Corruption in a Model of Human Capital and Income Distribution

April 22, 2017

Abstract

This paper presents an analysis of the role of corruption in determining the distribution of income and, with this, the degree of poverty and inequality. The analysis is based on an overlapping generations model in which individuals may seek to improve their productive efficiency by supplementing or substituting publicly-provided services (education and health care) with their own personal expenditures on human capital formation. Financial market imperfections mean that their ability to do this depends on their initial wealth status, implying the possibility of persistent inequality in multiple, history-dependent, long-run equilibria. We show how corruption may exacerbate this by compromising public service provision. It does so through the double whammy of both reducing the earnings and increasing the population of those who rely most on such services. Accordingly, higher levels of corruption are associated with higher levels of poverty and may even result in a complete polarisation between the rich and poor through the elimination of any middle class.

Keywords: Corruption, Bribery, Tax Evasion, Human Capital, Inequality, Poverty.

JEL Classification: D31, D73, H26, H41, O15.

1 Introduction

Recent years have witnessed a burgeoning literature on the role of corruption in determining economic and social development.[1] Underlying this has been a growing appreciation of the importance of governance for the functioning of society's public institutions.[2] Both theoretically and empirically, it has been shown how corrupt practices on the part of public officials can compromise growth and exacerbate inequalities by distorting incentives, destroying opportunities, squandering resources and perverting public policy. In many countries the scale of such practices is often quite staggering, as is the ingenuity of those who perpetrate them. Significantly, these countries are

[1]The most widely-used definition of corruption is the abuse of authority by public officials for personal gain. There are many excellent surveys of the existing literature, including Aidt (2003),Bardhan (1997), Jain (2001), Rose-Ackerman (1999), Svensson (2005) and Tanzi (1998).

[2]The concept of governance is broader than that of corruption, though there is an intimate connection between the two: just as bad governance fosters corruption, so corruption undermines good governance.

amongst the poorest of the world, leading many development experts to view corruption as one of the greatest obstacles to alleviating global poverty. This paper seeks to make a further contribution to the literature in a theoretical analysis of corruption, inequality and income distribution.

The thriving research on corruption and development has been stimulated in large part by the construction and refinement of various datasets that have become increasingly accepted as providing reliable measures of corrupt activity.[3] Armed with such data, a number of authors - including Gyimah-Brempong (2002), Keefer and Knack (1997), Knack and Keefer (1995), Li et al. (2000), Mauro (1995) and Sachs and Warner (1997) - have estimated significant adverse effects of corruption on growth. These and other studies also provide evidence on various ways in which corruption might take hold, such as lowering rates of investment (e.g., Mauro, 1995), creating obstacles to doing business (e.g., Brunetti et al., 1997, Fisman and Svensson, 2007, Kaufmann, 1997, Batra et al., 2002), reducing inflows of foreign investment (e.g., Wei, 2000) and causing misallocations of public expenditures (e.g., Haque and Kneller, 2015, Tanzi and Davoodi, 1997). Further evidence suggests that the direction of causation could go the opposite way, meaning that the incidence of corruption is, itself, determined by the level of per capita income(e.g., Ades and Di Tella, 1999, Fisman and Gatti, 2002, Montinola and Jackman, 2002, Paldam, 2002, Rauch and Evans, 2000, Treisman, 2000). Whilst some of these findings have been challenged, the broad consensus is that corruption and growth are linked in a relationship that is generally negative and possibly two-way causal.[4] There are many theoretical analyses which provide explanations for this relationship, together with addressing various other issues relating to the macroeconomics of misgovernance (e.g., Acemoglu and Verdier, 1998, 2000, Blackburn et al., 2006, 2010, Blackburn and Forgues-Puccio, 2007, 2009, 2010, Blackburn and Powell, 2011, Blackburn and Sarmah, 2008, Ehrlich and Lui, 1999, Murphy et al., 1991, Rivera-Batiz, 2001, Sarte, 2000).

The effects of corruption are not confined to aggregate outcomes alone. They extend to distributional outcomes as well [5], and it is this further aspect of development which occupies our principal concern in this paper. As above, research in the area has flourished over recent years, partly because of the quality improvements in data and partly because of the innovations in modeling corrupt behaviour.

At the empirical level, several studies have identified a strong positive correlation between the incidence of corruption and the degree of income inequality. Gyimah-Brempong (2002), using a panel of African countries, estimates sizable increases in the Gini coefficient as the level of corruption increases. Dincer and Gunalp (2008), employing data on US states, observe similar effects of corruption on different measures of inequality. Analogous findings appear in the contributions of Chong and Calderón (2000b), Gupta, Davoodi and Alonso-Terme (2002) and Gyimah-Brempong and de Camacho (2006), each of which is based on a broader sample of both developed and developing countries. Foellmi and Oechslin (2007) present additional results which suggest that an increase in the level of corruption leads to an increase in the income share of the wealthiest mem-

[3]Known as corruption perception indices, these datasets provide rankings of countries in terms of the extent to which corruption is perceived to exist based on questionnaire surveys sent to networks of correspondents around the world. For discussions and appraisals of the indices, see Tanzi and Davoodi (1997), Treisman (2000). Further remarks, together with a review of the empirical literature, can be found in Lambsdorff (2006).

[4]Of course, the strength of this relationship can vary across countries and regions, and various factors to explain this have been suggested, such as the quality of institutions, the degree of financial openness and the way in which corruption is practiced (e.g., Aidt et al., 2008, Neeman et al., 2008, Svensson, 2005)

[5]There are micro studies that deal with the relationship between corrupiton and inequality (e.g., Dutta and Mishra, 2013, Mishra and Ray, 2010)

bers of the population. Finally, evidence presented by Chong and Gradstein (2007) suggests that corruption and inequality may be mutually dependent, an increase in either causing an increase in the other. With due consideration, these observations may be given added significance by translating them to mean that corruption has the effect of exacerbating the degree of poverty, as established explicitly in some of the foregoing studies (e.g., Chong and Calderón, 2000b, Dincer and Gunalp, 2008).[6]

At the theoretical level, it has been shown how corruption may impact on inequality through various diverse channels. Ahlin (2001) and Foellmi and Oechslin (2007) develop occupational choice models in which at least some private agents must bribe public officials (bureaucrats) in order to engage in entrepreneurial activity that would make them better off. Both analyses predict that an increase in the size of bribe payments leads to a redistribution of wealth among the population. In the case of Ahlin (2001) this result is reflected in an inverted u-shaped relationship between corruption and inequality. In the case of Foellmi and Oechslin (2007) the result has the implication that a high incidence of corruption can cause a polarisation in income distribution. From a different perspective, Blackburn and Forgues-Puccio (2007) analyse the implications of corruption for redistributive policy in a model of bribery and tax evasion. It is shown how such behaviour can undermine attempts to reduce inequality by allowing the rich to benefit at the expense of the poor. Another avenue is explored by Alesina and Angeletos (2005) who develop a politico-economic model of corruption and redistribution. The main result is that there are multiple equilibria in the extent of government intervention, the level of rent-seeking and the degree of income inequality because of mutual interactions which reinforce each other. Finally, Glaeser et al. (2003) study the distributional consequences of legislative (as opposed to bureaucratic) corruption in a model of institutional subversion. The narrative in this case is that corruption can lead to greater inequality by prejudicing the judiciary in a way that favours the wealthier, more powerful members of the population to the detriment of the poorer, less influential sections of society.

In what follows we present an analysis of corruption and income distribution from a further public policy perspective. To many observers, the subversion of public policy is one of the major obstacles to reducing inequality, causing both a bias in the tax system in favour of the rich and a deterioration of social programmes designed to benefit the poor. Tax evasion by the wealthy, in collusion with bureaucrats, reduces the tax base and makes the tax system more regressive so that the burden of taxation falls disproportionately on the non-wealthy. Moreover, for any given tax system, tax evasion implies a loss of revenue to the government which may be forced to cut back on its expenditures targeted to the same group of low-income citizens (such as payments of subsidies, spending on health, and funding of education). The availability, provision and quality of social programmes may be threatened even further through the increased costs of accessing these programmes when bribes are demanded, through the diversion of resources towards other activities that offer greater scope for rent-seeking, or through a more blatant appropriation of public funds in a manner that amounts to pure theft. All of these pitfalls have been widely observed in practice and the literature on corruption is replete with examples of them.

The specific policy focus of our analysis is the government's provision of public goods and services designed to improve human development, especially amongst the poor. The cornerstones of this

[6]Caution is needed since inequality and poverty are two different concepts. In Chong and Calderon (2000a) and Li et al. (2000) the relationship between corruption and income inequality is found to be an inverted U-shape. An increase in corruption is associated with a decrease in inequality when inequality is initially high, but this does not necessarily mean that there is a decrease in poverty: a higher level of corruption may imply a lower level of inequality precisely because more of the population are made poor.

provision are public expenditures on education and health which are presumed to enhance human capital and, with this, the functionality and productivity of individuals.[7] Significantly, empirical support for this presumption is quite mixed. An extensive and diverse body of evidence produces some fairly ambivalent conclusions about the effects of social spending programmes on various economic and social indicators.[8] Whilst the effects are largely positive in the case of growth (e.g., Baldacci et al., 2004, Barbiero and Cournède, 2013, Blankenau et al., 2007, Kneller et al., 1999), they are much more ambiguous for other outcomes, such as inequality and poverty (e.g., Chu et al., 2000, Dollar and Kraay, 2002, Fan et al., 2002, Li et al., 1998, Bank, 2004), and education and health status (Anand and Ravallion, 1993, Bidani and Ravallion, 1997, Filmer and Pritchett, 1999, Gupta et al., 2001, Harbison and Hanushek, 1992, Pritchett, 1996). One of the most widely-accepted explanations of this conflicting evidence is that the efficacy of social programmes is often compromised by poor quality governance. This argument finds strong support in a number of empirical studies which seek to measure the effects of corruption on education and health status through its effects on the provision and quality of public education and health programmes (e.g., Azfar, 2001, Azfar and Gurgur, 2001, Baldacci et al., 2003, Gupta et al., 1999, 2003, Kaufmann et al., 1999, 2004, Lewis, 2006, Reinikka and Svensson, 2005, Rajkumar and Swaroop, 2008). Without exception, these effects are found to be significant and negative. Corruption undermines the effectiveness of social programmes by causing a wastage of programme funding through embezzlement and overspending. This compounds another well-known effect of corruption, which is the reduction of such funding to begin with due to the misallocation of public expenditures, the composition of which is distorted away from pro-development areas (like education and health) towards less productive areas (such as defense and infrastructure) (e.g., De la Croix and Delavallade, 2009, Delavallade, 2006, Gupta, Verhoeven and Tiongson, 2002). For these reasons, corruption can significantly impede human development, especially amongst the poor who may find themselves denied of basic public services which may offer their only means of escaping from their plight. In this way, corruption may foster both inequality and poverty. The objective of our analysis is to provide a simple illustration of this.

We present an overlapping generations model in which agents earn income according to their human capital which we interpret broadly to include both education and health status. The government pursues a social programme of providing education and health care using whatever public funds are at its disposal. Agents may enhance their human capital beyond the level implied by this programme alone through various types of personal expenditure which may either partially supplement or wholly substitute their use of public services. In the case of the former, this might include spending on tuition, medication, nutrition, location, lifestyle, sanitation and basic utilities.[9] In the case of the latter, it would mean paying for schooling and medical care in the private sector. An agent may or may not be able to afford these expenditures depending on her idiosyncratic inheritance of wealth. If not, then the agent must borrow under the terms and conditions of loan

[7]Note that these expenditures may cover not only the obvious items (school/hospital buildings and equipment, teachers'/doctors' wages and salaries, etc.), but also targeted areas of infrastructure (such as road, electricity and water supplies to schools/hospitals). For a wide-ranging discussion of the many issues involved (based specifically on a human development perspective), see Mehrotra and Delamonica (2007).

[8]There is, of course, a related, but distinct, body of research which focuses on the linkages between the indicators, themselves, such as the correlation of income and growth with education and health status. For overviews of this research, see, for example, Krueger and Lindahl (2001), López Casasnovas et al. (2005) and Strauss and Thomas (1998).

[9]These expenditures can work both directly and indirectly, and their effectiveness is enhanced by the complementarity between education and health. For a review of the literature on the links between education and health, see Cutler and Lleras-Muney (2006).

contracts in financial markets. Imperfections in these markets mean that loans are extended only to those agents with sufficient wealth to serve as collateral. This leads to a limiting wealth distribution that depends on the initial distribution, together with public policy. Against this background, we introduce corruption, initially in the form of the embezzlement of public funds. The immediate consequence of this is to reduce public service provision which impacts on distributional outcomes in two ways: the first - a wealth effect - is that any agent who relies on this provision to any extent is made worse off; the second - a credit effect - is that the number of agents who rely exclusively on this provision is increased. Together, these effects constitute a double-whammy for inequality and poverty. An extreme outcome of this is the elimination of any middle-income class of agents and the polarisation of the population in to the rich and poor.

We look at several extensions of the model by (i) introducing governance and institutional quality, (ii) endogenising the personal choice of human capital expenditures, (iii) introducing tax-financed public expenditures, and the most importantly, (iv) introducing the collusive corruption in terms of bribery and tax evasion. Our principle result holds for each of these cases.

This paper seeks to make a twofold contribution to the theoretical literature on corruption, inequality and income distribution. Firstly, it presents an analysis of corruption in an overlapping generations model, which examines how corruption on the part of public officials undermines the effectiveness of public spending, impacting individuals (who depend on the provision of public goods) and their accumulation of wealth over time, thus impacting the economy as a whole. Secondly, it also examines the dynamic equilibrium analysis if the public expenditures are financed by taxation. It presents an analysis of how corruption by public officials impact tax revenue and the distribution of income across the economy.

The remainder of the paper is organized as follows. In Section 2 we set out our basic model of public policy and human capital acquisition. In Section 3 we analyse the distributional implications of this model. In Section 4 we incorporate corruption into the model and study the consequences of this. In Section 5 we discuss some extensions of our analysis. In Section 6 we make a few concluding remarks.

2 The Basic Set-up

We consider a small open economy in which there is a constant population, N, of two-period lived agents belonging to overlapping generations of dynastic families connected through altruism. Each agent has one parent and one child, inheriting wealth from the former when young and bequeathing wealth to the latter when old. Young agents occupy themselves with acquiring human capital in one way or another. Old agents use their human capital to work for firms in the production of output. All agents have identical preferences and all markets are competitive.

2.1 Households

Each agent derives lifetime utility from her own old-age consumption and the bequests that she leaves to her offspring.[10] The utility of an agent born at time t is given by

$$u_t = c_{t+1}^{1-\gamma} b_{t+1}^{\gamma}, \tag{1}$$

($\gamma \in (0,1)$) where c_{t+1} denotes consumption and b_{t+1} denotes bequests. Let x_{t+1} be the total lifetime income of the agent so that $c_{t+1} + b_{t+1} = x_{t+1}$. Then the allocations of consumption and bequests that maximise (1) are $c_{t+1} = (1-\gamma)x_{t+1}$ and $b_{t+1} = \gamma x_{t+1}$, implying $u_t = \Gamma x_{t+1}$ ($\Gamma = (1-\gamma)^{1-\gamma}\gamma^{\gamma}$). Accordingly, the agent's final payoff is determined directly by the value of her final income.

In the first period of life an agent receives her inheritance of wealth and acquires human capital, the latter of which determines her future productivity and, with this, her future labour income. The agent acquires human capital in one of three ways: the first is by relying solely on the government's provision of public goods and services in education and health care; the second is by exploiting this provision as well, but supplementing it with her own expenditures on education and health; and the third is by foregoing such provision entirely and substituting it with more costlier purchases of education and health services from the private sector. Let e denote the agent's personal expenditure on human capital acquisition. In order of the aforementioned alternatives, we specify $e = 0$, $e = p > 0$ and $e = P > p$. Thus we assume that supplementing or substituting public goods provision entails a fixed cost for an agent. This assumption is used for the purposes of simplifying our main analysis. As we subsequently demonstrate, our key results are unchanged in an extension of the model that allows agents to choose optimally their preferred personal expenditures on human capital.[11] Whatever the case, for any given level of these expenditures and any given inheritance of wealth, an agent is either a net borrower or a net lender, where both borrowing and lending take place at the exogenous world rate of interest, $r > 0$.

In the second period of life an agent supplies one unit of labour to firms and earns a wage that depends on her human capital. Our basic assumption is that the aforementioned alternatives for acquiring education and health at successively higher costs deliver successively higher levels of human capital. This is a revealed presumption of individuals who are generally willing to incur personal expenditures on their own (or their children's) education and health if they can afford to do so. For example, it has been found that wealthier households spend more on various school fees and learning activities, and have a greater inclination towards using more costly health services (e.g., Foko et al., 2012, Gertler and Gaag, 1990, Tilak, 2002). Evidence to directly support the assumption - especially the relative effectiveness of public and private provision - is also available. For example, a number of studies for different countries conclude that private schooling has a positive effect on measures of educational attainment and labour market performance (e.g., Bedi and Garg, 2000, Binelli and Rubio-Codina, 2013, Brown and Belfield, 2001, Calónico and Ñopo, 2007, Cox and Jimenez, 1990, Jimenez et al., 1991). In the context of our model, the assumption is

[10] As in other models, we account for intergenerational altruism in the simplest way by assuming that parents derive utility from the size of their bequests, as opposed to the utility of their offspring. For further discussion, see Andreoni (1989).

[11] We also assume that relying solely on publicly-provided education and health services entails no cost for an individual. Of course, there may be out-of-pocket expenses (such as the costs of school uniforms, basic equipment and travel), but to the extent that these are always incurred regardless of other choices, we may normalise them to zero.

reflected in three possible levels of wages - a wage of w_1 for agents who rely solely on public goods provision, a wage of $w_2 > w_1$ for agents who supplement this provision with personal expenditures and a wage of $w_3 > w_2$ for agents who substitute such provision entirely with private services.

Based on the above, we may write the final income of an agent as

$$x_{t+1} = \begin{cases} (1+r)b_t + w_1 \text{ if } e = 0, \\ (1+r)(b_t - p) + w_2 \text{ if } e = p, \\ (1+r)(b_t - P) + w_3 \text{ if } e = P. \end{cases} \tag{2}$$

Throughout our analysis, we assume the parameter restriction $w_1 < w_2 - (1+r)p < w_3 - (1+r)P$. This has two implications: first, for any given level of bequests, an agent always prefers to spend more, rather than less, on acquiring human capital; second, if such expenditure requires borrowing, an agent is always able to repay her loan. As we shall see, these features do not trivialise the problem facing agents: whether or not preferences are actually realised when borrowing is needed depends on the terms and conditions of loan contracts in the presence of financial market imperfections.

It is evident at this stage that the population of households is potentially distributed across three groups. Each of these differ in terms of personal expenditures on human capital and wage earnings from labour. Specifically, there is a group for which expenditures are zero and wages are w_1, a group for which expenditures are p and wages are w_2, and a group for which expenditures are P and wages are w_3. We denote the corresponding populations of these cohorts by N_1, N_2 and N_3. As is apparent from (2), we abstract from any taxes that the government might levy on one or more of these cohorts in order to finance its provision of public goods and services. In a subsequent extension of our analysis, we show how the model can be modified straightforwardly to accommodate this without altering its main results. In view of this, we prefer to keep matters simple by assuming that the government finances its social programme through windfalls of public funds (e.g., from foreign aid or natural resources). This assumption also serves to illustrate how corruption can compromise a purely beneficial public policy that is costless to any member of society.

2.2 Firms

There is a unit population of firms, each of which produces output, y, using labour from all cohorts of households. The production technology is summarised by

$$y = A_1 N_1 + A_2 N_2 + A_3 N_3, \tag{3}$$

$$A_1 = a_1(g), \;\; A_2 = a_2(g,p), \;\; A_3 = a_3(P), \tag{4}$$

where g denotes public expenditures on education and health services. Following our previous discussion, we distinguish between the productivities of different groups of households according to their use of public services and their own personal expenditures on human capital (i.e., either p or P). This is reflected in the functions $a_i(\cdot)$, which are understood to be increasing in each of their arguments and to deliver the productivity ranking $A_3 > A_2 > A_1$.

Given the above, profit maximisation implies

$$w_i = A_i. \tag{5}$$

Thus, consistent with our prior assumption, $w_3 > w_2 > w_1$.

2.3 Banks

As indicated earlier, some agents may need to borrow in order finance their personal expenditures on human capital. Whilst there are no problems of bankruptcy, capital market frictions exist because of imperfect enforcement of loan contracts. Following others (e.g., Banerjee and Newman, 1993, Galor and Zeira, 1993). Borrowing is undertaken via competitive financial intermediaries which have access to a perfectly elastic supply of loanable funds at the world interest rate, r. Suppose that an agent puts up all of her inherited wealth, b_t, as collateral against a loan of either p or P for human capital investment. The agent has an opportunity of strategically defaulting by absconding with some proportion of this loan, $1-\delta \in (0,1)$, where δ provides a measure of contract enforcement. Doing so, however, means that she foregos any wage earnings and loses all of her collateral. Naturally, the payoff from defaulting must be no greater than the payoff from non-defaulting if defaulting is not to occur: formally, either $(1-\delta)p \leq (1+r)(b_t - p) + w_2$ or $(1-\delta)P \leq (1+r)(b_t - P) + w_3$, depending on the size of the loan. When holding with equality, each of these incentive conditions defines a critical level of wealth - b^c or b^{cc} - below (above) which loans are denied (granted). That is,

$$b^c = \frac{(2+r-\delta)p - w_2}{1+r}, \tag{6}$$

$$b^{cc} = \frac{(2+r-\delta)P - w_3}{1+r}. \tag{7}$$

Under the parameter restriction $(2+r-\delta)p - w_2 < (2+r-\delta)P - w_3$, we have $b^c < b^{cc}$. In summary, only if an agent inherits a level of wealth above b^c (b^{cc}) is she able to acquire a loan of p (P) to finance her personal expenditures on education and health. Otherwise, she is denied such credit and is forced to rely on her next best alternative for acquiring human capital.

3 The Dynamics of Wealth Distribution

Our first step in determining the evolution of income distribution is to determine the dynamics of wealth for each dynastic household. Then, given any initial distribution of income, we may use these dynamics to deduce the changes in the relative fortunes of dynasties and thereby establish long-run distribution outcomes.

As we have seen, an agent's ability to make personal investments in her human capital depends on her inherited level of wealth, b_t. Only if this inheritance is at least equal to some critical value - b^c in (6) - is she able to make an investment of p, and only if the inheritance is at least equal to some higher critical value - b^{cc} in (7) - is she able to make a greater investment of P. As we have also seen, each agent of each generation bequeaths an inheritance that is a constant fraction,

γ, of her realised income, x_{t+1} in (2). Based on these observations, we may conclude that the intergenerational evolution of wealth for an individual dynasty satisfies

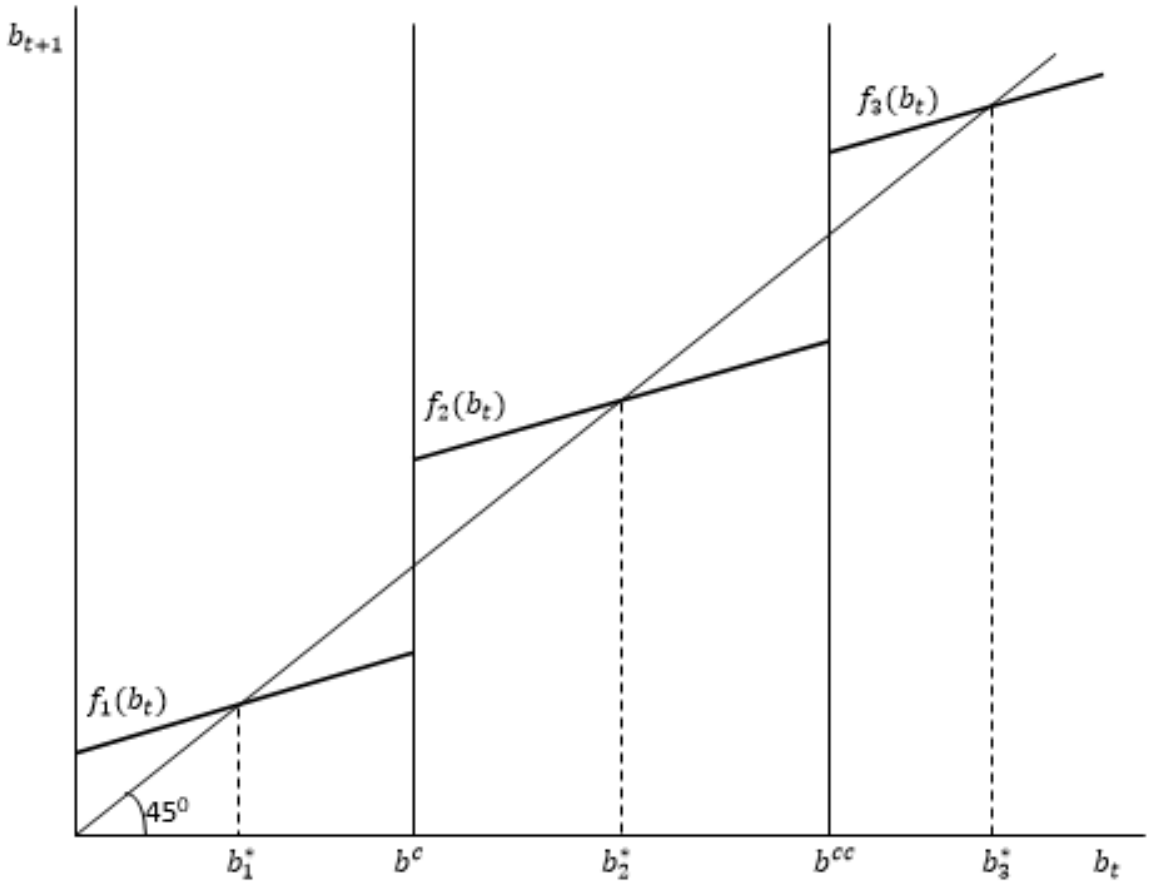
$$b_{t+1} = \begin{cases} \gamma[(1+r)b_t + w_1] \equiv f_1(b_t) \text{ if } b_t < b^c, \\ \gamma[(1+r)(b_t - p) + w_2] \equiv f_2(b_t) \text{ if } b^c \leq b_t < b^{cc}, \\ \gamma[(1+r)(b_t - P) + w_3] \equiv f_3(b_t) \text{ if } b_t \geq b^{cc}. \end{cases} \tag{8}$$

Assuming that $\gamma(1+r) \in (0,1)$, each of these lineage transition equations is stable and implies convergence to a unique steady state, as given by

$$b_1^* = \frac{\gamma w_1}{1-\gamma(1+r)}, \; b_2^* = \frac{\gamma[w_2 - (1+r)p]}{1-\gamma(1+r)}, \; b_3^* = \frac{\gamma[w_3 - (1+r)P]}{1-\gamma(1+r)}. \tag{9}$$

Evidently, $b_1^* < b_2^* < b_3^*$ by virtue of our earlier restriction on parameters.

Figure 1: **Wealth Distribution Without Corruption**



The above results are depicted in Figure 1 for the most interesting and least trivial scenario in which $b_1^* < b^c < b_2^* < b^{cc} < b_3^*$. This ordering ensures that both of the critical levels of wealth are relevant in determining the long-run distribution of income.[12] The characteristics of this distribution are

[12]For example, if the only difference in the ordering is $b_1^* > b^c$, then all agents for whom $b_t < b^c$ to begin with

summarised by three different groups of agents. First, any agent for whom $b_t < b^c$ is denied entirely of any credit for funding personal expenditures on human capital. Such an agent is forced to rely solely on the public provision of education and health services, implying a relatively low level of wages, w_1, and a relatively low long-run level of wealth, b_1^*. Second, any agent for whom $b_t \in (b^c, b^{cc})$ is able to acquire a loan of size p to finance her own human capital expenditures. Such an agent supplements her use of publicly-provided services with value-added personal spending, implying a higher wage of w_2 and a higher limiting wealth of b_2^*. Third, any agent for whom $b_t > b^{cc}$ is eligible to borrow a larger amount, P, for human capital investment. Such an agent substitutes public services with private services entirely, implying a further improvement of wages to w_3, and a further improvement of steady state wealth to b_3^*.

Based on the above, we may conclude that the population is divided into three income classes - a low-income class of size N_1, a middle-income class of size N_2 and a high-income class of size $N_3 = N - N_1 - N_2$. This division reflects the initial distribution of wealth, meaning that any inequalities to begin with tend to persist, rather than vanish, over time. Let $H_t(b_t) = \int h_t(b_t)db_t$ denote the cumulative distribution function of wealth at time t so that $\int_{\underline{b}}^{\overline{b}} h_t(b_t)db_t$ provides a measure of the population with $b_t \in (\underline{b}, \overline{b})$. In the absence of any class mobility the measure of each income group is time-invariant. That is, the sizes of these groups are fixed by the initial distribution, $H_0(b_0)$, together with the wealth thresholds, b^c and b^{cc}. Specifically, we have

$$N_1 = \int_0^{b^c} h_0(b_0)db_0, \;\; N_2 = \int_{b^c}^{b^{cc}} h_0(b_0)db_0, \;\; N_3 = N - \int_0^{b^{cc}} h_0(b_0)db_0. \tag{10}$$

The precise extent to which the population is divided depends on two main factors - the degree of capital market imperfections and the scope of public policy. From (6) and (7), together with (4) and (5), each of these is seen to affect the threshold levels of wealth. As regards the former, a stronger enforcement of loan contracts (i.e., an increase in δ) implies a reduction in both b^c and b^{cc} such that N_1 decreases and N_3 increases, whilst N_2 could go either way. As regards the latter, a greater provision of public goods and services (i.e., an increase in g) implies a reduction in b^c such that N_1 decreases and N_2 increases. In each case there are fewer agents on low incomes and more agents on higher incomes, which means not only that the average income of the population is higher, but also that the degree of poverty in the economy is lower. In the case of public policy, there is also a further effect, as reflected in (8) - namely, an increase in the wealth transition paths $f_1(b_t)$ and $f_2(b_t)$ (because of the increase in w_1 and w_2); this means that both low-income and middle-income classes end up at higher long-run levels of wealth, as given in (9).[13]

A final observation worth noting is that our analysis implies a link between distributional and aggregate outcomes. This is evident from (3) which shows how the division of the population into different cohorts of agents is important for determining the total output of the economy. Thus, for the same comparative exercises as performed above, one observes that total output increases in each of the cases of an increase in δ and an increase in g.

---

would end up at b_2^*, the same as all agents for whom $b_t \in (b^c, b^{cc})$ to begin with; hence b^c is irrelevant in the long-run. Similarly, if the only difference is $b_2^* > b^{cc}$, then all agents who start off with $b_t \in (b^c, b^{cc})$ would converge to b_3^*, the same as all agents who start off with $b_t > b^{cc}$; hence b^{cc} is irrelevant in the long-run. Other (more extreme) degenerate cases are also ruled out.

[13]These comparative exercises can be used to realise more extreme results in which one or more income classes vanish entirely. This may occur if changes in δ and/or g alter the ordering of $b_1^* < b^c < b_2^* < b^{cc} < b_3^*$.

4 Corruption

We introduce corruption into the model by assuming that the public funds earmarked for the government's social programme of education and health provision can be appropriated by public officials using their discretionary powers of administration. In other words, corruption takes the form of pure embezzlement, meaning the theft by an individual of resources that she is supposed to administer. This type of offense can be especially difficult to deal with when it entails the pilfering of public funds: whilst everyone in society may be affected, the fact that no private property is stolen or exchanged means that individuals have no legal rights by which to protest and seek compensation. We do not delve into issues of who perpetrates such malfeasance (bureaucrats or politicians), what factors may motivate it (economic or cultural), or how it may be curtailed (rewards or punishments). Such issues are dealt with elsewhere in the literature and are not the main concern of this paper. Rather, our focus is on studying the consequences of corruption, given that corruption exists as an endemic feature of the economy (which is sadly the case in many less developed countries).

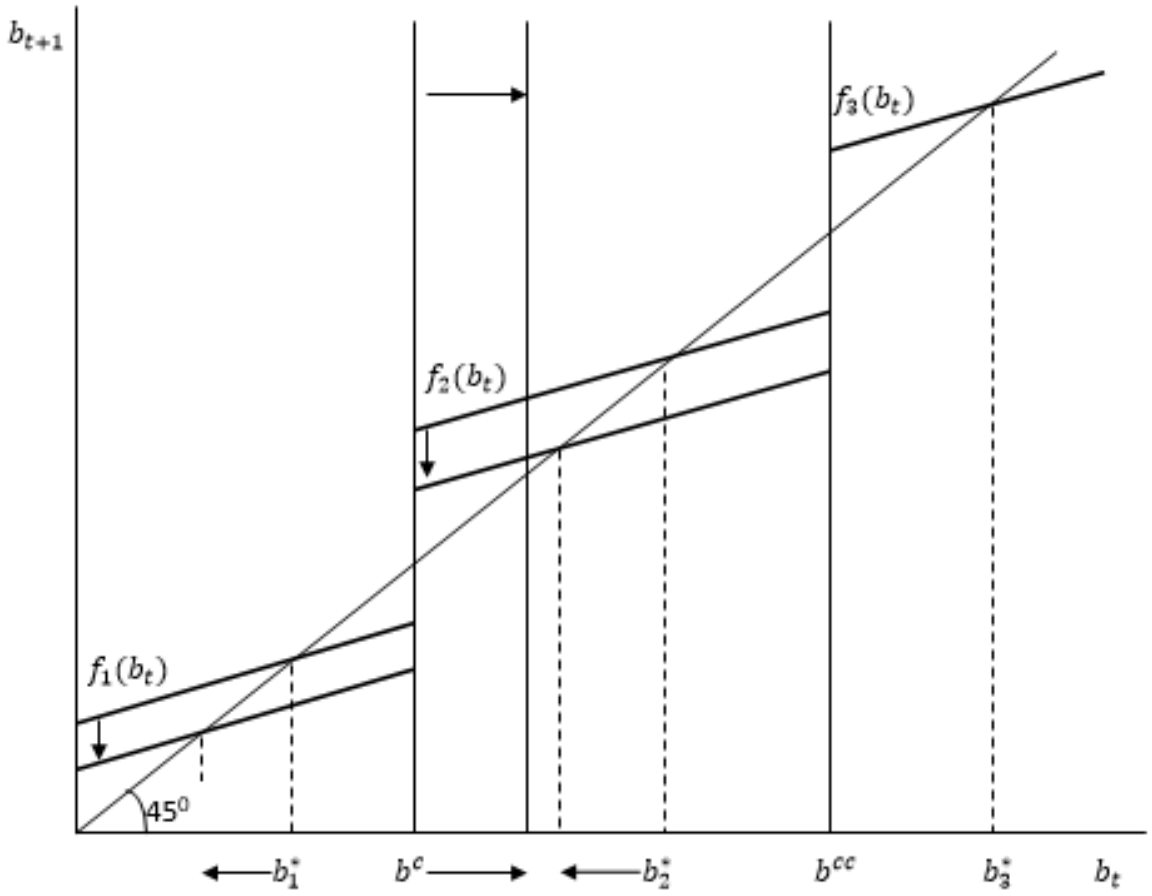
Our formal modeling of corruption, and the immediate impacts thereof, are described as follows. The appropriation of public funds by public officials manifests itself in a reduction in g, the provision of public education and health services. By virtue of (4), the consequence of this is that there is a decrease in both A_1 and A_2, the productivities of those agents who rely on such provision. In turn, this is reflected via (5) in a decrease in both w_1 and w_2, the wages of these agents.

Two main implications follow from the above. The first is that any lineage of agents which depends on publicly-provided education and health services suffers a reduction in its intergenerational transfers of wealth and, with this, a reduction in its long-run level of wealth: that is, there is a decrease in $f_1(b_t)$ and $f_2(b_t)$ in (8), together with a decrease in b_1^* and b_2^* in (9). The second is that these lineages are faced with a higher threshold level of wealth which is needed in order to supplement public services with credit-financed personal expenditures: that is, there is an increase in b^c in (6). Diagrammatically, these implications are illustrated by the arrows of movement in Figure 2.

Having established as much, one is able to see how corruption affects distributional outcomes through two channels - a wealth effect and a credit effect. The former (i.e., the shifts in $f_1(b_t)$ and $f_2(b_t)$) means that there is a population of agents, $N_1 + N_2$, who are made strictly worse off. The second (i.e., the shift in b^c) means that the composition of this population changes as N_2 falls whilst N_1 rises in accordance with (10). Together, these effects constitiute a double-whammy for the degree of poverty and inequality in the economy: not only are the poor made poorer, but also there is a greater number of such individuals. At the aggregate level, there are corresponding declines in average income and total output.

Naturally, the above effects are enhanced as the level of corruption increases. In principle the effects could be so pronounced as to deliver the extreme scenario in which $b_2^* < b^c$, meaning that b_2^* vanishes as a possible steady state as all agents whose wealth falls below b^{cc} will experience (either immediately or eventually) a decline in their wealth below b^c as well so that their ultimate wealth status is b_1^*. This is the case in which corruption leads to the disappearance of a middle-class and the polarisation of the population into the rich and poor.

Figure 2: **The Effects of Corruption**



5 Some Extensions

The foregoing analysis establishes our main results. In what follows we introduce some further considerations to illustrate how these results may be strengthened when viewed within a broader context and how they may survive under extensions of the model.

5.1 Governance and Institutions

Corruption is part of the broader concept of governance which, in turn, is an aspect of the wider issue of institutional quality. Recent years have witnessed a flourishing literature on the importance of institutions - economic, political and judicial - in determining the fortunes of an economy through their fundamental role in governing the incentives and opportunities of citizens via market structures, democratic processes and legislative mechanisms.[14] Our analysis has appealed to two sources of institutional imperfection in the economy - an imperfection in financial markets (i.e.,

[14]This literature has its origins in North (1990). A flavour of recent research by can be found in Acemoglu et al. (2005) and Acemoglu and Robinson (2010).

weak powers of contract enforcement) and an imperfection in governance (i.e., corruption amongst public officials). Whilst we have treated these aspects separately, one may envisage them as being connected in the sense that both of them have their origins in the general quality of institutions. A deterioration in this quality may therefore manifest in a poorer functioning of both markets and government.

With the foregoing in mind, consider the case in which g (public goods provision) and δ (banks' retrieval of loans) depend positively on some common measure of institutional quality. A reduction in this quality has a credit effect which is both more pronounced and more widespread than before: not only is there a decrease in g which increases b^c, but also there is a simultaneous decrease in δ which both raises b^c further and causes an increase in b^{cc} as well. Compared to our previous findings, there is a larger lower-income class, a smaller upper-income class, and either a larger or smaller middle-income class. Regardless of the last ambiguity, average income is lower as there are more agents who are credit-constrained, and total output is lower for the same reason. Accordingly, our previous results may be seen as being strengthened when one links corruption to the broader context of institutions.

5.2 Personal Choice of Human Capital Expenditures

In our main analysis we assumed that agents could supplement publicly-provided education and health services by incurring a fixed, exogenous expenditure of p. A natural extension of the model is to endogenise this expenditure by allowing agents to choose it optimally for themselves. A simple illustration of this is as follows.

Suppose that personal spending augments an agent's productivity in (4) according to

$$a_2(g,p) = a_1(g) + \alpha(p), \tag{11}$$

where $\alpha'(p) > 0$ and $\alpha''(p) < 0$. In principle p and g could be either complements or substitutes for each other as a low (high) quality of public service provision may motivate individuals to spend either less (more) or more (less) themselves in response to their discontent (satisfaction) with such provision. The specification in (11) may be viewed as abstracting from these interactions altogether, or assuming that the net effect of them is zero. Given this specification, it follows from (5) that the corresponding wage is

$$w_2 = w_1 + \alpha(p). \tag{12}$$

In turn, this implies a corresponding level of income from (2),

$$x_{t+1} = (1+r)(b_t - p) + w_1 + \alpha(p) \text{ if } e = p. \tag{13}$$

The decision problem for an agent is to choose a p so as to maximise x_{t+1} in (13). The solution to this is given by a $\overline{p}$ that satisfies

$$\alpha'(\overline{p}) - (1+r) = 0. \tag{14}$$

From (6) and (12), the lower critical level of wealth may be written as

$$b^c = \frac{(2+r-\delta)p - w_1 - \alpha(p)}{1+r} \equiv \beta(p). \tag{15}$$

This expression implies a u-shaped relationship between b^c and p. To be sure, observe that $sgn\beta'(p) = sgn[2+r-\delta-\alpha'(p)]$. Using (14), one may then infer the following: if $p < \overline{p}$, then $\alpha'(p) > (1+r)$ so that $\beta'(p) \gtrless 0$; conversely, if $p \geq \overline{p}$, then $\alpha'(p) \leq (1+r)$ so that $\beta'(p) > 0$. Accordingly, there exists a $\widehat{p} < \overline{p}$ such that $\alpha'(\widehat{p}) - (2+r-\delta) = 0$, implying $\beta'(\widehat{p}) = 0$, $\beta'(p) < 0$ for any $p < \widehat{p}$, and $\beta'(p) > 0$ for any $p > \widehat{p}$.

In recognition of the above, an agent who is free to choose p realises that she can influence b^c, which may give her the opportunity of acquiring at least some amount of loan for human capital expenditure (an opportunity that was precluded in our main analysis). To see this, let $\overline{b}^c = \beta(\overline{p})$ and $\widehat{b}^c = \beta(\widehat{p})$, where $\overline{b}^c > \widehat{b}^c$. If $b_t \geq \overline{b}^c$, then an agent is able to obtain the required amount of loan to finance her optimal expenditure, $\overline{p}$, which she will obviously select. If $b_t < \overline{b}^c$, however, then the agent is not able to do this, meaning that her optimal choice is not feasible. Nevertheless, the agent might be able to obtain a smaller loan to finance a smaller amount of expenditure: that is, the agent could choose a $p < \overline{p}$ in order to reduce b^c until $b_t \geq b^c$. Such an opportunity is available for any agent with $b_t > \widehat{b}^c$, and the second-best choice of p would be the value that delivers $b_t = b^c$. The opportunity is not available, however, for agents with $b_t \leq \widehat{b}^c$ since reducing p below $\widehat{p}$ causes b^c to increase (rather than decrease), in which case these agents are still denied loans.

Compared to (8), the dynamics of wealth distribution in this extended version of the model are summarised as follows: for each of the cases $b_t < \widehat{b}^c$, $\overline{b}^c \leq b_t < b^{cc}$ and $b_t \geq b^{cc}$, there is a single transition equation, as given by $f_1(b_t)$ (corresponding to zero personal expenditures), $f_2(b_t)$ (corresponding to personal expenditures of $\overline{p}$) and $f_3(b_t)$ (corresponding to expenditures of P); for the remaining case $\widehat{b}^c \leq b_t < \overline{b}^c$, there is a series of transition equations, as described by $f_2(b_t)$ for different values of $p \in (\widehat{p}, \overline{p})$ (associated with different values of b^c). Diagrammatically, the dynamics are illustrated in Figure 3. The principle difference from our previous analysis is that there is a distribution of long-run wealth amongst middle-income agents (i.e., agents for whom $\widehat{b}^c \leq b_t < b^{cc}$). Other than this, the implications of the model are the same, and our main results are unaltered.

5.3 Tax-financed Public Expenditures

Another of our simplifying assumptions has been that the government finances its social programme of education and health care using windfalls of public funds, such as receipts of foreign aid or revenues from natural resources. Again, it is possible to re-work our analysis using a modified version of the model in which public expenditures are financed by taxation. The following provides an illustration of this.

Suppose that taxes are levied only on high-income agents at a lump-sum rate of τ. From (2), we have

$$x_{t+1} = (1+r)(b_t - P) + w_3 - \tau \text{ if } e = P. \tag{16}$$

A trivial modification of our previous parameter restriction continues to ensure that agents always

prefer to spend more (rather than less) on acquiring human capital, and that any loans obtained to finance this spending can always be repaid.[15]

The only other notable change from our previous analysis relates to the upper critical level of wealth, b^{cc} in (7). Assuming that an agent who absconds with her loan also evades paying taxes, this threshold is now given by

$$b^{cc} = \frac{(2 + r - \delta)P - w_3 + \tau}{1 + r}. \tag{17}$$

Given the above, the dynamics of wealth distribution are essentially the same as those displayed in Figure 1, with b^{cc} determined according to (17) and $f_3(b_t)$ adjusted from (8) to include τ in conformance with (16). The effects of corruption are also the same. Under our assumption of balanced budget financing, $g = N_3\tau$. The pilfering of public funds by public officials means a reduction in tax revenues, $N_3\tau$, implying a reduction in public expenditures, g, which produces the effects indicated in Figure 2.

5.4 Bribery and Tax Evasion

In the forgone analysis, we used purely non-collusive corruption by defining it as the appropriation of public funds for education and health provision by the public officials using their discretionary powers of administration. To some, this may seem just a reduction of public goods provision that leads to a decrease in the exogenous productivity and therefore wages of workers differentiated by their skills. We can address this by introducing tax-financed public spending as in Section 5.3 along with the opportunity for public officials to demand bribe from the households in exchange of allowing the households not paying taxes that are due.

As in 5.3 above, suppose that taxes are levied only on high-income agents, of whom there is a fixed measure of mass N_3 as in the main analysis, at a lump-sum rate of τ , and collected by public officials, of whom there is a fixed measure of mass $M < N_3$, using the authority delegated to them by the government. In this set up, it is natural for some of these public officials to be tempted to abuse their authoritative powers by colluding with potential tax payers in the concealment and fabrication of information.

In order to generate the income levels of different groups as in equation (2), first, we need to specify the behaviour of public officials and households who collude with each other to evade taxes. The population of public officials is divided into a fraction, v , of unknown corruptible public officials and a remaining fraction, $(1 - v)$ of unknown non-corruptible public officials. Each public official is endowed with one unit of labour which he supplies inelastically to the government in return for a salary. For simplicity, we assume that public officials are neither liable to pay taxes nor eligible to receive public provisions for education and health services. The government sets their salaries in accordance with the following considerations. Any public official (whether corruptible or non-corruptible) can work for a firm to receive an income equal to the wage paid to high-income households, w_3 . Any public official willing to accept a salary less than this wage must be expecting to receive compensation through bribery and is therefore immediately identified as being corrupt. As in other analyses (e.g. Acemoglu and Verdier (1998)), we assume that a

[15] That is, $w_1 < w_2 - (1 + r)p < w_3 - \tau - (1 + r)P$.

public official who is discovered to be corrupt is subject to the maximum fine of having all of his income confiscated. Given this, then no corruptible bureaucrat would ever reveal himself in the way described above. As such, the government can minimise its labour costs, while ensuring complete bureaucratic participation, by setting the salaries of all public officials to this wage.

Since the government knows how much tax revenue is due in the absence of corruption (since it knows the number of taxable households and since it is responsible for setting taxes), any shortfall of revenue below this amount reveals that corruption is occurring. Under such circumstances, the government investigates the behaviour of bureaucrats using a costly and imprecise monitoring technology. This technology entails d units of additional expenditure and implies that a public official who is corrupt faces a probability, $\theta \in (0, 1)$, of avoiding detection, and a probability, $(1-\theta)$, of being found out. The tax-evading household with who the public official conspires faces the same probabilities of remaining anonymous and being exposed. In the event of the latter, the household is forced to pay its full tax liability.

The government runs a continuously balanced budget by equating its total revenues to its total expenditures. From above, the former consist of the taxes paid by high-income households plus the fines paid by any public officials who are caught being corrupt, while the latter include the salaries of public officials, the costs of monitoring in the event of corruption, and the level of public provisions for education and health services.

5.4.1 Households:

We assume that the identity of a middle- or high-income household is private information. Thus, while the government knows the distribution of houseold income (or the size of each income class), it is unable to observe the actual income that each household earns [16]. As the high-income households chose to forgo the government provision and substitute it with private sector purchase of education and health services, this assumption allows corruption to occur in the evasion of taxes by high-income households, but not in the appropriation of public funds for education and health services. Thus, by bribing a bureaucrat, a high-income household may seek to evade taxes by having itself reported to the government as a middle-income type. It will not, however, choose to go for public fund for its education and health services in order to maintain the qaulity they look for.

Given the above, expressions for the final income, or wealth, remains the same for both low- and middle-income households as in (2), although due to reduction in the provision of public funds for education and health services as a result of corruption, the amount of final income for these two groups will be reduced. For a high-income household, wealth status is more a matter of choice, being determined by the households decision as to whether or not to conspire with a public official in bribery and tax evasion. If not, the final income is equal to the value of own income, $(1+r)(b_t - P) + w_3$, less the value of tax, τ. If so, then final income is uncertain and depends on the amount of bribe paid and the probability of being caught. Let q_t denote the bribe. With probability θ, the household and public official succeed in their conspiracy, implying that the household obtains $(1 + r)(b_t - P) + w_3$, less q_t. With probability $(1 - \theta)$, their collusion is exposed, meaning that

[16] Since both middle- and high-income households use private sector provisions for their educaiton and health services, the government will be unable to differentiate between them. However, only the bureaucrats may come to know who is who while collecting taxes from the households. Once they can identify the high-income households, that is the point where they cand demand bribe in exchnage of misreporting about their status and giving them the opportunity for tax evasion.

the household retains the same amount, less τ. In conclusion, we may now summarise household incomes in this setting as

$$x_{t+1} = \begin{cases} (1+r)b_t + w_1 \ \textit{if } e = 0, \\ (1+r)(b_t - p) + w_2 \ \textit{if } e = p, \\ (1+r)(b_t - P) + w_3 - \tau \ \textit{if } e = P, \textit{ and } q_t = 0 \\ (1+r)(b_t - P) + w_3 - q_t \textit{ with prob.}\theta \textit{ if } e = P, \textit{and } q_t > 0 \\ (1+r)(b_t - P) + w_3 - q_t - \tau \textit{ with prob.}(1-\theta) \textit{ if } e = P, \textit{and } q_t > 0 \end{cases} \tag{18}$$

5.4.2 Public Officials:

For simplicity, we assume that a public official has no other source of income (i.e., income from parental bequests). As an administrator of the governments policy of redistribution, each public official has jurisdiction over N_3/M high-income households, from which he collects taxes.

The total incomes of public officials are determined as follows. For a non-corruptible official, total income is simply equal to earnings from his labour, w_3 . For a corruptible official, total income is determined according to whether or not corruption is engaged in. If not, then the official receives just his labour earnings, w_3 , as before. If so, then the bureaucrat's final income depends on the amount of bribes received, the chances of being caught, the resources spent on trying to avoid detection and the penalties incurred if rent-seeking is exposed. For the purposes of the present analysis, we make the simple assumption that a public official who is corrupt needs to spend resources on trying to conceal his behaviour if he is to stand any chance of not being caught [17]. It is plausible to imagine that more resources must be spent to conceal more illegal income. We model this in terms of a convex cost function, $\beta(Q_t)$, where $Q_t = (N_3/M)q_t$ is the total value of bribes that the bureaucrat receives. With probability θ, the bureaucrat succeeds in his deception and retains the net value of his salary and rents, $w_3 + Q_t - \beta(Q_t)$. With probability $1 - \theta$, the public official is caught and left with nothing. It follows that the total final income of a public official, $x_{i,t}$, may be summarised as

$$x_{i,t} = \begin{cases} w_3 & \textit{if non-corruptible} \\ w_3 & \textit{if corruptible, but } q_t = 0 \\ w_3 + Q_t - \beta(Q_t) & \textit{with prob. } \theta, \textit{ if corruptible, and } q_t > 0 \\ 0 & \textit{with prob. } (1-\theta) \textit{ if corruptible, and } q_t > 0 \end{cases} \tag{19}$$

5.4.3 Incentive to be corrupt:

Corruption occurs if a high-income household and a corruptible official find it mutually advantageous to conspire with each other in concealing information from the government. For a corruptible official, the expected return from accepting bribe is, according to (19), $E(x_{i,t} \mid q_t > 0) = \theta[w_3 + Q_t - \beta(Q_t)]$. This return is maximized by setting $\beta'(.) = 1$, implying an optimal fixed amount of bribe income, $Q_t = Q^*$, and a corresponding optimal fixed size of bribe income,

[17] In general, corrupt individuals, in order to remain inconspicuous, may hide their illegal income, may invest this income differently from legal income and may alter their patterns of expenditure. These activities typically entail costs in one form or another.

$q_t = q^*$, for all t. The official's expected return from not accepting a bribe is also obtained from (19) as $E(x_{i,t} \mid q_t = 0) = w_3$. If $E(x_{i,t} \mid q_t > 0) \geq E(x_{i,t} \mid q_t = 0)$, then the public official has an incentive to be corrupt. For the case in which $q_t = q^*$, this condition may be stated as

$$\theta[Q^* - \beta(Q^*)] \geq (1 - \theta)w_3 \tag{20}$$

Intuitively, a public official is more likely to be corrupt the less he expects to lose in legal income if he is caught.

For a high-income household, the expected returns from paying and not paying a bribe are computed from (18) as $E(x_{3,t} \mid q_t > 0) = (1 + r)(b_t - P) + w_3 - q_t - (1 - \theta)\tau$, and $E(x_{3,t} \mid q_t = 0) = (1 + r)(b_t - P) + w_3 - \tau$ respectively. The household has an incentive to offer a bribe if $E(x_{3,t} \mid q_t > 0) \geq E(x_{3,t} \mid q_t = 0)$. This condition may be written as

$$q_t \leq \theta\tau \tag{21}$$

Intuitively, the household is prepared to bribe a public official by no more than what it expects to save in taxes.

Observe that, if (21) is satisfied for $q_t = q^*$, then the household is willing to pay the public official his optimal bribe. Moreover, if $q^* \leq \theta\tau$, then the household is always willing to do this. For the purposes of simplifying our subsequent analysis, we assume that this is the case. Under such circumstances, the condition for corruption to occur is given solely by the condition in (20), being determined exclusively by the incentives of corruptible public officials.

5.4.4 Corruption and Inequality:

Consider, first, the case in which corruption is absent, meaning that the condition in (20) is violated. Each and every public official, of whom there are M, collects the maximum amount of tax revenue, $(N_3/M)\tau$, from those high-income households under his jurisdiction and returns all of this revenue to the government. The total proceeds from taxation are used by the government to finance its total expenditures on the salaries of public officials, Mw_3, and public fund for education and health services, g^n. The amount of g^n is determined from the government's budget constraint as

$$g^n = N_3\tau = Mw_3 \tag{22}$$

Given (22), the expressions for final incomes only change for high-income households from (2) and is replaced by (16). In this setting, w_2 and w_3 will be lower than those in (2) as here government incurs an additional expense on salaries for public officials.

Now consider the case in which corruption exists as a result of the condition in (20) being satisfied. The total population of corrupt public officials is vM, of whom a fraction, θ, evade detection by the government, while the remaining fraction,$(1 - \theta)$, are caught. The government's tax receipts are zero from each of the former and$(N_3/M)\tau$ from each of the latter who is also fined the amount $w_3 + Q^* - \beta(Q^*)$. From each non-corrupt public official, of whom there are $(1 - v)M$, the government receives $(N_3/M)\tau$ in tax revenue. In addition to its officials salaries, Mw_3, and public funds for education and health, g^c, the government devotes d units of expenditure to monitoring.

Under such scenario of corruption, the amount of g^c may be computed from the government's budget constraint as

$$g^c = (1-\theta v)N_3\tau - [1-(1-\theta)v]Mw_3 + (1-\theta)vM[Q^* - \beta(Q^*)] - d \tag{23}$$

Given (23), the final incomes of households are deduced from (18) (including the case in which bribe payments are positive). Continuing as before, denote by x^c_{t+1} the final incomes of each group of households under corruption. Note that the fraction of high-income households that pay (do not pay) bribes is equal to $v(1-v)$, the fraction of public officials who are corrupt (non-corrupt). Note also that a proportion, $\theta(1-\theta)$, of bribe-paying households succeed (fail) in their attempts to evade taxes. It follows that the distribution of household income in this corrupt environment is given by

$$x^c_{t+1} = \begin{cases} \textit{for} N^c_1 & | \ (1+r)b_t + w_1(g^c) \\ \textit{for} N^c_2 & | \ (1+r)(b_t - p) + w_2(g^c) \\ \textit{for} (1-v)(N^c_3) & | \ (1+r)(b_t - P) + w_3 - \tau \\ \textit{for} \ \theta v(N^c_3) & | \ (1+r)(b_t - P) + w_3 - q^* \\ \textit{for} \ (1-\theta)v(N^c_3) & | \ (1+r)(b_t - P) + w_3 - q^* - \tau \end{cases} \tag{24}$$

A comparison between (22) and (23) reveals that

$$g^c = g^n - vN_3[\theta\tau - q^*] - vM[\theta\{Q^* - \beta(Q^*)\} - (1-\theta)w_3] - vM\beta(Q^*) - d \tag{25}$$

Recall that, in the case of corruption, both of the conditions in (20) and (21) are satisfied. Consequently, the above expression yields the unambiguous result that $g^c < g^n$: That is, for any given wage, the amount of public fund received by each low-income and middle-income household is lower under corruption than under non-corruption. This follows from the fact that corruption entails both a loss of revenue to the government from the evasion of taxes by high-income households and an additional outlay for the government from the costly monitoring of bureaucratic behaviour. Although the government earns some extra revenue from fines, the net effect of corruption is to reduce the amount of resources available for public funds for education and health.

Again, a trivial modification of our previous parameter restriction continues to ensure that agents always prefer to spend more (rather than less) on acquiring human capital, and that any loans obtained to finance this spending can always be repaid [18].

The only other notable change from our previous analysis relates to the upper critical level of wealth, b^{cc} in (7). Taking the final incomes from (24), there will be three thresholds $(b^{cc}_1, b^{cc}_2, b^{cc}_3)$:

$$b^{cc} = \begin{cases} b^{cc}_1 : \frac{(2+r-\delta)P - w_3 + q^*}{(1+r)} \\ b^{cc}_2 : \frac{(2+r-\delta)P - w_3 + \tau}{(1+r)} \\ b^{cc}_3 : \frac{(2+r-\delta)P - w_3 + \tau + q^*}{(1+r)} \end{cases} \tag{26}$$

Given the above, again the dynamics of wealth distribution are essentially the same as those displayed in Figure 2, with three thresholds for high-income agents according to (26) and corresponding three functions of $f_3(b_t)$ adjusted from (8) to include τ and q^* . The effects of corruption are

[18] That is, $w_1 < w_2 - (1+r)p < w_3 - \tau - q^* - (1+r)P$.

also the same under our assumption of balanced budget in (23), where the bribery and tax evasion means a reduction in tax revenues, implying a reduction in public expenditure, g^c , which produces the effects indicated in Figure 4. The principle difference from our previous analysis is that there is a distribution of long-run wealth amongst high-income agents (i.e., agents for whom $b_t > b_1^{cc}$).

6 Conclusions

This paper has sought to contribute to the literature on corruption and development by showing how public sector malfeasance, in the form of either embezzlement or bribery, can undermine the effectiveness of social programmes designed to reduce inequality and poverty in an economy. Using an overlapping generations economy, it's emphasis has been on the acquisition of human capital - defined broadly to include both education and health status - as a means by which individuals become productive and earn income. Education and health services are provided by both the public and private sectors, the latter of which may be accessed to either supplement or substitute the use of the former through various types of personal expenditure. The "suppliment" might include spending on tuition, medication, nutrition, location, lifestyle, sanitation and basic utilities, while "substitute" might mean paying for schooling and medical care in the private sector. The ability to do this depends on an individual's wealth status which determines whether or not she requires a loan to finance such expenditure, and whether or not she is eligible for a loan as a consequence of capital market imperfections.

In our initial analysis, corruption manifests as the appropriation of public funds by public officials, the immediate impact of which is a reduction in the provision of public education and health services. Individuals who rely on such provision for acquiring human capital are then faced with the prospect of lower wage earnings because of their lower productivity. This is the wealth effect of corruption. In addition, the same individuals face a higher threshold level of wealth for loans to be granted, meaning that more of them are constrained in their ability to borrow. This is the credit effect of corruption. Our analysis shows how these two effects combine to adversely affect both distributional and aggregate outcomes in an economy. Together, these effects constitute a double-whammy for inequality and poverty. An extreme outcome of this is the elimination of any middle-income class of agents and the polarisation of the population in to the rich and poor.

For the robustness of our results, we show several extensions of the model by (i) introducing governance and institutional quality, (ii) endogenising the personal choice of human capital expenditures, (iii) introducing tax-financed public expenditures, and the most importantly, (iv) introducing the collusive corruption in terms of bribery and tax evasion. In each of these cases, we find that corruption reduces public funds and their effectiveness in reducing poverty and inequality. As a result, due to both "wealth effect" and "credit effect", the middle class gets eliminated and the polarisation between the rich and poor takes place, implying the widening of inequality. It would be interesting to use empirical analysis to examine how the individuals and the economy are affected as corrupt public officials take advantage of their position and compromise the effectiveness of social spending.

References

Acemoglu, D., Johnson, S. and Robinson, J. A. (2005). Institutions as a fundamental cause of long-run growth, *in* P. Aghion and S. Durlauf (eds), *Handbook of Economic Growth*, North-Holland, Amsterdam.

Acemoglu, D. and Robinson, J. A. (2010). The role of institutions in growth and development, *in* D. Brady and M. Spence (eds), *Leadership and Growth*, World Bank, Washington D.C.

Acemoglu, D. and Verdier, T. (1998). Property rights, corruption and the allocation of talent: a general equilibrium approach, *Economic Journal* **108**(450): 1381–1403.

Acemoglu, D. and Verdier, T. (2000). The choice between market failures and corruption, *American Economic Review* pp. 194–211.

Ades, A. and Di Tella, R. (1999). Rents, competition, and corruption, *The American Economic Review* **89**(4): 982–993.

Ahlin, C. (2001). Corruption: Political determinants and macroeconomic effects, *Working Paper No 01-W26*, Department of Economics, Vanderbilt University.

Aidt, T., Dutta, J. and Sena, V. (2008). Governance regimes, corruption and growth: Theory and evidence, *Journal of Comparative Economics* **36**(2): 195–220.

Aidt, T. S. (2003). Economic analysis of corruption: a survey*, *Economic Journal* **113**(491): F632–F652.

Alesina, A. and Angeletos, G.-M. (2005). Corruption, inequality, and fairness, *Journal of Monetary Economics* **52**(7): 1227–1244.

Anand, S. and Ravallion, M. (1993). Human development in poor countries: on the role of private incomes and public services, *Journal of Economic Perspectives* pp. 133–150.

Andreoni, J. (1989). Giving with impure altruism: applications to charity and ricardian equivalence, *Journal of Political Economy* pp. 1447–1458.

Azfar, O. (2001). Corruption and delivery of health and education services, *Working Paper No.01/01, Center for Institutional Reform and the Informal Sector* .

Azfar, O. and Gurgur, T. (2001). Does corruption affect health and education outcomes in philippines?, *Memo, Center for Institutional Reform and the Informal Sector* .

Baldacci, E., Clements, B., Gupta, S. and Cui, Q. (2004). *Social spending, human capital, and growth in developing countries: Implications for achieving the MDGs*, number 4-217, International Monetary Fund.

Baldacci, E., Guin-Siu, M. T., De Mello, L. et al. (2003). More on the effectiveness of public spending on health care and education: a covariance structure model, *Journal of International Development* **15**(6): 709–725.

Banerjee, A. V. and Newman, A. F. (1993). Occupational choice and the process of development, *Journal of Political Economy* pp. 274–298.

Bank, W. (2004). World development report, 2004.

Barbiero, O. and Cournède, B. (2013). New econometric estimates of long-term growth effects of different areas of public spending, *Technical report*, OECD Publishing.

Bardhan, P. (1997). Corruption and development: a review of issues, *Journal of Economic Literature* **35**(3): 1320–1346.

Batra, G., Kaufmann, D. and Stone, A. H. (2002). Voices of the firms 2000: Investment climate and governance findings of the world business environment survey (wbes), *World Bank, Washington DC* .

Bedi, A. S. and Garg, A. (2000). The effectiveness of private versus public schools: The case of indonesia, *Journal of Development Economics* **61**(2): 463–494.

Bidani, B. and Ravallion, M. (1997). Decomposing social indicators using distributional data, *Journal of Econometrics* **77**(1): 125–139.

Binelli, C. and Rubio-Codina, M. (2013). The returns to private education: evidence from mexico, *Economics of Education Review* **36**: 198–215.

Blackburn, K., Bose, N. and Emranul Haque, M. (2006). The incidence and persistence of corruption in economic development, *Journal of Economic Dynamics and Control* **30**(12): 2447–2467.

Blackburn, K., Bose, N. and Emranul Haque, M. (2010). Endogenous corruption in economic development, *Journal of Economic Studies* **37**(1): 4–25.

Blackburn, K. and Forgues-Puccio, G. (2007). Distribution and development in a model of misgovernance, *European Economic Review* **51**(6): 1534–1563.

Blackburn, K. and Forgues-Puccio, G. (2009). Why is corruption less harmful in some countries than in others?, *Journal of Economic Behavior & Organization* **72**(3): 797–810.

Blackburn, K. and Forgues-Puccio, G. F. (2010). Financial liberalization, bureaucratic corruption and economic development, *Journal of International Money and Finance* **29**(7): 1321–1339.

Blackburn, K. and Powell, J. (2011). Corruption, inflation and growth, *Economics Letters* **113**(3): 225–227.

Blackburn, K. and Sarmah, R. (2008). Corruption, development and demography, *Economics of Governance* **9**(4): 341–362.

Blankenau, W. F., Simpson, N. B. and Tomljanovich, M. (2007). Public education expenditures, taxation, and growth: Linking data to theory, *American Economic Review* pp. 393–397.

Brown, C. and Belfield, C. R. (2001). The relationship between private schooling and earnings: a review of the evidence for the us and the uk, *Working Paper* .

Brunetti, A., Kisunko, G. and Weder, B. (1997). *Institutional obstacles to doing business: region-by-region results from a worldwide survey of the private sector*, Vol. 1759, World Bank Publications.

Calónico, S. and Ñopo, H. (2007). Returns to private education in peru, *Working Paper* .

Chong, A. and Calderon, C. (2000a). Institutional quality and income distribution, *Economic Development and Cultural Change* **48**(4): 761–786.

Chong, A. and Calderón, C. (2000b). Institutional quality and poverty measures in a cross-section of countries, *Economics of Governance* **1**(2): 123–135.

Chong, A. and Gradstein, M. (2007). Inequality and institutions, *Review of Economics and Statistics* **89**(3): 454–465.

Chu, M. K.-y., Davoodi, M. H. R. and Gupta, M. S. (2000). *Income distribution and tax and government social spending policies in developing countries*, number 0-62, International Monetary Fund.

Cox, D. and Jimenez, E. (1990). The relative effectiveness of private and public schools: Evidence from two developing countries, *Journal of Development Economics* **34**(1): 99–121.

Cutler, D. M. and Lleras-Muney, A. (2006). Education and health: Evaluating theories and evidence, *NBER Working Paper* (w12352).

De la Croix, D. and Delavallade, C. (2009). Growth, public investment and corruption with failing institutions, *Economics of Governance* **10**(3): 187–219.

Delavallade, C. (2006). Corruption and distribution of public spending in developing countries, *Journal of Economics and Finance* **30**(2): 222–239.

Dincer, O. C. and Gunalp, B. (2008). Corruption, income inequality, and poverty in the united states, *Working Paper 2008.54*, Fondazione Eni Enrico Mattei.

Dollar, D. and Kraay, A. (2002). Growth is good for the poor, *Journal of Economic Growth* **7**(3): 195–225.

Dutta, I. and Mishra, A. (2013). Does inequality foster corruption?, *Journal of Public Economic Theory* **15**(4): 602–619.

Ehrlich, I. and Lui, F. T. (1999). Bureaucratic corruption and endogenous economic growth, *Journal of Political Economy* **107**(S6): S270–S293.

Fan, S., Zhang, L. and Zhang, X. (2002). Growth, inequality, and poverty in rural china: the role of public investments, *Technical report*, International Food Policy Research Institute (IFPRI).

Filmer, D. and Pritchett, L. (1999). The impact of public spending on health: does money matter?, *Social Science & Medicine* **49**(10): 1309–1323.

Fisman, R. and Gatti, R. (2002). Decentralization and corruption: evidence across countries, *Journal of Public Economics* **83**(3): 325–345.

Fisman, R. and Svensson, J. (2007). Are corruption and taxation really harmful to growth? firm level evidence, *Journal of Development Economics* **83**(1): 63–75.

Foellmi, R. and Oechslin, M. (2007). Who gains from non-collusive corruption?, *Journal of Development Economics* **82**(1): 95–119.

Foko, B., Tiyab, B. K. and Husson, G. (2012). *Household Education Spending: An Analytical and Comparative Perpective for 15 African Countries*.

Galor, O. and Zeira, J. (1993). Income distribution and macroeconomics, *Review of Economic Studies* **60**(1): 35–52.

Gertler, P. and Gaag, J. v. d. (1990). *The willingness to pay for medical care: evidence from two developing countries.*, Johns Hopkins University Press.

Glaeser, E., Scheinkman, J. and Shleifer, A. (2003). The injustice of inequality, *Journal of Monetary Economics* **50**(1): 199–222.

Gupta, S., Davoodi, H. and Alonso-Terme, R. (2002). Does corruption affect income inequality and poverty?, *Economics of Governance* **3**(1): 23–45.

Gupta, S., Davoodi, H. and Tiongson, E. (2001). Corruption and the provision of health care and education services, *The Political Economy of Corruption* .

Gupta, S., Verhoeven, M. and Tiongson, E. (1999). Does higher government spending buy better results in education and health care?, *Technical report*, Working Paper No WP/99/21, International Monetary Fund.

Gupta, S., Verhoeven, M. and Tiongson, E. R. (2002). The effectiveness of government spending on education and health care in developing and transition economies, *European Journal of Political Economy* **18**(4): 717–737.

Gupta, S., Verhoeven, M. and Tiongson, E. R. (2003). Public spending on health care and the poor, *Health Economics* **12**(8): 685–696.

Gyimah-Brempong, K. (2002). Corruption, economic growth, and income inequality in africa, *Economics of Governance* **3**(3): 183–209.

Gyimah-Brempong, K. and de Camacho, S. (2006). Corruption, growth, and income distribution: are there regional differences?, *Economics of Governance* **7**(3): 245–269.

Haque, M. E. and Kneller, R. (2015). Why does public investment fail to raise economic growth? the role of corruption, *The Manchester School* **83**(6): 623–651.

Harbison, R. W. and Hanushek, E. A. (1992). *Educational performance of the poor: lessons from rural Northeast Brazil.*, Oxford University Press.

Jain, A. K. (2001). Corruption: A review, *Journal of Economic Surveys* **15**(1): 71–121.

Jimenez, E., Lockheed, M. E., Luna, E. and Paqueo, V. (1991). School effects and costs for private and public schools in the dominican republic, *International Journal of Educational Research* **15**(5): 393–410.

Kaufmann, D. (1997). Corruption: the facts, *Foreign policy* pp. 114–131.

Kaufmann, D., Kraay, A. and Mastruzzi, M. (2004). Governance matters iii: Governance indicators for 1996, 1998, 2000, and 2002, *The World Bank Economic Review* **18**(2): 253–287.

Kaufmann, D., Kraay, A. and Zoido, P. (1999). Governance matters, *World Bank policy research working paper* (2196).

Keefer, P. and Knack, S. (1997). Why don't poor countries catch up? a cross-national test of an institutional explanation, *Economic Inquiry* **35**: 590–602.

Knack, S. and Keefer, P. (1995). Institutions and economic performance: Cross-country tests using alternative institutional measures, *Economics and Politics* **7**(3): 207–227.

Kneller, R., Bleaney, M. F. and Gemmell, N. (1999). Fiscal policy and growth: evidence from oecd countries, *Journal of Public Economics* **74**(2): 171–190.

Krueger, A. and Lindahl, M. (2001). Education for growth: Why and for whom?, *Journal of Economic Literature* **39**: 1101–1136.

Lambsdorff, J. G. (2006). Causes and consequences of corruption: what do we know from a cross-section of countries, *International Handbook on the Economics of Corruption* **1**: 3–51.

Lewis, M. (2006). Governance and corruption in public health care systems, *Center for Global Development working paper* (78).

Li, H., Squire, L. and Zou, H.-f. (1998). Explaining international and intertemporal variations in income ine quality, *Economic Journal* **108**(446): 26–43.

Li, H., Xu, L. C. and Zou, H.-f. (2000). Corruption, income distribution, and growth, *Economics and Politics* **12**(2): 155–182.

López Casasnovas, G., Rivera, B. and Currais, L. (2005). *Health and economic growth: findings and policy implications*, Mit Press.

Mauro, P. (1995). Corruption and growth, *The Quarterly Journal of Economics* pp. 681–712.

Mehrotra, S. K. and Delamonica, E. (2007). *Eliminating human poverty: macroeconomic and social policies for equitable growth*, Zed Books.

Mishra, A. and Ray, R. (2010). Informality, corruption, and inequality.

Montinola, G. R. and Jackman, R. W. (2002). Sources of corruption: a cross-country study, *British Journal of Political Science* **32**(01): 147–170.

Murphy, K. M., Shleifer, A. and Vishny, R. W. (1991). The allocation of talent: Implications for growth, *The Quarterly Journal of Economics* **106**(2): 503–30.

Neeman, Z., Paserman, M. D. and Simhon, A. (2008). Corruption and openness, *The BE Journal of Economic Analysis & Policy* **8**(1).

North, D. C. (1990). *Institutions, institutional change and economic performance*, Cambridge University Press.

Paldam, M. (2002). The cross-country pattern of corruption: economics, culture and the seesaw dynamics, *European Journal of Political Economy* **18**(2): 215–240.

Pritchett, L. (1996). Mind your p's and q's: the cost of public investment is not the value of public capital, *World Bank policy research working paper* (1660).

Rajkumar, A. S. and Swaroop, V. (2008). Public spending and outcomes: Does governance matter?, *Journal of Development Economics* **86**(1): 96–111.

Rauch, J. E. and Evans, P. B. (2000). Bureaucratic structure and bureaucratic performance in less developed countries, *Journal of Public Economics* **75**(1): 49–71.

Reinikka, R. and Svensson, J. (2005). Fighting corruption to improve schooling: Evidence from a newspaper campaign in uganda, *Journal of the European Economic Association* **3**(2-3): 259–267.

Rivera-Batiz, F. L. (2001). International financial liberalization, corruption, and economic growth, *Review of International Economics* **9**(4): 727–737.

Rose-Ackerman, S. (1999). *Corruption and government: Causes, consequences, and reform*, Cambridge University Press.

Sachs, J. and Warner, A. (1997). Sources of slow growth in african economies, *Journal of African Economies* **6**(3): 335–376.

Sarte, P.-D. G. (2000). Informality and rent-seeking bureaucracies in a model of long-run growth, *Journal of Monetary Economics* **46**(1): 173–197.

Strauss, J. and Thomas, D. (1998). Health, nutrition, and economic development, *Journal of Economic Literature* pp. 766–817.

Svensson, J. (2005). Eight questions about corruption, *Journal of Economic Perspectives* **19**(3): 19–42.

Tanzi, V. (1998). Corruption around the world: Causes, consequences, scope, and cures, *Staff Papers-International Monetary Fund* **45**(4): 559–594.

Tanzi, V. and Davoodi, H. (1997). Corruption, public investment, and growth, *IMF Working Paper No WP/97/139*, International Monetary Fund.

Tilak, J. B. (2002). *Determinants of household expenditure on education in rural India*, number 88, National Council of Applied Economic Research.

Treisman, D. (2000). The causes of corruption: a cross-national study, *Journal of Public Economics* **76**(3): 399–457.

Wei, S. (2000). How taxing is corruption on international investors?, *Review of Economics and Statistics* **82**(1): 1–11.

Appendix

Figure 3: **Endogenising Human Capital Expenditures**

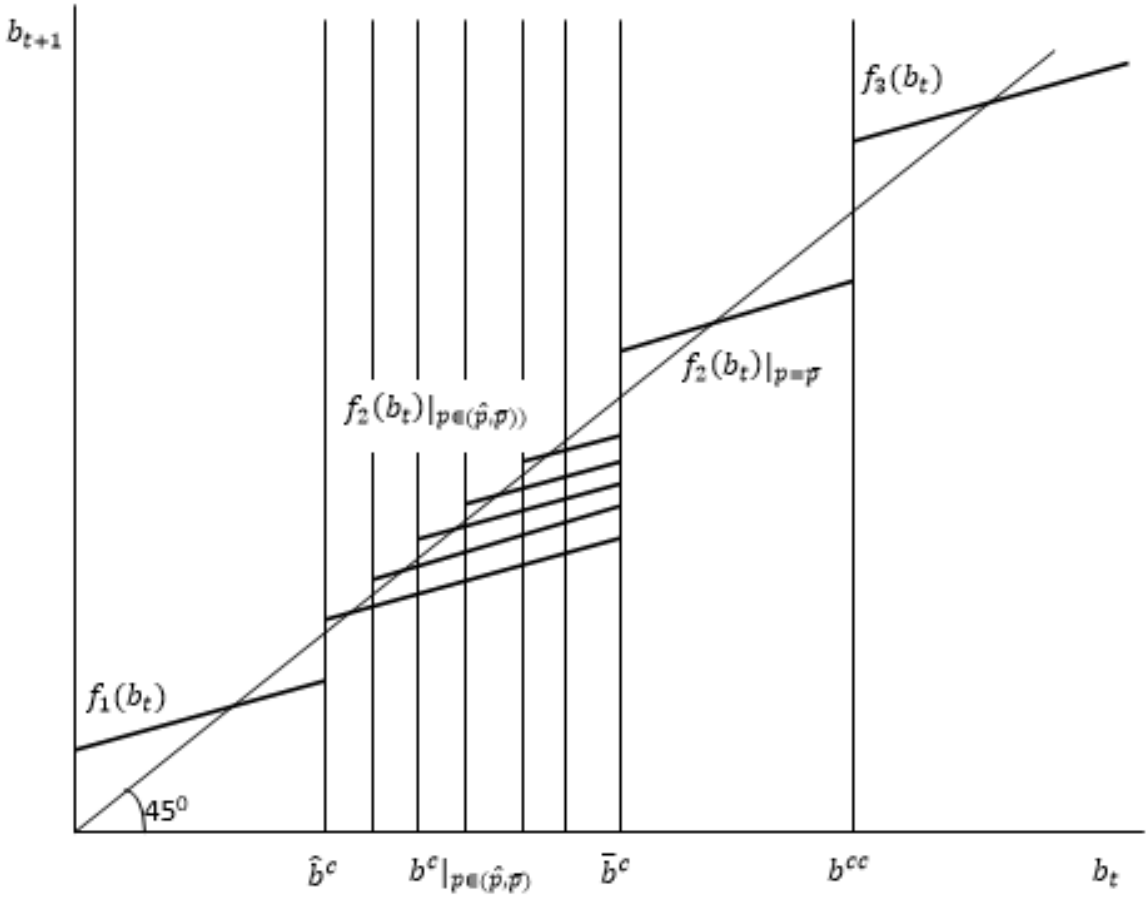


Figure 4: **Endogenising Corruption by Bribery and Tax Evasion**