The Impact of Corruption on Economic Development of Bangladesh:Evidence on the Basis of an Extended Solow Model

Mohammad Habibullah Pulok

Stockholm Univrsity

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***Abstract*:** The purpose of this thesis is to examine the long run relationship between economic growth and corruption in Bangladesh over the period 1984-2008. In this study, I have extended the neoclassical model of economic growth by Solow (1956) including human capital and public sector explicitly at first. Then, I have incorporated corruption into the augmented model using a specific functional form for total factor productivity and three other channels to show impact of corruption on real GDP per capita. To investigate empirically the existence of a long run relationship or co-integration between corruption and real GDP per capita, I have used Auto-Regressive Distributed Lag (ARDL) Bounds Test method. The results of co-integration test confirms that there is a long run relation among corruption, GDP per capita and other determinants of GDP over the study period. The long run estimates indicate that corruption has direct negative impact on per capita GDP i.e. economic development of Bangladesh.

***Keywords*:** ARDL Bounds test, Co-Integration, Corruption, Economic Growth, Neoclassical Model.

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1. 1: Introduction

Corruption is regarded as an inherent problem for human civilization because of its adverse impact on the progress of humankind. Although its definition, dimension and consequences are continuously changing over time, corruption has spread deep root in the societies since the Stone Age. Sometime, it is claimed that corruption is beneficial for the society to some extent but in a single word, it is a curse for the society. If it is pervasive in any society then it becomes a disastrous virus to halt the normal functioning of that society in particular. After the end of cold war, the issue of corruption has received distinct attention around the world especially in developing countries due to immense freedom of press and flourish of democracy. In any case, growing public awareness and concern over corruption in last two decades have resulted in a significant upsurge in both theoretical and empirical researches to analyze economic consequence of corruption. Thus, an increasing bulk of empirical analysis reveals that corruption has undesirable, devastating and widespread consequences on investment, human development, poverty reduction, effectiveness of both public and private sectors and thus on economic development of many countries in the world.

When corruption is prevalent in a country, it causes economic malaise, wastage of public resources, jeopardizes the environment for domestic and foreign investment and general morale in the public service, reinforces political instability and propagates social and economic disparities even in the presence of favorable economic and social policies. The World Bank (1997) has identified corruption as "the single greatest obstacle to economic and social development"[1]. Again, the World Bank (2004) has projected that more than US$ 1 trillion is paid for bribes over the world as a whole each year. In a nutshell, corruption has detrimental effect on economic prosperity and sustainable development of a country through several transmission mechanisms. This thesis pays a particular attention to the impact of corruption on economic development of Bangladesh. Bangladesh is a poor country by definition. At the same time Bangladesh is among the highly corrupted countries of the world according to Transparency International's corruption perception index (CPI) and other indices of corruption.

The purpose of this thesis is to examine the long run relationship between economic growth and corruption in Bangladesh over the period 1984-2008. Intensifying discussions and debates

[1] Anti-corruption website of World Bank (www1.worldbank.org/publicsector/anticorrupt)

among the economists, policy makers, civil society, domestic and foreign investors and multilateral donors regarding the costs and consequences of corruption in Bangladesh have motivated me to undertake this research work. Because no effort has been taken yet to investigate the impact of corruption on economic development using time series data for Bangladesh.

Many of the earlier studies of corruption and growth relationship suffer from weak linkage between theoretical framework and empirical model adapted. Moreover, it is difficult to get precise estimation of the impact of corruption on economic development via different channels such as investment, human capital, public sector, openness etc. for a single country from cross-sectional regression analysis. In fact, times series studies on corruption- growth relationship using sophisticated econometric methods are almost rare in existing literatures. Therefore, to overcome these shortcomings, I have extended the neoclassical model of economic growth by Solow (1956) including human capital and public sector explicitly at first. Then I have incorporated corruption into the augmented model using a specific functional form for total factor productivity and three other channels to show impact of corruption on real GDP per capita. To investigate empirically whether there exists a long run relationship or co-integration between corruption and real GDP per capita or not, I have used Auto-Regressive Distributed Lag (ARDL) Bounds Test method which has certain advantages for small sample size over traditional co-integration techniques using time series data for that period. Then, I have estimated the overall impact corruption on economic development (Real GDP per capita) as well as the effects through different transmission channels of economic growth.

The organization of the thesis is outlined here as follows. A brief definition of corruption from an economic point of view and a precise overview of economic development and corruption in Bangladesh are provided in the next two sections of this chapter. In chapter two, I discuss the existing literatures on corruption and economic growth with few examples of specific studies related to Bangladesh. The theoretical framework for my empirical analysis is presented in chapter three. Econometric models, data and the methodology are presented in chapter four. A simple contemporaneous correlation and graphical analyses of key variables are provided straightaway after that chapter. Chapter six presents the empirical results from this study. Last of all, chapter seven summarizes the main conclusions from my study.

1. 2: Definition of Corruption

It is very a very challenging task to define a complex phenomenon like corruption because it is viewed differently from different aspects. Although there is rapidly growing interests among policy makers, NGOs ,donor agencies, academicians etc. to identify the causes and consequences of corruption, still no consensus has been made to define corruption comprehensively in existing literatures. Its notion varies across country, culture, society and of course overtime. One activity may be viewed as corruption in developing countries while it may not be in developed countries. In general, the term "corruption" is always used to label a large set of illegal activities ranging from "bribery" to "extortion", from "embezzlement" to "nepotism". In this paper I am concerned with the corruption in public sector governance and its impact on economy of Bangladesh. That is why the scope to define corruption from different perspective is limited here. The World Bank's definition of corruption is "The abuse of public office for private gain. Corruption is every transaction between actors from the private and public sectors through collective utilities that are illegally transformed into private gains"[2]. But there is no way to believe that corruption is only a problem within public administration. Corruption is also pervasive in private sector. Klitgaard (1998) has given a very simple definition of this multidimensional subject as: C=M+D-A-S where C=Corruption, M= Monopoly, D= Discretion, A= Accountability and S= Public sector salaries[3]. Put differently, the degree of corruption depends on the amount of monopoly power and unrestricted supremacy that official's exercise and the extent to which they are held responsible for their actions. The UN's Dictionary of Social Science explain as " Corruption in public life is the use of public power for private profit, preferment of prestige or for the benefit of group or class, in a way that constitutes a breach of law of standards of high moral conduct"(1978:43). According to Transparency International (TI-2009), corruption is the misuse of entrusted political power for personal gain.

In the light of the above discussion, corruption can be defined in a broader perspective as the exploitation of public resources and avoidance of public laws that results in unfair personal gains, lessen economic growth rate and encourages greater inequality of income.

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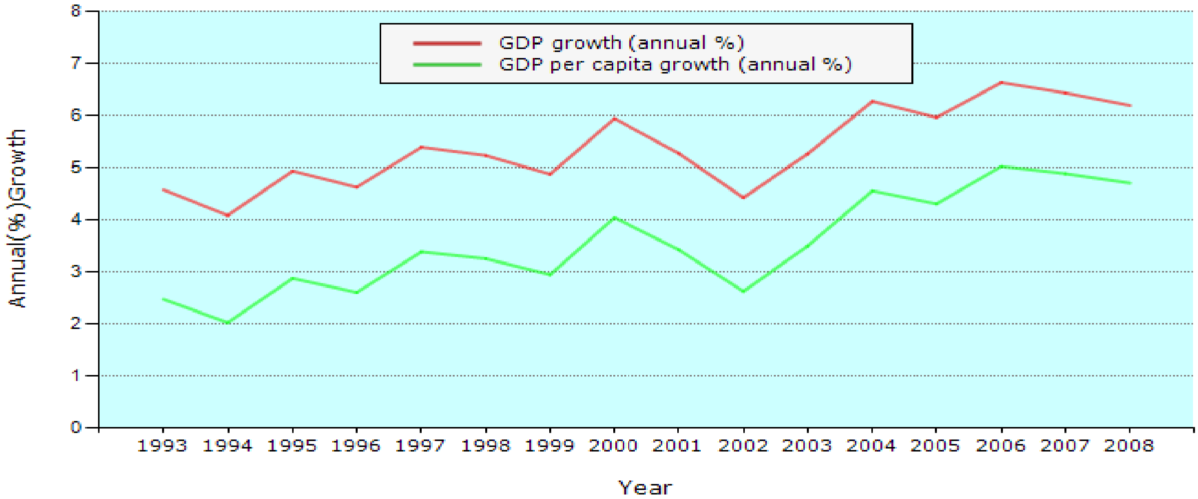
[2]Helping Countries Combat Corruption: The Role of the World Bank, PREM, World Bank, 1997(pp-8)

[3] Mathematically, we can say that C varies positively with M and D, and negatively with A and S.

1. 3: Economic Development and Corruption in Bangladesh: Some facts

Bangladesh is a very small a country in South Asian region but having a large population of almost 160 million. About one fifth of economy was destroyed during the liberation war in 1971, which resulted into slow economic growth in the following years. After that, Bangladesh has done reasonably well in accelerating its GDP growth during last two decades because of major expansion in readymade garments industry and contribution of foreign remittances. Figure-1 illustrates the trend in real GDP growth and per capita GDP growth for the country during 1993-2008. In recent years, Bangladesh has performed relatively well in improving its macro-economic indicators, reducing the level of extreme poverty, raising women empowerment and literacy rate and in achieving other millennium development goals (MDGs) despite of several natural calamities, political instability and other draw backs.

Figure-1: Growth in real GDP and GDP per capita during 1993-2008.



Source: World Bank (WDI Data Base-2010)

However, Bangladesh falls into low-income category country according to the World Bank's classification of economic development. The country's per capita GDP (constant 2000 US$) was US$462 in 2008. Still the standard of living is very low here and about 34% of its population in under poverty line[4]. Moreover, Bangladesh is falling behind in terms economic development compared to the countries with similar characteristics. But it is widely discussed that Bangladesh would be able to improve its category into middle income by 2025 if it could properly utilize its economic capabilities.

[4]Poverty gap at $2 a day (PPP) (%):Source World Bank -2005

In Bangladesh, corruption is considered as one of the major obstacles in the path economic development. It has become rampant all over the society in this county since the independence in 1971. In general, corruption is regarded somewhat obviously as 'a way of life' among the mass people of Bangladesh. Re-establishment of parliamentary democracy from a dictatorial military government in 1991 does not seem to have any influence on the nature and scope of corruption. Corruption is a severe problem in the public sector of Bangladesh from an international perspective also. Bangladesh had been ranked as the most corrupt country in 2001, 2002 and 2003 consecutively in Transparency International Corruption Perceptions Index (CPI). According to the index of the International Country Risk Guide (ICRG), Bangladesh was ranked as the sixth most corrupted nation out of the 123 nations of the world during 1991-97. The following table-1 presents the comparative score of Bangladesh based on above two corruption indices:

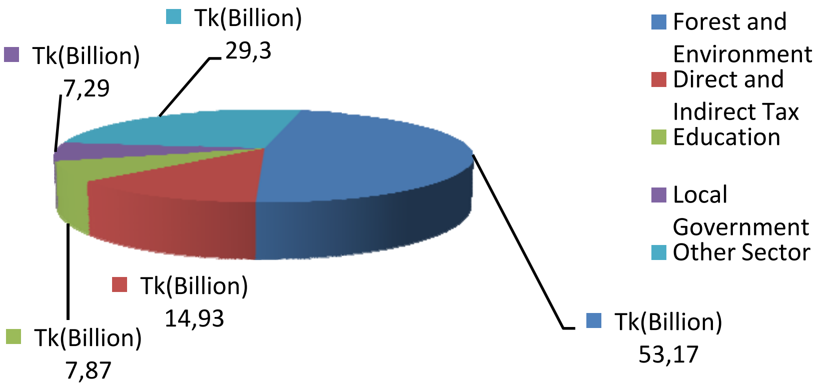
Table-1: Bangladesh's score in Corruption Indices:2001-2008

	TI Corruption Perceptions Index	ICRG Corruption Index
Year	**Score 0—10 0=most corrupt**	**Score* 0—6 0=most corrupt**
2001	0.40	1.80
2002	1.20	1.00
2003	1.30	1.00
2004	1.50	1.04
2005	1.70	2.50
2006	2.00	2.50
2007	2.00	2.04
2008	2.10	2.50

Note:* Monthly values are averaged to get index score of each of year.
Source: Transparency International (TI-2009) and International Country Risk Guide (ICRG-2010).

It is evident from the table that the score of perception-based level of corruption in Bangladesh has remained very low over the period of 2001-2008 though the situation has been better in recent later years. As corruption has infected every sphere of the society like a cancer, it has devastating impact on overall economic development of the country. The image of the country among donors and foreign investors has moved away largely. Corruption in Bangladesh shifts away public resources from productive to unproductive sectors, lessens the efficiency of the public officials involving them into rent seeking, restrains government from implementing good policies, demoralizes public confidence in government and so on. United Nations Development Programme (UNDP) report on "Corruption and Good Governance" states that "If Bangladesh were to improve the reliability and competence of its bureaucracy, its investment would rise by more than five percentage points and its yearly GDP rate would rise by over half a percentage point"[5]. Based on articles on corruption published in newspaper in 2001, which report the amount of money losses due to corruption in several public sectors, Transparency International Bangladesh (TIB) calculated that the government incurred a loss of TK. 112.56 billion (US$2.0 billion), which was equivalent to 4.7% of GDP for the same fiscal year[6]. The following figure-2 illustrates the financial losses incurred by the government indifferent sectors in 2001.

Figure-2: Sector wise Financial Losses to the Government due to Corruption in 2001



Source: Transparency International Bangladesh, Corruption Database-2002

As mentioned earlier a big part of the population of Bangladesh still lives below the poverty level. Every year, Bangladesh receives a big portion of money as foreign aid and grants which is allocated to alleviate poverty, but about 75% (Abul Barakat, 2000) is abused and the poverty alleviation goals have not been achieved.

Thus, corruption has endangered the growth and development of the country by exerting negative impact on public and private investment, misusing scarce recourses, demoralizing people's confidence and destroying the overall atmosphere of leading a customary livelihood.

[5]Khan (1998) at www.ti-bangladesh.org/index.php?page_id=373

[6]Transparency International Bangladesh, News Scan Analysis 2002 (Dhaka: Transparency International Bangladesh, March 2003)

Chapter- 2: Review of previous literatures

This chapter is designed to give an overview of the earlier research works on corruption. Although theoretical and empirical research on investigating the relation between corruption and economic development is relatively a new arena in modern economics, there exists a vast literature on this field[7]. Research on corruption has attracted immense importance since the early 1990's among the economists because it has widespread consequences on economic development[8]. Most of the empirical works are either cross sectional or based on panel data while there is probably no study yet using pure time series data for a single country.

Although there is a budding consensus that corruption is detrimental to the society, theories concerning the influence of corruption have been conflicting to some extents. Some studies have found that corruption works as lubricant to increase the speed of wheels of economic activity and thus accelerates economic growth. Inspired by Leff (1964) and Huntington (1968), this school of thought claims that corruption is beneficial in a sense that bribes act as speed money for the entrepreneurs and businessmen to avoid bureaucratic delays and cumbersome rules and regulations in investment mechanisms. For example, in an equilibrium queuing model Lui(1985) suggest that efficiency of the public administration improves as bribing tactics to reduce waiting costs form a non co-operative Nash equilibrium game among businessmen. Again, competition among public officials can also reduce corruption (Rose-Ackerman, 1978). On the other hand, many studies have claimed that corruption is a hindrance to development as it slows down the pace economic activity by exerting negative externalities through its long-lasting effect in the economic environment. This opposite strand to the speed money proposition claims that corrupt practices between public administration and investors are very detrimental to the overall economic prosperity as it undesirably affects the quality and quantity of investment. Shleifer and Vishny (1993) point out that corruption is more distortionary than taxation and is responsible for raising the cost of doing business, which in turn impedes economic growth. Because it is illegal and it must be kept secret to evade detection and penalty. Moreover, corrupt government officials in poor countries are always interested to spend much resource on military and infrastructure where the scope on

[7]Bardhan.P(1997), Lambsdorff, J. G.(1999), Jain (2001) and Adit (2003)provide extensive review on empirical literatures of corruption.

[8] See Figure-A1 in the appendix-1which displays the studies on the consequences of corruption during1995-2005.

corruption is vast rather than spending on education and health. In a very famous paper Murphy, Shleifer and Vishny (1993) give evidence that the pace of development of country is usually halted when talented people are involved in rent seeking activities. In order to get a clear overview of previous studies on the affect of corruption on economic development, I have divided the discussion as underneath.

2. 1 Corruption and Economic Growth

Most of the empirical studies that investigate the direct relationship between corruption and economic growth have found that pace of economic growth rate is slowed down due to corruption[9]. The problem associated with this kind of research is the direction of causality between corruption and economic growth. Lambsdorff (1999) in his review of literature argues that low GDP per capita can cause corruption while opposite might be true. Mauro initiated the systemic study on the corruption and growth using econometric tools in 1995. Following Solow-Barro style cross-country growth regression framework, he studied the relationship between corruption and economic growth using Business International (BI) corruption index. He found substantial negative association between corruption and the average annual economic growth rate over the period of 1960-85for 70 countries. With the help of Lucas type model Brunetti (1997) gives evidence that corruption has negative insignificant impact on growth .In an environment of less effective government and fragile rule of law corruption is even more harmful for economic growth. Ehrlich and Lui (1999) claimed that economic growth rate is lower due corruption (which is a result of higher level of government intervention).Again, Mo (2001) has shown that corruption reduces economic growth through human capital and political instability channels. His study reveals that 1% rise in the corruption level decreases the growth rate by about 0.72%. Furthermore, in a similar kind of study Pellegrini and Gerlagh (2005) catch that corruption substantially impacts economic growth and income over time. Nevertheless, the negative effect is not always evident in empirical studies. For example Barreto (2001), replicating Mauro (1995) has proved that there exists a direct positive relation between growth and corruption. More specifically, some East Asian countries have performed well to sustain a good GDP growth rate in spite of high perceived level of corruption (Rock and Bonnett, 2004). Augmenting the

[9]Mauro (1995,1997), Brunetti, (1997), Poirson, (1998), Ehrlich and Lui, (1999),Li, Xu and Zou (2000), Mo (2001), Abed and Davoodi (2002), Leite and Weidmann (2002) and Meon and Sekkat (2005) have found that corruption hurts economic development.

work of Mauro (1995) and using ICRG index of corruption, Rahman, Kisunko and Kapoor(2000)provide evidence in a cross sectional study that corruption has significant negative impact on per capita GDP of Bangladesh. The study points out "if corruption in Bangladesh could be reduced to levels existing in transition economies like Poland, then during the 1990-97 period Bangladesh could have increased its annual average per capita growth rate by more than 2 percent (from 3.4 percent to about 5.5 percent per annum)"[10]. In line with Mauro's findings, Wei (2001) calculated that per capita GDP growth rate in Bangladesh could be doubled by 1985 if it would be able to reduce its corruption level to that of Singapore. Dreher and Herzfer, (2005) estimated that GDP growth rate in Bangladesh is reduced by 23%as it has above average corruption level according to ICRG index. So far, econometric studies largely confirm that corruption is detrimental to economic growth.

2. 2: Corruption and Investment

Levine and Renelt (1992) show that the investment is a robust determining factor of economic growth. In most of cases economists have found negative relation between corruption and investment. Beginning again with the seminal work Mauro (1995) confirms that corruption has substantial negative effect on investment. Corruption acting as tax on return to private investment indirectly lowers both the quality and quantity of investment. For example, Mauro(1995,pp-3) says "if Bangladesh were able to reduce corruption by one standard deviation to the level of Uruguay, its investment rate would increase by almost 5 percent and its annual rate of growth would rise by over one-half percent." Similar findings are also illustrated in Rahman, Kisunko and Kapoor (2000) in which corruption has significant impact on gross domestic investment of Bangladesh. In addition, effect of corruption on the quality of investment is investigated by Tanzi and Davoodi (1997) and discovered that it decreases the quality of the infrastructure as measured by the condition of paved roads and power outages. In a cross sectional study over 1970-85 Mo (2001) finds that investment channel causes about 28% of the growth rate reduction in the corruption–growth linkage. In addition, Campos, Lien and Pradhan (1999) verified that impact of corruption on investment is not severe if corruption is predictable. FDI inflows are also affected by corruption in transition economies (Abed and Davoodi, 2002). To summarize, we can say that most studies found that corruption hinders investment, which is an important contributor of GDP.

[10]Rahman, Kisunko and Kapoor, (2000,pp-11)

2. 3: Corruption and Public Sector

In most cases the relationship between public sector and corruption are investigated under empirical studies of economic development and corruption. In an explicit research, Tanzi and Davoodi (1997) explored several important findings. The most important among these is corruption provides opportunities to increase the size of public investment at the cost of private investment. Again, corruption lessens the efficiency of government investment and of a country's infrastructure. Mauro (1998) also gets almost similar results. Again, Tanzi (1998) mentioned that corruption increases government spending while it reduces government revenue at the same time. In addition corruption induces higher military spending which indirectly results in higher government expenditure exerting negative impact on growth Gupta *et al*. (2001).So, many studies conclude that corruption affects public sector in various ways.

2. 4: Corruption and Human Development

Research has not grown so far too much to explore corruption and human capital investment relation both theoretically and empirically. Corruptions also have some indirect negative impacts on human development through lowering economic growth. Corrupt countries tend to have less human development. Corruption shifts away government investment from health and education to unproductive sectors as the rent extracting scope is limited in these sectors (Tanzi and Davoodi, 1997). Gupta, Davoodi, and Tiongson (2002) indicates that corruption decreases the level of social spending, nurtures education inequality, lowers secondary schooling, and causes uneven distribution of land. Mauro (1998) gives empirical evidence that corruption skews public investment on education in a cross sectional study. Further, Mo (2001) finds that a country where corruption is more pervasive, average schooling is lower. Using Human Development indicator (HDI)-1998, Akçay (2006) establishes that there is strong negative relation between human development and corruption indices in a sample of 63 different countries of the world. So, according the previous studies we can summarize that corruption tends to lower human development in many cases.

Thus, according to the above discussion on earlier studies, I can conclude that corruption adversely effects economic development having negative impact on various determinants of economic growth. However, there are also few exceptions to this finding

Chapter-3: Theoretical framework

This section deals with developing a neo-classical framework for corruption- growth relation based on the hypothesis that corruption has negative impact on economic growth. The existing literatures on examining the consequence of corruption on growth suffer from a theoretical structure work that does not includes the possible effect of corruption on income per capita via different transmission mechanisms. In other words, these studies have failed to analyze both direct and indirect effect together in some cases. Economic growth of a country depends on several determinants such as physical capital investment, public sector investment, foreign investment, trade ,human capital investment etc. and of course on technological advancement. These factors can also be affected by corruption. Thus, it is essential to decompose the direct and indirect effects of corruption on growth. Based on the classical work of Solow (1956), an extended neoclassical model of economic growth will be developed in this chapter that explicitly includes not only physical capital accumulation but also human capital accumulation and public sector. Later on, using a specific functional form, corruption will be incorporated into the augmented model to show how it can directly affect income per capita as well through the different transmission mechanisms as mentioned above.

3. 1: An extended Solow model with public sector

In the Solow model, output, physical capital, labor and knowledge (reflects the degree of technological development of a country) are the four variables which are used to explain the economic growth path of a country. In this model savings rate, population growth, and technological progress are exogenous variables. Capital and labor are the two inputs of production and each are paid their marginal price. Based on these specifications, a labor augmenting neoclassical production function in Cobb-Douglas form at time (t) can be written as follows:

$$Y(t) = F\left[(K(t),A(t)L(t)\right] = K(t)^{\alpha} \ (A(t)L(t))^{1-\alpha} \quad \text{where, } 0 < \alpha < 1 \qquad (1)$$

Here, Y is the aggregate level of real income, K is the level of physical capital, L stands the amount of labor employed, and A denotes total or multifactor productivity. In the above function, time affects output only through K, L and A.

There is no explicit place for government or public sector in the Solow model as stated above. But the role of public sector economic development is very crucial in many respects. In a developing or less developed country like Bangladesh, the role of government in distributing and allocating resources is very important. Public sector has productive externality for the private producers, which come at the cost of private disposable income by the taxes. Moreover, in the earlier stage of development government sector often plays the key role as an engine of economic growth. In reference to, Arrow and Kurz (1970) and Barro (1991), public sector can be incorporated directly into the production function as follows:

$$Y(t) = F\left[K(t), G(t), A(t)L(t)\right] = K(t)^{\alpha}\ G(t)^{\gamma}\ (A(t)L(t))^{1-\alpha-\gamma} \quad \text{where} \quad (\alpha+\gamma) < 1 \tag{2}$$

Here G stands for public sector. The above equation presents how output is depended upon physical capital, public sector, and labor.

3. 2: An extended Solow model with public sector and human capital

Following the approach of Mankiew, Romer and Weil (1992), human capital has been included into the Solow model including a public sector. Human capital has been considered as a key determinant of economic growth in growth literature. Many researchers have shown that including human capital in the production function improves the explanatory power of the Solow model. Based on the above discussion, it now possible to present the complete neoclassical model of growth including government sector and human capital accumulation in the following form:

$$Y(t) = F\left[K(t), H(t), G(t), A(t)L(t)\right] = K(t)^{\alpha}\ H(t)^{\beta}\ G(t)^{\gamma}\ (A(t)L(t))^{1-\alpha-\beta-\gamma} \quad \text{where } (\alpha+\beta+\gamma)<1 \tag{3}$$

Here, H is the stock of human capital. The equation (3) is the extended Solow model with public sector and human capital. It shows how aggregate level of output is determined by three inputs.

The growth rate of labor force is defined as $L(t)=L(0)e^{nt}$. So the growth rate of labor force is constant overtime that is $\frac{\dot{L}}{L}=n$ where n is the population growth rate. It is also assumed that overall productivity function evolves according to the function $A(t)=A(0)e^{\varpi t}$ and it constant over time that is $\frac{\dot{A}}{A} = \varpi$ where ϖ is the growth rate of technological progress. Here, $(\alpha+\beta+\gamma)<1$ implies that production function exhibits decreasing returns to each input. Now the intensive form of production function can be written as below:

$$y(t) = k(t)^{\alpha} h(t)^{\beta} g(t)^{\gamma} \qquad (4)$$

where, $y(t)=\frac{Y(t)}{A(t)L(t)}$, $k(t)=\frac{K(t)}{A(t)L(t)}$, $h(t)=\frac{H(t)}{A(t)L(t)}$ and $g(t)=\frac{G(t)}{A(t)L(t)}$ represents the level of income per unit of effective labor, physical capital per unit of effective labor and so on. Let us denote S_k, S_h and S_g as the shares of income which are invested in physical, human and government capital. So the evolutions for physical, human and government capital per unit of effective labor can be stated as follows:

$$\dot{k}(t) = s_k y(t) - (n + \varpi + \delta_k) k(t) \qquad (5)$$

$$\dot{h}(t) = s_h y(t) - (n + \varpi + \delta_h) h(t) \qquad (6)$$

$$\dot{g}(t) = s_g y(t) - (n + \varpi + \delta_g) g(t) \qquad (7)$$

The implication of equations (5), (6) and (7) is that all capitals per effective unit of labor converge to a steady-state value. "It is assumed that same production function applies to human capital, physical capital, government capital and consumption. In other words one unit of consumption can be transformed costly into either one unit of private capital or human capital or government capital" (Mankiw, Romer, and Weil, 1992,pp-11). For the sake of simplicity, let us assume $\delta=\delta_k=\delta_h=\delta_g$ which means that depreciation rate is same for all capitals. Using equations (5), (6) and (7) when the economy converges to a steady-state can be defined as follows:

$$k^* = \left(\frac{s_k^{1-\beta-\gamma} s_h^{\beta} s_g^{\gamma}}{n+\varpi+\delta}\right)^{1/(1-\alpha-\beta-\gamma)} \qquad (8)$$

$$h^* = \left(\frac{s_h^{1-\alpha-\gamma} s_k^{\alpha} s_g^{\gamma}}{n+\varpi+\delta}\right)^{1/(1-\alpha-\beta-\gamma)} \qquad (9)$$

$$g^* = \left(\frac{s_g^{1-\alpha-\beta} s_k^{\alpha} s_h^{\gamma}}{n+\varpi+\delta}\right)^{1/(1-\alpha-\beta-\gamma)} \qquad (10)$$

Equations (8), (9), and (10) indicate that steady-state capitals increase with higher levels of saving and decrease with higher rates of population growth. By substituting equations (8), (9) and (10) into the production function and taking the natural logarithm ,the following equation for income per capita is obtained :

$$\ln\left\{\frac{Y(t)}{L(t)}\right\} = \ln(A_0) + \varpi t - \left[\left\{\frac{(\alpha+\beta+\gamma)}{(1-\alpha-\beta-\gamma)}\right\}\ln(n+\varpi+\delta)\right] + \left\{\frac{\alpha}{(1-\alpha-\beta-\gamma)}\right\}\ln(s_k) + \left\{\frac{\beta}{(1-\alpha-\beta-\gamma)}\right\}\ln(s_h) + \left\{\frac{\gamma}{(1-\alpha-\beta-\gamma)}\right\}\ln(s_g) \qquad (11)$$

The equation (11) shows how income per capita is dependent on population growth, depreciation rate, initial level of total factor productivity and its growth and accumulation of public, physical and human capital. Without the government sector, this model is similar to the model developed by Mankiew, Romer and Weil (1992). Equation (11) reveals that steady state income per worker is accumulative in initial level of total factor productivity and its growth rate and physical, public and human capital investment rates. Higher initial level of total factor productivity increases steady state income per worker and the higher the growth rate of total factor productivity the higher the steady state income per worker, as well. The above equation also implies that a country that saves more of its income has more capital per worker and more income per worker. Furthermore, a country with higher population growth has less capital and income per worker because savings must be depleted in order to maintain its capital-labor ratio.

3.3: Reformulating the extended Solow model by incorporating corruption

The model developed in the previous section does not provide a deep understanding of economic growth. There are several other factors, which can have, both level and growth effect on economic growth of a country. For example, North (1990) argued that institutions in a country determine its long-run economic performance. Here institutions refer to political stability, quality of government, independent judicial system, political rights, property rights etc. So it is possible to modify the above model of economic growth to explain how these matters can also have impact on the development of a country. In recent past, many researchers have investigated the impact of several dimensions of institutions both theoretically and empirically. Many of them have taken either the level of corruption or level of corruption control as a measurement of institutions. Corruption can directly affect the income per capita or growth through affecting total factor productivity of the country. Besides, corruption influences growth indirectly by affecting physical capital investment, public sector investment, human capital, etc.

Let us first concentrate on the discussion of the direct impact of corruption on growth in the light of the augmented Solow model derived above. Total factor productivity (TFP) growth measures the changes in output not caused by changes in inputs. TFP growth explains the effect of technological change, efficiency improvements, and our inability to measure directly the contribution of all other inputs. Therefore, it is reasonable to assume that corruption reduces the efficiency gain from technological advancement by imposing negative externality on it. Countries with high level of corruption gain less benefit from technological advancement. In order to show the direct of corruption via total factor productivity a structural form for the evolution of total factor productivity should be assumed. To allow for specification, let us assume that

$$A_{(t)}(\theta) = A_{(t)} e^{-\eta\theta} \tag{12}$$

Here, $0 \leq \theta \leq 1$ and $A(t) = A(t)e^{\varpi t}$

The parameter θ is the index of corruption that we will use later as a measurement of level of corruption in a country and η determines the magnitude of the effect of corruption on growth. It is assumed that $\frac{dA(t)}{d\theta} < 0$ and $\frac{d^2A(t)}{d\theta^2} > 0$. From equation (12), when there is no corruption or (θ=0) then $A_t=A_0e^{\varpi t}$.This is also same for the case when η=0.The specific functional form in equation (12) reproduces the result of equation (11) into the following equation:

$$\ln\left\{\frac{Y(t)}{L(t)}\right\} = \ln(A_0) + \varpi t - \left[\left\{\frac{(\alpha+\beta+\gamma)}{(1-\alpha-\beta-\gamma)}\right\}\ln(n+\varpi+\delta)\right] + \left\{\frac{\alpha}{(1-\alpha-\beta-\gamma)}\right\}\ln S_k + \left\{\frac{\beta}{(1-\alpha-\beta-\gamma)}\right\}\ln S_h + \left\{\frac{\gamma}{(1-\alpha-\beta-\gamma)}\right\}\ln S_g - \eta\theta \tag{13}$$

The above model explains how corruption has direct influence on income per capita. It shows that corruption has direct impact on growth by changing the overall productivity of the economy. If the level of corruption is high according to corruption index (θ), it will reduce per capita income. Again, a positive value of η implies that corruption diminishes output per worker while a negative value means that corruption is output enhancing.

Now, I will define the transmission channels through which impact of corruption on economic growth is diffused in the augmented Solow model. Let us consider the case of the public sector channel at first. In order to finance public sector expenditure government imposes taxes. However, at the presence of corruption in the public sector, the effective tax system gets distorted. Again, due to the corrupt behavior of the public officials the provision of the public input can also be mismanaged. According to Tanzi and Davoodi (1997), corruption retards the productivity of public investment and of a country's infrastructure and may reduce tax revenue because it compromises the government's ability to collect taxes and tariffs. Therefore, the government generates fewer amounts of productive inputs for a given amount of tax revenue at the presence of corruption[11].Moreover; corruption skews the composition of public expenditure away from needed operation and maintenance towards expenditure on new equipment (Klitgaard, 1990). Thus, it is possible to express the public sector input or investment as a function of the average tax rate (τ), output (y_t) and the level of corruption; $g_t = g(\tau, y_t, \theta)$

Secondly, corruption can affect growth by having impact on investment. Corruption raises operational cost, creates uncertainty, and thereby lowers investment (Shleifer and Vishny, 1993). According to Lambsdorff (2003) and Mauro (1995, 1997) by increasing uncertainty and reducing productivity, corruption can affect investment negatively. Because of corruption, uncertainty necessitates an added premium on investment returns, which in turn raises real interest rate and leads to lower investment demand. It should be noted that when the quality and quantity of public input is depressed as through above discussed channels, it also has negative externality on private capital productivity. This relationship can be postulated as follows:

$k_t = k(r_t(\theta))$ where, $r_t$is the real interest rate which is itself an increasing function of corruption. In our context $r_t'(\theta) > 0$ and $k_t'(\theta) < 0$.

Finally, the impact of corruption on human capital formation should be considered to make the growth model complete and comprehensive. Although it is somewhat complex to capture the idea how human capital formation is distorted at the presence of corruption, I try to keep it

[11] "The Effects of Corruption on Growth, Investment and Government Expenditure: A Cross Country Analysis" by Mauro.P (1997) has good explanation on how corruption affects tax revenue collection and the adverse consequences of corruption on government budget.

as simple as possible. Corruption distorts the allocation of resources in human capital formation and quality of human capital investment also. According to Mauro (1998), public officials do not want to spend more on education and health because this spending programme offers less opportunity for rent seeking. Gupta, Davoodi, and Tiongson (2000) conclude that corruption has negative impact on health care and education services in two ways: (1) corruption may raise the cost of these services, and (2) corruption may reduce the quality of these services. Moreover, skilled and talented workforce engaged in rent seeking activities which lowers the pace of human development. In this paper, I will only consider the case where corruption affects human capital accumulation through its negative effect on educational expenditure. The mechanism can be presented by assuming the following functional form:

$h_t = h(EX_t(\theta))$ where $EX(\theta)$ shows that expenditure on education is a function of corruption and $EX'(\theta)<0$

Based on the above arguments, the steady state equation for income per worker from equation (13) including corruption for revealing both direct and indirect effect can be reproduced as follows:

$$\ln\left\{\frac{Y(t)}{L(t)}\right\} = \ln(A_0) + \varpi t - \left[\left\{\frac{(\alpha+\beta+\gamma)}{(1-\alpha-\beta-\gamma)}\right\}\ln(n+\varpi+\delta)\right] + \left\{\frac{\alpha}{(1-\alpha-\beta-\gamma)}\right\}\ln s_{k(r_t(\theta))}$$
$$+\left\{\frac{\beta}{(1-\alpha-\beta-\gamma)}\right\}\ln s_{h(EX_t(\theta))} + \left\{\frac{\gamma}{(1-\alpha-\beta-\gamma)}\right\}\ln s_g(\tau, y_t, \theta) - \eta\theta \qquad (14)$$

Equation (14) illuminates both the direct and indirect impacts of corruption on the per capita output over time. As an increase in corruption reduces total factor productivity, an increase in the level corruption has an inverse relationship with growth of income per worker Corruption also indirectly impacts per capita output growth by reducing the growth of physical capital, human capital and diminishing the productive externality provided by the public sector. This modeling approach has several advantages over the models used in the literature: i) importantly, it builds on the well-known neoclassical growth model ii) the model allows the use of the modern time series data methods in estimations iii) in addition the incorporation of the growth effects of corruption into the model is done in a general way that captures both direct and indirect effect of corruption.

Chapter-4: Empirical framework, Data and Methodology

4. 1: Econometric Models

To achieve the main purpose of this research i.e. testing the existence of long run relationship between economic growth and corruption and examining the direct and indirect consequences of corruption on economic development in Bangladesh, I have used modern time series econometric techniques for the period of 1984-2008. If there is a long run relationship(co-integration), then I would estimate impact of corruption on economic growth. Therefore, this chapter outlines the structure of econometric models designed and their relevance in the light of the theoretical framework developed in the previous chapter. It is apparent from our extended Solow model that income per capita depends on physical, public and human capital accumulation. Thus, the following base model without corruption will be estimated at first:

$$\ln Y_t = \beta_0 + \beta_1 \ln INV_t + \beta_2 \ln GVX_t + \beta_3 \ln EDX_t + \beta_4 \ln Z_t + u_t \qquad (I)$$

$$\text{Here,} \quad Z_t = \ln(\varpi_t + \delta + n_t)$$

In the above specification, Y denotes Real GDP per capita, which is used as an alternative for income per worker. In most of the empirical growth literatures, researchers use this as an indicator of economic growth of a country. Gross fixed capital formation is used for measuring physical capital formation, which is denoted by INV. Further, GVX stands government final consumption expenditure, which is taken as proxy for public sector input, and EDX indicates public expenditure on education, which is proxy for human capital formation. Here, Z is used to denote the accumulation of total factor productivity growth rate (ϖ), depreciation rate (δ) and population growth rate (n) as explained in theoretical frame work. Lastly, u is the usual error term with classical properties and t stands for the time index. Hence, the estimation of the above equation would be used to explain the long run determinants of economic growth of Bangladesh. Based on the theoretical framework, it is expected that the signs of coefficients of INV, GVX and EDX would be positive. The value of each parameter associated with each variable will reflect the long run contribution of various determinants of economic development.

Adding corruption as an explanatory variable in the base model, it is possible to estimate the effect of corruption on economic growth. Therefore, motivated by the theoretical model stated in equation (14), the following empirical model will be estimated:

$$\ln Y_t = \beta_0 + \beta_1 \ln INV_t + \beta_2 \ln GVX_t + \beta_3 \ln EDX_t + \beta_4 \ln Z_t + \beta_5 \ln COR_t + u_{t1} \qquad \text{(II)}$$

Here, COR represents the index of corruption, which will be discussed in details in the next section of this chapter. In order to avoid the problem of non-normality and interpretation, I have multiplied the index corruption by hundred (100) and taken natural log of it. The expected sign of corruption parameter is negative which would reflect the negative impact on real GDP per capita or economic growth as derived in the theoretical model. It shows the direct effect of corruption on per capita real GDP. By analyzing the signs and change in the parameter value associated with the determinants of GDP, we would be able to understand how corruption influences it through various channels. As priori, we can say that it will decrease the parameter values as in equation (I).

4.2: The choice of indicators and their sources

This section provides a discussion of the choice of indicators used in this research paper and their sources. Annual aggregate time series data for Bangladesh is used in this study which consists of 25 observations for the period of 1984-2008. The sample size is relatively small due to the unavailability of the data on the measurement of corruption for Bangladesh. But the most important matter is that the most recent data has been used for this study. Real GDP per capita (constant 2000 US$) is used as proxy for income per capita which is the dependent variable in our empirical models. It is the value of all final goods and services produced within the geographical area of a country during one-year period divided by consumer price index. Gross fixed capital formation or investment comprises land improvements, plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings[12].Government final consumption expenditure consists all contemporary government expense to buy goods and services including salaries of employees. Note that military investment is not included in government final consumption expenditure. Public expenditure on education is the government current expense on education sector. These three

[12] Definition of World Bank's world development indicator (WDI-2008) database.

variables are taken as a percentage share of GDP. Population growth rate is annual growth of population in percentage term. I have assumed 3% (percentage) depreciation rate for all capitals. The primary sources of these statistics are World Bank Development Indicators (WDI) data base, Ministry of Education and Ministry of Finance Bangladesh, Bangladesh Bank (Central Bank of Bangladesh) etc.

I have extracted data for total factor productivity (TFP) growth rate from the total economy data base of the Conference Board[13]. According to their definition, TFP growth measures the changes in output not produced by the changes in inputs. It can be technological advancement, improvement in efficiency and many other factors which are not measurable. A complete list of variables used in this paper including their sources and description is provided in table-A1 in appendix-2.

I have chosen the corruption index of the International Country Risk Guide (ICRG) ratings complied by the Political Risk Services (PRS) Group Inc. The prime reason for using this index is that it has data on corruption date back to 1984 for Bangladesh. Again, this data base is used extensively for researches in corruption, appearing recently in the empirical studies of Knack and Keefer (1995), Tanzi and Davoodi (1997), Rahman, Kisunko and Kapoor (2000), Dreherand Herzfel (2005)Seldadyo and Haan (2006) ,Wei (2000)and so on. According to ICRG,this corruption index is an estimator of the degree of political corruption in a political system. It is a subjective measure of corruption that ranges from "0" to "6", with "0" being the highest corrupt. This index is prepared on monthly basis. As all other variables used in this study are yearly, I have transformed the monthly data in to yearly data by taking the average at first. Secondly, for tranquil and simple interpretation of the empirical results and to make it more intuitive, I have reversed the raw corruption data into an index ranging from "0" to "1" where the higher the index the higher the level of average corruption. In a nutshell, the proxy variable for corruption index is constructed in this way: $COR_t = (1 - \frac{\theta}{6})$, Where COR_t stands for the measurement of corruption in the empirical analysis**.** Now-a-days, there are several organizations which have constructed indices for measuring the level of corruption. Except ICRG, these are Corruption Perception Index (CPI) by Transparency International, Kaufman and Kraay' index (KK), the Business International Index (BI) and the World Economic Forum index (GCR). It should be noted that correlation among different corruption

[13]The Conference Board Total Economy Database, January 2010, http://www.conference-board.org/data/economydatabase/

indices are high (see table-A2 in appendix-2). Although these quantifiable measures that are widely used by researchers to link economic performance with corruption, the main limitations of the majority of these measures are their heavy bias towards the perception of foreign investors and experts, their poll-based nature and restricted coverage.

4. 3: Regression Techniques

There are a number of methods available to examine the existence of long run equilibrium relationship or the co-integration among the time series variables. The most common techniques are residual based Engle-Granger (1987) two-step and one step procedures and Johansen (1988), Johansen and Juselius (1990) test for co-integration based on maximum likelihood method. However, there are several major disadvantages associated with these methods. For instance, Enders (2004) proved that variables must be integrated in the same order by definition for co-integration in Engle-Granger procedure. These two methods for finding the co-integration are not that much reliable for studies with small sample size. This research work adopts relatively a new technique for testing the existence of a co-integration which developed in a series of studies by Pesaran and Shin (1995a,1995b) and Pesaran, Shin and Smith (1996,2001)known as Auto-Regressive Distributed Lag (ARDL) Bounds Test methodology.

The bounds testing approach has certain econometric advantages in comparison to other co-integration procedures, According Pesaran(1997), the ARDL procedure yields precise estimates of long run parameters and valid t-statistics even in the presence of endogenous variables. In line with Banerjee *et al.* (1993), the error correction model (ECM) can be derived from the ARDL through a simple liner transformation. In addition, the ARDL approach to test for the existence of a long-run relationship among the variables is applicable regardless of whether the underlying regressors are purely I(0), purely I(1), or mutually integrated. Finally, according to Narayan (2005), the small sample properties of the bounds testing approach are far superior to that of multivariate co-integration[14]. So considering all the above mentioned points and based on the theory that per capita GDP in dependent on

[14]In particular, Pesaran and Shin (1999) show that the ARDL approach has better properties in sample sizes up to 150 observations

investment, government expenditure and educational expenditure the unconditional ARDL–ECM representation of the empirical equation (I) can be designed as follows:

$$\Delta \ln Y_t = \beta_0 + \lambda_1 \ln Y_{t-1} + \lambda_2 \ln INV_{t-1} + \lambda_3 \ln GVX_{t-1} + \lambda_4 \ln EDX_{t-1} + \lambda_5 \ln Z_{t-1} + \sum_{i=1}^{p} \eta_i \ln\Delta Y_{t-i}$$

$$+ \sum_{i=0}^{q_1} \theta_i \Delta \ln INV_{t-i} + \sum_{i=0}^{q_2} \partial_i \Delta \ln GVX_{t-i} + \sum_{i=0}^{q_2} \phi_i \Delta \ln EDX_{t-i} + \sum_{i=0}^{q_2} \gamma_i \Delta \ln Z_{t-i} + u_t \qquad \text{(I.a)}$$

Where β_0 is the constant and u_t is the white noise error term. The terms associated with summation signs denote the short run dynamics, whereas λ_is are the long run multipliers. In order to maintain consistency, the bounds test must be executed on the second model (II) also. Because of adding corruption as an independent variable in the model, co-integration may not be found or vice-verse. The equations for the model with corruption are given in Appendix-3.

The first step in the ARDL bounds test approach is to estimate equation (I.a) by ordinary least square (OLS) method. The regression results of the full model are of no interest. An F-test is performed to test the presence of long run relationship among the variables. The null hypothesis of non-existence of long run relationship in equation (I.a) $H_o{:}\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0$ is tested against the alternative hypothesis of co-integration $H_o{:}\ \lambda_1 \neq 0, \lambda_2 \neq 0, \lambda_3 \neq 0, \lambda_4 \neq 0, \lambda_5 \neq 0, \neq 0$. However, the asymptotic distribution of this F-statistic is nonstandard, depending on the regressors whether they are I (0) or I (1). It rests on the number of regressors and whether the ARDL model comprises an intercept and/or trend. If the computed F-statistic is greater than the upper critical value, the null hypothesis of no long-run relationship (No Co-integration) can be rejected irrespective of the orders of integration for the time series. On the contrary, if the test statistic is less than the lower critical value the null hypothesis cannot be rejected. However, if the test statistics lies between the lower and upper critical values, no conclusion regarding co-integration can be made. Two sets of critical values are provided in Pesaran and Pesaran (1997) and in Pesaran et al. (2001).These critical values are generated on sample sizes of 500 and 1000 observations and 20,000 and 40,000 replications, respectively. However, Narayan (2005) argue that such critical values cannot be used for small sample sizes like the one in this study.[15] Given the relatively small sample size in the present study

[15] For instance, he makes a comparison of the critical values generated with 31 observations and the critical values in Pesaran et al. (2001) and finds that the upper bound CV at the 5% significance level for 31 observations with 4 regressors is 18.3% lower than the CV for 31 observations

(25 observations); I extract the appropriate critical values from Narayan (2005) which were generated for small sample sizes of between 30 and 80 observations. The appropriate lag length for the model can be selected on the basis Schawrtz-Bayesian Criteria (SBC) and Akaike Information Criteria (AIC) or any other information criterion. After finding a long run relationship (co-integration) among the variables, the following the conditional ARDL (p, q_1, q_2, q_3, q_4) long run model for Y_t is estimated in the second step:

$$\ln Y_t = \beta_0 + \sum_{i=1}^{p} \lambda_{1i} \ln Y_{t-i} + \sum_{i=0}^{q_1} \lambda_{2i} \ln INV_{t-i} + \sum_{i=0}^{q_2} \lambda_{3i} \ln GVX_{t-i} + \sum_{i=0}^{q_3} \lambda_{4i} \ln EDX_{t-i} + \sum_{i=0}^{q_4} \lambda_{5i} \ln Z_{t-i} + u_t \quad \text{(I.b)}$$

Following the same procedure, the long run model adding corruption as an independent variable can be estimated. In the third and final step, we obtain the short-run dynamic parameters by estimating an error correction model (ECM) associated with the long-run estimates. This is specified as below:

$$\Delta \ln Y_t = \beta_0 + \sum_{i=1}^{p} \eta_i \Delta \ln Y_{t-i} + \sum_{i=0}^{q_1} \theta_i \Delta \ln INV_{t-i} + \sum_{i=0}^{q_2} \partial_i \Delta \ln GVX_{t-i} + \sum_{i=0}^{q_3} \phi_i \Delta \ln EDX_{t-i} + \sum_{i=0}^{q_4} \gamma_i \Delta \ln Z_{t-i} + \upsilon ECM_{t-1} + u_t \quad \text{(I.c)}$$

Here, the most important point should be kept in mind that the sign of the error correction term must be negative. All coefficients of the short run equation (I.c) are coefficients relating to the short run dynamics of the models convergence to equilibrium and υ represents the speed of adjustment for short run divergence to the long run equilibrium. It shows how disequilibrium of the previous year's shock adjusts back to the long run equilibrium in the current year.

Last of all, in order to ascertain that the estimated models do not suffer from serial correlation, non-normality and heteroscidasticity, I have performed Ljung-Box test, Jarque–Bera test and Shapiro–Wilk test and ARCH test respectively in each model. Moreover, even in the presence of co-integration, the results will be erratic, if the parameters are not constant. In order to test for long-run parameter stability, Pesaran and Pesaran (1997) suggest applying the cumulative sum of recursive residuals (CUSUM) test proposed by Brown *et al* (1975) to the residuals of the estimated ARDL-ECMs to test for parameter constancy.

Chapter-5: Contemporaneous correlation and graphical analyses

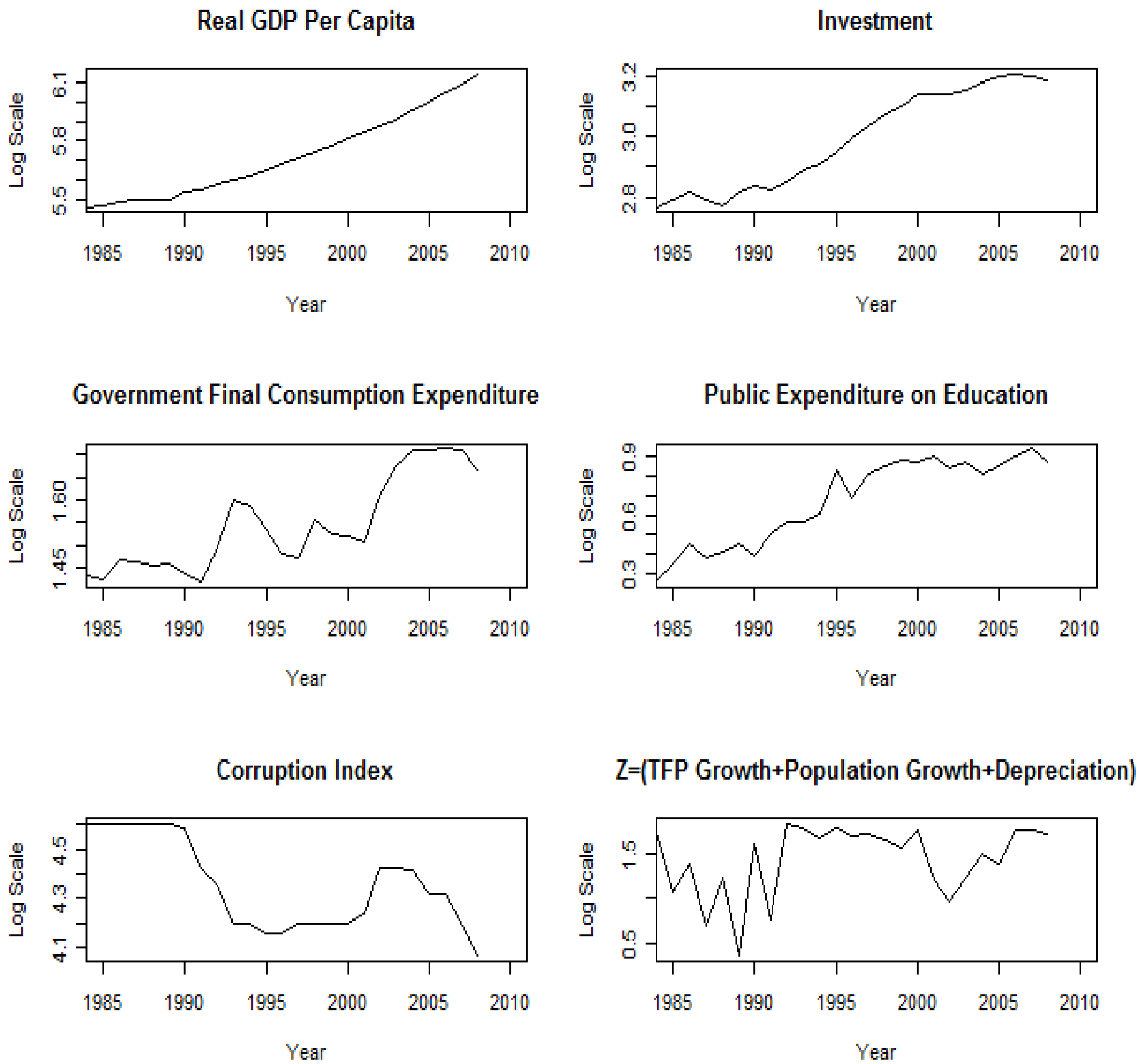
Before moving to formal empirical analysis, it is a good idea to show the relationship among the variables using contemporaneous correlation and graphical analysis. Although correlation matrix cannot give us the exact relationship among the variables of this study, contemporaneous correlation among all the variables has been calculated in the following table-2 in order to understand how the variables are moving and how these are correlated.

Table-2: Correlation Matrix among the variables in levels

Variables	Y	N	TFP	INV	GVX	EDX	COR
Y	1.00						
N	-0.95	1.00					
TFP	0.45	-0.49	1.00				
INV	0.94	-0.95	0.45	1.00			
GVX	0.87	-0.85	0.43	0.82	1.00		
EDX	0.85	-0.94	0.49	0.95	0.71	1.00	
COR	-0.58	0.73	-0.71	-0.63	-0.46	-0.77	1.00

It is evident that the contemporaneous correlation between Y and the level of INV, GVX and EDX is positive and very high. It is also noticeable total factor productivity growth rate and real per capita GDP is positively correlated though the magnitude is low. We can see that correlation between GDP per capita and corruption is negative which is -0.58.There also exist negative correlation between the level of corruption and the determinants of economic growth. For example, investment and corruption has a negative correlation by the magnitude of 0.63. The relationship among other variables is not that much important here. Graphical presentation is another to describe data systematically. The plot of underlying variables in natural logarithmic form is depicted in figure-1 on the next page. Guided by the theoretical explanation I have constructed a new variable denoted by Z by adding up total factor productivity, population growth and depreciation rates. There is clearly an increasing trend in real GDP per capita which indicates Bangladesh has maintained a good growth rate during the last two decades. Investment and public education expenditure is also increasing with very little fluctuations. As illustrated in the figure-3, government final consumption series has also upward trend but there lies frequent fluctuations in this series which implies potential presence of structural breaks. It is apparent that level corruption is always very high in Bangladesh after observing the figure of corruption index. It was in the peak period of 1984 to 1990 when the country was under military rule. After that there a gradual decrease until

Figure-3: Plot of Main Variables



1993and it has remained more or less constant up to 2000. After that corruption index has again increased to some extent during 2001 to 2004. Again there is a sharp reduction in the corruption series and it has reached the lowest level in 2008.It implies that Bangladesh has done relatively well to combat corruption to some extent under democratic rules but the improvement should be much more as expected.

Chapter-6: Presentation of the empirical results

6. 1: Unit Root Tests

Although it is not necessary that all the variables must be integrated in same order in ARDL Bounds testing procedure for co-integration, unit root must be conducted in order to ascertain that no variable is integrated in order of beyond I (2).Because the critical values for F-statistics for bounds tests are not valid in the presence of any I(2) variable (Ouattara,2004).The Augmented Dickey-Fuller (ADF)and Phillips-Perron tests are conducted for this purpose proposed by Dickey and Fuller (1979) and Phillips and Perron (1988).The result of the unit root tests are provided in table-4.

Table -3: Unit Root Tests

Test	**Augmented Dickey-Fuller (ADF)** Null Hypothesis: Unit Root			**Phillip-Perron (P-P)** Null Hypothesis: Unit Root		**Decision**
Variable	Trend and Constant	Constant	No Trend and Constant	Trend and Constant	Constant	
lnY	-0.399(0)	--	--	-0.489	8.1308	I(1)
ΔlnY	-5.717***	--	--	-5.866***	--	
lnINV	-1.601(1)	-0.678(1)	1.862(1)	-1.295	-0.663	I(1)
ΔlnINV	-3.097(0)	-3.167**(0)	--	-3.100	-3.172**	
lnGVX	-3.247*(1)	-1.643(1)	0.656(1)	-2.451	-1.178	I(1)
ΔlnGVX	-3.401*(0)	-3.525**(0)	--	-3.378*	-3.502**	
lnEDX	-2.032(4)	-1.341(4)	0.4522(4)	-1.210	-2.515	I(1)
ΔlnEDX	-5.133***(1)	--	--	-5.934***	--	
lnCOR	-2.634(2)	-1.6718(2)	-1.024(2)	-1.596	-1.111	I(1)
ΔlnCOR	-2.972(0)	-3.062**(0)	--	-3.040	-3.123**	
lnZ	-3.863**(0)	-3.399**(0)	--	-3.921**	-3.470**	I(0)
ΔlnZ	--	--	--	- 8.459***	--	

Notes: 1) (***), (**) and (*) represent significance at the 1%, 5% and 10% levels, respectively.
2) Lag lengths are in parenthesis.
3) The critical values are based on the finite sample values computed by McKinnon (1991).

The last column of the table reports the order of integration. The null hypothesis of existence of unit root in both tests is tested against alternative hypothesis of no unit root.I draw conclusion about the order of integration whether the series has both trend and constant and only constant or no constant and trend. I have chosen 5% significant level to test the null hypotheses in each case. The result indicates that all variables expect lnZ are non-stationary at their levels but stationary when 1^{st} difference is taken in each test. The series lnY is non-stationary with trend and constant but it becomes stationary at 1 % level after taking the 1^{st} difference. lnEDX is also stationary at 1% level at it is 1^{st} difference. According to ADF test lnZ is I (0) but I (1) in PP test. As none of the selected series is beyond (1) according to two unit root tests results, I can confidently apply Bounds test to examine co-integration among variables.

6. 2: Results of Bounds Test for Co-integration

In the first stage of Bounds test, I conduct OLS regression for the base model as well as the model with corruption. To obtain parsimonious specification I have adopted "General-to-Specific Modeling" approach guided by short data span .In this case, I have chosen 2(two) as maximum order of legs as the observations are annual suggested by Pesaran and Shin (1999) and Narayan (2004).Here, it must be noted that visual inspection of all the series indicates that there may be one structural break in the series of government final consumption expenditure in 1993. In order to be certain, I have applied Quandt likelihood ratio[16] (QLR) test for detecting the structural break in the models. The result of this test identifies that there is in fact a structural break in 1993.Therefore, I put a dummy variable "D1" for this period in each model when the OLS regression is performed. To work with general-to-specific modeling procedure, I have eliminated the insignificant lags except for the level variables and intercept. The benefit of this approach is that it ensures the assumption of no serial correlation as emphasized by Pesaran et.al (2001) and normality is not violated. I have used Akaike Information Criterion (AIC) to determine the optimal number of lags to be included in the unconditional ARDL-ECMs. Thus the order of selected ARDL models are of (1, 1, 1, 0, 1) and (1, 1, 1, 0, 1, 0) for the base model and model with corruption respectively.

[16]Detail is available in the article "Tests for Parameter Instability and Structural Change With Unknown Change Point" by Donald W. K. Andrews(1993)

The computed F-statistics with the appropriate critical values[17] for testing long run relation or co-integration are reported in Table-4A and Table-4B for the base model (eqn. I.a.) and model with corruption (eqn. II.a).

Table-4A:Bounds Tests for Co-integration (Base model-I)

Calculated F-statistics	1% Critical Bound*		5% Critical Bound*		10% Critical Bound*	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
13.83	4.280	5.840	3.058	4.223	2.525	3.560

Note:* Extracted from Narayan(2004) with **4** regressors and with restricted intercept and no trend

Table-4B: Bounds Tests for Co-integration (Model with corruption-II)

Calculated F-statistics	1% Critical Bound*		5% Critical Bound*		10% Critical Bound*	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
22.05	4.134	5.761	2.910	4.193	2.407	3.517

Note:* Extracted from Narayan(2004) with **5** regressors and with restricted intercept and no trend

The calculated F-Statistics in both cases (13.830and 22.05) are higher than the upper bound critical value even at 1% significant levels which clearly implies that we can confidently reject the null hypothesis of no integration. Put differently, there exists a strong evidence of long run relationship among the variables in both models. Thus, we can proceed to next step to estimate the long run models as there is co-integration. The diagnostic tests on selected ARDL models are presented in table–A4 of appendix-4.There is evidence of auto correlation at lag-2 model with corruption .That is why I have used Newey-West HAC-standard errors to generate precise standard errors is this case to tackle for presence of autocorrelation. Again, the plots of Rec-CUSUM and OLS-based CUSUM tests to check for long-run parameter stability are also enclosed in Appendix-5. It is clear from figure-A2 and figure-A3 that Rec-CUSUM and OLS-CUSUM plots stay inside the 5% critical bound thus providing confirmation that the parameters of both models do not suffer from any structural instability over the entire period of under this study.

[17] The critical values taken here are for 30 observations .It is found as the number of observations and regresorss increase, critical value decreases.

6. 3: Estimated long run results

As I have found long run relationships among the variables in both models, I can proceed to estimate two different long run models to find the long run impact of corruption on the economy of Bangladesh. The estimates of the long run coefficients for both models results are presented together the in table-5 for the sake of comparison. The sign of all coefficients are positive in the base model as expected on the basis theoretical framework developed in chapter-3.It is clear from the table that GDP per capita of the present period is highly

Table -5: Estimated Long Run Coefficients using the ARDL Technique

Dependent Variable: $\ln Y_t$	**Base Model**		**Model with Corruption**	
Regressors	**Coefficients**	**T-Ratios**	**Coefficients**	**T- Ratios**
Constant	-0.371^{***}	-5.962(0.000)	-0.046	-0.242(0.812)
$\ln Y_{t-1}$	1.053^{***}	67.547(0.000)	-	-
$\ln Y_{t-2}$	-	-	0.895^{***}	16.576(0.000)
$\ln INV_t$	0.124^{***}	5.701(0.000)	0.068	0.666(0.517)
$\ln INV_{t-1}$	0.139^{**}	2.608(0.021)	0.319^{***}	3.218(0.006)
$\ln INV_{t-2}$	-0.258^{***}	-3.073(0.008)	-	-
$\ln GVX_t$	0.033^{*}	1.960(0.071)	0.057	1.301(0.215)
$\ln EDX_t$	0.004	0.395(0.699)	-0.088^{**}	-2.772(0.015)
$\ln EDX_{t-1}$	0.016	0.638(0.534)	-0.057^{*}	-1.836(0.089)
$\ln Z_t$	0.012^{***}	5.635(0.000)	0.007	1.476(0.163)
$\ln COR_t$	-	-	-0.102^{***}	-4.268(0.000)
D1	-0.021^{***}	-4.067(0.001)	-0.022^{*}	-1.866(0.084)
	Adj. R^2=0.999 F(9,13)= 5247(0.000)		Adj. R^2=0.9995 F(9,13)= 2424(0.000)	

Note: (***), (**) and (*) represent significance at the 1%, 5% and 10% levels, respectively. p-values are in parenthesis.

dependent on last year' one and is statistically significant at 1 % level. From the base model, results show that investment is one of the significant determinants of GDP for Bangladesh. Other things being held, a 1% increase in physical capital investment causes around 0.12%

increment in per capita real GDP. lnGVX is significant at 10% level and a 1% rise in GVX leads to around 0.3% increase in per capita GDP. It reveals that government expenditure in other words public sector is not contributing to economic growth in Bangladesh as much as expected in a developing county. Public expenditure on education (lnEDX) does not have a significant impact on GDP in statistical terms and its magnitude is also small (0.004). The estimate of the accumulated term lnZ is significant at 1% level but effect on the economy is very low (0.012). Now I am going to analyze the results of the extended model with corruption. After adding corruption as an independent variable in the regression analysis, corruption (lnCOR) is found to be highly significant (at 1% level) and its effect on real GDP per capita of Bangladesh during 1984-2008 in negative. It shows the direct impact of corruption in the economy in the long run. According to our results, real per capita GDP in Bangladesh reduces by 0.10%in the long run if there is a1% increase in the level of corruption other thing being held constant. This result is similar to the findings of cross sectional study of Mauro (1995), Rahman et.al (2000) and Dreher and Herzfel (2005). Based on the above results, we can say that real GDP per capita in Bangladesh would be 508.20 US$ instead of 462.12 US$ in 2008 if it could reduce its level of corruption by 1%.

Now let us move to the discussion on how corruption is affecting the economy through different mechanisms i.e. indirect affect described in the theoretical chapter. Table-5 reports that coefficient of physical capital investment (lnINV) has become insignificant at the presence of corruption and its magnitude is also reduced to 0.068. It implies that corruption has substantial negative consequence on investment of Bangladesh. Previous cross sectional empirical studies have also found similar result. On the other hand, the size of the coefficient for government final consumption expenditure (lnGVX) or public sector investment has increased but it insignificant now. In this regard, we can say that public sector investment has increased but it does have not significant contribution to the economic growth of Bangladesh. Earlier studies such as Gupta, Mello and Sharan(2001), Tanzi and Davoodi (1997) Mauro (1998) have got this kind of result in cross country analysis. In developing countries, there are many opportunities of corruption in public sector. For example, government official and politicians can take bribe by importing unnecessary modern technological equipments, which are not appropriate in the current stage of development. My findings also indicate that corruption has negative impact on human capital investment. The result shows that public sector education expenditure has negative influence on per capita GDP at presence of corruption in Bangladesh.

So based on the long run results and above discussion, we can conclude that corruption has negative consequences in economic growth of Bangladesh. It has direct negative impact on per capita GDP as well as through different transmission mechanisms of economic growth. The estimates of the short-run dynamic coefficients associated with the long-run relationships obtained from the ECM equations are presented in table-6. The equilibrium error correction term ECM_{t-1} is significant in both models with negative sign which reinforces the existence of long run relationship among the variables. The estimated ECM_{t-1} term is the indicator of how disequilibrium of the previous year's shock adjusts back to the long run equilibrium in the current year. So it specifies that the speed of adjustment from short run deviation to long run equilibrium is which is fairly high (62%) in the model with corruption. We can say that about

Table-6: Estimated Short Run Dynamics of the Selected ARDL Models

Dependent Variable : ΔlnY_t	Base Model		Model with Corruption	
Regressor	**Coefficients**	**T-Ratios**	**Coefficients**	**T Ratios**
Constant	0.0009	0.205(0.841)	0.009****	6.329(0.000)
ΔlnY_{t-1}	0.9130***	3.764(0.002)	1.0797 ***	4.654(0.000)
ΔlnY_{t-2}	-	-	0.338**	2.549(0.024)
$\Delta lnINV_t$	0.1405	0.638(0.280)	-0.0563	-1.509(0.155)
$\Delta lnINV_{t-1}$	0.0588	0.638(0.535)	-	-
$\Delta lnGVX_t$	0.0037	0.104(0.918)	-0.022	-0.894(0.387)
$\Delta lnEDX_t$	-0.0258	-1.046(0.316)	-0.033*	-1.988(0.068)
$\Delta lnEDX_{t-1}$	-0.0059	-0.239(0.815)	-	-
ΔlnZ_t	0.0141***	4.474(0.000)	0.010 ***	13.66(0.000)
$\Delta lnCOR_t$	-	-	-0.053***	-3.043(0.009)
ECM_{t-1}	-1.3478**	-2.727(0.018)	-0.620 ***	-3.183(0.007)
D1	-0.0004	-0.060(0.953)	0.016 ***	3.455(0.004)
	Adj. R^2 = 0.7374 F(9,12)= 7.552(0.000)		Adj. R^2 = 0.5681 F(8,13)= 4.453 (0.008)	

Note: (***), (**) and (*) represent significance at the 1%, 5% and 10% levels, respectively. p-values are in parenthesis.

62% of imbalance from the preceding year's shock converges back to the long-run equilibrium in the current year. The results of the diagnostic tests for long run models as well as error correction models are reported in table-A5 and table-A6 respectively in appendix-4.

Chapter-7: Concluding Remarks

Corruption has become rampant almost in every sphere of life in Bangladesh. The country is listed as one of the most corrupt counties in the world in various rankings of corruption. It is widely discussed that corruption is hurting economic progress of the country to a large extent. News Scan Analysis of Transparency International Bangladesh (2002) reports that about 1.85% of the GDP had been lost because of corruption in the fiscal year of 1999-2000.

The main objective of this thesis is to empirically investigate the impact of corruption on the economic development of Bangladesh using annual time series data for the period of 1984-2008. According to my knowledge, this is the first attempt to apply a multivariate approach to examine the relationship between GDP per capita and corruption for Bangladesh using time series data.

With a view to achieving the aim of the thesis, I have extended the Solow model of economic growth to include public sector and human capital and then reformulated this augmented model incorporating corruption in a specific functional form to decompose the direct and indirect consequences of corruption on income per capita. Based on the priori assumption of negative consequences of corruption, this model entails how corruption directly affects per capita income through total factor productivity channel as well as indirectly via physical capital, public sector and human capital channel. Then I have tested the long run relationship between corruption and real GDP per capita for that time span using ARDL Bounds method for co-integration using International Country Risk Guide (ICRG) corruption index as a proxy to measure the level corruption in Bangladesh. The results of co-integration test confirms that there is a long run relation among corruption, GDP per capita and other determinants of GDP over this period. The long run estimates indicate that corruption has direct negative impact on per capita GDP i.e. economic development of Bangladesh. It shows that a 1% increase in the level of corruption during this period has resulted in about 10% reduction in per capita GDP of Bangladesh. It means that corruption is affecting the economic growth of Bangladesh adversely. In other words that Bangladesh could achieve faster economic development if it could curb widespread corruption. This finding is similar to the results of Mauro (1995), Rahman, Kisunko and Kapoor (2000) and Dreher and Herzfel (2005) but differs in magnitude as these studies are based on average of cross sectional data for different time period. Results from my study also suggest that corruption has strong negative impact on physical capital investment and human development in Bangladesh. The findings imply that corruption has increased public sector investment but it does not have significant contribution to economic growth of Bangladesh in the presence of high level of corruption.

The main limitation of my study is the short time span that the study considers and annual data. The reason behind that is the unavailability of the data on measurement of corruption for longer time period. Besides trade and remittances from abroad have significant contributions in economic growth of Bangladesh in recent years, a fact that has not been considered in this study. Future researches may get results that are more robust after the inclusion of these determinants of GDP using data for longer periods. However, it will not probably alter the conclusion drawn from my time series analysis that corruption has strong and significant retarding consequences on economic development of Bangladesh.

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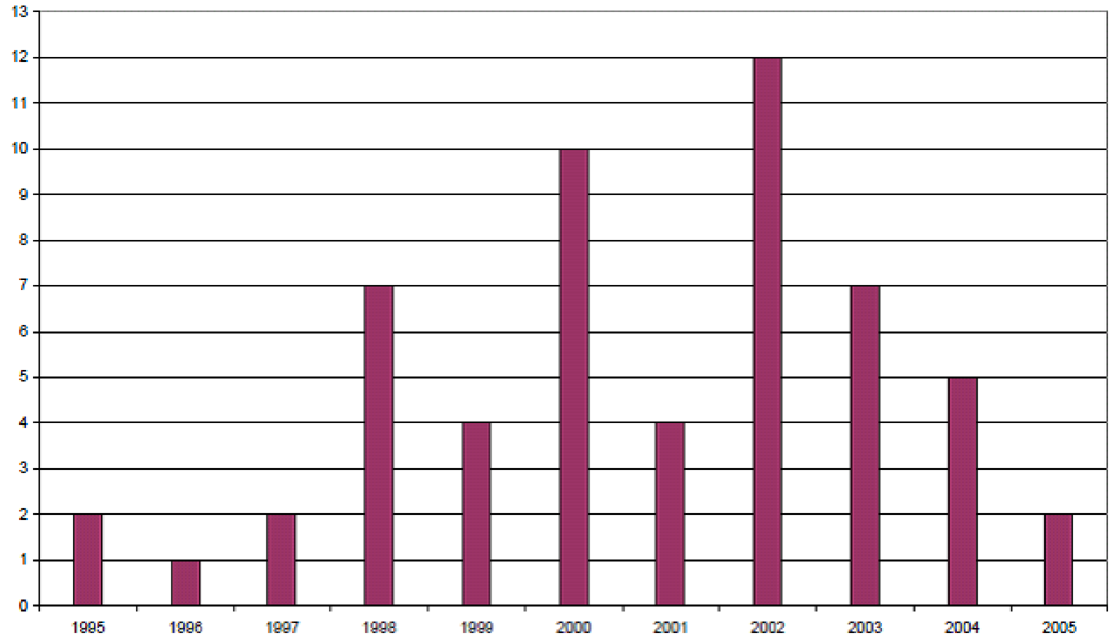
Appendix-1

Figure-A1: Number of studies on the consequences of corruption over1995-2005



Source: Dreher, .A and Herzfel, T(2005):"The Economic Costs of Corruption: A Survey and New Evidence"

Appendix -2:

Table-A1: List of Variables

Variables[1] Involved	Original Source
Real GDP Per Capita(Constant 2000 US$)	World Bank(**WDI** online data base)
Total Factor Productivity Growth rate (%)	The Conference Board Total Economy Database[2], January2010
Population growth rate (%)	World Bank(**WDI** online data base)
Gross Fixed Capital Formation or Investment(% of GDP)	World Bank(**WDI** online data base)
Government Final Consumption Expenditure (% of GDP)	World bank(**WDI** online data base) and Ministry of Finance, Bangladesh
Public Expenditure on Education(%of GDP)	World bank(**WDI** online data base) , Ministry of Finance and Ministry of Education, Bangladesh, Bangladesh
Corruption Index[3] (Ranging from "0" to "6") The Higher value the lower the level of corruption on a country.	International Country Risk Guide **(ICRG)** - prepared by The Political Risk Services**(PRS)** Inc.

Notes: 1) Natural logs of all variables are taken after extracting from the original source.

2) http://www.conference-board.org/data/economydatabase/"

3) Rescaled to an index ranging from "1 to 0"

Table –A2: Correlation matrix of Different Corruption Indices

Index	KK	TI	ICRG
KK	1.00	0.96**	0.88**
TI	0.96**	1.00	0.87**
ICRG	0.88**	0.87**	1.00

** Correlation is significant at 0.01 level(2-tailed)

Source: Dahlstrom,T.(2009):**"**Causes of Corruption" JIBS Dissertation Series No.05

Appendix-2

1) The unconditional ARDL –VECM representation of the empirical equation (II)

$$\Delta \ln Y_t = \beta_0 + \lambda_1 \ln Y_{t-1} + \lambda_2 \ln INV_{t-1} + \lambda_3 \ln GVX_{t-1} + \lambda_4 \ln EDX_{t-1} + \lambda_5 \ln Z_{t-1} + \lambda_6 \ln COR_{t-1} + \sum_{i=1}^{p} \eta_i \Delta \ln Y_{t-i}$$
$$+ \sum_{i=0}^{q} \theta_i \Delta \ln INV_{t-i} + \sum_{i=0}^{q} \partial_i \Delta \ln GVX_{t-i} + \sum_{i=0}^{q} \phi_i \Delta \ln EDX_{t-i} + \sum_{i=0}^{q} \gamma_i \Delta \ln Z_{t-i} + \sum_{i=0}^{q} \psi_i \Delta \ln COR_{t-i} + u_t \qquad \text{(II.a)}$$

2) The conditional ARDL (p, q_1, q_2, q_3, q_4, q_5) long run model for Y_t

$$\ln Y_t = \beta_0 + \sum_{i=1}^{p} \lambda_{1i} \ln Y_{t-i} + \sum_{i=0}^{q_1} \lambda_{2i} \ln INV_{t-i} + \sum_{i=0}^{q_2} \lambda_{3i} \ln GVX_{t-i} + \sum_{i=0}^{q_3} \lambda_{4i} \ln EDX_{t-i} + \sum_{i=0}^{q_4} \lambda_{5i} \ln Z_{t-i} + \sum_{i=0}^{q_5} \lambda_{6i} \ln COR_{t-i} + u_t \qquad \text{(II.b)}$$

3) The Error Correction Model (ECM):

$$\Delta \ln Y_t = \beta_0 + \sum_{i=1}^{p} \eta_i \Delta \ln Y_{t-i} + \sum_{i=0}^{q_1} \theta_i \Delta \ln INV_{t-i} + \sum_{i=0}^{q_2} \partial_i \Delta \ln GVX_{t-i} + \sum_{i=0}^{q_3} \phi_i \Delta \ln EDX_{t-i} + \sum_{i=0}^{q_4} \gamma_i \Delta \ln Z_{t-i} + \sum_{i=0}^{q_5} \psi_i \Delta \ln COR_{t-i} + + \upsilon ECM_{t-1} + u_t \qquad \text{(II.c)}$$

Table-A3: Summary Statistics of all the variables in levels

Variables	No. of Obs.	Minimum	Maximum	Mean	Standard Deviation
Y	25	236.71	462.12	312.32	68.46
N	25	1.41	2.57	1.96	0.33
TFP	25	-3.81	1.29	-0.52	1.55
INV	25	15.92	24.65	20.15	3.29
GVX	25	4.14	5.54	4.71	0.49
EDX	25	1.29	2.56	2.07	0.41
COR	25	0.58	1.00	0.79	0.15

Appenidx-4

Table-A4: Diagnostic Tests for Selected ARDL Models

	Base Model	Model with Corruption
Adj. R^2	0.932	0.962
F-Statistics	F(14,8)=22.75(0.000)	F(16,6)=36.25(0.000)
Liung Box lag-1	χ^2 (1)=0.093(0.760)	χ^2 (1)= 0.557(0.455)
Liung Box lag-2	χ^2 (2)=0.562(0.755)	χ^2 (2)= 5.275(0.071)
F-ARCH (4)	F(14,4)=1.034(0.424)	F(14,4)=0.358(0.833)
Jarque-Bera	χ^2 (2)=1.817(0.403)	χ^2 (2) =3.8211(0.148)
Shapiro-Wilk	W=0.932(0.125)	W= 0.946(0.2522)

Table-A5: Diagnostic Tests for Long Run Models

	Base model	Model with Corruption
Liung Box lag-1	χ^2(1)=2.433(0.118)	χ^2(1)=1.456(0.227)
Liung Box lag-2	χ^2 (2)=2.4511(0.293)	χ^2 (2)=1.790(0.408)
F-ARCH (4)	F(4,14)=0.0491(0.996)	F(4,14)=0.325(0.856)
Jarque-Bera	χ^2 (2)=1.596(0.450)	χ^2 (2)=1.296(0.522)
Shapiro-Wilk	W=0.942(0.200)	W= 0.946(0.248)

Table-A6: Diagnostic Tests for Error Corrections Models

Base model	Model with Corruption	
Liung Box lag-1	χ^2(1)= 0.074(0.784)	χ^2(1)=1.679(0.195)
Liung Box lag-2	χ^2 (2)=0.810(0.666)	χ^2 (2)=3.905(0.141)
F-ARCH (4)	F(4,13)= 0.218(0.923)	F(4,13)= 0.611(0.661)
Jarque-Bera	χ^2 (2)=1.294(0.523)	χ^2 (2)=3.717(0.155)
Shapiro-Wilk	W = 0.963(0.558)	W = 0.942(0.227)

Appendix -5

Figure-A2: CUSUM Test for Coefficients Stability for ARDL Model-(I .a)

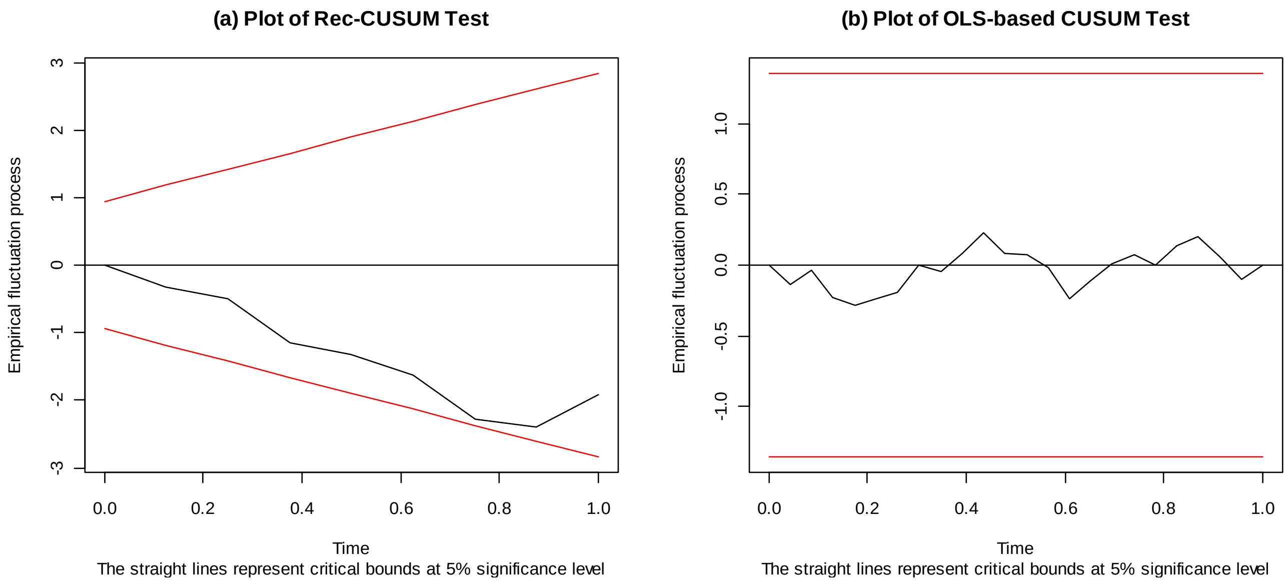


Figure-A3: CUSUM Test for Coefficients Stability for ARDL Model-(II.a)