and can become ingrained and systemic in a society's institutions.

However, despite the widespread recognition of corruption, it is only recently that systematic analyses of its causes, effects, and remedies have been undertaken.[2] For example, there is now evidence that corruption distorts incentives, misallocates resources, lowers investment and economic growth, reduces tax revenues, and redistributes income and wealth, among other things.[3] The prevention of corruption is a more difficult issue. Suggested remedies include the obvious ones of rewards for honesty and penalties for dishonesty.

[1] In this regard, Niskanen (1971, 1994), develops a theory of supply by bureaus.
[2] See, for example, Alam (1990), Geddes and Neto (1992), Kurer (1993), and Lapalombara (1994).
[3] There is a significant body of work in institutional economics linking the functions of government, particularly property rights, to economic development; see especially North (1990, 1993). Also, see Mauro (1993) for empirical evidence on the effects of corruption on economic growth. Note that Leff (1964) suggests that

Increasing the transparency in government decision-making, improving the accountability of public officials, and, more generally, reducing the scope of government via privatization, deregulation, and other market reforms have been shown to help reduce or minimize corruption (Klitgaard, 1988; Klitgaard, MacLean-Abaroa, and Parris, 2000).

However, despite these many useful insights, the effects of corruption on the tax structure of a country remain largely unexamined. There is a large literature on the tax structure that maximizes social welfare in a static setting (e.g., Diamond and Mirrlees, 1970; Atkinson and Stiglitz, 1976), and there has also been much recent work on the appropriate mix of consumption versus income taxes to generate maximum growth (e.g., Jones, Manuelli, and Rossi, 1993; Stokey and Rebelo, 1995). However, as recently emphasized by Tanzi and Davoodi (2000), the effects of corruption on the structure of a country's tax system have not been studied.

This is our purpose here: to determine the effects of corruption on the optimal mix between consumption and income taxes, using a simple neoclassical growth model with a self-seeking and corrupt public sector.[4] In our model, the government is assumed to provide two kinds of public goods, one that enters the utility function of individuals and one that is used as an input in private production. There are two agents, one public and one private, and each maximizes a utility function that depends upon consumption of the public good and also of a private good, where the public good is subject to congestion. The government finances its activities by a consumption tax and an income tax. Importantly, the public agent is assumed to have the ability to exploit monopoly rents in the provision of a public good to private industry; that is, there is corruption institutionalized within the public sector. The government

corruption might actually enhance efficiency by cutting through bureaucratic red-tape, a notion later demonstrated theoretically by Barreto (2000).

[4] In most of the endogenous growth literature that explicitly accounts for a government, the public sector is modeled with public goods that are trivially produced from tax revenues; see, for example, Barro (1990). Barreto (2000) shows that the consideration of a more realistic public production function does not alter these analyses, as long as the government charges the competitive price.

is assumed to choose its instruments to maximize a social welfare function that is the sum of public and private agent utilities.[5]

Our results indicate that the presence of corruption significantly alters the mix of consumption and income taxes. Compared to an economy without corruption, the socially optimal tax structure with a corrupt government involves a greater reliance upon consumption taxes and a smaller use of income taxes. However, this mix depends upon the social welfare weights of the public and private agents: the public agent prefers more use of income taxes than consumption taxes because the public agent's income from corruption cannot be taxed under an income tax, while the private agent has the opposite preference. In addition, our results are to examine the effect of corruption on the optimal size of government. Our results show that this optimal government size balances the wishes of the corrupt public sector for a larger government, and so greater opportunities for corruption, with the desire of the private sector for a smaller government. Not surprisingly, the optimal size of government is smaller in an economy with corruption than in one without corruption.

The next section presents our model and discusses its solution. Section III examines our results, and our conclusions are in Section IV. An Appendix contains a complete description and solution of our analytic model.

II. A Theoretical Model of Endogenous Growth with a Corrupt Government

Consider a simple endogenous growth model with a public good sector and two representative agents, one representing the public sector and one for the private sector. The government is assumed to provide a public good for private consumption and one also for private production. In the latter case, the public agent is assumed to have the ability to exploit

[5] There exist several endogenous growth models that examine the role of the public sector. See Barro (1990), King and Rebelo (1990), Rebelo (1991), Barro and Sala-I-Martin (1992), Glomm and Ravikumar (1992), Devereux and Mansoorian (1992), Saint-Paul (1992), Jones, Manuelli, and Rossi (1993), Stokey and Rebelo

the potential for monopoly rents in the provision of the public good. The government finances its production with separate taxes on consumption and on income. The public and private agents optimize intertemporally, and the government maximizes social welfare, defined as the unweighted sum of individual utilities.

Government can be viewed as providing two kinds of public goods. Public goods are nonrival and nonexclusive, and, as such, they can serve two basic and distinct functions. One is to give utility to consumers by providing them with certain goods that they value but that are unlikely to be provided in efficient amounts by private markets. The classic example of this type of public good is national defense; other examples include public parks, swimming pools, and similar kinds of public facilities. We denote this type of public good a *public consumption good*, or z_t, where the subscript t represents the time period.

A second function of public goods is to facilitate private production. Contract enforcement falls into this category, as does much public infrastructure like roads and bridges. This type of public good may therefore be thought of as an intermediate good in the production process. We call this type of public good a *public production good*, or g_t. Production of this good depends upon the amount of public capital k_{1t}. The public production good g_t is assumed to be an input in the production of the private output, which is denoted y_t. Private production also requires the use of private capital, or k_{2t}.

There are two agents. Agent 1 is assumed to be the public agent, and Agent 2 is the private agent. Corruption is introduced by allowing Agent 1 to control the production and distribution of the public production good g_t; that is, the public agent is assumed to derive revenue, or corruption income y_t, by the ability to extract monopoly rents from the sale of the public production good g_t to private industry. Agent 2 controls production of the private good

(1995), and Turnovsky (1996). Endogenous growth models that address rent-seeking behavior include Pecorino (1992) and Grossman and Helpman (1991, 1994).

y_t, which is produced with private capital k_{2t} and the public production good g_t. Capital is completely mobile between the public and private sectors.

The two representative agents receive income from separate sources. The private agent has income only from the production of the private good y_t. In contrast, the public agent receives all income y_t from the ability to exercise market power over the distribution of the public production good g_t to private industry. The intuition follows Shleifer and Vishney (1993), and is straightforward. Private industry requires some degree of services, or cooperation, from the public sector in order to produce anything (e.g., licenses, contract enforcement, public infrastructure). However, these services are ultimately in the hands of individuals within government, and these officials need not provide their services free of charge. In fact, since private industry really may have no choice but to accept whatever degree of public cooperation that is offered at whatever price is asked, a public official may act as a monopolist over the administration of this particular arm of the government. The implication for our model is that the public agent receives the monopoly rent, or corruption income y_t, from the provision of the public production good.

Although their income sources differ, the agents are faced with similar intertemporal utility functions, in which utility depends upon consumption of the private consumption good c_{it} and the public consumption good z_t, over an infinite planning horizon, where i denotes Agent 1 or 2. Each agent's utility function takes the general form:

$$\mathrm{U_i} = \int_{t=0}^{\infty} e^{-rt} \cdot u(c_{it}, z_t) \cdot dt = \int_{t=0}^{\infty} e^{-rt} \cdot \frac{1}{g} \cdot \left(c_{it} \cdot z_t^{s}\right)^{g} \cdot dt\ , \quad i=1,2, \qquad (1)$$

where r is the pure rate of time preference, s measures the impact of public consumption on the welfare of the individual agent, and g is related to the intertemporal elasticity of substitution.[6]

[6] The functional form of the utility function follows Turnovsky (1996), who shows that the intertemporal elasticity of substitution equals 1/(1-γ).

The government derives revenue from an income tax and a consumption tax. The income of the private agent is taxed at rate t. However, because income from corruption is by definition illegal income, the income of the public agent is assumed to be untaxed. In contrast, consumption expenditures of both agents are taxed at rate w. Total government tax revenue is denoted by c_t, where

$$c_t = w \cdot (c_{1t} + c_{2t}) + t \cdot (y_t - y_t). \qquad (2)$$

Aggregate public goods c_t are subject to congestion, represented as

$$z_t = c_t^{\,d} \cdot \left(\frac{c_t}{y_t} \right)^{1-d}, \qquad (3)$$

where d is the congestion coefficient and y_t is aggregate private output. In order for the level of public services z_t available to the individual to be constant over time, it must be the case that:

$$\frac{\dot{c}_t}{c_t} = (1-d) \cdot \frac{\dot{y}_t}{y_t}. \qquad (4)$$

By representing public goods in this manner, less than perfect degrees of non-excludability and non-rivalness may be considered. Analytically, congestion affects the growth rate and therefore the model's solution through the term for the marginal utility of capital that appears in the Euler equations.[7]

The public agent maximizes utility, subject to the following constraints:

$$y_t = (r_{1t} - r_{2t}) \cdot k_{1t} = P_{gt} \cdot g_t - r_{2t} \cdot k_{1t} \qquad (5)$$

$$y_t = c_{1t} \cdot (1 + w) + s_{1t} \qquad (6)$$

$$g_t = v \cdot k_{1t} \qquad (7)$$

$$k_t = k_{1t} + k_{2t} \qquad (8)$$

$$\dot{k}_t = s_{1t} + s_{2t} - x \cdot k_t \ , \qquad (9)$$

where

y_t = total output at time t
g_t = public production good at time t
P_{gt} = price of the public good at time t
v = inverse productivity factor = coefficient of "red tape", $0 \leq v \leq 1$
c_{it} = agent i's consumption at time t, $i = 1,2$
s_{it} = agent i's saving at time t, $i = 1,2$
y_t = corruption at time t
r_{1t} = the marginal product of capital in the public sector at time t
r_{2t} = the after-tax marginal product of capital in the private sector at time t
k_{1t} = capital used in the public sector production function at time t
k_{2t} = capital used in the private sector at time t
r = the pure rate of time preference
x = the economy-wide depreciation rate of capital
w = the consumption tax rate,

and where a dot over a variable denotes a time derivative. Equation (5) defines the income of Agent 1, equation (6) is the public agent's budget constraint, equation (7) denotes a linear technology for the public production good, equation (8) shows the total supply of capital, and equation (9) is the equation of change for total capital. The private agent, Agent 2, faces a similar set of constraints:

$$y_t = k_{2t} \cdot f\left(\frac{\bar{g}_t}{k_{2t}}\right) = k_{2t} \cdot A \cdot \left(\frac{\bar{g}_t}{k_{2t}}\right)^a \qquad (10)$$

$$y_t = P_{gt} \cdot \bar{g}_t + r_{2t} \cdot k_{2t} \qquad (11)$$

$$\bar{g}_t = v \cdot k_{1t} \qquad (12)$$

$$(y_t - \bar{y}) \cdot (1 - t)_t = c_{2t} \cdot (1 + w) + s_{2t} \qquad (13)$$

$$k_t = k_{1t} + k_{2t} \qquad (14)$$

$$\dot{k}_t = s_{1t} + s_{2t} - x \cdot k_t \ , \qquad (15)$$

[7] By explicitly considering congestion within the utility function, the marginal utility of capital becomes non-zero; an additional implication is that another element enters each agent's Euler equation. The presence of congestion in endogenous growth models is discussed in Barro and Sala-i-Martin (1992).

where $f(\ )$ is the general production function for total output, A and are coefficients in the production function, and t is the income tax rate. A bar over a variable signifies that the variable is fixed and given for the agent. Equation (10) specifies the production technology for total output, equation (11) defines the uses of output, and equation (13) is the budget constraint for Agent 2. Other equations are identical to those of Agent 1.

The two agents engage in a simple sequential game.[8] At any given time, say $t=0$, there exists some total supply of capital $k_{t=0}$. Agent 1, the public agent, is assumed to go first by choosing the amount of $k_{1t=0}$ that is needed to produce the desired amount of the public production good $g_{t=0}$. However, Agent 1 is a monopolist in the provision of the public production good to Agent 2, and limits the amount of $g_{t=0}$ available to the economy in order to raise its price. The public agent maximizes utility by choosing $k_{1t=0}$ such that $P_{gt} = \frac{r_{1t}}{v}$, which is endogenously determined via a modified golden rule. Corruption income $y_{t=0}$ is paid in final goods. The corrupt agent may devote income toward consumption $c_{1t=0}$ or saving $s_{1t=0}$, as given in equation (6), where Agent 1's consumption is taxed but the agent's income is untaxed.

Then, the private agent (Agent 2) maximizes utility, deriving revenue from the production of the composite output $y_{t=0}$. The private agent accepts as given the monopolistically determined price $P_{gt=0}$ and quantity $g_{t=0}$ of the public production good, as set by Agent 1; recall that a bar over a variable means that this variable is fixed and given to the agent. Given this amount of the public production good, Agent 2 devotes all of the remaining capital $k_{2t=0}$ to the production of the composite output good $y_{t=0}$.

The allocation of capital between the two sectors is demonstrated in Figure 1. Here, D_{ki} represents the demand for capital in sector i, MR_{k1} is the corresponding marginal revenue of public sector capital, and r_i denotes the return to capital in sector i. If the public agent behaved competitively, capital would be allocated between the sectors so as to equalize the returns to capital in each sector at r_{pc} . However, with monopolistic power, the public agent restricts the allocation of capital to the public sector, thereby generating a monopoly rent of $(r_1 - r_2)\, k_1$.[9]

Recall that Agent 1 goes first by choosing k_{1t} and c_{1t}. More formally, Agent 1 maximizes the present value Hamiltonian, defined as

$$L_1 = U_{1t} + p_t \cdot \left[s_{1t} + s_{2t} - x \cdot \left(k_{1t} + k_{2t} \right) \right] + m_t \cdot \left[y_t - c_{1t} \cdot (1+w) - s_{1t} \right] \qquad (16)$$

This optimization defines the resulting growth path as

$$\begin{aligned} \frac{\dot{c}_{1t}}{c_{1t}} &= \frac{1}{\left[g \cdot (1 + d \cdot s) - 1 \right]} \cdot \frac{\dot{m}_t}{m_t} \\ &= \frac{-1}{\left[g \cdot (1 + d \cdot s) - 1 \right]} \cdot \left\{ d \cdot s \cdot (1+w) \cdot a \cdot \frac{c_{1t}}{k_{1t}} + v \cdot f' - (1-a) \cdot (1-t) \cdot f - x - r \right\} \end{aligned} \qquad (17)$$

where the first term in the brackets is the marginal utility of k_{1t} and the second is the marginal product of k_{1t}.

The private agent accepts the public agent's choice of k_{1t} and consequently accepts the levels of g_t and y_t. Agent 2 then optimizes the present value Hamiltonian with respect to c_{2t} and k_{2t}, or

$$L_2 = U_{2t} + j_t \cdot \left[s_{1t} + s_{2t} - x \cdot \left(k_{1t} + k_{2t} \right) \right] + l_t \cdot \left[\left(y_t - \bar{y}_t \right) \cdot (1-t) - c_{2t} \cdot (1+w) - s_{2t} \right]. \qquad (18)$$

This optimization defines the growth path as

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[8] In order that Agent 2 accept the level of corruption as given, it is easier to assume a sequential game. Also, if the agents move sequentially, it is the case that $dk_2/dk_1 = dk_1/dk_2 = 0$.

[9] Note that Agent 1's saving s_{1t} is not directly associated with k_{1t} , and Agent 2's saving s_{2t} is also not directly associated with k_{1t}. This occurs because of the relationships

$$\begin{aligned} &\dot{k}_t = s_{1t} + s_{2t} - x \cdot k_t = \dot{k}_{1t} + \dot{k}_{2t} \\ &s_{1t} \neq \dot{k}_{1t} \\ &s_{2t} \neq \dot{k}_{2t} \ , \end{aligned}$$

which mean that agents' consumption decisions are independent of their capital allocation decisions.

$$\frac{\dot{c}_{2t}}{c_{2t}} = \frac{1}{\left[g\cdot(1+d\cdot s)-1\right]}\cdot\frac{\dot{j}_t}{j_t}$$
$$= \frac{-1}{\left[g\cdot(1+d\cdot s)-1\right]}\cdot\left[d\cdot s\cdot(1-a)\cdot(1+w)\cdot\frac{c_{2t}}{k_{2t}} + f\cdot(1-a)\cdot(1-t) - x - r\right] \qquad (19)$$

The balanced growth equilibrium is then defined as

$$\frac{\dot{c}_{1t}}{c_{1t}} = \frac{\dot{c}_{2t}}{c_{2t}} = \frac{1}{\left[g\cdot(1+d\cdot s)-1\right]}\cdot\frac{\dot{m}_t}{m_t} = \frac{1}{\left[g\cdot(1+d\cdot s)-1\right]}\cdot\frac{\dot{j}_t}{j_t} \quad . \qquad (20)$$

Notice that each agent's consumption growth is a function of $\frac{c_{1t}}{k_{1t}}$ and $\frac{c_{2t}}{k_{2t}}$, respectively.

Equations (17) and (19) may be solved using the capital accumulation equation to get the following analytic results:[10]

$$\frac{c_{1t}}{k_{1t}} = \frac{y_t\cdot(1-t)+t\cdot\bar{y}-x\cdot(k_{1t}+k_{2t})-\dot{k}_t}{(1+w)\cdot k_{1t}}$$
$$-\frac{\left\{d\cdot s\cdot a\cdot\left[y_t\cdot(1-t)+t\cdot\bar{y}-x\cdot(k_{1t}+k_{2t})-\dot{k}_t\right]\cdot k_{1t}^{-1}+v\cdot f'-(1-a)\cdot(1-t)\cdot f\cdot 2\right\}}{d\cdot s\cdot(1+w)\cdot\left[(1-a)\cdot\frac{k_{1t}}{k_{2t}}+a\right]}$$

(21)

$$\frac{c_{2t}}{k_{2t}} = \frac{\left\{d\cdot s\cdot a\cdot\left[y_t\cdot(1-t)+t\cdot\bar{y}-x\cdot(k_{1t}+k_{2t})-\dot{k}_t\right]\cdot k_{1t}^{-1}+v\cdot f'-(1-a)\cdot(1-t)\cdot f\cdot 2\right\}}{d\cdot s\cdot(1+w)\cdot\left[(1-a)+a\cdot\frac{k_{2t}}{k_{1t}}\right]}$$

(22)

The basic solution is illustrated by Figure 2, which depicts a simple Solow-Swan type of growth model with the ratio (instead of the level) of capital stocks on the horizontal axis and net investment on the vertical axis. Start from an initial allocation of capital between the sectors, given by $(k_1/k_2)_0$. As a country that is subject to corruption moves toward its steady

[10] Remember that a bar over a variable signifies that the level is given for the agent in question. This is a direct result of the sequential nature of model. For example, $\bar{y}$ denotes the level of corruption that is predetermined as far as the private agent is concerned.

state equilibrium distribution of capital, the amount of publicly provided goods increases, implying a lower rate of return on capital, a lower monopoly rent for the public agent, and lower corruption; that is, more public services are provided at lower cost. As a result, the welfare of both agents increases at the expense of lower growth. The full model and a discussion of its solution are in the Appendix.

However, the basic solution is characterized by extreme non-linearity in the solution for the economy-wide growth rate. Consequently, there exist multiple equilibria for any given choice of k_{1t} and k_{2t}. Furthermore, it can be shown that

$$\frac{\hat{c}_{2t}}{k_{2t}} = \frac{c_{2t}}{k_{2t}}(k_{1t}, k_{2t}, a, d, g, s), \qquad (23)$$

where a hat "^" denotes an analytic solution and where there is a strict association among these variables such that $\frac{\hat{c}_{2t}}{k_{2t}} > 0$. Although there likely does exist this same type of association between the analytic solutions for $\frac{\hat{c}_{1t}}{k_{1t}}$ and $\frac{\hat{c}_{2t}}{k_{2t}}$ and the model's coefficients, this association cannot be defined analytically because the analytic solutions to $\frac{\hat{c}_{1t}}{k_{1t}}$ and $\frac{\hat{c}_{2t}}{k_{2t}}$ each contain a $\dot{k}_t$ element while the no-corruption solution to $\frac{\hat{c}_{2t}}{k_{2t}}$ does not. Put differently, the multiple equilibria are such that the optimal choices of c_1 and c_2 are related to the analytic results for $\hat{c}_{1t}$ and $\hat{c}_{2t}$ by the relation [$\hat{c}_{1t} + \hat{c}_{2t} = c_{1t} + c_{2t}$] at any balanced growth equilibrium choice of $\frac{k_{1t}}{k_{2t}}$.

As a result, numerical solutions are needed to explore the model's implications for optimal taxation. These simulations are discussed next.

III. Simulation Results

Some initial insights into the choice of an optimal tax structure can be obtained by observing the effects on welfare of changes in one tax rate, holding the other tax rate constant. Tables 1, 2, and 3 report some of the results of these simulations, and Figures 3, 4, and 5 give a more complete presentation of the welfare effects of different tax mixes.[11]

In Table 1 income taxes vary from 10 to 50 percent, while consumption taxes are set to zero. Note that lower income tax rates generate less corruption (and also greater relative amounts of public capital). However, each agent has a very different preference for income taxes. At a 0 percent consumption tax rate, the public agent prefers a relatively high income tax (about 40 percent) because Agent 1 does not pay income taxes but nevertheless benefits from the public consumption good provided from tax revenues. In contrast, the private agent prefers a relatively low income tax (about 10 percent). With a zero consumption tax rate, global welfare is maximized at an income tax rate of over 20 percent, a level that can be viewed as balancing the wish of the public agent for a high income tax rate with that of the private agent for a low income tax rate.

Tables 2 and 3 present the results of steady states as consumption tax rates vary, with constant 10 percent and 20 percent income tax rates, respectively. Consumption taxes have significant welfare implications. Unlike with income taxes, each agent's preferences over consumption taxes are identical; that is, utility for each agent is maximized at the same

[11] All simulations are done with the following coefficient values:

$A = 0.1$
$v = 1$
$a = 0.25$
$r = 0.02$
$g = 0.11$
$s = 0.25$
$\delta = 0.75$.

Recall that s is the coefficient on the public consumption good in the agents' utility functions and d is the congestion coefficient on the public consumption good. A value of 0.25 for s signifies a public good that has moderate value to the agents, and a value of 0.75 for signifies some degree of congestion in the good.

consumption tax rate. In Table 2, maximum utility occurs at a consumption tax of 5 percent (with an income tax of 10 percent), so that at a low income tax rate individual and global utilities increase with higher consumption taxes. In contrast, a lower consumption tax of about 10 percent maximizes utility when the income tax is 0 percent (Table 3). Since both agents are equally subject to consumption taxes and both agents equally benefit from consumption tax revenue, then both agents exhibit the same preferences over consumption taxes.[12]

The general nature of these results is also depicted in Figures 3, 4, and 5, which demonstrate that agents have very different preferences over the tax mix.[13] The public agent generally prefers a mix of a high income tax and a low consumption tax, while a private agent has the opposite preference. As demonstrated in Figure 5, the optimum tax mix for society balances these conflicting wishes of the agents.

In Tables 1, 2, and 3 (and in Figures 3, 4, and 5), the size of government varies with the amount of taxes collected. Table 4 and Figure 6 present the results where the relative size of government, defined by $\frac{c_t}{y_t}$, remains constant, but where differing tax mixes are considered at the steady state. As income taxes fall, consumption taxes are increased to compensate for the loss in public revenue. The changing tax mix leads to a decline in relative corruption, which generates in turn a decrease in the public agent's utility and an increase in that of the private agent. Conversely, as government relies more heavily on income taxes, the public agent's utility rises while the private agent's utility falls. Social welfare, defined simply as the unweighted sum of the individual utilities (U_1+U_2), balances these conflicting changes in utility. In this case, the optimal tax mix occurs with a consumption tax rate of 21 percent and

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[12] Other parameter values yield different quantitative results, but the basic qualitative results are unchanged. For example, if $s = 0.50$ and $d=0.50$, the optimal consumption tax (with a 10 percent income tax) is 25 percent, and the optimal consumption tax with a 20 percent income tax) is 10 percent.

[13] Note that Tables 1, 2, and 3 are imbedded in Figures 3, 4, and 5.

an income tax rate of 50 percent. Changing the level at which government is held fixed (e.g., 10 percent, 20 percent, 30 percent, and 50 percent) affects the exact levels of the optimal tax rates, but does not affect the general result that an optimal tax mix exists, one that balances the wish of the public agent for a greater reliance on the income tax with that of the private agent for more use of the consumption tax. Changing the social welfare function to weight more heavily the welfare of the private agent shifts the optimal tax structure toward a greater reliance upon consumption taxation, while a greater welfare weight for the public agent leads to heavier income taxation at the social optimum.

Importantly, how does the optimal tax mix for a corrupt economy compare to that for an economy without corruption? Recall that, in the absence of corruption, public goods are provided competitively at least cost. Recall also that the private agent's welfare rises as the tax mix shifts toward income taxes and away from consumption taxes, since both agents pay consumption taxes but only the private agent pays income taxes. Consequently, the tax mix in a "clean" economy relies more heavily on income taxes than on consumption taxes; put differently, in a "corrupt" economy the optimal tax mix makes greater use of consumption taxes than of income taxes. Figure 7 depicts this result.

IV. Conclusion

Our main result suggests that, holding the relative size of government constant, the presence of corruption generates an optimal tax mix that relies more heavily on consumption taxes than on income taxes. This result is consistent with standard tax advice given to developing countries, especially those in which corruption is endemic: developing countries should rely more heavily upon indirect taxation than upon direct taxation (Newbery and Stern, 1995).

This result is derived in a model in which the (relative) size of government is held constant. Our model also allows us to investigate how social welfare varies with tax structure when the size of government of government is allowed to vary; that is, we are able to calculate the optimal size of government, and to compare the optimal size of government in a corrupt versus a clean economy. To present this more fully, the relative government size (irrespective of the specific tax mix that generates it) is plotted in Figures 8, 9, and 10 against the utility of the public agent, the utility of the private agent, and social welfare (the sum of the utilities of the two agents), respectively. The optimal government size necessarily occurs at the global welfare-maximizing tax mix. In the presence of a corrupt public sector, there is still an important role for government; that is, neither agent achieves maximum utility in an economy with no government, even when that government is corrupt. The optimal government size from the public agent's point of view is roughly 30 percent (Figure 8), while the optimal government size from the private agent's point of view is only 13 percent (Figure 9). The government size that maximizes social welfare balances these conflicting objectives at 20 percent (Figure 10).

However, it is not surprising that the optimal size of government is greater in a clean economy than in a corrupt economy (Figure 11).[14] When there is no corruption, the optimal size of government is significantly greater, at 80 percent, because the negative effects of corruption on social welfare via the implied loss in production of the public consumption and production goods are no longer present.

In short, fiscal policy is decidedly affected by corruption, and affected in ways that are largely consistent with expectations. Specifically, a corrupt economy should have a tax mix that relies more heavily upon consumption taxes than income taxes, and also one that has a

[14] Figures 8, 9, 10, and 11 are generated using the same parameter values as everywhere else in the paper, that is, the public good parameter in each agent's utility function, or σ, is assumed to equal 0.25, and the congestion parameter on the public good δ equals 0.75. Other (unreported) simulations demonstrate that an increase in the

smaller government, than an economy without corruption. The task then becomes finding ways in which corruption can be reduced.

preference parameter σ leads to a larger optimal size of government, while an increase in the congestion parameter δ generates a smaller optimal government.

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Figure 1
The Allocation of Capital Between the Public and Private Sectors

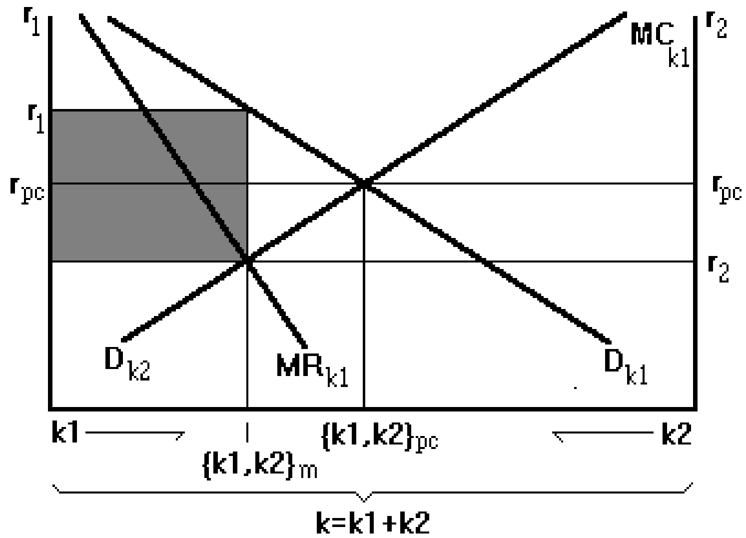

Figure 2

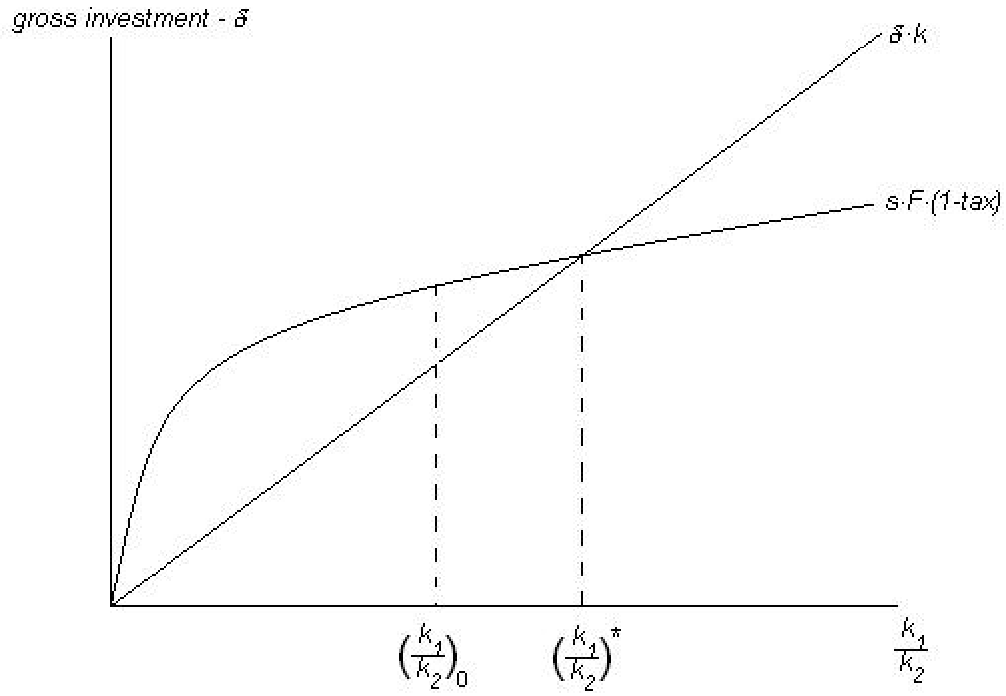

Figure 3
Tax Substitution Effects On Welfare At The Steady State: Public Agent

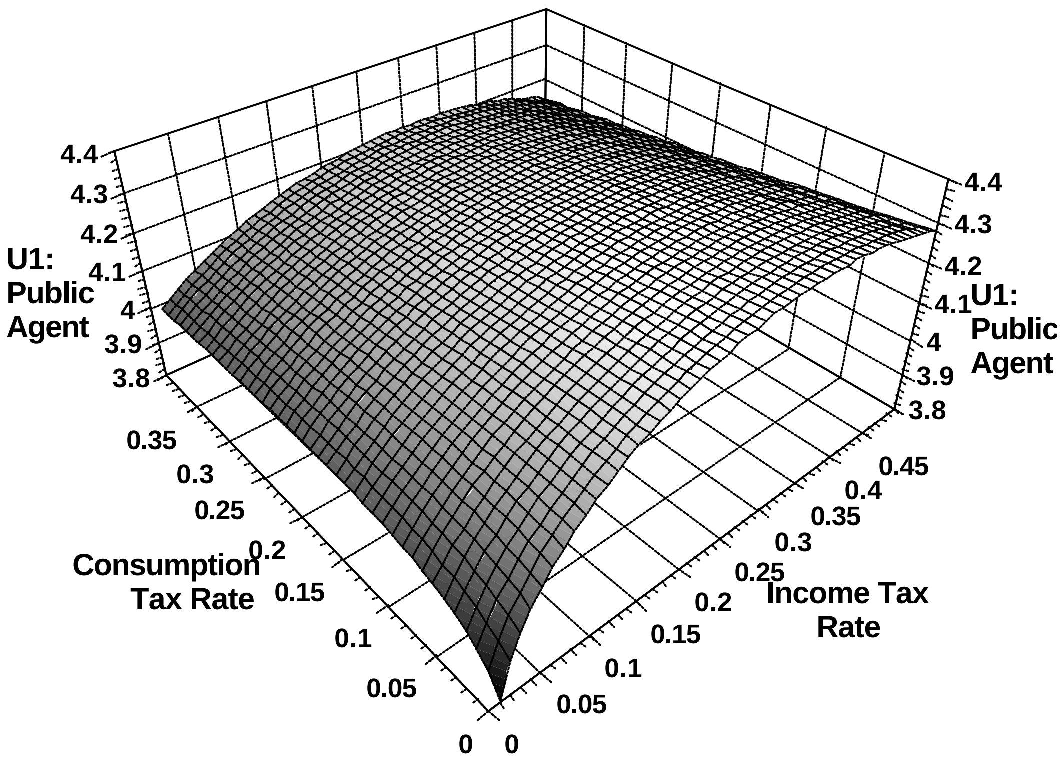

Figure 4
Tax Substitution Effects On Welfare At The Steady State: Private Agent

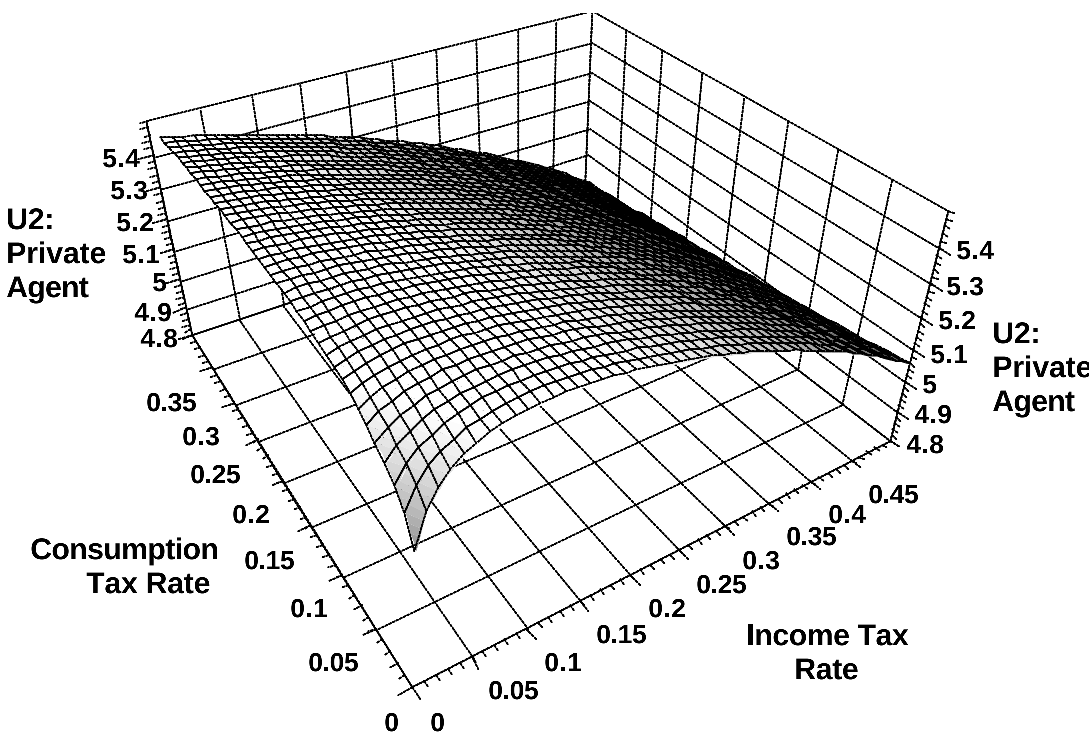

Figure 5
Tax Substitution Effects On Welfare At The Steady State: Social Welfare

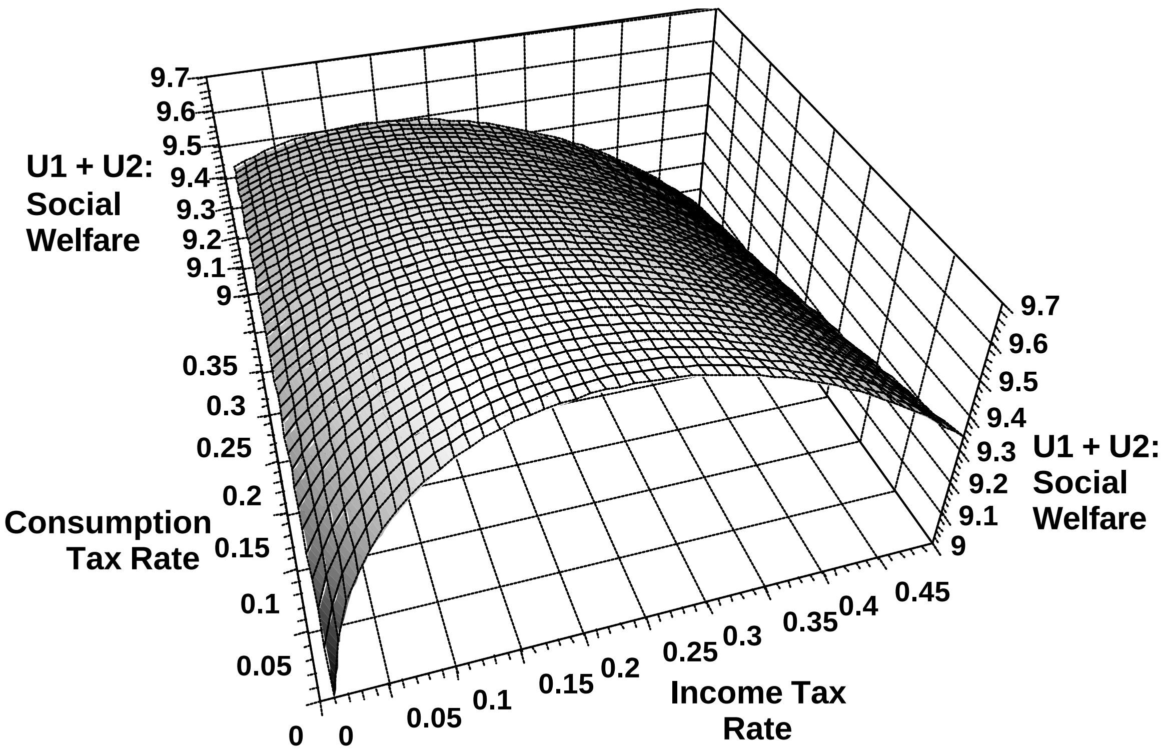

Figure 6
Tax Substitution Given A Constant Government Size

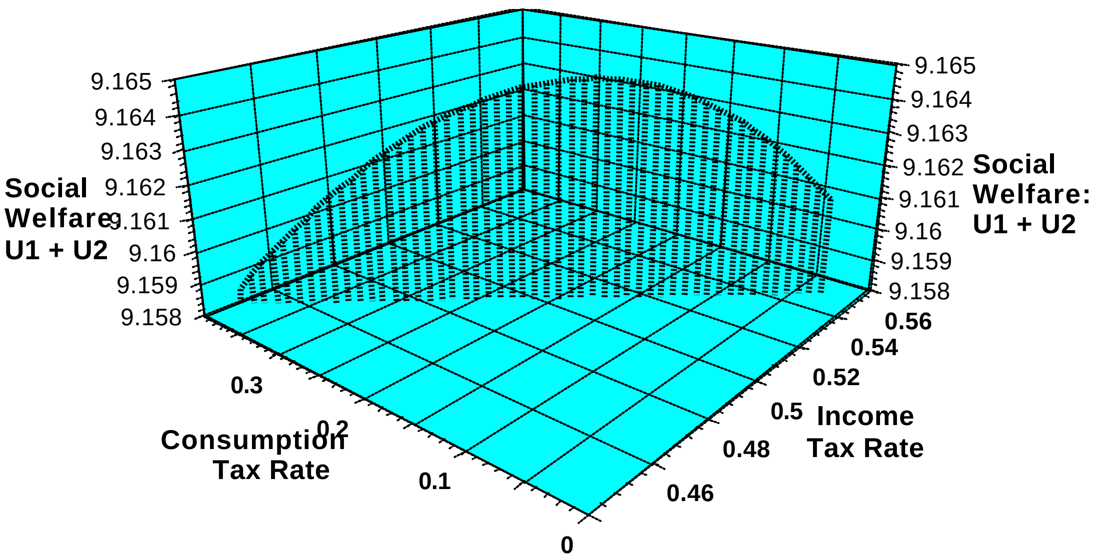

Figure 7
Tax Substitution Effects On Welfare At The Steady State: No Corruption

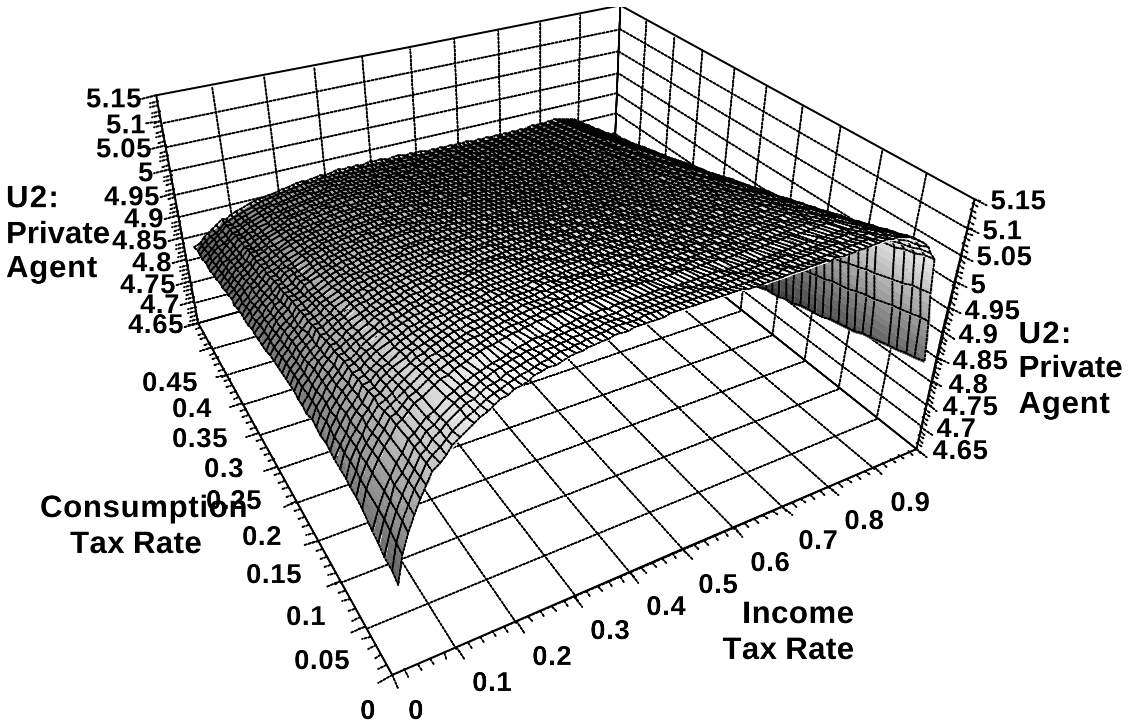

Figure 8
Relative Size of Government Versus Welfare At The Steady State: Public Agent

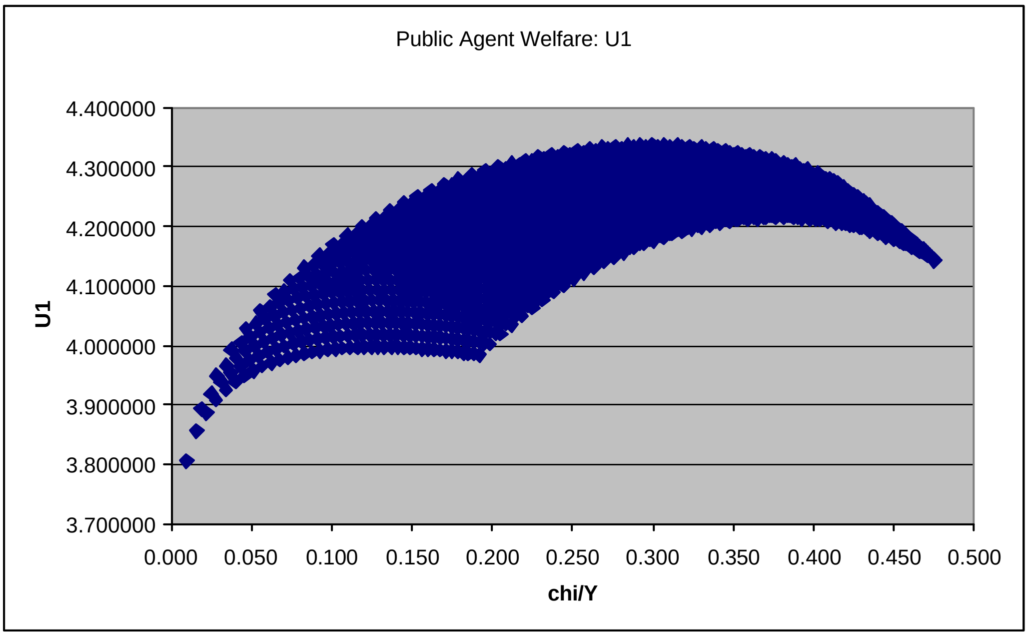

Figure 9
Relative Size of Government Versus Welfare At The Steady State: Private Agent

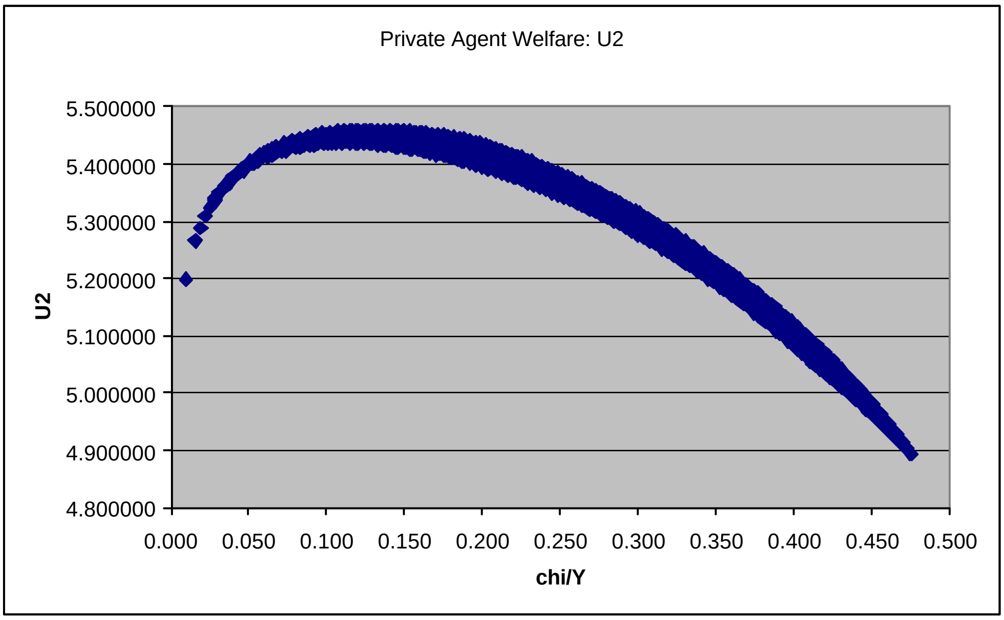

Figure 10
Relative Size of Government Versus Welfare At The Steady State: Social Welfare

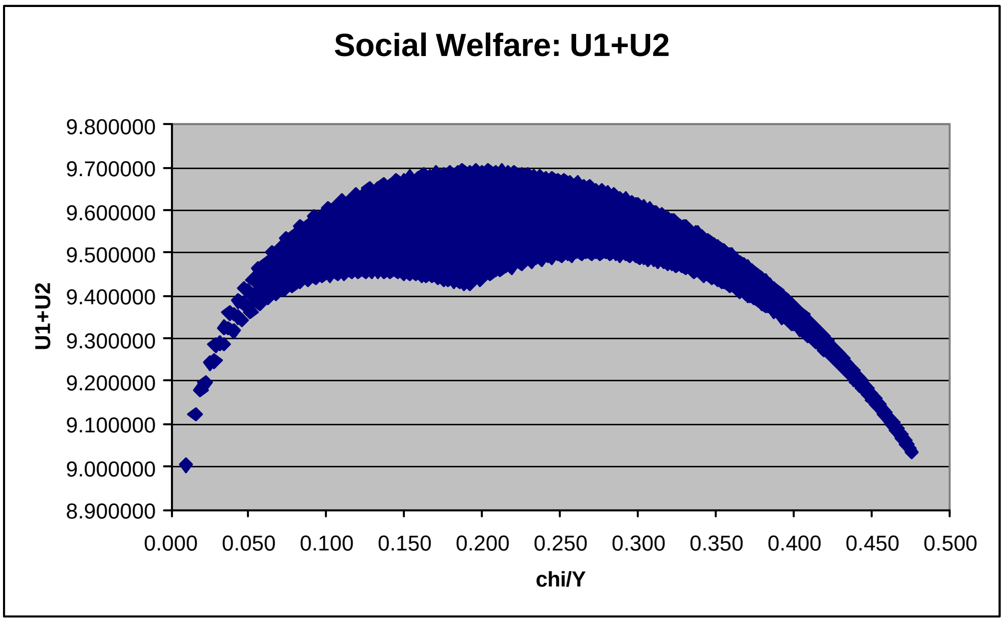

Figure 11
Relative Size of Government Versus Welfare: No Corruption

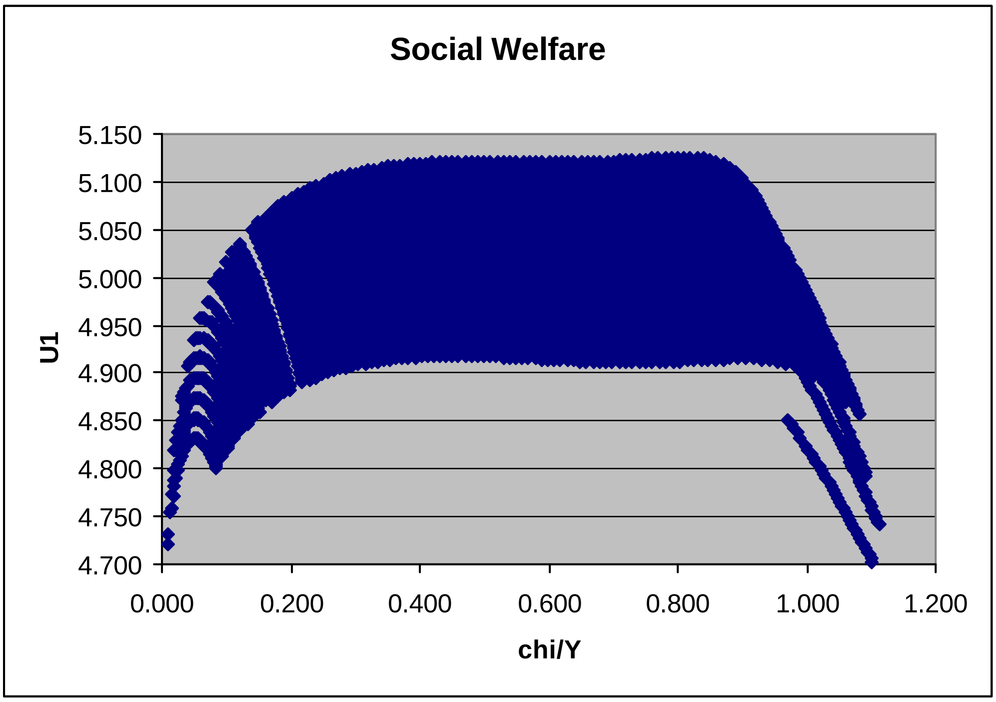

Table 1
Steady State at Various Income Tax Rates

	1	**2**	**3**	**4**	**5**
U2 + U1 =	9.337	9.545	9.662	**9.689**	9.584
U1=	4.281	**4.3313**	4.331	4.279	4.151
U2=	5.056	5.214	5.331	5.411	**5.433**
k1/k2=	0.185	0.208	0.226	0.240	0.252
y **/y=**	0.180	0.156	0.131	0.106	0.080
t **=**	**0.500**	**0.400**	**0.300**	**0.200**	**0.100**
w **=**	0.000	0.000	0.000	0.000	0.000
Tax Revenue/y=	0.410	0.337	0.261	0.179	0.092

Table 2
Steady State: t=10% and Various Consumption Tax Rates

	1	**2**	**3**	**4**	**5**	**6**
U2 + U1 =	9.557	9.575	9.590	9.599	**9.5992**	9.584
U1=	4.139	4.147	4.153	4.157	**4.1572**	4.151
U2=	5.418	5.428	5.437	5.442	**5.4420**	5.433
k1/k2=	0.252	0.252	0.252	0.252	0.252	0.252
y **/y=**	0.080	0.080	0.080	0.080	0.080	0.080
t **=**	0.100	0.100	0.100	0.100	0.100	0.100
w **=**	**0.250**	**0.200**	**0.150**	**0.100**	**0.050**	**0.000**
Tax Revenue/y=	0.203	0.184	0.164	0.142	0.118	0.092

Table 3
Steady State: t=20% and Various Consumption Tax Rates

	1	**2**	**3**	**4**	**5**	**6**
U2 + U1 =	9.564	9.592	9.619	9.645	9.669	**9.689**
U1=	4.223	4.236	4.247	4.259	4.269	**4.279**
U2=	5.341	5.356	5.371	5.386	5.399	**5.411**
k1/k2=	0.240	0.240	0.240	0.240	0.240	0.240
y **/y=**	0.106	0.106	0.106	0.106	0.106	0.106
t **=**	0.200	0.200	0.200	0.200	0.200	0.200
w **=**	**0.250**	**0.200**	**0.150**	**0.100**	**0.050**	**0.000**
Tax Revenue/y=	0.272	0.257	0.240	0.221	0.201	0.179

Table 4
Steady State: Tax Substitution with Constant Government Size

	1	**2**	**3**	**4**	**5**	**6**	**7**
U2 + U1 =	9.161	9.164	9.165	**9.165**	9.164	9.162	9.159
U1=	**4.220**	4.213	4.206	4.202	4.198	4.188	4.178
U2=	4.941	4.951	4.959	4.963	4.966	4.974	**4.980**
k1/k2=	0.171	0.177	0.183	0.185	0.188	0.193	0.198
y **/y=**	0.192	0.188	0.183	0.180	0.178	0.173	0.169
t **=**	**0.550**	**0.530**	**0.510**	**0.500**	**0.490**	**0.470**	**0.450**
w **=**	**0.031**	**0.104**	**0.177**	**0.213**	**0.250**	**0.324**	**0.398**
Tax Revenue/y=	0.450	0.450	0.450	0.450	0.450	0.450	0.450