

# Educational Corruption and Growth

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## **Abstract**

Educational corruption is a worldwide phenomenon yet its impact on economic growth is unclear. In this paper we formulate a macroeconomic model to explore the impact educational corruption may have on growth, educational attainment, and the education wage premium. We find that our model can produce a negative relationship between economic growth and educational corruption as well as a positive relationship between the education wage premium and educational corruption. We find empirical support for these relationships in a cross-section of countries. In addition to this fact, our model also produces a negative relationship between the level of educational attainment and educational corruption as found in the data. To add to a recent line of literature on social status and its implications for growth, we show that attaching status to education can be growth enhancing in countries that experience low to medium levels of educational corruption but growth reducing in countries that experience high levels of educational corruption. We also show that borrowing constraints can exacerbate the impact educational corruption has on economic growth, the wage premium, and educational attainment rates.

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# 1 Introduction

Educational corruption is a worldwide phenomenon yet its impact on economic growth is not clear. Problematic levels of educational corruption have been reported in China, Colombia, Russia, Georgia, New Zealand, Nigeria, Thailand, Afghanistan, and Kenya to name only a few.<sup>1</sup> Various types of educational corruption have been reported including, but not limited, bribing for entrance, bribing to pass exams, and paying for degrees. MacWilliams (2002) describes one instance where a professor of a Georgian school actually distributed a price list for various types of bribes to his students.

The first step to exploring educational corruption is defining it. Following the literature on corruption, Heyneman (2004) defines educational corruption as: “the abuse of authority for personal as well as material gain.” Educational corruption is not solely for material gain because it also includes gains from personal advancement such as an increase in social status. Students may use bribing as a way of avoiding the selection mechanisms or quality measures in place to distinguish themselves from their fellow students with the expectations of some current or future gain.

Rumyantseva (2005) goes further in defining educational corruption by explaining what the author refers to as the “taxonomy” of educational corruption. She finds that two main types of educational corruption exist. One type involves students directly, which has the potential to impact students’ values, opportunities, and beliefs. The other type of educational corruption does not directly involve students but indirectly affects the outcome of students. An example of this type might be a school administrator embezzling funds from an educational institution which reduces the resources available to students. We focus on the prior and more specifically we focus on bribing for entrance.

In Shaw (2007), I find that approximately 56% of Ukrainian students bribed to enter their educational institution. Of those surveyed, women were approximately 6% more likely to have given a bribe than men. Those students who bribed on their final exams in high school were 16% more likely to bribe for entrance into college. As reported by Rumyantseva (2004b), a World Bank study revealed that in Kazakhstan, 69% percent of those students who bribed did so for entry into universities while 10% bribed to

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<sup>1</sup>For a review of cases of educational corruption around the world, see Rumyantseva (2004a).

obtain better grades. Although studies like Shaw (2007) and Rummyantseva (2004b) shed some light as to the frequency and the potential determinants of educational corruption, they do not give us any idea as to the potential impact educational corruption has on economic growth, nor do they provide us with an analytical framework for studying corruption in education. It is therefore the goal of this paper to provide that framework thus allowing us to say something about the economic impacts of educational corruption.

Educational corruption allows students to bypass quality and selection metrics that are normally in place within educational institutions. Quality of education is important because it determines the quality of the labor force and therefore has impacts on productivity and innovation for a country. Hanushek and Kim (1995) explore the importance of the quality of labor force and its impacts on economic growth and find a positive and significant relationship with economic growth for a cross-section of countries. Using international test scores to obtain a quality index, they find a one standard deviation in measured cognitive skills translates into a one percent difference in the average growth rate. Their results are robust to model specification and lead to increased precision in the prediction of average growth rates for the sample used. Their results present evidence to support the important relationship between educational quality and economic performance. Educational corruption may deteriorate the quality of education thus inhibiting economic growth.

Fershtman, Murphy, and Weiss (1996) explore the relationship between social status, education, and economic growth and find that while social status plays an important role in the allocation of talent; its role may lead to decreased economic performance. Professions carrying high levels of status tend to draw people of all types of ability. Talent may be misallocated because people with high wealth levels have access to “high quality” institutions or specialized training that allows them to be employed in high status positions regardless of their ability. Furthermore, if those high-wealth individuals are of low-ability, then there may be a negative impact on economic growth if those high status industries are growth enhancing. The optimal allocation of talent would be allocating the high-ability individuals to growth enhancing industries regardless of their wealth. Schools have the ability to achieve this if they are operating effectively. It is important to note that we do not state that the misallocation of talent does not occur in countries without educational corruption, only that this process is accelerated in countries that do have corruption in education. Thus educational corruption inhibits ed-

educational establishments' ability to act as a filter thus allowing high-wealth low-ability students to enter institutions that have better connections to positions of high status. The results of Fershtman et al. (1996) reveal another path in which educational corruption is detrimental to economic performance.

Heyneman (2004) supports the argument that educational corruption destroys the selection method that can be created by educational establishments. Klitgaard (1986) stresses the importance of basing selection into educational institutions based on ability and discusses the impact of proper selection mechanisms on both efficiency and equity in educational outcomes. It therefore easy to see how bribing into educational institutions can work to reduce the importance of ability in the admissions process. Pinera and Selowsky (1981) attempt to quantify the impacts of the misallocation of talent on economic performance finding that developing countries could improve their per capita gross national product by five percentage points if they were to base their leadership upon merit as opposed to gender or social status.

The purpose of this paper is to provide a theoretical framework to study the effects educational corruption has on economic growth, educational attainment, and the education wage premium. Building on the framework developed by Fershtman et al. (1996), we develop an overlapping generations model with borrowing constraints explicitly modeling educational corruption. Educational corruption is introduced into the model by allowing agents to increase their entrance probabilities through bribing. We show that educational corruption has a negative impact on economic growth and increases the educational wage premium. Given the presence of educational corruption, higher importance of social status may be growth enhancing in low corruption countries, while the opposite effect is found for highly corrupt countries. Model implications are shown to match empirical evidence obtained by utilizing Transparency Internationals Corruption Perceptions Index. We also show that growth rates can be improved by relaxing borrowing constraints, even for countries with a high degree of educational corruption.

The remainder of the paper is structured as follows. In Section 2 we develop and overlapping generations model of educational corruption. Section 3 describes the simulation exercise and its results. We conduct an empirical verification of model implications in Section 4. Section 5 concludes.

## 2 Model

Here we formulate an overlapping generations model of educational corruption. Our economy is populated by a continuum of households of mass 1, and a representative firm. The intuition and setup of the model is similar to Fershtman et al. (1996). In their model, they assume agents can choose to go to school or not. If an agent decides to go to school, he automatically gets in. In our model, agents do not know with certainty if they will join the educated work force but instead they face a probability. Households not only give up wage earnings by going to school, but they also can bribe in order to increase their chance of entering an education institution.

### 2.1 Households

Agents are assumed to live for two periods and are heterogeneous in two dimensions – innate ability,  $\mu$ , and asset holdings (wealth),  $a$ . Thus, we denote the distribution of agents by the density function  $f(\mu, a)$ . We assume that the distribution of agents is time invariant such that each new generation is born identically distributed in terms of their asset holdings and innate ability.<sup>2</sup> When agents are born, they choose to go to school or not. If an agent decides not to go to school, he or she immediately joins the labor force and becomes a laborer ( $l$ ) earning the market wage  $w_t^l$  for that period. We further assume that if they decide not to go to school, they remain laborers for the remainder of their life. If an agent decides to go to school they face a probability  $\pi(m)$  of getting in and becoming a manager ( $m$ ) in the second period of their life. If they become a manager, they will receive a wage of  $w_{t+1}^m \mu$ . Therefore agents who become managers get paid the market wage as well as an ability premium. The way we model educational corruption is to allow students to bribe  $z_t$  which increases their probability of entry into school. Thus agents who decide to go to school face the probability  $1 - \pi(m)$  of not getting in and becoming a laborer in the second period of their life. If an agent does not get into school he/she receives a wage of  $w_{t+1}^l$  in the second period of life. Agents choose over current consumption  $c_t$ , future consumption  $c_{t+1}$ , and asset holdings  $a_{t+1}$ . The return on assets is defined endogenously as  $r_{t+1}$ . It is also assumed that agents receive status

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<sup>2</sup>It would be interesting to investigate the endogenous distribution of young agents, but this complicates the model and requires one to make an assumption about the evolution of ability across generations.

from their respective occupations which we denote as  $S_{t+1}^s$  for  $s \in [m, l]$ . If an agent decides to *not* go to school he or she faces the following maximization problem:

$$U(c_t, c_{t+1}) = \max_{a_{t+1}, c_t, c_{t+1}} \ln(c_t) + \ln(c_{t+1}) + \ln(S_{t+1}^l) \quad (1)$$

subject to

$$c_t + a_{t+1} \leq w_t^l + r_t a \quad (2)$$

$$c_{t+1} \leq r_{t+1} a_{t+1} + w_{t+1}^l \quad (3)$$

$$a_{min} \leq a_{t+1} \quad (4)$$

Equation 2 is the budget constraint of the first period and Equation 3 is the second period budget constraint. Equation 4 denotes a borrowing constraint. An agent who decides to attempt to go to school must choose the following:  $a_{t+1}$ ,  $c_t$ ,  $z_t$ , and  $c_{t+1}^s$  where  $s \in [m, l]$ . Thus an agent who attempts to attend school must choose over future contingent claims to consumption in addition to time  $t$  variables because his or her future is not known with certainty. Therefore the maximization problem facing the agent who attempts schooling is as follows:

$$U(c_t, c_{t+1}^s) = \max_{a_{t+1}, c_t, z_t, c_{t+1}^s} E_t \ln(c_t) + \sum_s [\ln(c_{t+1}^s) + \ln(S_{t+1}^s)] \pi(s) \quad (5)$$

subject to

$$c_t + a_{t+1} + z_t \leq r_t a \quad (6)$$

$$c_{t+1}^m \leq r_{t+1} a_{t+1} + w_{t+1}^m \mu \quad \text{w.prob. } \pi(m) \quad (7)$$

$$c_{t+1}^l \leq r_{t+1} a_{t+1} + w_{t+1}^l \quad \text{w.prob. } 1 - \pi(m) \quad (8)$$

$$a_{min} \leq a_{t+1} \quad (9)$$

$$z_t \leq z_{max} \quad (10)$$

Equation 6 denotes first period constraint and Equations 7 and 8 denote second period constraints conditional on the entrance to the educational institution. A key assumption of the model is the fact that attempting school comes with a fixed cost of foregone labor wages in addition to an extra expenditure in the form of a bribe. This cost will be taken into consideration when agents decide to attempt schooling or not. Agent simply compare the

indirect utility associated with both maximization problems and choose over the one that yields the highest level of utility. We also introduce borrowing constraints through the variable  $a_{min}$  so that we can see how the lack of financial markets impact equilibrium outcomes. An agent who attempts schooling will also be bound above by the perceived maximum bribe in the economy which we denote as  $z_{max}$ . We make this assumption for two reasons: 1) it ensures that our probability function is a proper probability function and 2) we believe that when bribes are offered it is not the amount of the bribe that matters, but instead it is the size of the bribe relative to the maximum bribe offered. Note that although each agent takes  $z_{max}$  as given, it is endogenously determined. A more detailed discussion of this can be found in the next section of the paper.

Another variable that we introduce into our model is social status. As pointed out by Fershtman and Weiss (1993) social status plays an important role in the allocation of individuals across different occupations. The authors point out that people don't only consider the wages of a particular occupation when making choices but they also consider the level of social status that is attached to a particular profession. In their paper they introduce a two-sector general equilibrium model with production in which social status is defined to be a function of the average wage and average level of skill within a particular occupation. Agents in their model can give up current period wage income to obtain education and become skilled workers. They show that agents with higher non-wage incomes are more likely to sacrifice current period wage income to obtain higher social status. The authors also show that economies with a higher emphasis on social status will have a lower level of aggregate output and also experience higher levels of wage inequality between skilled and unskilled workers. In later work by Fershtman et al. (1996), they explore the impact of social status on economic growth. They show that if that social status can have a negative effect on economic growth if there is a "crowding out" effect in the sense that the low ability high non-wage income agents replace the high ability low non-wage income in the market for managers.

In light of these recent findings we consider social status to play an important role in the choice to educate and can therefore impact the determination of equilibrium wages and growth. Given this finding we will include it in our formulation of the model. Following Fershtman et al. (1996) closely we assume that status is measured in terms of the relative average ability of the profession. An educated worker receives the following level of social status:

$$S_{t+1}^m = \left( \frac{\bar{\mu}_m}{\bar{\mu}_l} \right)^\delta$$

where

$$\bar{\mu}_m = \frac{\int \int_{\Psi_{t+1,m}} \mu f(\mu, a) d\mu da}{\int \int_{\Psi_{t+1,m}} f(\mu, a) d\mu da}$$

and

$$\bar{\mu}_l = \frac{\int \int_{\Upsilon_{t+1,l}} \mu f(\mu, a) d\mu da + \int \int_{\Theta_{t+1,l}} \mu f(\mu, a) d\mu da}{\int \int_{\Upsilon_{t+1,l}} f(\mu, a) d\mu da + \int \int_{\Theta_{t+1,l}} f(\mu, a) d\mu da}$$

Social status of uneducated is  $S_{t+1}^l = \left( \frac{\bar{\mu}_l}{\bar{\mu}_m} \right)^\delta$ . We denote the set of agents that attempted schooling in time  $t$  and were successful as  $\Psi_{t+1,m}$ . Let  $\Theta_{t,l}$  denote the set of agents who did not attempt schooling and went directly into the workforce in time  $t$ .  $\Delta_{t,l}$  is the set of agents that attempted schooling but were *not* successful. Therefore the set of “old” laborers at time  $t+1$  is defined by  $\Upsilon_{t+1,l} = \Theta_{t,l} \cup \Delta_{t,l}$ .  $\Theta_{t+1,l}$  is the set of young agents who choose to not attempt schooling at time  $t+1$ . Thus the set of all time  $t+1$  laborers can be defined by  $\Psi_{t+1,l} = \Upsilon_{t+1,l} \cup \Theta_{t+1,l}$ . Finally denote the entire set of young agents at time  $t+1$  as  $\Gamma_{t+1}$ . The parameter  $\delta$  represents the importance of social status as found in Fershtman et al. (1996).

An interesting feature of social status as pointed out by Fershtman et al. (1996) is the fact that it has a public good characteristic because each agent of a given profession shares the same level of social status. It is often difficult to observe the individual ability of each agent of a profession thus the best measure of a person’s ability is the average ability of his/her cohort.

## 2.2 The Probability of Entry

If agents face a probability of becoming educated and thus becoming a manager, a natural question is what should determine the probability? It seems that reasonable place to start is to assume that any agents probability of becoming a manager should be a function of ability ( $\mu$ ) and the amount they bribe ( $z_t$ ). We investigate several ways these two variables can influence the probability of entry. The first probability function we propose is the following:

$$P1 : \pi(m) = p(\mu, z_t) = (\mu - 1)\gamma + (1 - \gamma) \left( \frac{z_t}{z_{\max}} \right)^\alpha \quad (11)$$



where  $\gamma \in [0, 1]$ ,  $\alpha \in (0, 1)$  and  $\mu \in [1, 2]$ . Therefore the probability that an agent becomes a manager is a convex combination of ability and the ratio of an agent's bribe to that of the maximum bribe in the economy which we denote as  $z_{\max}$ . The function  $P1$  has a few desirable features including the fact that this function is a true probability function. To see this evaluate the probability at the maximum values for  $\mu$  and  $z_t$  which gives us  $p(2, z_{\max}) = 1$  ensuring that  $p(\mu, z_t) \in [0, 1]$ . Furthermore notice as  $\gamma \rightarrow 1$  the probability of entrance is solely a function of an agent's ability but when  $\gamma \rightarrow 0$  the agents probability of entry is only a function of the amount he or she bribes relative to the maximum bribe in the economy. This feature will be particularly useful when we examine equilibrium outcomes of the model under the assumption of no educational corruption ( $\gamma = 1$ ), or a maximum level of educational corruption ( $\gamma = 0$ ).

One problem facing our analysis is the fact that we cannot know in advance what the probability function should look like. To estimate such a function from the data we would need to observe the amount students bribed for entry as well as their ability, which in itself is historically hard to obtain. Even if we did observe some rough measure of ability and the amount a student bribed, we would need this data for both students who were successful in gaining entrance and those who were not successful. To our knowledge this data set simply does not exist. To address the ambiguity surrounding the probability function we introduce an alternative specification for the probability of entrance:

$$P2 : \pi(m) = p(\mu, z_t) = (\mu - 1)\gamma + (1 - \gamma)(\mu - 1) \left( \frac{z_t}{z_{\max}} \right)^\alpha \quad (12)$$

The first thing to notice about  $P2$  is that when  $\gamma \rightarrow 1$  (no ed. corruption)  $P2$  and  $P1$  are equivalent. Notice however that when  $\gamma \rightarrow 0$   $P1$  is only a function of an agents bribe while for  $P2$  ability still matters even under a fully corrupt regime ( $\gamma = 0$ ). In other words, functional form  $P2$  allows for interaction between the bribe and ability.

Another notable difference between  $P1$  and  $P2$  is that for equal values of  $\mu$ ,  $z_t$ , and  $z_{\max}$  it is true that  $P1 \geq P2$  (higher probability of entrance). This relationship will play an important role in explaining the results of the model.

### 2.3 The Firm

The representative firm employs both types of workers and produces a single consumption good according to the following production function:

$$Y_t = A_t \{a[bK_t^\theta + (1-b)NM_t^\theta]^{\frac{\rho}{\theta}} + (1-a)NL_t^\rho\}^{\frac{1}{\rho}} \quad (13)$$

where  $NL_t$  is the number of uneducated workers,  $NM_t$  is the efficiency units of educated labor, and  $K_t$  is the capital stock. A nice feature of this production technology is the fact that it is very flexible in terms of representing various levels of complementarity and substitutability in the three factors of production. Notice that if  $\rho, \theta = 1$ , then production is represented by perfect substitutability, and with  $\rho, \theta = -\infty$ , then production is represented by perfect complementarity. When  $\rho, \theta = 0$ , then production is of Cobb-Douglas type.

Another reason to use this type of production technology comes from the fact that there has been a line of literature that has focused on the estimation of the parameters of this function.

The goal of the firm is to maximize each period profits taking factor prices as given:

$$\max_{NL_t, NM_t, K_t} Y_t - w_t^l NL_t - w_t^m NM_t - K_t r_t$$

This yields the following factor demand curves:

$$\begin{aligned} r_t &= A_t^\rho Y_t^{1-\rho} a [bK_t^\theta + (1-b)NM_t^\theta]^{\frac{\rho}{\theta}-1} bK_t^{\theta-1} \\ w_t^l &= A_t^\rho Y_t^{1-\rho} (1-a) NL_t^{\rho-1} \\ w_t^m &= A_t^\rho Y_t^{1-\rho} a [bK_t^\theta + (1-b)NM_t^\theta]^{\frac{\rho}{\theta}-1} (1-b) NM_t^{\theta-1} \end{aligned}$$

Notice, that we implicitly assume that labor is hired in efficiency units. The efficiency of managers depend on their ability, while the efficiency units of laborers is simply equal to the total number of laborers employed. In other words, given the two managers that differ by ability, the one with the higher ability will produce more. For laborers it is assumed that their productivity is independent of their ability.

### 2.4 Learning Technology

We model the evolution of the technological parameter  $A_t$  following Fershtman and Weiss (1993) where they assume that only the educated can add

to the stock of knowledge. When managers attend school they not only gain access to the current stock of knowledge, but add to it by utilizing their ability in school and adding to the total stock of knowledge available in the second period of their life. Thus technology evolves as follows:

$$A_{t+1} = (1 + g_{t+1})A_t,$$

where

$$g_{t+1} = \tau \int \int_{\Psi_{t+1,m}} \mu f(\mu, a) d\mu da = \tau NM_{t+1} \text{ and } \tau > 0.$$

Thus the growth rate of technological progress at any given time is solely a function of the aggregate ability of the educated agents.

## 2.5 Equilibrium

In this section we focus on the characteristics of a stationary rational expectations equilibrium. Each period agents form expectations over future wages and the status of each occupation as well as future interest rates. Given their expectations they make their decisions appropriately. In a rational expectations equilibrium the expectations of each agent must be confirmed. Since the distribution of characteristics  $f(\mu, a)$  is invariant over time we only need to find a stationary distribution of laborers and managers. The definition of a stationary rational expectations equilibrium is as follows:

**Definition 1.** *A rational expectations equilibrium is defined by (i) an invariant distribution of young agents  $F(\mu, a)$ , (ii) expectations set  $E_t \Lambda_{t+1} = [E_t S_{t+1}^s E_t w_{t+1}^s E_t g_{t+1} E_t r_{t+1}]$ , (iii) known probability function  $p(z_t, \mu)$ , (iv) individual household decision rules  $z_t, a_{t+1}, c_t$ , and (v) contingent consumption  $c_{t+1}^s, s \in [m, l]$  such that:*

- 1) *Given the expectations set, individual household consumption rules and contingent consumption solve the household problem.*
- 2) *Given the probability function,  $p(z_t, \mu)$ , the set of managers and laborers is time invariant:  $\Psi_{t,m} = \Psi_{t+1,m}$  and  $\Psi_{t,l} = \Psi_{t+1,l}$ .*
- 3) *Expectations are realized so that  $E_t \Lambda_{t+1} = \Lambda_{t+1}$ .*
- 3) *Aggregate consistency conditions hold:*

- i)  $NM_t = \int \int_{\Psi_{t,m}} \mu f(\mu, a) d\mu da$

- ii)  $NL_t = \int \int_{\Upsilon_{t,l}} f(\mu, a) d\mu + \int \int_{\Theta_{t,i}} f(\mu, a) d\mu da$

iii)  $K_t = \int \int_{\Psi_{t,m}} a_t f(\mu, a) d\mu da + \int \int_{\Upsilon_{t,l}} a_t f(\mu, a) d\mu da + \int \int_{\Gamma_t} a f(\mu, a) d\mu da$   
 4)  $\{NL_t, NM_t, K_t\}$  solves the firm's maximization problem.

## 3 Simulation

Since there is no closed form solution of the model we have to resort to numerical methods. The model is solved using the standard algorithm for perfect foresight rational expectations equilibrium.<sup>3</sup>

### 3.1 Parametrization

#### 3.1.1 Production function

For the parametrization of the production function we turn to the literature. Duffy, Papageorgiou, and Perez-Sebastian (2004) estimate the equation for a panel of countries using three different forms of nonlinear estimation including non-linear least squares (NLLS), NLLS with fixed effects (NLLS-FE), and generalize method of moments with fixed effects (GMM-IV). Duffy et al. (2004) results suggest that under Monte Carlo simulations NLLS has the lowest absolute median bias in the estimation of  $\rho$  over different Monte Carlo specifications, while GMM-IV produces the lower absolute median bias in the estimation of  $\theta$ . Duffy et al. (2004) show estimates of between .23861 and 1.25 for  $\rho$  and for  $\theta$  they provide estimates ranging from 0.03832 to 0.56737. Krusell, Ohanian, Rios-Rull, and Violante (2000) and Polgreen and Silos (2005) also focus on the estimation of  $\rho$  and  $\theta$ , however, their specifications include both capital structures and capital equipment, which is not applicable to our model specification. Furthermore, they estimate the parameters of their model using only U.S. data unlike the 73 country panel used by Duffy et al. (2004). The values we assign for  $\rho$  and  $\theta$  can be found in Table 1.

#### 3.1.2 Distribution of Young

Due to the fact that the distribution of the young agents  $f(\mu, a)$  is fixed over time, the results of the model could vary depending upon the how the distribution of ability ( $\mu$ ) and assets ( $a$ ) is defined. If agents born with high levels

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<sup>3</sup>A nice exposition is provided in Heer and Maussner (2005).

of wealth are also of high ability, then the impact educational corruption has on growth may be very small as it will be the highest ability agents who will decide to go to school and pay the highest bribes, because they are also the agents who can afford to take the risky investment in schooling. However, if wealth and ability are negatively correlated, the impact of educational corruption may be expected to be very large – wealthy lowest ability agents may be the ones who obtain schooling due to the higher probability of entry. To address this ambiguity we vary the distribution of the young to see how the results vary across different specifications.

Rather than just guess what the distribution of wealth and ability looks like at the aggregate we draw on some recent literature for some hints. A recent study by Zagorsky (2007) shows that while ability is a strong predictor of income, it has no statistical relationship with initial wealth after controlling for other factors. Zagorsky (2007) reports a simple correlation between wealth and ability of only .12 suggesting that if there is any relationship between wealth and ability, it is close to zero, at least for the United States. Because the study was isolated to only the U.S. we still vary the distribution of wealth and ability restricting our analysis to two cases only: one in which the correlation between ability and wealth is .85 (Distribution I) and another in which the correlation between ability and wealth is zero (Distribution II).

### 3.1.3 Other parameters

Regarding the parametrization of the production function we draw on the results of Duffy et al. (2004). Table 1 shows the values assigned for each of the respective parameters:

Table 1: Parametrization

Production Function	Free Parameters		
$\theta$	0.4	$\delta$	0.5
$\rho$	0.5	$\gamma$	[0,1]
$a$	0.4	$\alpha$	0.5
$b$	0.5	$a_{min}$	0

Since it is unclear what values  $\alpha$ ,  $\gamma$ , and  $\delta$  should take we try a broad range of values. More specifically we vary  $\gamma$  over the interval [0, 1] to see how

educational corruption, as defined in this model, impacts economic growth as well as the education wage premium and the choice to educate or not.

## 3.2 Simulation results

In this section we discuss the numerical results for the model. Figures 1-3 show the results of the model in terms of the impact varying degrees of educational corruption have on economic growth, the education wage premium, and the proportion of agents who obtain education for both Distribution I and Distribution II. We also perform simulations for both specifications of the entrance probability function.

### 3.2.1 Correlated Ability and Wealth

Figures 1(a), 2(a), and 3(a) have the results under the assumption that wealth and ability are strongly positively correlated. Notice in Figure 1(a) using the first probability function specification *P1* the impact on annual growth is very small when moving from  $\gamma = 0$  (ability does not matter) to  $\gamma = 1$  (only ability matters). This is a stark contrast to the results under the assumption that the probability function takes the form presented by *P2* which show a monotonically increasing relationship between the annual growth rate and the importance of ability in the probability of entrance. A highly corrupt country ( $\gamma = 0$ ) would experience an annual growth rate of 2.16% versus 2.49% for an uncorrupt educational system ( $\gamma = 1$ ). This difference in growth would lead to a 10% difference in the level of GDP per capita between the uncorrupt and corrupt country after 30 years. Thus the impact educational corruption has on growth can be quite small when wealth and ability are highly correlated.

Figure 2(a) presents the results for the education wage premium as we vary the degree of corruption. Notice that like the growth rates, the education wage premium is flat across values of  $\gamma$  for *P1* suggesting that the degree of corruption has no real impact on the wage premium. Once again, this result is quite different when using *P2* for the probability of entrance. The results show a monotonically decreasing relationship between the education wage premium and  $\gamma$ . For example, when  $\gamma = 0$  the wage premium is 69.91% as compared to 43.57% when  $\gamma = 1$ .

The results for the proportion of educated agents are found in Figure 3(a). When we use *P1* the proportion of educated workers is increasing in corruption, however, the difference at the minimum and maximum values is

rather small. For example, when  $\gamma = 0$  the proportion educated is 19.98% as compared to 19.39% for  $\gamma = 1$ . When using  $P2$  the proportion educated is increasing in  $\gamma$ . The difference in the proportion educated when  $\gamma = 1$  as compared to  $\gamma = 0$  is 3.71%.

### 3.2.2 Uncorrelated Ability and Wealth

Figures 1(b), 2(b), and 3(b) have the results under the assumption that there is no correlation between wealth and ability as suggested by Zagorsky (2007). Figure 1(b) shows that once again depending on which function we use for the probability on entrance the results can be quite different. Using  $P2$  we find that as you reduce the degree of corruption in the economy the annual growth rate increases monotonically. Also notice that the magnitude of this change is much larger under Distribution II as compared to Distribution I. The annual growth rate for a very corrupt country ( $\gamma = 0$ ) is approximately 1.42% as compared to 2.41% for a country with  $\gamma = 1$ . This difference is quite large over a period of 30 years leading to a difference of 34% in levels. For the function  $P1$ , growth is decreasing as we move from  $\gamma = 0$  towards  $\gamma = .7$  suggesting that educational corruption can be good for growth in a certain range for  $\gamma$ . However, after  $\gamma = .7$  corruption is detrimental to growth.

Figure 2(b) shows the impact educational corruption has on the education wage premium. For the function  $P1$  the wage premium is increasing for values of  $\gamma$  between 0 to .7 but then declines as  $\gamma \rightarrow 1$ . For  $P2$  wage premium is strictly decreasing as we decrease the degree of educational corruption. When  $\gamma = 0$  the wage premium is 155% as compared to 51% when  $\gamma = 1$ .

The function  $P1$  produces a U-shaped pattern in the number of educated agents as we increase  $\gamma$  from 0 to 1 as found in Figure 3(b). This result comes from the fact that  $P1 \geq P2$  as discussed above. It is generally true that agents with higher ability and higher wealth will tend to choose to go to school because they have the higher expected payoff from doing so, due to higher probabilities of entrance and higher expected wages in the future. Agents with a low ability parameter  $\mu$  will not choose to try schooling when using  $P2$  but will try schooling under  $P1$  when  $\gamma = 0$  thus the aggregate ability will be driven up as long as the low ability agents are not replacing the high ability. Given that growth is defined by the aggregate ability of the educated, this will increase the growth rate of the economy. Furthermore, as the low ability high wealth agents choose to go to school they drive down the wage premium

as they add to the stock of aggregate ability. For medium values of  $\gamma$ , the low ability high wealth agents will start to drop out as their probability of entrance declines thus increasing the wage premium and reducing the growth rate. Notice that when we use *P2* the number of educated workers increases monotonically as  $\gamma \rightarrow 1$ . Note that when  $\gamma = 0$  the percent educated is approximately 9.33% as compared to 18.54% for  $\gamma = 1$ . Thus the percentage of agents who obtain education when ability is the only factor of selection is almost twice that of a fully corrupt country.

The main results of the paper suggest that the distribution of wealth and ability certainly change the size of the effect educational corruption has on growth, the wage premium, and the proportion educated, but for the most part, leave the trends unaffected.<sup>4</sup> This result is particularly true for the functional form *P2*. Comparing across the two types of probability functions we are left with two very different stories for the impact educational corruption has on growth. In one case educational corruption decreases economic growth while it may be growth enhancing in another case. We are therefore left with conflicting results. To help clarify we turn to the data to see if our model can replicate some of the basic facts that we observe about the wage premium, economic growth, and educational attainment and respective relationships to educational corruption.

### 3.2.3 Other Theoretical Implications

In the next section we will establish that function form *P2* (allowing for interaction between ability and bribing) seems to produce results consistent with the data. Thus here we report more results of the theoretical model under the assumption that the probability of entry is fully defined by *P2*<sup>5</sup>. We can then provide more results from the model as we remove social status from the model and relax the borrowing constraints to see how this impacts the results of the model. To save on computational time we define what we call three regimes of educational corruption: no corruption ( $\gamma = 1$ ), medium corruption ( $\gamma = .5$ ), and finally high corruption ( $\gamma = 0$ ). Table 3 reproduces the results of the baseline model with the parameters as laid out in section 4. Table 4 only differs from our baseline model because we now allow agents

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<sup>4</sup>Results for a negative correlation between wealth and ability suggest the same pattern. However, the magnitude of the impact corruption has on growth, the wage premium, and proportion educated is much larger depending upon the degree of correlation.

<sup>5</sup>These results do not differ qualitatively for *P1*, thus we do not report them here.



borrow. Given that agents can borrow against future income, they may be able to bribe more to increase their probability of entry which should have an effect on the allocation of agents and thus growth. As can be seen from Table 3, allowing agents to borrow is growth enhancing across all three regimes. Relaxing the borrowing constraint for a highly corrupt country increases the growth rate by .27% annually. It also increases the number of educated from 9.3% to 11.4% and drives down the wage premium by 35%. Notice this pattern is true for both non-corrupt and medium corrupt country. Relaxing the borrowing constraint leads to higher growth for a couple of reasons. One reason is that in the high to medium corruption countries agents can borrow against future earnings and use this to increase the amount of their bribe thus increasing the probability of entry. This will induce some agents to attempt schooling because they now face a higher probability of becoming a manager. As more people choose to attempt schooling it must be true that at least a portion of them will get into school. Therefore, the aggregate ability of the educated must go up as long as their isn't a crowding out effect. Notice that this story is consistent with the higher average bribe reported in Table 4.

Up till this point, we have not really discussed what role social status plays in the choice to educate. In order to explore the link between social status and educational corruption we remove status from the model to see how it changes the results. Fershtman et al. (1996) show that social status can have different impacts on economic growth depending upon the production technology used. In their paper Fershtman et al. (1996) show that when there is an increase in the importance of social status, growth can decrease if there is a "crowding out" effect, meaning that high ability agents are replaced with low ability agents thus dragging down the aggregate ability and thus reducing growth. Social status can also be good for growth under what the authors refer to as the "dilution effect". Although an increase in lower ability agents may drive down the *average* ability of the educated, it may actually increase the aggregate ability of the educated thus increasing growth. Thus the impact social status has on growth can be good or bad depending upon which type of effect exists in equilibrium. For this paper we would like to build on their analysis by investigating how educational corruption and social status interact in equilibrium.

Table 5 and Table 6 show the results with borrowing constraints and reduced borrowing constraints, when we take status out of the model. Notice that the same trends exist with or without social status in the model. What is interesting is the fact that social status can be good or bad depending upon

the regime in place. When agents are restricted from borrowing, introducing social status is good for medium to no corruption economies but bad for high corruption countries. Notice that in Table 5 the annual growth rate for a high corruption economy is 1.48% when there is no social status as compared to 1.42% when status is taken into consideration by agents.

## 4 Empirical verification

In order to relate the implications of the model to the data and to motivate the choice between the two specifications for the entrance probability, we estimate bivariate relationships between the variables of interest. Thus these empirical relationships should be treated as indicative only.

### 4.1 Data

Unfortunately, data on educational corruption is not readily available so empirically measuring the impact educational corruption has on economic growth, the education wage premium, and educational attainment is difficult. One potential way of getting around this problem is to find a proxy variable for educational corruption. One that immediately stands out as a potential candidate is Transparency International's Corruption Perceptions Index (CPI). The CPI uses country experts, business leaders, residents and non residents to assess the perceived degree of corruption within each country.<sup>6</sup> The index is on a scale of 0 to 10 where a score of 10 is associated with the *lowest level of corruption* while a score of 0 is associated with the *highest level of corruption*. The CPI has been used in many empirical studies including, but not limited to, Seligson (2002), Habib and Zurawicki (2002), Javorcik (2004), and Smarzynska and Wei (2000).

We take data on the return to education across countries from Psacharopoulos (1993). Psacharopoulos (1993) compiles the data from his own work as well as various other studies. For annual growth rates we take the data from the Penn World Tables (PWT) as found in Heston, Summers, and Aten (2006). We calculate annual growth rates for a period of 30 years. We also use tertiary completion rates from the Barro-Lee data set on educational attainment as found in Barro and Lee (2000). Given these variables we now turn to estimation procedure.

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<sup>6</sup>For a complete description of methodology go to <http://www.transparency.org/>

## 4.2 Estimation

To estimate the relationship between growth, the college wage premium, and tertiary completion rates we turn to nonparametric estimation. The distinct advantage of using nonparametric estimation is the fact that we don't need to specify functional form. We can express an estimator for  $E(y|x)$  as follows:

$$\hat{m}_b(x_j) = \frac{\sum_{i=1}^n K_b\left(\frac{x_j-x_i}{b}\right)y_i}{\sum_{i=1}^n K_b\left(\frac{x_j-x_i}{b}\right)} \quad (14)$$

where  $K_b$  is the kernel function and  $b$  is the bandwidth which is chosen using the method of cross validation. We can also compare the nonparametric estimate to an alternative parametric model using the H-M stat developed by Härdle and Mammen (1993). When using nonparametric estimation we will generally take interest in the shape of the functions estimated thus we would like to test the functional form estimated against an alternative specification including testing whether a variable is mean independent of another. Using the previous notation we construct the H-M stat as follows:

$$T_n = nb^{d/2} \int (\hat{m}_b(x_j) - \Gamma_{b,n}m_{\hat{\theta}}(x_j))^2 dx_j \quad (15)$$

As suggested by Härdle and Mammen (1993) we replace the integral with the sum over the design points obtaining:

$$\tilde{T}_n = nb^{d/2} \sum_{j=1}^N (\hat{m}_b(x_j) - \Gamma_{b,n}m_{\hat{\theta}}(x_j))^2 \quad (16)$$

where  $\Gamma_{b,n}m_{\hat{\theta}} = \frac{\sum_{i=1}^n K_b\left(\frac{x_j-x_i}{b}\right)m_{\hat{\theta}}(x_i)}{\sum_{i=1}^n K_b\left(\frac{x_j-x_i}{b}\right)}$  and  $m_{\hat{\theta}}(x_i)$  is a parametric estimate for  $E(y|x)$ . Härdle and Mammen (1993) show that the asymptotic distribution of  $T_n$  is not a good approximation in finite samples so they recommend constructing the null distribution using the wild bootstrap. We also report the SELR statistic from Tripathi and Kitamura (2003) and the H-S statistic taken from Horowitz and Spokoiny (2001).<sup>7</sup> As shown by Tripathi and Kitamura (2003), all three statistics have different power properties depending on whether the errors are normal, extreme value, or a mixture of two normal

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<sup>7</sup>The author would like to thank Gautam Tripathi for access to the Gauss code needed to run the SELR test and the H-S stat.

distributions. For a sample size of 250, Tripathi and Kitamura (2003) show that the SELR, H-M, and H-S all have size close to their nominal levels. It should be noted that we estimate bivariate regressions to get a rough picture of what relationship exists between educational corruption and each of the dependent variables listed above. It is acknowledged that these regressions do not provide any kind of definitive results. Instead, they simply allow us to capture some basic relationships between corruption and the dependent variables of interest. With this in mind, we proceed to the results under the assumption that we are dealing with exogenous independent variables.

### 4.3 Empirical results

Figure 4(a) shows the results for the nonparametric estimate of the conditional mean of annual growth on the corruption perceptions index (CPI). Notice that on the same graph we plot the density estimate of the CPI. Towards the tails of the distribution the functional form estimated is not as reliable as towards the center of the distribution thus in the tails we should place little weight on the curvature of the function. Note that the  $E(AnnualGrowth|CPI)$  is upward sloping in the range 1-5.9 for the CPI and then monotonically decreases there after. It seems that corruption has a negative impact on countries that experience high to medium levels of corruption but has a positive impact on growth for countries experiencing moderate to low levels of corruption.

When we compare this result to the model found in Figure 4(b) we see that the function  $P1$  produces the exact opposite of what we observe in the data. However, for the function  $P2$  the model seems to match the data in the range of 1-5.9 for the CPI. Since it is most likely that the countries that do have educational corruption are in this range, our model seems to do a decent job of replicating the relationship between corruption and growth for the countries that our analysis might be applied to.

Turning to the the wage premium and educational corruption, Figure 5(a) and 5(b) compare the results from our estimation to the results produced by the model. Once again the probability function  $P2$  produces results that match the data quite well. This is in contrast to the results produced using the function  $P1$  which suggests a negative relationship between corruption and the wage premium over the range 1-5.9 for the CPI. If this were true, we should see the wage premium rise (fall) as we move to the right (left) along the horizontal axis. From Figure 5(a), it is clear that this relationship does

not exist in the data. Instead we can see that as the degree of corruption increases, so does the wage premium.

Another nice feature about the probability function  $P2$  is the fact that it also reproduces the relationship we observe between corruption and proportion educated. Notice from Figure 6(a) and 6(b) that the proportion educated is negatively correlated with corruption. Our model produces exactly this result when we assume the probability of becoming educated is defined by the function  $P2$ . When we assume the functional form under  $P1$ , the model produces results that are inconsistent with what we observe for our cross-section of countries. Thus there seems to be broad support for our model in the data when we specify the probability of obtaining an education by the function  $P2$ .

Table 5 reports the results for the SELR, H-S, and H-M statistics for various null hypotheses regarding three different types of functional forms including linear, quadratic, and cubic. We also test whether the mean of each dependent variable is independent of corruption. Under all three regressions the null of mean independence is rejected at the 5% level. In terms of model specification, we reject the a linear model for growth using the H-S and H-M statistics but fail to reject quadratic and cubic specification using the SELR and H-M stats. This result suggest that there is a significant degree of nonlinearity in the relationship between growth and corruption. For the wage premium we can only exclude the quadratic specification and mean independence. For post secondary completion rates, the model we fail to reject the linear, quadratic, and cubic specifications using the SELR and H-M statistic while rejecting the cubic specification when using the H-S statistic. The results therefore offer us little guidance as to the functional form between post secondary completion rates and corruption. The only thing we can conclude is that they are negatively related.

## 5 Conclusions

Up to this point, the impact of educational corruption on growth has been unclear. This paper provides an analytical framework for studying the macroeconomic implications of educational corruption. We develop an overlapping generations model of educational corruption and show that educational corruption has a negative impact on economic growth and the level of educational attainment. The driving force behind this result is the fact that

high-ability low-wealth individuals face much lower probabilities of entry than they otherwise would if there was no educational corruption. In this sense a misallocation of talent occurs. Higher income groups, regardless of their innate ability, can be expected to enter the educational institution more frequently which can lead to a lower accumulation of knowledge and slower economic growth if the “crowding out” effect is present. It is also shown that this mechanism increases the wage premium on education. Apart from increasing wage premium, this may perpetuate the existence of educational corruption. In this sense, educational corruption can be seen as a self-sustaining process.

While education provides higher income, it is also associated with a higher social status. Given the presence of educational corruption, higher importance of social status may be growth enhancing in low corruption countries, while growth reducing for highly corrupt countries.

If agents are constrained financially and cannot borrow, the distortions created by educational corruption are exacerbated. We find that relaxing borrowing constraints is growth enhancing even when educational corruption is rampant. Thus one policy implication for countries experiencing high levels of corruption in the educational sector is to institute mechanisms that would increase access to educational credit. The creation of this financial market leads to increased levels of educational attainment and can serve to offset the impact educational corruption has on the economy.

Using Transparency International’s Corruption Perceptions Index, we show that the predictions of the model match up well with what we observe for a cross-section of countries. Using nonparametric estimation, we are able to find hints about the appropriate modeling assumptions of how bribing changes the probability of entry. We find that even in highly corrupt countries, the probability of entry is not solely based on bribes, but rather some combination of bribes and an agent’s ability.

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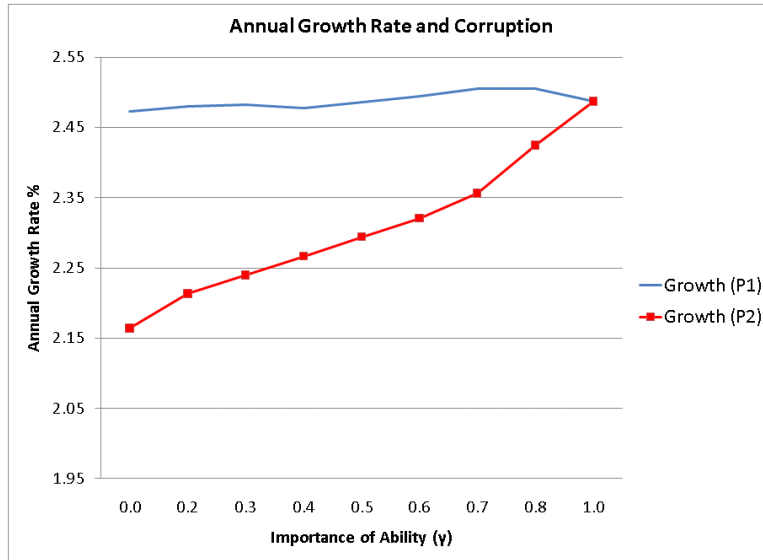
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Table 2: Results for SELR, H-S, and H-M statistics (5% level)

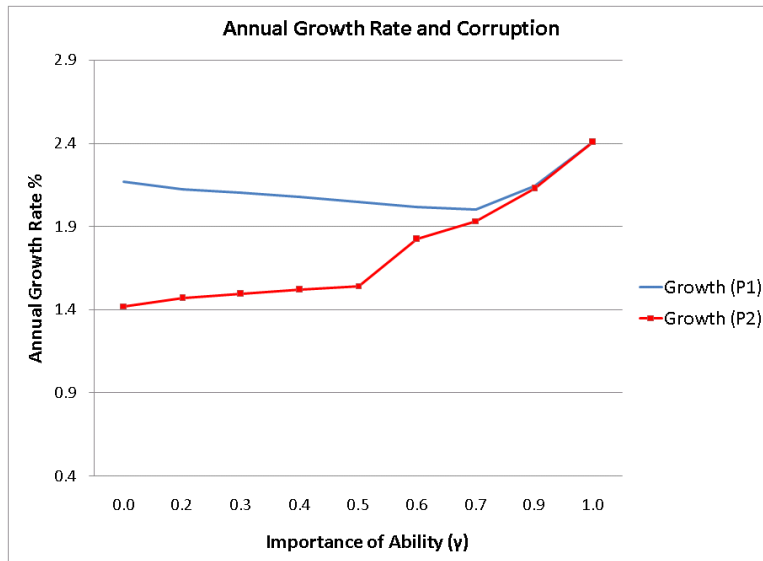
Growth Regression			
Null	SELR	H-S	H-M
<i>H0</i> : linear	No	Yes	Yes
<i>H0</i> : quadratic	No	Yes	No
<i>H0</i> : cubic	No	Yes	No

Wage Premium Regression			
Null	SELR	H-S	H-M
<i>H0</i> : linear	No	No	No
<i>H0</i> : quadratic	Yes	No	Yes
<i>H0</i> : cubic	No	No	No

Post-Secondary Regression			
Null	SELR	H-S	H-M
<i>H0</i> : linear	No	No	No
<i>H0</i> : quadratic	No	No	No
<i>H0</i> : cubic	No	Yes	No

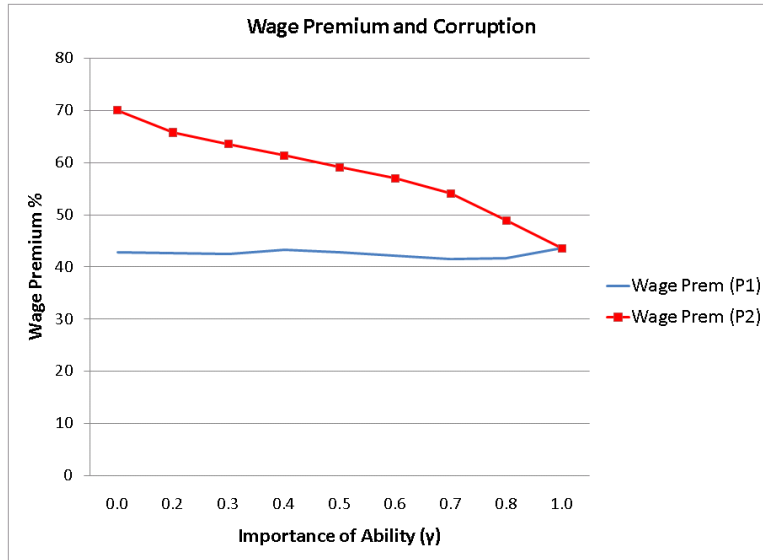


(a) Distribution I

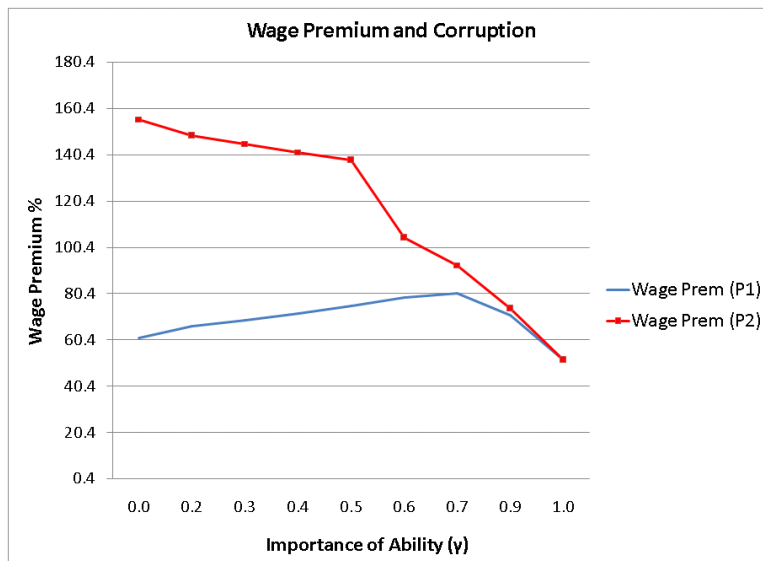


(b) Distribution II

Figure 1: Annual Growth Rate

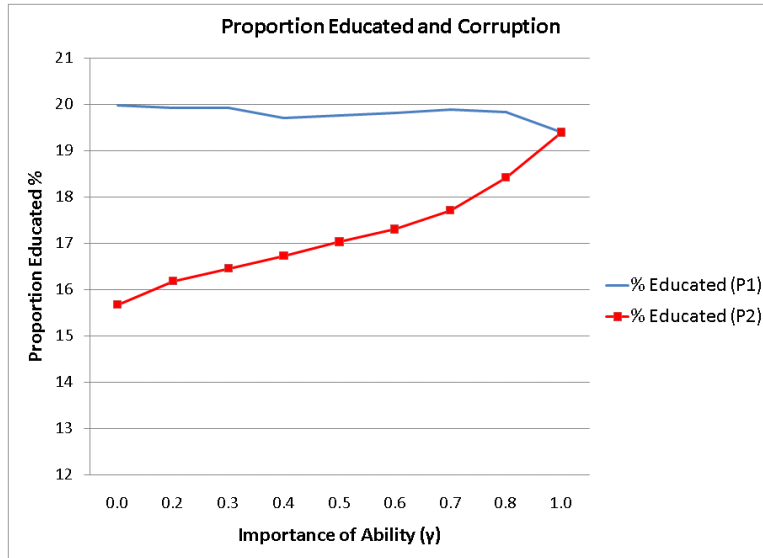


(a) Distribution I

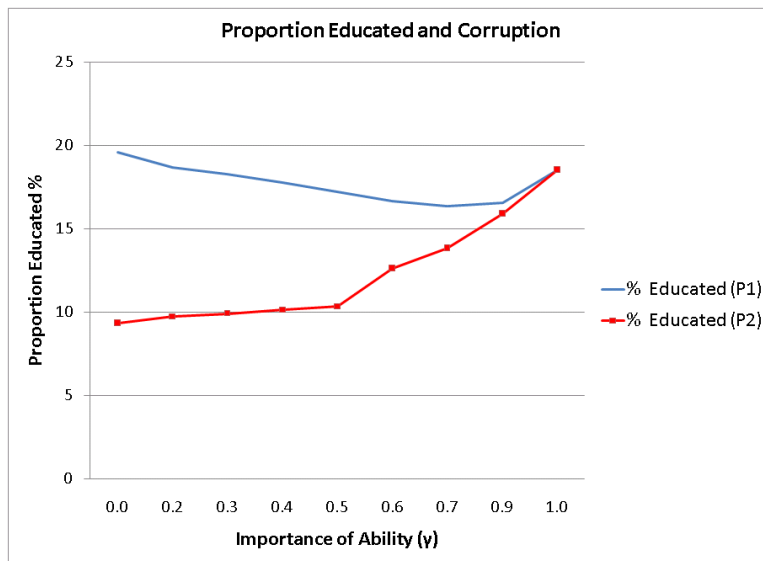


(b) Distribution II

Figure 2: The Education Wage Premium

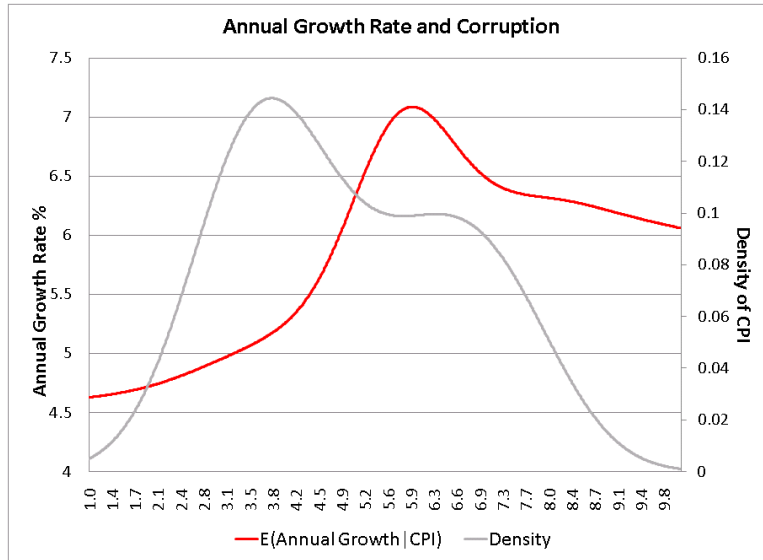


(a) Distribution I

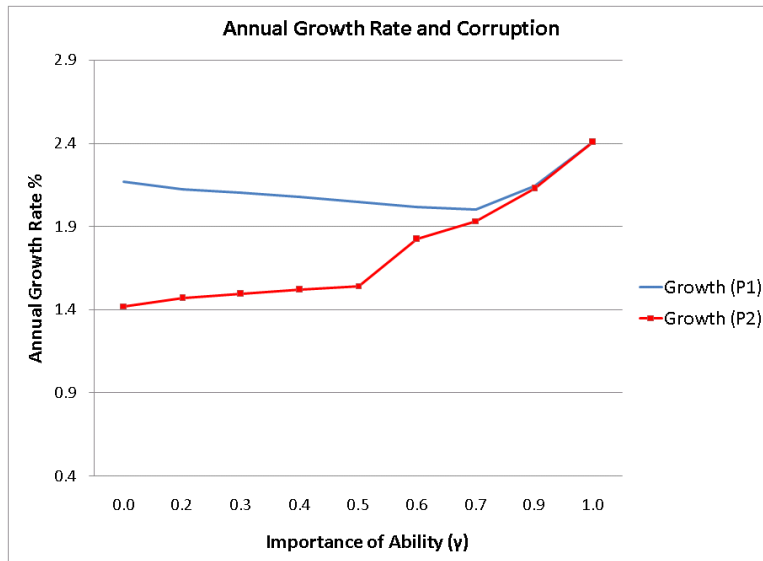


(b) Distribution II

Figure 3: Proportion Educated

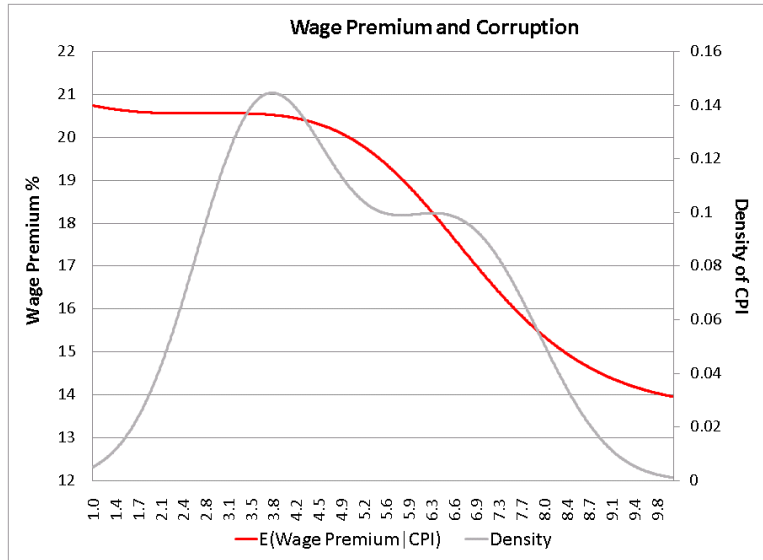


(a) Data

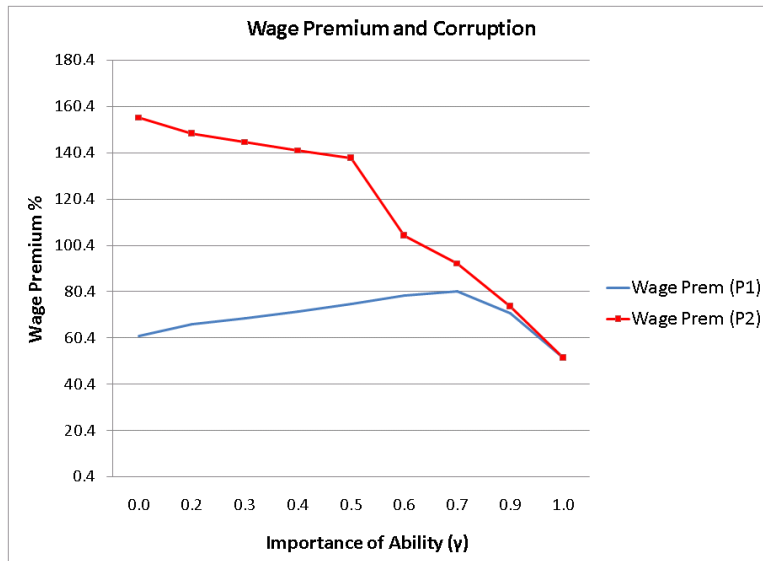


(b) Model

Figure 4: Annual Growth Rate

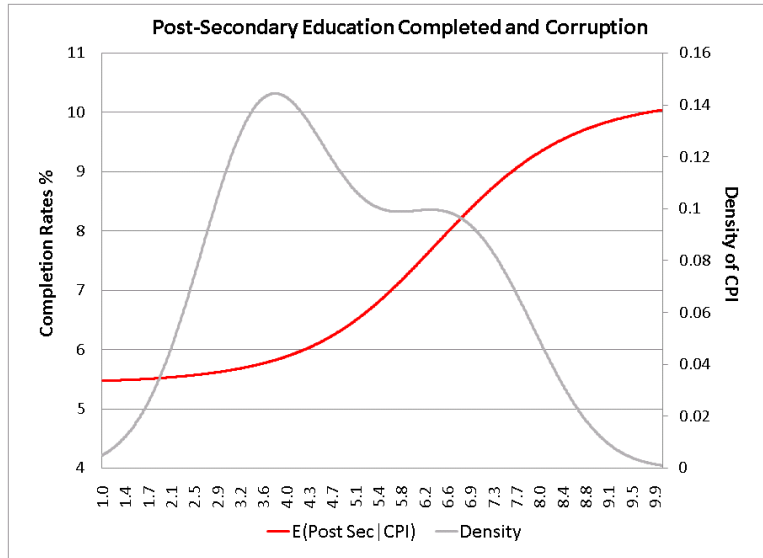


(a) Data

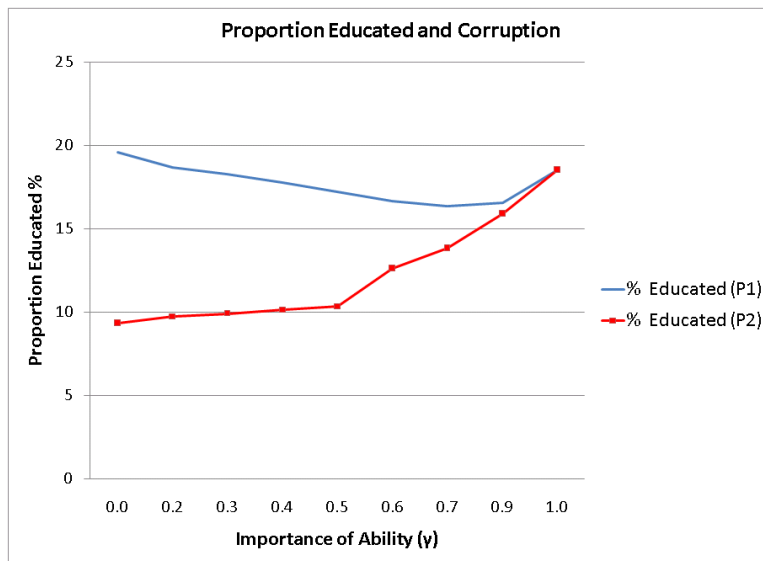


(b) Model

Figure 5: The Education Wage Premium



(a) Data



(b) Model

Figure 6: Proportion Educated



Table 3: With borrowing constraints

Regime	Educated (%)	Annual Growth Rate (%)	Wage Premium (%)	Average Bribe
No Corruption	18.8	2.425	50.843	0.000
Medium Corruption	12.2	1.775	110.878	0.039
High Corruption	9.3	1.423	156.480	0.069

Table 4: With reduced borrowing constraints

Regime	Educated (%)	Annual Growth Rate (%)	Wage Premium (%)	Average Bribe
No Corruption	23.1	2.775	25.286	0.000
Medium Corruption	17.3	2.297	60.943	0.051
High Corruption	11.4	1.685	121.023	0.087

Table 5: With borrowing constraints and no social status

Regime	Educated (%)	Annual Growth Rate (%)	Wage Premium (%)	Average Bribe
No Corruption	14.2	2.003	87.431	0.000
Medium Corruption	10.8	1.595	132.250	0.027
High Corruption	9.8	1.479	148.196	0.052

Table 6: With reduced borrowing constraints and no social status

Regime	Educated (%)	Annual Growth Rate (%)	Wage Premium (%)	Average Bribe
No Corruption	21.5	2.688	32.301	0.000
Medium Corruption	17.7	2.340	57.544	0.035
High Corruption	9.9	1.487	146.798	0.063