Understanding & Modelling Corruption: Exploiting System Dynamics

Dr. M. Aman Ullah,
Joint Chief Economist,
Planning and Development Board, Government of Punjab, Lahore, Pakistan.
m.aman@auckland.ac.nz

Associate Professor Tiru Arthanari,
Department of Information Systems and Operations Management, University of Auckland Business School, Owen G Glenn Building, 12 Grafton, Road, Private Bag 92019 Auckland, New Zealand, University of Auckland, New Zealand.
t.arthanari@auckland.ac.nz

Professor Cathy Urquhart,
Manchester Metropolitan University Business School, Manchester Metropolitan University, United Kingdom.
c.urquhart@mmu.ac.uk

Dr. Anson Li,
Department of Information Systems and Operations Management, University of Auckland Business School, Owen G Glenn Building, 12 Grafton, Road, Private Bag 92019 Auckland, New Zealand, University of Auckland, New Zealand.
a.li@auckland.ac.nz

Keywords: Corruption, Developing Countries, System Dynamics, Simulation.

Abstract

Over the past few decades, many studies of corruption have been carried out. This study builds a system dynamics model of corruption, which helps in the understanding of corruption and acts as an input into future policy-making on corruption. System dynamics modeling allows researchers to discover 'hidden' dynamics. Moreover, system dynamics provides the analyst an increased level of flexibility, as these models use both the theoretical underpinnings and empirical data. Some of our key findings, such as the effect of inflation, government size, transparency in international negotiations and the juxtaposition of religious values with corruption, have not been widely discussed in the literature. In this study, we can offer an explanation that uncovers the underlying factors that address the dynamics of corruption, social, economic, political, judicial and cultural factors in the case of any developing country, which can be applied with some modifications for the developed world as well.

INTRODUCTION

Corruption is an extensively studied but still a contested phenomenon (Andvig *et al.* 1991; Kaufmann *et al.,* 1998). Corruption is ubiquitous and has serious affects in developing countries. Research on corruption is a vital aspect of understanding dynamics of corruption so that anti-corruption strategies might be effective. Corruption is conventionally understood and referred to as the private wealth seeking behavior of someone who represents state and public authority. It is the misuse of public resources by public officials, for private gain. As Moreno (2000) argues, 'Corruption has a cultural side, and most societies have a certain degree of corruption permissiveness, with some of them being, on average, more likely to justify corrupt practices than others'. The working definition used by the World Bank (1995), Transparency International (1998) and others is that corruption is the abuse of public power for private benefit (or profit). Incidental corruption is an aspect of life in more or less all societies, but it can be systematic in many public institutions in developing countries, if not systemic in society as a whole (Riley, 1983), and it can be both prevalent and planned.

Corruption takes place in societies where there is significant discretion for public officials, limited accountability, and little transparency in governmental operations; in such societies and cultures, civil society institutions and independent private sector are often weak or undeveloped (Khan, 2004; Papyrakis, 2016). The establishment of corruption on a systemic basis may be an outcome of the continuation of existing inequalities and weak ('soft' or 'hollow') states where it can thrive 'on disorganization, the absence of stable relationships among groups and of recognized patterns of authority' (Huntington, 1968; Andreski, 1970).

Human endeavors are bound by invisible fabrics of interrelated actions, which may take seconds to years to fully play out their effects on each other. Systems thinking provides tools to make the full patterns clearer and to help us see how to change them effectively (Checkland, 1981). It is a unique approach to problem solving, in that it views certain 'problems', e.g. corruption, as part of the overall system. The systems approach provides a way to fully understand why a problem occurs and persists by trying to understand the part in relation to the whole. The approach proposes to view systems in a holistic manner. Consistent with systems philosophy, systems thinking involves the examination of linkages and interactions between all the elements that comprise the entirety of the system (Midgley, 2003). The previous discussion raises questions about the genuine benefits a systems approach can offer to study corruption. We quote a cogent statement to initiate the definition of the problem that guides this research:

> *"Corruption literature provides a rich source of data and theory which can serve as a foundation for system dynamics models of corruption including, mathematical sub-models and typologies of corrupt systems, narratives of instances of corruption, and proposed remedies. An overall paradigm, allowing us to consider, in a holistic way, the many sub-systems of corruption have not been developed".*
>
> (Dudley, 2000)

The main objective of this study is to develop a logical theoretical framework which can be used to study corruption dynamics. The study explores corruption dynamics by analyzing computational simulations based on a broad structure around corruption constructed in the framework of SDM. This model aims to see corruption from a new perspective. An attempt is, therefore, made in this research to understand the problem of corruption, law and order, social, cultural, economic problems and political instability through a systems approach. This will be achieved by the use of simulation modeling to explore how the social system of corruption develops its stable macro-state. The conceptualization of corruption used in this research is that it is a social phenomenon, which involves public dealing in general; manifested as a social system of corruption that affects all other systems in one way or another. This research aims to explore the following issues in detail.

- How can the understanding of corruption be extended by using a system dynamics approach?
- What would a system dynamics model of corruption in Pakistan look like?
- What are the contributions of such a model?

The ultimate goal of this research is to assist in the development of a logical theoretical framework which can be used to examine the dynamics of corruption. While it is difficult to judge the ultimate effect such a modest activity can have on actual reform of corrupt systems, without a firm logical framework for reform, meaningful reform itself seems unlikely.

SYSTEMS APPROACH

A number of recent studies including Patching (1990), Wolstenholme (1990), Richardson (1991), Vennix (1996), Checkland and Scholes (1999), Checkland (2007), Sterman (2000), Maani and Cavana (2007), have contributed to the development of systems thinking and system dynamics (hereafter SD). Many studies have offered definitions of the systems thinking and systems dynamics methodologies, but in this research we take the recent one provided by Sterman (2000) and Maani and Cavana (2007) as most appropriate. A system dynamics model depicts a theory about a specific problem. Since any model in the social sciences is only a theory, the most that can be attained from these models is that they be useful (MacDonald., 2011). It has been stated that system dynamics models are useful because the mathematical foundation needed for computer simulation needs that the theory be precise. The method of combining numerical data, written data, and the knowledge of experts in mathematical form often identifies inconsistencies about how we think the system works. The model informs us by identifying these inconsistencies. On the other hand, simulation allows us to see how the complex interactions we have identified in the model work when they are all active at the same time. This is what occurs in the real system. Furthermore, we can test a variety of policies quickly to see how they play out in the long run. The bottom line is that the model will represent a theory about what is causing the problem and what can be done to solve the problem.

According to MacDonald (2011), "system dynamics models are excellent tools to study problems that occur in closed-loop systems, systems in which conditions are transformed into information that can be observed and acted upon in order to change the initial condition". For example, when the backlog of pending cases for state prosecutors increases beyond a certain level it sends a signal to state prosecutors that additional plea bargains may be required in order to reduce the backlog to an acceptable level. This completes a feedback loop. However, this same feedback loop could also work in the opposite direction. If the backlog of cases is below some desired or acceptable level it will indicate to state prosecutor's that the need to plea bargain, for purposes of reducing the backlog of cases, is no longer required and the willingness of state prosecutor's to offer plea bargains will be reduced.

In the present study, we focus on some key issues that affect economic, social, political, judicial and cultural behavior in the society. According to Sterman (2000), in system dynamics models variables are classified as either exogenous or endogenous variables. Table 1 shows the variables of the model that are endogenous, exogenous, and variables that are excluded. Exogenous variables are those that are not part of a feedback loop (in this study bureaucratic quality is exogenous), while endogenous variables are members of at least one feedback loop. A few variables are excluded from the model due to non-availability of reliable data and for the sake of simplicity.

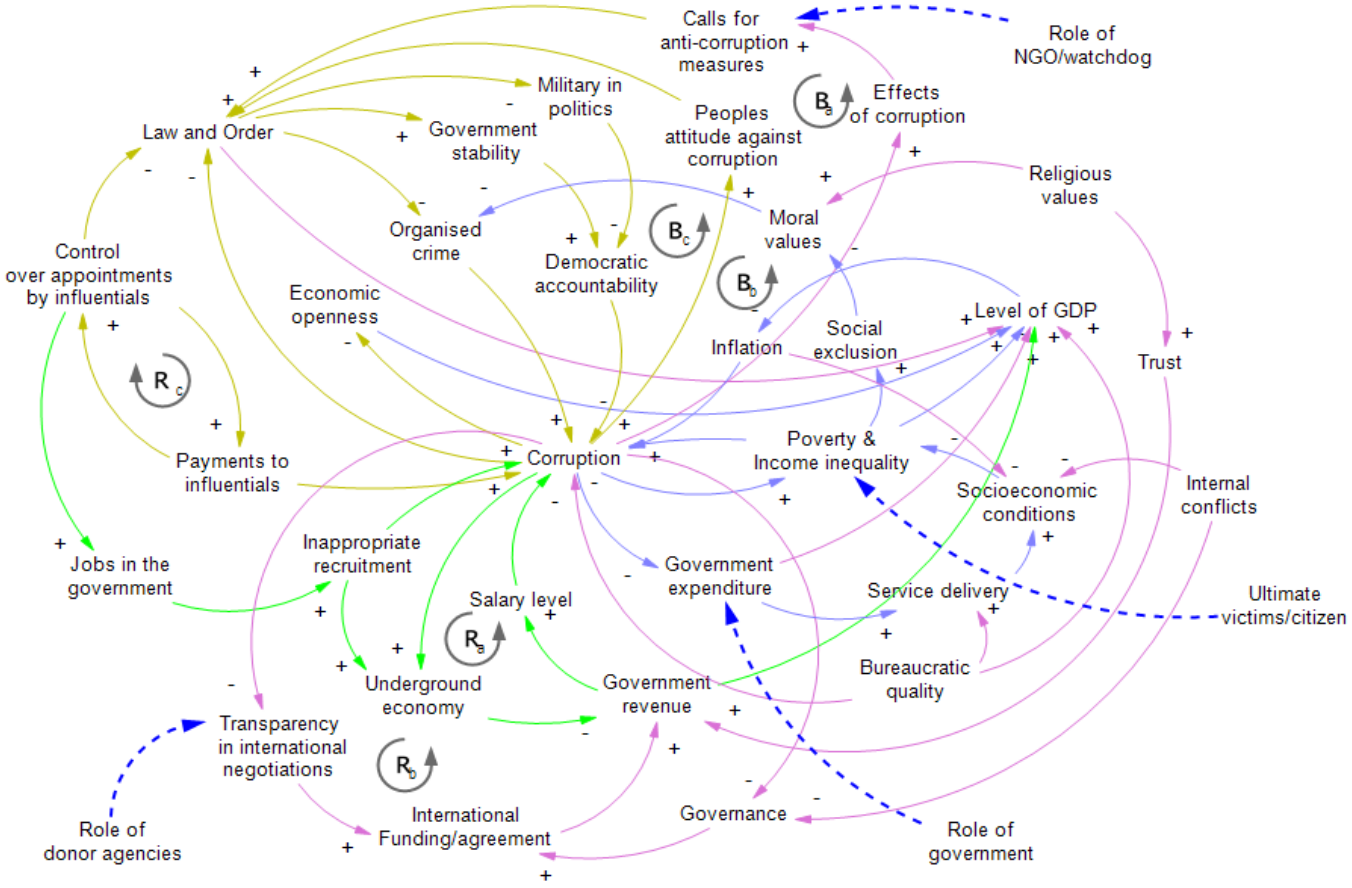
To develop the System Dynamics model, we used the interview material that describes the structure and the behavior dynamics that result from that structure. While the interviews do not provide any empirical data, they do provide detailed qualitative descriptions that can be represented formally in a SD model. Moreover, the literature review conducted for the present study helps in defining many of the relationships between the variables under consideration. Moreover, empirical literature on the determinants of corruption has presumed a strong relationship between corruption abatement and good governance (Treisman, 2000). But for this relationship to bear desirable results, the overriding influence of the influentials must be appropriately dealt with.

There are several feedback loops in a high-level diagram of a corruption model. The primary task in identifying the systems approach to modeling corruption is to define the key system features and to construct a high level causal loop diagram that captures the key elements of the system in question including the major feedback loops. In Figure 1, there are a whole range of potentially significant joint dependencies (and feedback dynamics) that capture the overall system behavior and performance over time rather than one 'dependent variable'. This approach is different from the commonly adopted approach in social sciences. Therefore a systemic framework of analysis essentially provides a useful

mechanism for understanding the incidence of corruption in different systems: the complex nature of change in the context of a continuing crisis of accumulation, and the impact of that change on regulated legal, economic and social institutions.

The paper tests results of the model at the different combination of scenarios: at the different scenarios focus on changes in variables affecting level of corruption, level of GDP and income inequality. The system dynamics model enables the projection of several different scenarios. As mentioned earlier, the time horizon is selected equal to 15 years (2011-2025) which is a period sufficiently long for showing how corruption is affected by change in some important variables like democratic accountability, income inequality in the country, inflation rate, and organized crime as well as for verifying the necessity to fight against corruption.

Figure 1: High-level Diagram of System Dynamics Model of Corruption



A causal loop diagram of the model's variables was constructed from these key variables, illustrating the major feedback processes of the corruption model in Figure 1. Behavior of the corruption model is constrained by one balancing feedback and eight reinforcing loops (see Figure 2 and 3). The structure of this model contains political and judicial variables (including democratic accountability, government stability, law and order, organized crime, military in politics, and corruption) identified during qualitative data analysis.

Table 1: Key Variables of the Corruption Model

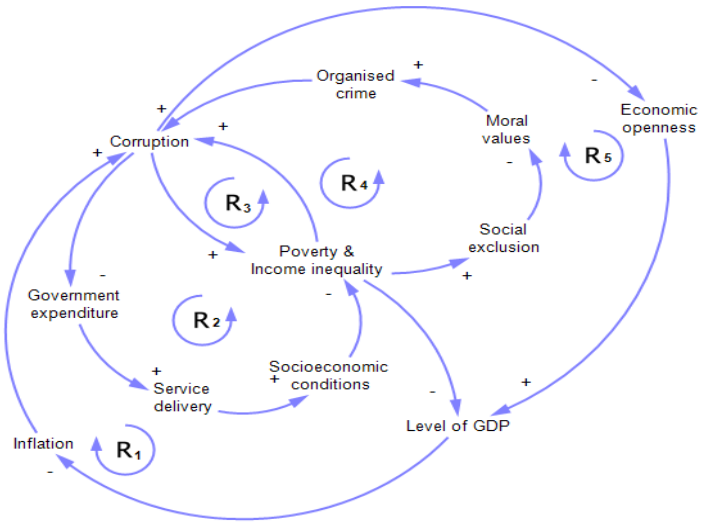
Endogenous	Exogenous	Excluded
Corruption	Bureaucratic quality	Control over appointments by influential
Democratic accountability		Governance
Economic openness		Government revenue
Government expenditure		Inappropriate recruitment
Government stability		Internal conflicts

Income inequality/Poverty		International funding/agreement
Inflation rate		Jobs in the government
Law and order		Moral values
Level of GDP		Payments to influential
Military in politics		Religious values
Organized crime		Salary level
Peoples attitude against corruption		Service delivery
Socioeconomic conditions		Social exclusion
		Transparency in international negotiations
		Trust
		Underground economy

Modelling Corruption

Based on the literature review and qualitative data analysis, Figure 2 presents five reinforcing loops "R_1", "R_2", "R_3", "R_4" and "R_5". The role of government can be observed in the section of the model in feedback loop R_2, which deals with the constructs of government expenditure and service delivery. Lower levels of government expenditure result and consequently slows down improvement in socioeconomic conditions, which also increases poverty levels and distorts income inequality. Bureaucratic malpractice manifest in the diversion of public funds to the areas where bribes are easiest to collect, implying a bias in the composition of government spending towards low-productivity projects (e.g. large-scale construction) at the expense of value-enhancing investments (e.g., maintenance or improvements in the quality of social infrastructure). Thus, abuse of public office may not only reduce the volume of public funds available to the government, but also lead to misallocation of those funds. It will further lower quality services provided by government (see Figure 2). We may also believe that organized crime can be dissipated by inculcating moral values to achieve corruption-free society (Feedback loop R_4). Feedback loop R_5 signifies the role of imports and exports (economic openness) that affect economic development positively. Moreover, R_5 also signifies the role of trade-lead economic development in controlling high inflation rate in an economy. There is a positive correlation between inflation and corruption, as inflation causes an increase in the cost of living and thus people use illegal means to increase their earnings.

Figure 2: Feedback Loops of Economic and Social Factors

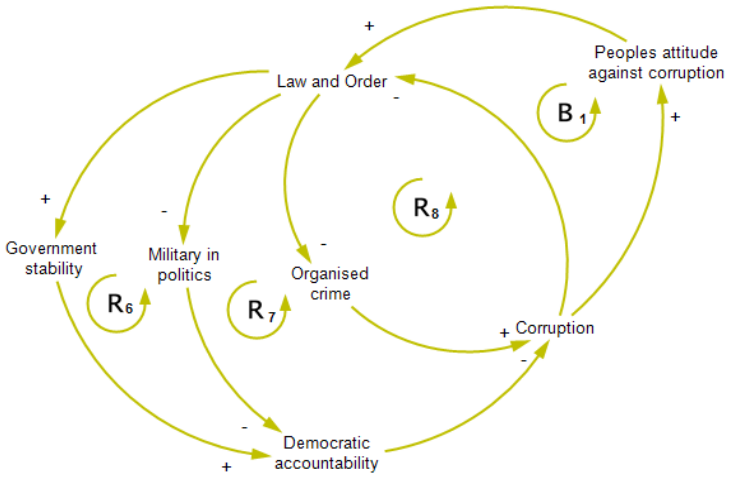


Feedback Loops Legal and Political Factors

It can be seen from feedback loop R_7 (see Figure 3) that if the law and order situation is deteriorated in the country; the military might, for example, become involved in politics by toppling the regime because of an actual or created internal or external threat. This kind of situation would have negative implications. The distortion of government policy in order to meet this threat, for example by increasing the budgetary expenditures on defense at the expense of other budget allocations, or involvement of military in politics, even at a peripheral level, is a diminution of democratic accountability (Political Risk Services 2011). However, it also has other significant implications. The risk of military take-over can force democratically elected government to change its policies or cause replacement of the government by another government more amenable to the military's wishes.

Moreover, a military takeover or threat of a takeover may also signify a high risk if it is an indication that the government is incompetent to function efficiently and that the country therefore has an uneasy environment for foreign investment. On the other hand, if the political leadership does not enjoy popular support, the highly elitist civilian bureaucracy might be able to reserve for itself the role of final conciliator on many policy decisions, in conjunction with the military. Feedback loop R_6 indicates that widespread corruption and government instability diminish the effectiveness of accountability systems. The role of judiciary can be seen in the section of the model that deals with the construct of law and order. Negative effects of corruption increase calls for anti-corruption measures, which causes a strengthening of the legal system. In particular, an effective judiciary can fulfill its role as an institutional guarantor of the rule of law. The criminal justice system deals effectively with crimes committed in the countries with low levels of organized crime (Feedback loop B_1).

Figure 3: Feedback Loops of Legal and Political Model



In the system dynamics modeling process, computational tools support formulation of the model based on the causal loop diagrams in the previous stages. To perform a more detailed quantitative analysis, a causal loop diagram of the corruption model given in Figure 2 and 3 are transformed to stock and flow diagram. Moreover, it is important to perform a sort of validation with historical data, since the setup of a past condition of all variables should end up with the depiction of a known state of the system in the same period (Sterman, 2000).

Data Sources

For system dynamics modeling for this study we use iThink™ software (Richmond and Peterson, 1997), which supports model design in stock and flow format, following the same relation of the causal loop model of Figure 2 and Figure 3. The corruption model consists of thirteen stocks: Corruption (Dmnl), Democratic Accountability (Dmnl), Law and Order (Dmnl), Peoples Attitude against Corruption (Dmnl), Government Stability (Dmnl), Military in Politics (Dmnl), Government Expenditure (Per cent of GDP), Organized Crime (Dmnl), Level of Gross Domestic Product (GDP, US dollars per year), Income Inequality (Dmnl), Economic Openness (Dmnl), Inflation (per cent per year) and Socioeconomic Conditions (Dmnl). The data has been collected from different sources; for instance, Political Risk Services (PRS 2011) "International Country Risk Guide" (ICRG) and World Bank's

World Development Indicators (World Bank, 2013) henceforth WDI. We kept the maximum value the same as given in the original data source. That's why the range of different variables is not the same. The range of most of these stocks is from zero to 6, 10, 12 and 100. In case of ICRG indices, a higher value is the best possible for the stocks (Low risk), while zero is the worst possible value (High risk) for these stocks (see Table 2).

Parameter Estimates

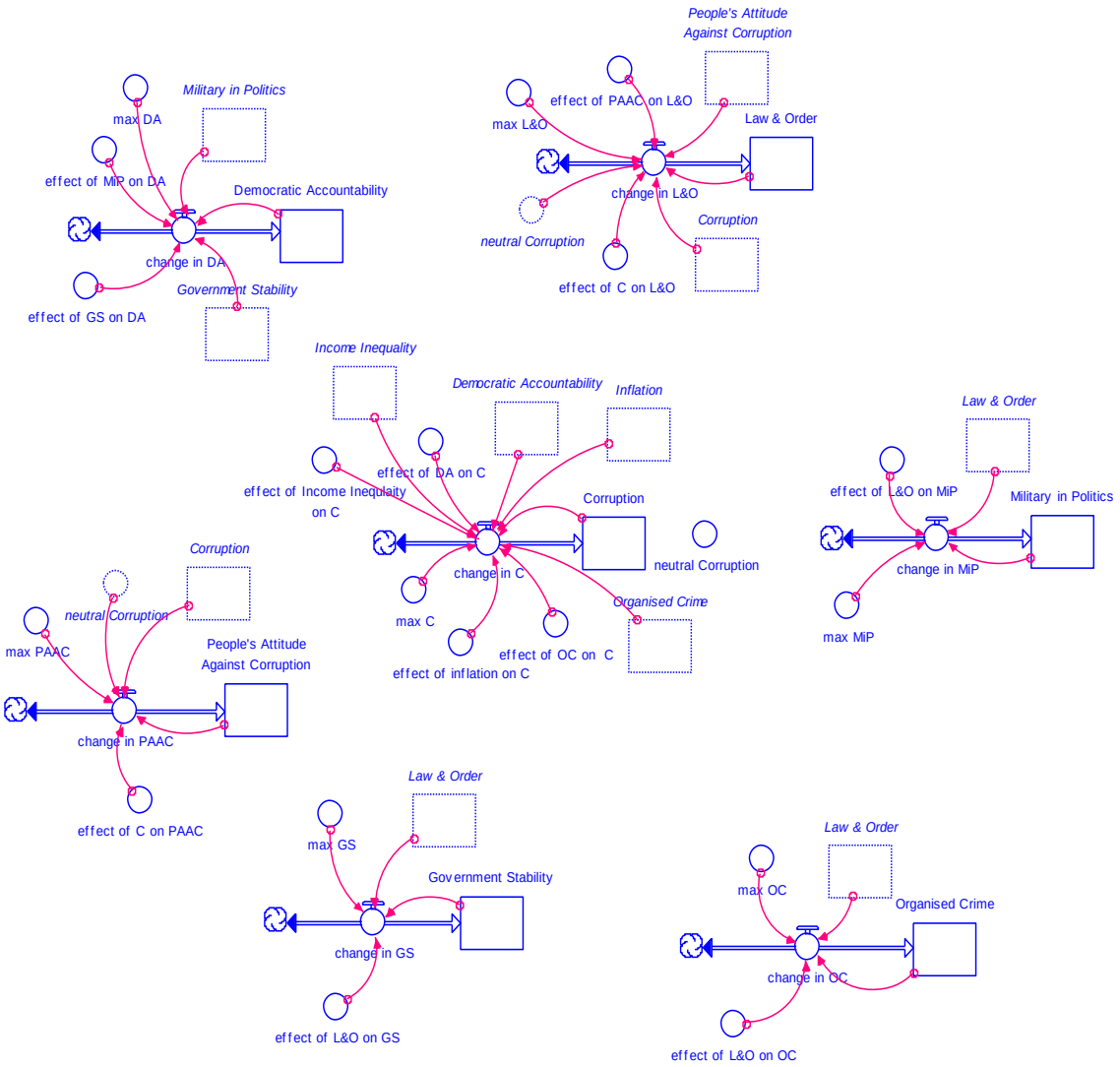
It is pertinent to mention here that the literature review helps in providing interrelationships between these variables. Wherever possible the qualitative descriptions have been supplemented with quantitative data to provide parameter values for the constants and initial conditions for the state variables. The model has been calibrated to represent multi-layers of historical time series data of 1984-2010, with R-square of over 70 per cent for most of the regression models, which establishes its behavioral validity. The initial values of stocks in system dynamics models can be determined in a variety of ways. In the case of the corruption model presented here, we obtained the values for the stock variables from ICRG and WDI for the year 2010 (see Table 2). The initial values for most of the stock parameters were obtained from Ullah's (2006: pp 71-74) study on corruption, economic growth and income inequality. For some variables the parameter are estimated using the available dataset from 1984-2010.

Table 2: Model Initial, Minimum, Maximum Values and Variable Dimensions

Variables	Initial Stock Value	Unit of Measurement	Minimum Value	Maximum Value
Democratic accountability	1.00	Dimensionless	0	6
Economic openness	33.70	Dimensionless	0	100
Government expenditure	12.00	Per cent of GDP	0	100
Government stability	5.25	Dimensionless	0	12
Level of Gross Domestic Product	35.24	Billion US dollars per year	35.2	116.3
Income inequality/Poverty	34.50	Dimensionless	0	100
Inflation rate	6.09	Per cent per year	2.9	20.3
Law and order	2.00	Dimensionless	0	6
Corruption	2.00	Dimensionless	0	6
Military in politics	1.00	Dimensionless	0	6
Organized crime	84.00	Dimensionless	0	100
Peoples attitude against corruption	5.00	Dimensionless	0	10
Socioeconomic conditions	6.92	Dimensionless	0	12

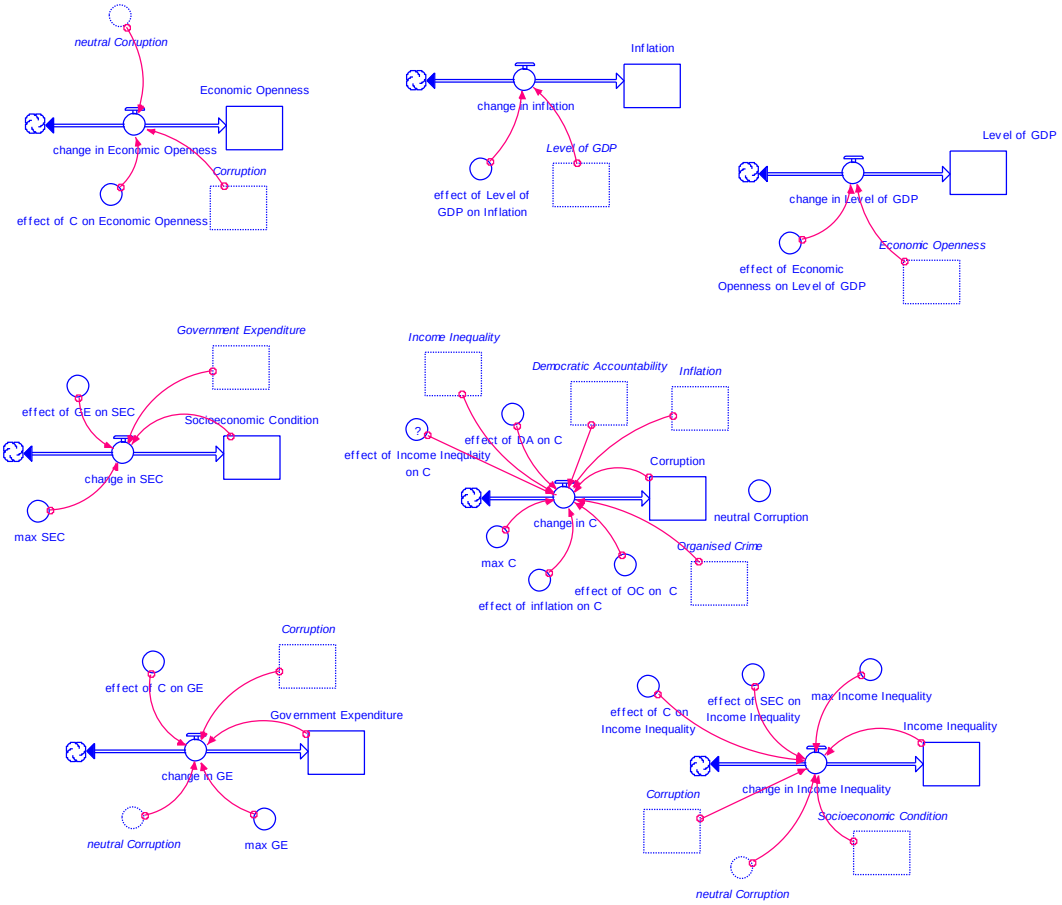
According to Qureshi (2009), the system dynamics models are causal models and these models should generate the right behavior for right reasons. Time constants for the flows are constant per year for the simulation. It is likely that democratic accountability not only affects corruption directly by removing corrupt persons, but also operates through the fear of being detected and punished. This fear could change more rapidly than the legal system itself. This might happen, for example, via the prosecution of corrupt politicians and high level bureaucrats where convictions would have high public visibility (Klitgaard, 1988; Dudley, 2000, Rock 2009). Figures 4 and 5 present the interrelations among the 13 stock variables measuring social, economic, political, judicial and cultural factors collectively. It is also suggested in the literature that as corruption grows, law and order situation deteriorates. Moreover, corruption of public officials, including law enforcers like police department and judiciary, is a common characteristic of organized crime that allows criminal organizations to secure survival and minimize the risk of being arrested and prosecuted.

Figure 4: Stock and Flow Diagram of Corruption Model with Political and Judicial Factors[1]



[1] DA=Democratic Accountability, GS=Government Stability, C=Corruption, L&O=Law and Order, MIP=Military in Politics, and PAAC=Peoples Attitude against Corruption.

Figure 5: Stock and Flow Diagram of Corruption Model with Social and Economic Factors[2]



The so-called "Reference Mode" depicts the dynamic behavior pattern of variables of interest over time which illustrates how these have evolved and how these might develop given the continuity of current trends (Qureshi, 2009). Results from the base case scenario, in which political, judicial, social and economic factors affect corruption, GDP and income inequality in the country positively or negatively, are shown in Figure 6. The focus of these simulations is to analyze the impact of different anti-corruption measures on different indicators of interest. To reproduce reference mode behavior (base case), involves putting in provisional values for the parameters at first to try and reproduce the general pattern of the reference mode. As discussed earlier, more accurate and detailed parameter values are obtained later and these are inserted into the model. The reference mode is reproduced in Figure 6 — this is generally called the base case.

The model assumes that an improvement in income inequality will subsequently decrease the corruption level (corruption index will improve) in the economy as shown in Feedback loop R_3 in Figure 2. It also seems realistic to assume that if corruption increases then income inequality in the economy deteriorates. In addition, income inequality has a detrimental effect on economic growth. Since corruption increases income inequality, it causes diminution in economic growth too. The model also assumes that economic openness improves economic growth, as some researchers stated that opening up of economies to international trade is generally viewed as an effective strategy for increasing level of GDP (see Feedback loop R_5 in Figure 2).

Baseline Projections

We opted to explain three important variables in the current study because of the importance of these variables in the existing literature. According to many economic studies, Income inequality has been

[2]GE=Government Expenditure, C=Corruption, and SEC=Social and Economic Conditions.

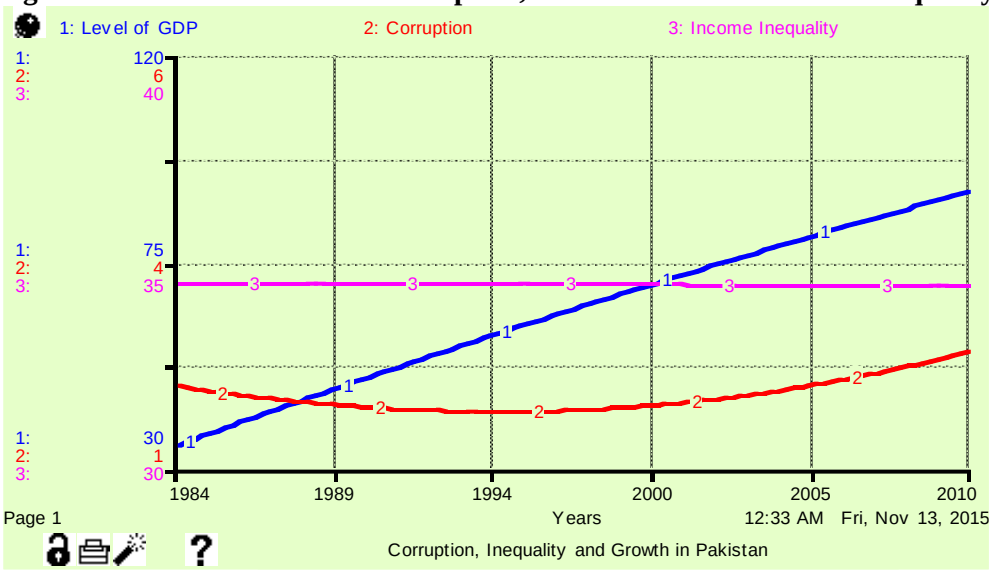
shown to be harmful to economic growth, so if corruption increases income inequality, it will also reduce economic growth and thereby aggravate poverty. The development policy community widely believes that reducing corruption would improve growth rates in less developed countries. In addition, corruption and income inequality affect each other, giving rise to the possibility of vicious and virtuous cycles.

In order to avoid sharp variations of the corruption index, which would be justified by evidences, the index is modeled by means of a level variable, dimensionless, with an explicit aim to attain the current value as we get in our behavior over time (BoT) diagram. In addition, its evolution has to keep certain characteristics in order to correctly quantify the degree of corruption in the economy, and likewise, to reflect other evidence (Dudley, 2000 and Treisman, 2000).Firstly, the range of variation in the index is selected to be from zero to six and like the ICRG corruption index, the higher the value of the index, the lower will be the level of corruption. In particular, if the index reaches the maximum value, the society will not have any corruption; but the index cannot be null, because in that case, the whole society will be corrupt, which is not a realistic proposition. Secondly, different evidences justify that corruption could be led by a feedback process, particularly, if the corruption is high due to the perceptions that individuals have to act corruptly. Thirdly, variations in corruption have to depend on the current level of corruption.

The stock and flow diagram contains several political, judicial, social and economic factors that affect corruption. The unit of time in the model is set equal to a year; the step of simulation is 0.25 years. The time horizon is selected equal to 26 years which is a period sufficiently long for showing how corruption affects to the tendency of the paths of economic growth as well as for verifying the necessity to fight against corruption.

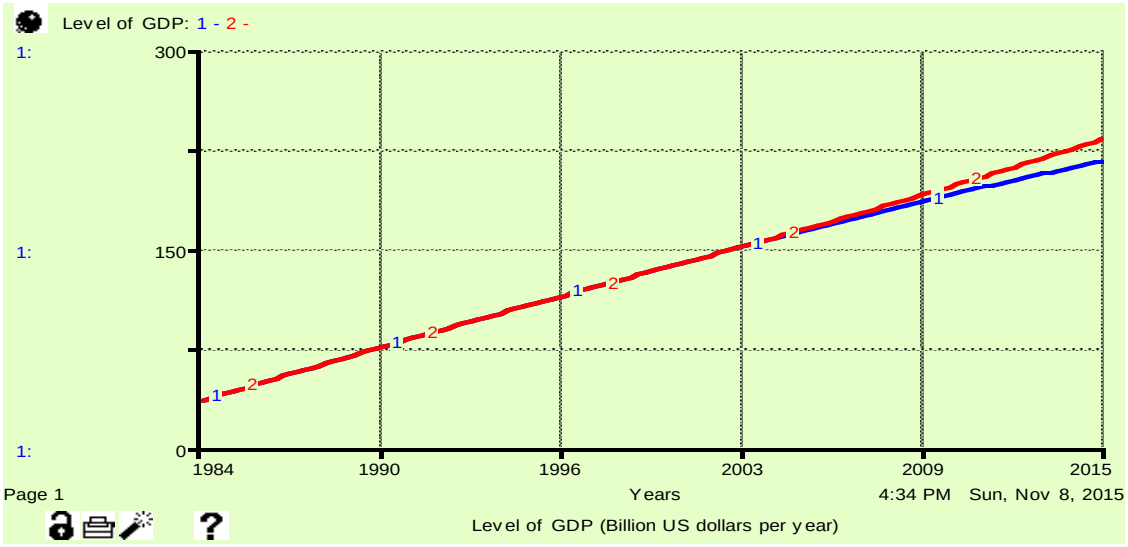
Figure 6 presents the BoT as predicted through the dynamic model as specified above and the associated stock-flow structure. The figure shows that the level of corruption index is predicted to remain quite low, close to 2 throughout the period, indicating a high level of corruption. Starting with a little less than 2 the index takes a downward through the mid-1980s and 1990s before rising back to slightly more than 2. The level GDP, on the other hand, shows a strong almost linear upward trend indicating about 233% growth over the entire period, which translates into 4.74 annual compound growth rate. Finally, Gini index of income inequality remains almost constant starting with 34.5 in 1984 and ending at 34.45.

Figure 6: Reference Mode for Corruption, Level of GDP and Income Inequality



As described in the stock and flow diagram in Figures 4 and 5, if the economy suffers from corruption activities, the foreign investment process will imply bribes payment. Corruption reduces the level of foreign direct investment and, consequently, affects the level of GDP. It can be seen from Figure 7 that an increase in the corruption index (decrease in Corruption) would help in increasing the level of GDP (orange line compared to blue line in Figure 7). Similarly, if there is a decrease in the corruption index (increase in corruption), it would cause decline in the level of GDP in the country. An increase in corruption increases the complexity of the feedback structure of the economic system since these factors (including inflation, government expenditure and economic openness etc.) add new causal relationships connected to those affected by unequal distribution of resources and going into the poverty trap. The whole feedback structure can fully explain why the corruption activities influence socioeconomic conditions in the country as well as the wealth of citizens (Soto-Torres et al., 2007). It is pertinent to mention here that we had to use a 'neutral' level of corruption because (a) we believe that a certain level of corruption always exists, and (b) the level of corruption is subject to balancing effects as well, so a 'non-zero' neutral level can facilitate the balancing dynamics better (accommodating both increases and decreases).

Figure 7: Effect of Corruption on the Level of GDP



The time horizon for future projections is selected equal to 5 years (2011-2015), which is a period sufficiently long for showing how corruption is affected by change in some important variables like democratic accountability, income inequality in the country, inflation rate, and organized crime as well as for verifying the necessity to fight against corruption. It can be seen from Figure 7 that due to

decrease in corruption there will be a change in economic openness of a country for international trade which substantially improves the level of GDP.

SIMULATION RESULTS

As per the standard practice in system dynamics modeling, the dynamic behavior of the corruption model can be studied through simulations. Along with the original BoT path of the variable under consideration, the potential shift in the path following a pre-specified change in certain parameter of interest is also drawn. The focus of these simulations is to analyze the impact of different policies on different indicators of interest. First the model needs to be placed in equilibrium (see Appendix I). At the equilibrium, the model does not generate shift in the dynamic path unless otherwise disturbed.

As we initialized the model, we simulated it with the reference mode representing status quo (Figure 6). Stocks will approach their higher or lower values if one or more of the stock variables is pushed up or down. Although the rapidity of that change is dependent on the extent of the push. In other words, when we change the value of stock parameters of the model, the system approaches either a more corrupt or a less corrupt state.

There are several variables in the model whose parameters can be changed to trace the possible changes in time paths of the variables of interest. These changes give rise to several model scenarios, which will be illustrated here.

In all the scenarios considered in the following figures we consider alternatively 0.5 point increase and decrease in a variable of interest taking place in the year 2010 and trace the effect of both these shocks of the variable under consideration. There are two sets of scenarios, one analyzing how corruption affects other variables and the other explaining the how corruption is affected by other factors.

We first consider the time path of income inequality and the effect of changes in corruption index on various variables. It can be seen from Figure 8 that according to the model's simulations, Gini index of income inequality is expected to remain almost constant at about 34.5. It is further seen that an improvement in the corruption (increase in the corruption index) by 0.5 point would help in decreasing income inequality (Line 3). Similarly, if there is deterioration in the corruption index by 0.5 points (decrease in the corruption index) it would cause increase in income inequality (Line 1). The figure shows that the role of corruption in determining the state of income inequality is substantial. Within just four years the effect of 0.5 points improvement in corruption index on the scale 1 to 6, is expected to result in almost one percentage point improvement in income inequality.

The high-level diagram in Figure 1 shows that the role of corruption in income inequality is quite complex. Even if we confine our discussion to the feedback loop of economic and social factors as depicted in Figure 2, we can see that apart from the direct effect, corruption disturbs income distribution through a number of channels including inflation, government spending and economic openness. This relationship is further strengthened by the feedback channel working through social exclusion, declining moral values and organized crime. The direct effect of corruption on income inequality strengthens the generally held belief that corruption is carried out by powerful members of society against the weak members. All-in-all, corruption is found to result in unequal distribution of income, which in turn becomes the cause of various socioeconomic evils.

Figure 8: Effect of Corruption on Income Inequality

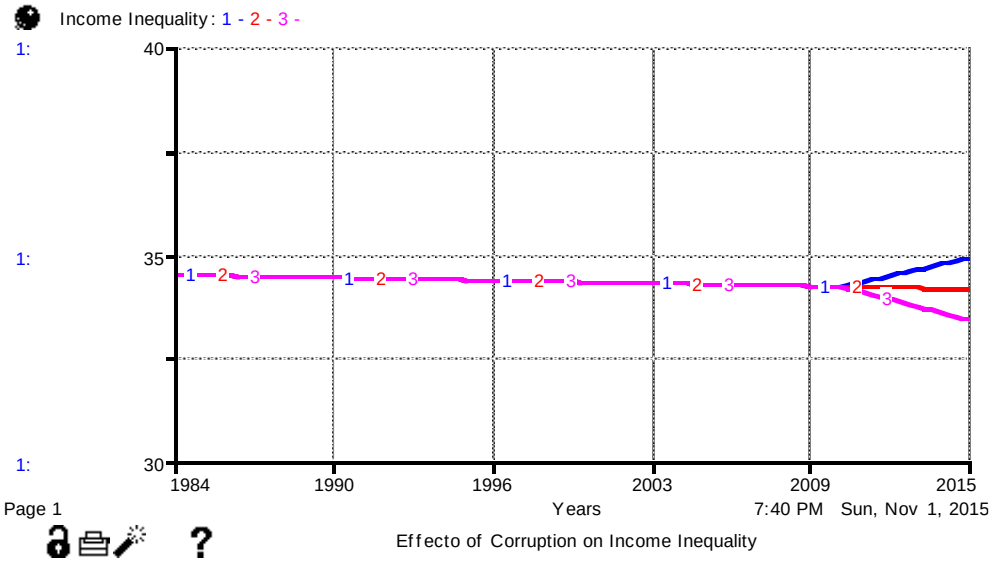
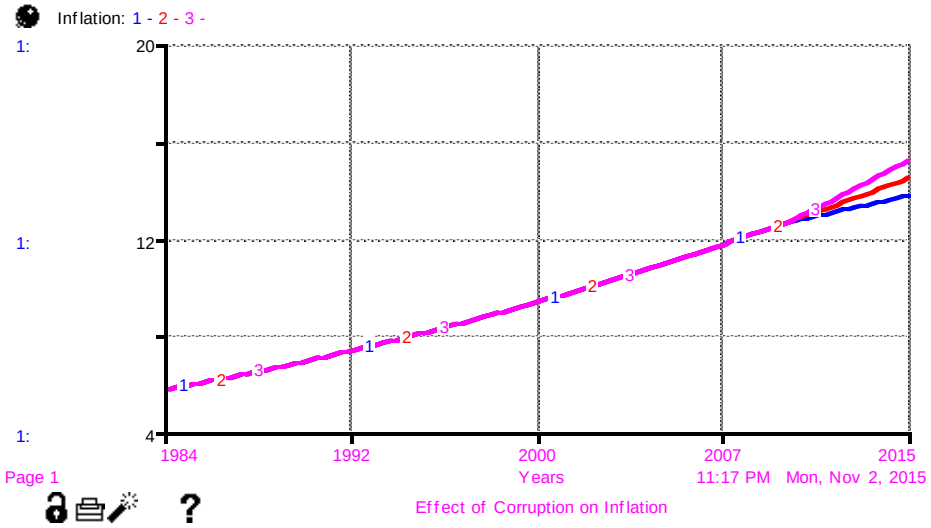


Figure 9 shows that inflation rate in Pakistan has been predicted to rise from 1984 to 2010. Furthermore, an improvement in the corruption would help in reducing inflation rate (Line 1) and vice versa (Line 3). In particular, an improvement in corruption index by 0.5 point is observed to reduce the inflation rate by close to one percentage point. The feedback loop of economic and social factors presented in Figure 2 shows the connection between corruption and inflation, direct as well as indirect working through various channels. The main factor contributing to this relationship is the financial corruption that increases the cost of doing business, which ultimately translates into increased prices of goods and services whether these are provided by private sector or public sectors. Another factor is that corruption increases the cost of service delivery from public to private sector. This increased cost is met through additional taxes, direct borrowing or, most commonly, monetary borrowing from the central bank. All these factors, especially money creation, are known to result in increased inflation.

Corruption, no matter how it could be justified, is not a free lunch and someone has to pay the price. The adverse effect of corruption on inflation shows just one form in which almost the entire society has to bear economic burden of corruption.

Figure 9: Effect of Corruption on Inflation

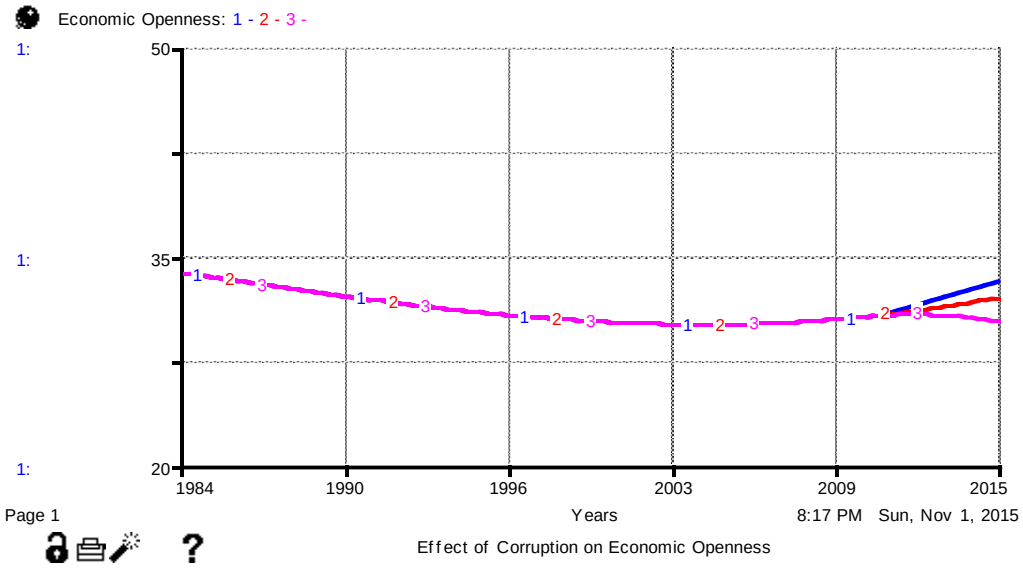


Next, we consider the time path of economic openness and the effect of corruption on economic openness. Figure 10 shows that starting at about 34% economic openness takes a downward swing through the 1980s and 1990s before turning up slightly in the 2000s. The figure also shows that an improvement (deterioration) in the corruption index by 0.5 points would help in increasing (decreasing) economic openness as shows by Line 1 (Line 3) in the figure. In particular 0.5 point improvement in

corruption index is seen to increase economic openness by a bit more than one percentage point. In Figure 2 corruption is seen to affect economic openness directly and through a number of feedback channels.

There can be several reasons why corruption is detrimental to economic openness. First, corruption increases the cost of doing business and as a result it adversely affects trade with rest of the world, especially because trading partners can find less corrupt countries to do trade. Second, corruption also discourages foreign direct investment, especially by multinational corporations that seek to locate their businesses to such countries where the cost of production is low. In this way, corruption also adversely affects trade, which could otherwise have taken place through multinational corporations operating within the country. Third, corruption retards economic activity, which adversely affects trade, especially imports. Fourth, corruption causes inflation, which makes domestic goods less competitive in the world market and as a result exports decline.

Figure 10: Effect of Corruption on Economic Openness



According to Figure 11 socioeconomic conditions in the country are expected to improve somewhat from 6.92 in the year 1984 to 8.28 in 2010 on the scale 1-12. It can be seen from Figure 11 that although corruption is found to exert adverse effects on socioeconomic condition, the size of this effect appears rather small and not worth further deliberations. The obvious reason is that according to our construct socioeconomic conditions are affected by corruption only indirectly through the effect of corruption on government expenditure and, hence, the state of service delivery from government to the public.

Figure 11: Effect of Corruption on Socioeconomic Conditions

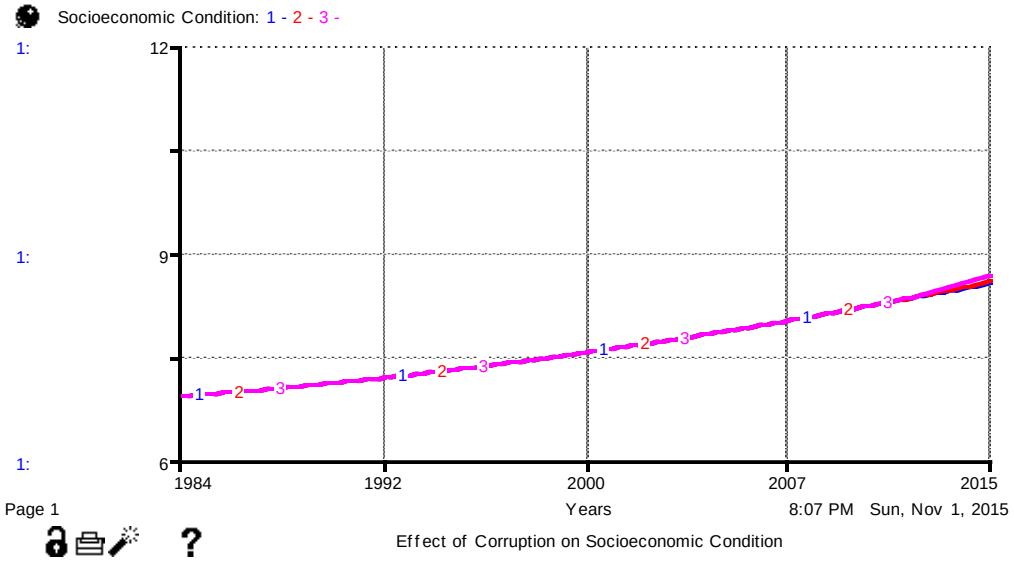


Figure 12 shows that according to the models predictions democratic accountability is to improve substantially from 1 to more than 3 on 1-6 scale. This improvement can be attributed to independence of judiciary gained throughout 1990s and 2000s. In certain instances courts have taken bold decisions against non-democratic moves such as removal of Prime Minister or imposition of emergency.

The figure also shows that democratic accountability is substantially dependent on the level of corruption. An improvement (deterioration) in corruption by 0.5 point results in 0.35 points improvement (deterioration) in democratic accountability, measured on 1-6 scale, in the year 2015 as can be seen by Line 3 (Line 1) in the graph. Corruption not only tends to weaken the effectiveness of law and order directly, this relationship is further enhanced by the adverse effects of corruption on government stability, the role of military in politics and organized crime, all of which further aggravate corruption. Another channel through which corruption affects democratic accountability which we can observe through Figure 13 is that the prevalence of corruption in the society also corrupts people's attitudes towards corruption and, hence, weakens the democratic accountability in the system.

Figure 12: Effect of Corruption on Democratic Accountability

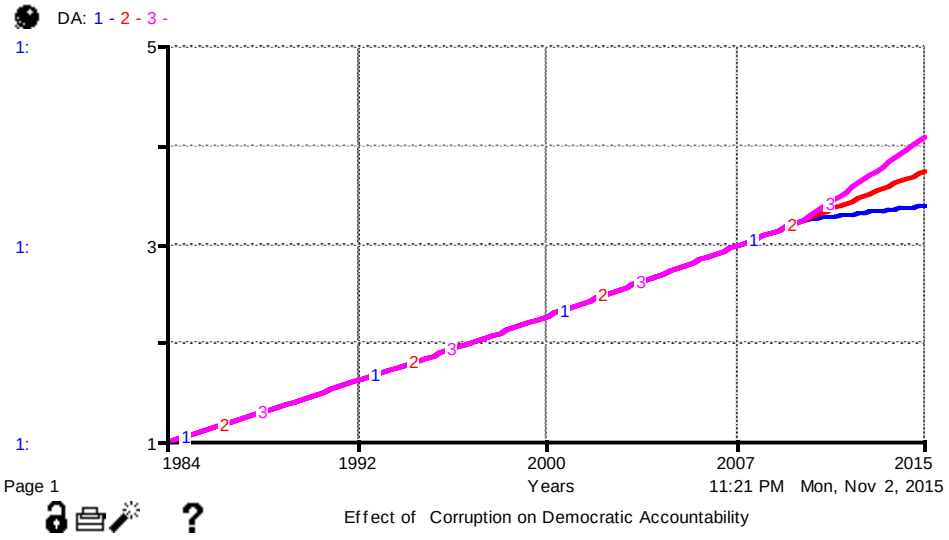
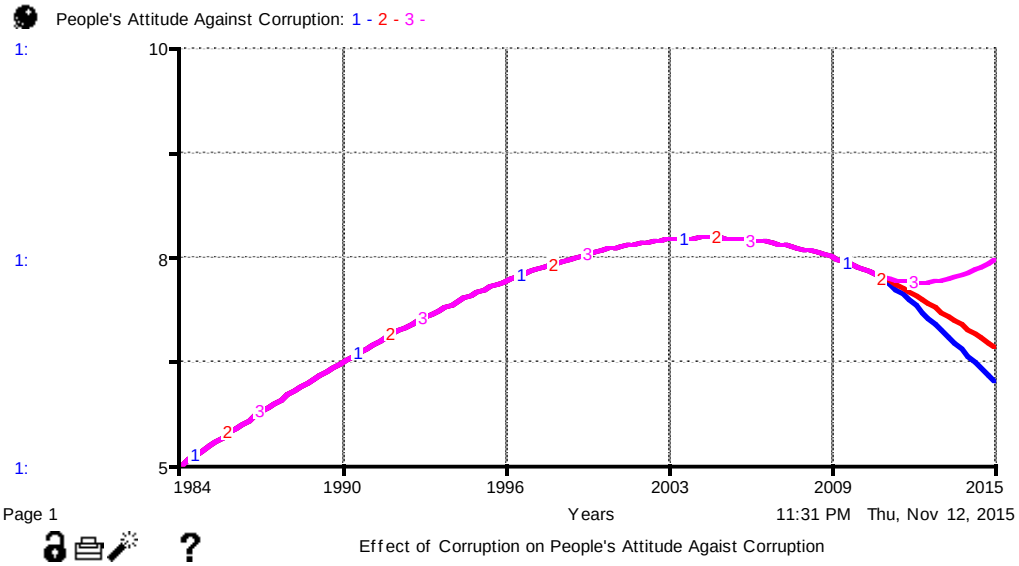


Figure 13 shows that attitude against corruption as predicted by the model follows an inverted U-shaped time path, starting at 5.0 in the year 1984 and ending at 7.24 in 2010. This indicates that the initial surge in unacceptability of corruption in public seems to have subsided and even reversed in the recent years. Corruption in Pakistan has sustained for too long a period to test people's resolve against its prevalence. People seem to have ultimately started tolerating corruption as a necessary evil.

The figure also indicates that an improvement (deterioration) in corruption by 0.5 point would result in a substantial improvement (deterioration) in people's attitude against corruption, as can be seen from Line 3 (Line 1). If corruption continues to prevail in a society, people tend to become immune to it and start accepting it as a fact of life. As corruption penetrates in the society, people's attitude against corruption also softens. In other words, corruption also corrupts people's minds and corruption ultimately becomes acceptable at least as a necessary evil if not as part of the normal behaviour. The mental threshold against corruption is drifted to the extent that small to medium levels of corruption in public dealings are no more considered as criminal as other forms of financial crimes. Another factor is that corruption becomes so widespread that it becomes quite difficult to get through legal matters from government offices such as obtaining licence to start a new business, getting electricity, gas and water connections and event paying the due and correct amount of taxes.

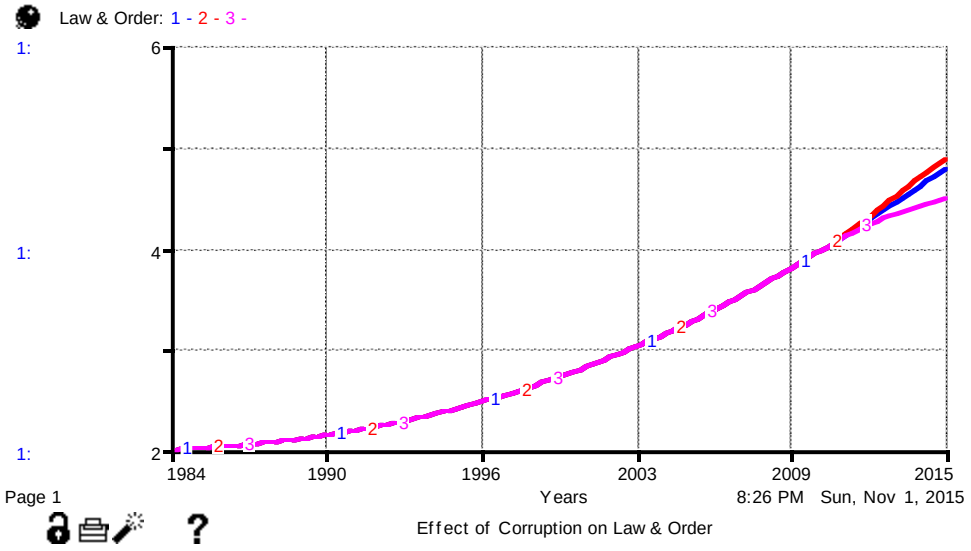
Figure 13: Effect of Corruption on People's Attitude against Corruption



As Figure 14 shows, according to the model's predictions law and order situation is expected to have improved substantially over the years from about 2 in the year 1984 to about 4.50 in 2015 on 1-6 scale. This improvement can be attributed to modernization of police and justice system through training and reforms.

It can also be seen from the figure that an improvement in the corruption would help in improving law and order situation in the country (Line 2), whereas deterioration in corruption would cause deterioration in law and order situation as well (Line 3). The feedback loop diagram in Figure 3 shows various linkages through which corruption can affect law & order situation in the country. First, corruption directly affects the efficiency and effectiveness of the law & order situation because corruption is very much present in the institutions responsible for law & order, such as police and courts. Widespread corruption means that law & order agencies remain entangled in corruption cases and corruption in the form of misuse of authority diverts the attention of local administration from their responsibility at district level. Often corruption also takes the form of bribe to deny justice. All these factors mean that improvement in corruption would improve the law & order situation in the country. The indirect channels through which corruption affects law & order situation include government stability, military in politics, organized crime and people's attitude against corruption all of which are favourably affected when the corruption situation is improved (see Figure 3).

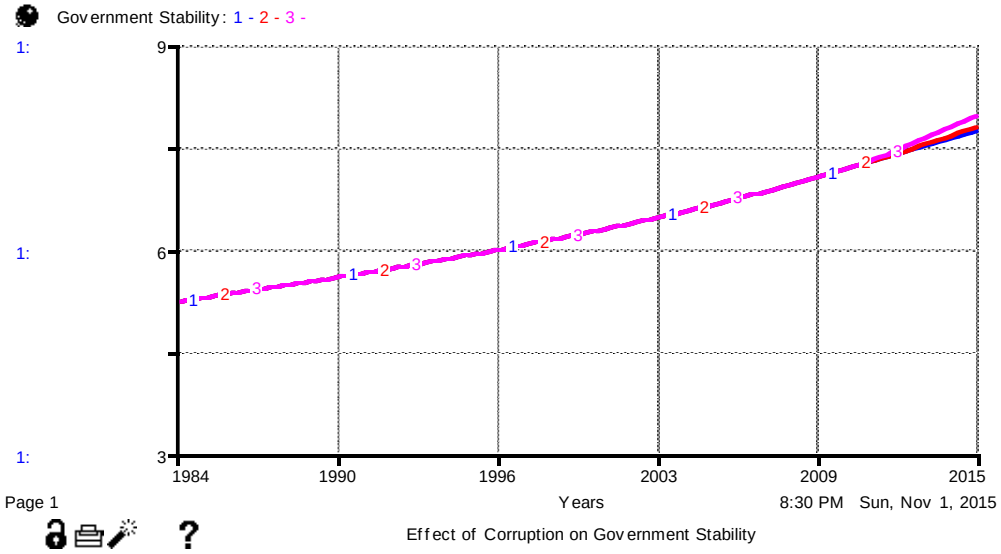
Figure 14: Effect of Corruption on Law & Order



It can be seen from Figure 15 the index of government stability is expected to have improved from about 5.3 in the year 1984 to 7.3 in 2015 on 1-12 scale. This can be partially verified from the observed that during the past 15 years there governments were allowed to complete their terms and the practice of disruption in the form of interim governments for a few months or a year followed in the past was no more adopted. The government democratically elected in the year 2008 was the first to complete its tenure and hand over the government to the next democratically elected government in the year 2013.

The figure shows that improvement (deterioration) in the corruption index associates with the improvement (deterioration) in government stability as indicated by Line 3 (Line 1). Government stability index is affected by corruption directly by feedback channel through various factors as indicated in Figure 3.

Figure 15: Effect of Corruption on Government Stability



The above analysis indicates how corruption affects other important indicators of socioeconomic conditions in Pakistan. We now turn our attention to analyse how corruption could be affected by other socioeconomic conditions. In the following four diagrams the time path of corruption as predicted by the model is obviously the same and has already been discussed.

Figure 16 indicates that an improvement/decrease in Gini index of income inequality by 0.5 points will result in improvement in corruption or increase in the corruption index (Line 3), whereas deterioration/increase in Gini index of income inequality by 0.5 points will result in deterioration in

corruption or decrease in the corruption index (Line 1). In numerical terms 0.5 point improvement in income inequality on 0-100 scale results in about 0.1 point improvement in corruption on 1-6 scale.

According to feedback loop diagram in Figure 2 income inequality is the direct cause of corruption. In theory there is a strong linkage between income inequality and corruption. Increase in income inequality results in increased feeling of deprivation among the poor. In a society where the prevalence of corruption is known to have resulted in unequal distribution of economic wellbeing, the people on lower end of the income distribution have great temptation to get out of the poverty trap through unfair means and, hence, indulge in corruption.

Figure 2 also highlights a number of indirect channels through which income inequality promotes corruption. One such important channel is from income inequality to social exclusion to degradation of moral values to organized crime to corruption. Social exclusion obviously means that the leftover segments of society develop the feeling of being outside the mainstream social network, which means that they are not necessarily bound by the prevailing social norms and are gradually drifted away towards crime mafia. Figure 6.2 also shows how income inequality affects the level of corruption through GDP and the feedback (reverse causation) from corruption to income inequality.

Figure 16: Effect of Income Inequality on Level of Corruption

Figure 17 shows that democratic accountability is an important indicator through which it is possible to control corruption. The figure shows that 0.5 point improvement in democratic accountability on 1-6 scale will cause improvement in corruption (increase in the corruption index) and vice versa by about 0.3 point as shown by Line 3 and Line 1 respectively. Democratic accountability has direct bearing on corruption and it is the lack of democratic accountability that promotes corrupt practices in government departments. In a fully functional democratic system people's representative holding the reign of government are accountable for all their acts and have little room left for corruption.

According to the feedback loop diagram in Figure 3 democratic accountability affects corruption without any intermediate factor. In addition, this relationship is strengthened by the feedback from corruption towards democratic accountability working through a number of political factors, particularly, people's attitude against corruption, law & order, government stability and military in politics.

Figure 17: Effect of Democratic Accountability on Level of Corruption

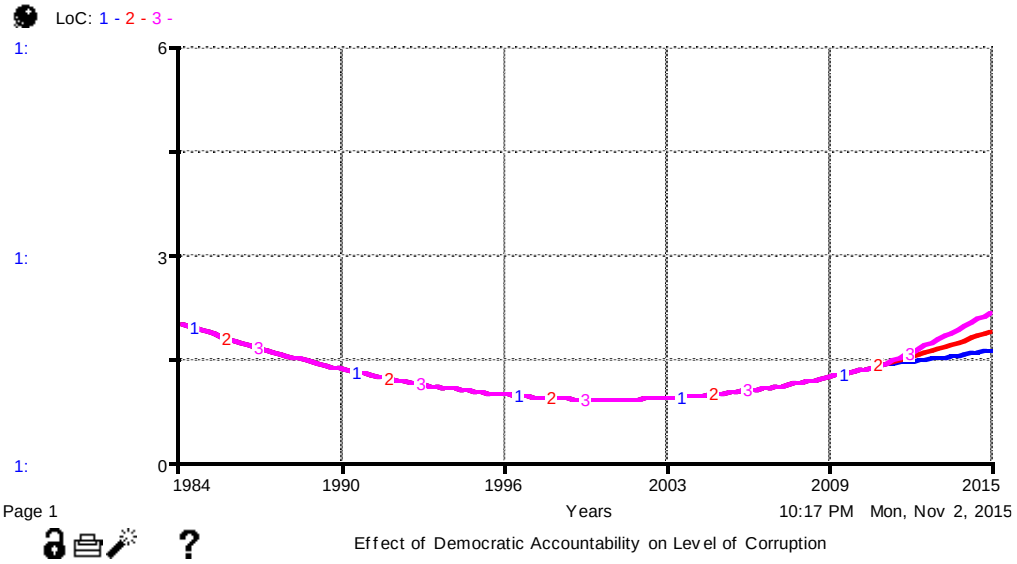


Figure 18 highlights the importance another factor, organized crime, that in has strong linkage with corruption. Increase (decrease) in organized crime by 0.5 points on 0-100 scale results in a substantial improvement (deterioration) in the level of corruption by about 0.3 point. According to Figure 3 organized crime has direct effect on corruption without any intermediate variables. This relationship is further intensified by the feedback from corruption to organized crime working through people's attitude against corruption and law & order.

Organized crimes are invariably carried out with the connivance of government officials in powerful position. Therefore this category of crime involves great deal of corruption (often defined as the use of state power for unlawful private gains). One of the major obstacles to fight against corruption is the network of organized crime that has to be weakened for any effort against crime to be effective.

Figure 18: Effect of Organized Crime on Level of Corruption

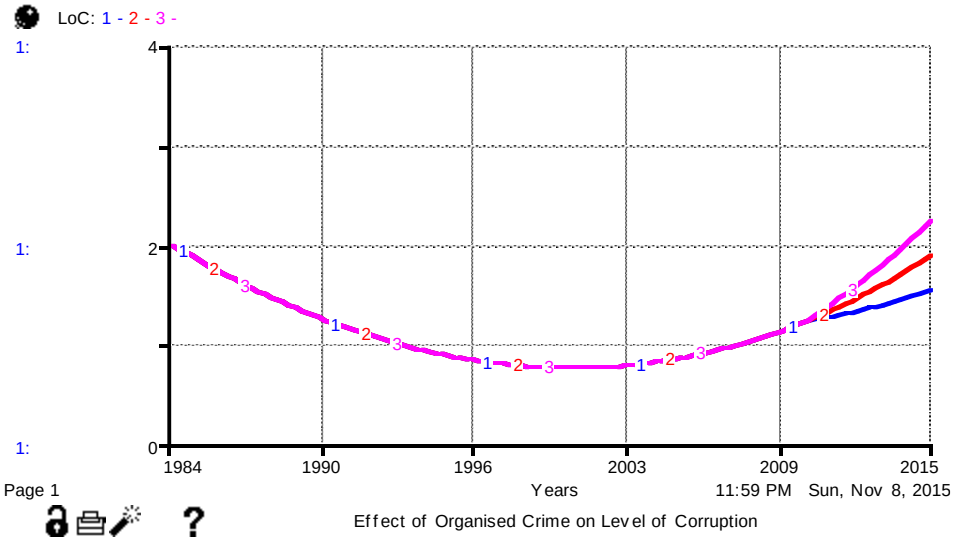
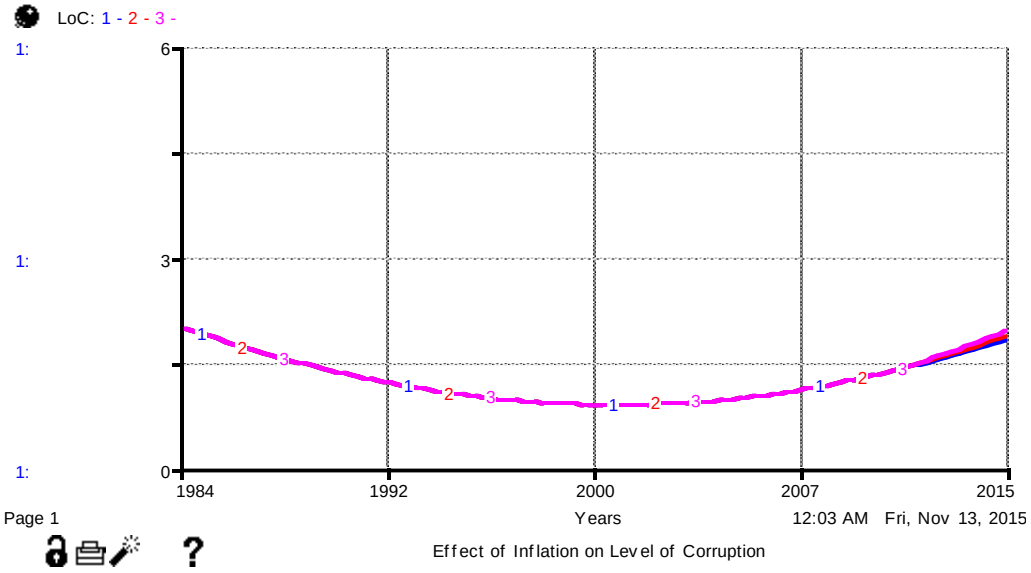


Figure 19 indicates that increase (decrease) in inflation rate by 0.5 percentage point will cause deterioration (improvement) in corruption by about increase in corruption by 0.05 point, which seems to be less substantial as compared to other comparative dynamic results presented in the above three figures. It appears, therefore, that inflation is more a result rather than a cause of corruption.

Figure 19: Effect of Inflation on Level of Corruption



We conclude from the above analysis that corruption is significantly affected by three factors namely income inequality, democratic accountability and organized crime. Since producing a fair income distribution is in any case an important goal of economic policy, its link with corruption provides additional reason to focus on income distribution in economic policy framework. Special attention has to be paid to the other two factors, democratic accountability and organized crime, through long term reforms in criminal justice system, especially police, district administration and district-level to higher courts.

Model Validation

According to Maani and Cavana (2007), the ultimate objective of system dynamics model validation is to establish the validity of the structure of the model. The corruption model has been subjected to a series of tests, which are briefly summarized below.

a) The causal loop diagram must correspond to the statement of the problem:

   The causal loop diagram for the corruption model provided in Figure 2 and 3 does correspond to the problem statement outlined in the Section 1 of this study.

b) The equations must correspond to the causal loop diagram; in particular the '+' and '-' signs in the equations must match the signs in the causal loop diagram:

   A close inspection of the model equations contained in the model formulation section revealed that the direction of the relationships in the causal loop diagram (see Figures 2 and 3) matched the direction of relationships in the simulation model in iThink™. However, it must be mentioned that the stock and flow diagram contains less variables than the causal loop diagrams (see Figures 4 and 5), which form the basis for the detailed model equations.

c) The model is dimensionally consistent without the use of parameters that have no real world meaning:

   It may not be usual to base a model almost entirely with indices rather than actual values, but this should not be a problem as the corruption model behaves in a reliable fashion. (Figure 6)

d) Are the rate equations plausible if imaginary maximum/minimum values of stock variable (or combination of stock variables) on which they depend are inserted into the model?

   Numerous extreme condition tests were conducted and equations are sensible at extreme values. For example, when the parameter values of level of GDP, income inequality, and corruption were set to zero, the model became completely static. (Appendix I)

e) How well does model-generated behavior match observed behavior of the real system?

   An exact matching between real data and model data points is not required for model validity (see Appendix II), because a System Dynamics model is not designed to include the internal

and external details and random factors that are needed in short term forecasting (Maani and Cavana, 2007). Moreover, the model endogenously approximated the hypothesized behavior of the system under normal and extreme conditions. The assumed reference mode behavior was reproduced given the current model structure.

CONCLUSION

Significant amounts of corruption modeling have been carried out in the past using econometric approaches, the technical knowledge needed to understand and comment on those approaches tends to limit their usefulness except among interested experts. To understand corruption, econometric analysis is not enough. Econometric studies have brought about useful insight into the many facets of corruption modeling, while efforts mostly have focused on supporting theories with linear approaches of analysis. System dynamics offers an opportunity to understand and communicate these systems and their dynamics with its non-linear approach (Forrester, 1987; Sterman, 2000). Most importantly, qualitative data analysis also provides input as well as foundation for a system dynamics model of corruption for this study.

We developed the system dynamics model based on the cause and effect relationship among variables related to the economic, social, political, judicial and cultural factors, represented in a causal loop diagram, which gives a broader picture of the dynamics of corruption in a country (Pakistan). This guided the design of a computational model with iThink™, whose outcome is useful in formulating anti-corruption strategy at the government level. System dynamics simulation provides a better picture by giving five different scenarios to control corruption. The behavior of income inequality and level of GDP lead to changes in the level of corruption. On the other hand, a change in economic openness of a country for international trade substantially improves the level of GDP. Moreover, future scenarios were planned with different combinations of inputs, simulating for different level of corruption in the country.

Indeed, as a result of this study, we can offer an explanation that uncovers the underlying factors that address the dynamics of corruption, social, economic, political, judicial and cultural factors in the case of any developing country, which can be applied with some modifications for the developed world as well. This explanation gives an answer to the research questions presented in the introductory section. In this research we try to systematically explore the problem of corruption in societies by incorporating very complex and different social, cultural and even religious aspects that were mostly untouched in system dynamics studies in the past. Returning to the question posed at the beginning of this study, it is now possible to state that the problem of corruption is studied in a broader perspective by using the system dynamics methodology. Moreover, the study has gone some way towards enhancing our understanding of corruption by using system dynamics modeling.

Appendix I

SYSTEM DYNAMICS MODEL AT EQUILIBRIUM

Figure 1: System Dynamics Model at Equilibrium (Level of GDP)

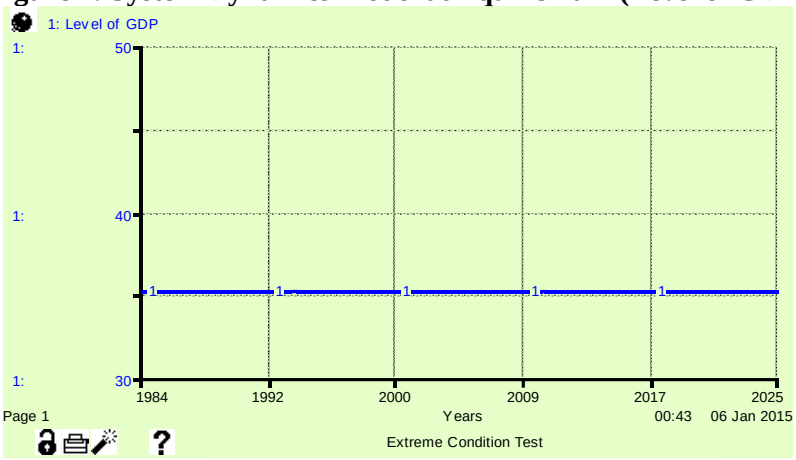


Figure 2: System Dynamics Model at Equilibrium (Income Inequality)

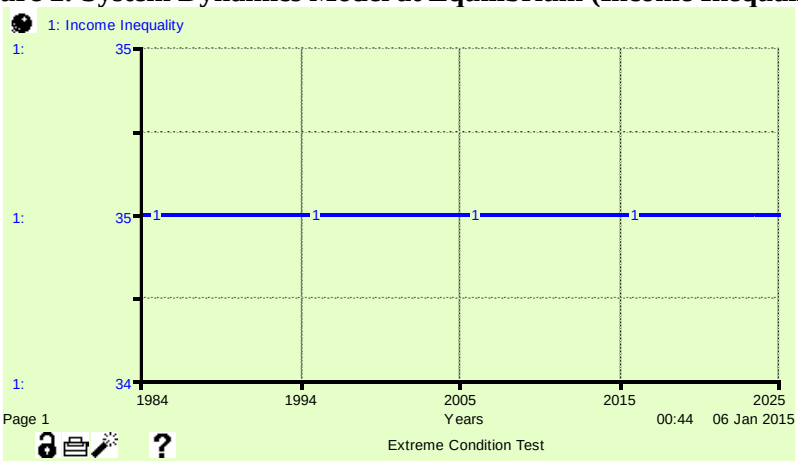
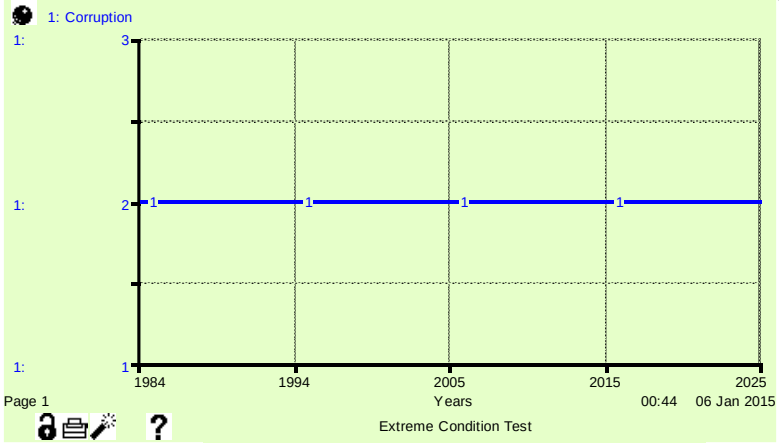


Figure 3: System Dynamics Model at Equilibrium (Corruption)



Appendix II

TEST OF MODEL BEHAVIOR

Figure 1: SD Model Behavior Reproduction (Level of GDP)

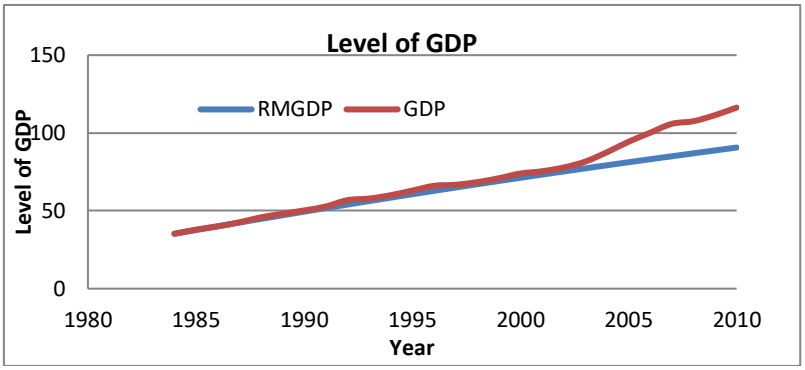


Figure 2: SD Model Behavior Reproduction (Income Inequality)

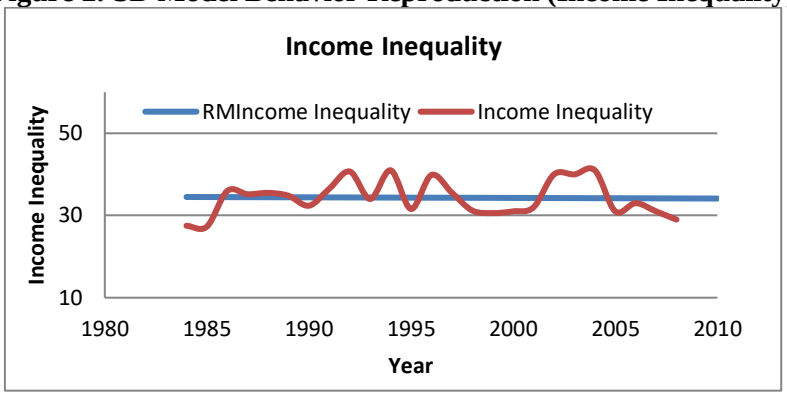
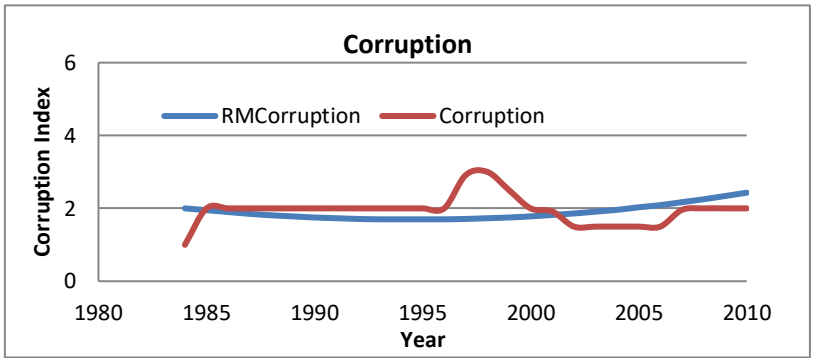


Figure 3: SD Model Behavior Reproduction (Corruption)



REFERENCES

Andreski, A. (1970), *Parasitism and Subversion*, London, United Kingdom: Weidenfeld and Nicolson.

Andvig, J. (1991), The Economics of Corruption: A Survey, *Studi Economici*, 43, 57-94.

Checkland, P. (1981), *Systems Thinking, Systems Practice*, London, United Kingdom: John Wiley.

Checkland, P. (2007), Reply to Eden and Ackerman: Any future for problem structuring methods? *Journal Operational Research Society*, 57(7): 769-771.

Checkland, P., and Scholes, J. (1999), *Soft Systems Methodology in Actio*n, New York, Unites States: Wiley.

Dudley, R. G. (2000), *The Rotten Mango: The Effect of Corruption on International Development Projects*, Eighteenth International Conference of the System Dynamics Society Sustainability in the Third Millennium. Retrieved from http://pws.prserv.net/RGDudley/PDF/rtmango1.pdf.

Forrester, J. W. (1987), Nonlinearity in High-Order Models of Social Systems *European Journal of Operational Research*, 30(2), 104-109.

Huntington, Samuel P. (1968), *Political Order in Changing Societies*. New Haven, United States of America: Yale University Press.

Kaufmann, D., and Shang-Jin, Wei. (1998), *Does 'grease money' speed up the wheels of Commerce?,* NBER Working Paper No. 7093(04).

Khan, M. (2004), T*he Public Sector and Privatization*, Discussion Paper.

Klitgaard, R. (1988), *Controlling Corruption. Berkeley*, United States of America: University of California Press.

Maani, K., E., and Cavana, R., Y. (2007), S*ystems Thinking, System Dynamic: Managing Change and Complexity* (2 ed). Pearson Education New Zealand: Pearson: Prentice Hall.

MacDonald, R. (2011), *System Dynamics Modeling*, Retrieved from URL:http://www.isdps.org/System%20Dynamics.htm

Midgley, G. (2003), *Systems thinking*, Sage: London, United Kingdom:

Moreno, O. L. (2000), *Structural Corruption and Normative Systems: The Role of Integrity Pacts*' en J. S. Tulchin y R. H. Espach (eds.) *Combating Corruption in Latin America*, Washington D.C.: Woodrow Wilson Centre Press.

Patching, D. (1990), *Practical Soft Systems Analysis*, Pitman Publishing, London.

Papyrakis, E., Rieger. M., and Gilberthorpe, E. (2016): Corruption and the Extractive Industries Transparency Initiative, *The Journal of Development Studies*, 53(2), 295-309.

Political Risk Services (2011), *International Country Risk Guide Dataset*, Available for purchase at http://www.icrgonline.com.

Political Risk Services (2011), *Pakistan Country Report*, New York, USA: The PRS Group, Inc.

Qureshi, M. A. (2009), Human development, public expenditure and economic growth: a system dynamics approach, *International Journal of Social Economics*, 36(1/2), 93-104.

Richardson, G. P. (1991), *Feedback Thought in Social Science and Systems Theory*. Philadelphia, United States of America: University of Pennsylvania Press.

Richmond, B., and Peterson, S. (1997), *An introduction to systems thinking*. Hanover, NH, United States of America: High Performance Systems.

Riley, S. P. (1983), *The Land of Waving Palms: Corruption Inquiries, Political Economy and Politics in Sierra Leone*'. in M. Clarke, (ed.) Corruption: Causes, Consequences and Control, London: Frances Pinter.

Rock, M. T. (2009), Corruption and Democracy, *Journal of Development Studies*, (45(1), 55-75.

Silverman, B. G., Gnana K. B., and Benjamin N. (2007), *Profiling is politically 'Correct': Agent-Based Modeling of Ethno-Political Conflict*, Departmental Papers (ESE) Available at: http://works.bepress.com/barry_silverman/23

Soto-Torres, M. Dolores, Ramon Fernandez-Lechon, and Pedro, F. S. (2007), *A system dynamics model about public corruption: the influence of bribes on economic growth* Paper presented at The 2007 International Conference of the System Dynamics Society, July 29 – August 2, 2007, Boston, Massachusetts, USA.

Sterman, J. D. (2000), *Business dynamics: systems thinking and modeling for a complex world*. Boston, United States of America: Irwin/McGraw-Hill.

Transparency International (1998), *Transparency International Corruption Perceptions Index:* Berlin, Germany.

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

Vennix, J. A. M. (1996), *Group Model Building: Facilitating Team Learning Using System Dynamic*, Chichester, United Kingdom: Wiley.

Ventana Systems (2002), *Vensim User's Guide*, Version 5, USA: Ventana Systems Inc.

Ullah, M. A. (2006), *Corruption, Income Inequality and Economic Growth* (M.Phil thesis), Quaid-i-Azam University, Pakistan.

Wolstenholme, E. F. (1990), *System Enquiry: A System Dynamics Approach*, New York, NY, United States of America: John Wiley & Sons, Inc.

World Bank (1995), *Bureaucrats in Business, The Economics and Politics of Government Ownership*, A World Bank Policy Research Report: Washington DC.

World Bank (2013), *World Development Indicators 2013*: Washington, DC.