Enhancing the Understanding of Corruption through System Dynamics Modelling

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Abstract

Over the past few decades, many studies of corruption have been carried out. These studies have mainly focussed on specific characteristics such as: economic issues, legal issues, social propositions, impact on national development, and in relation to economic policy. The rationale of this research is to build initial system dynamics models of corruption, so that these models can extend our understanding of corruption and act as an input to future policy making on corruption. System dynamics modelling allows researchers to discover 'hidden' dynamics. Moreover, system dynamics enables the analyst an increased level of flexibility, as system dynamics modelling uses both theoretical understanding, as well as empirical data collection.

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 case of any developing country, which can be applied with some modifications for developed world. In this we try to determine 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 past. Systems dynamics model of corruption developed in this study would be of use to policy makers and non-governmental organisations in understanding the complex nature of corruption.

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

1 Introduction

Over the past few decades many studies of corruption have been carried out (Leff 1964, Huntington 1968, Friedrich 1972, Nye 1967, Mauro 1995, Lambsdorff 1999, Treisman 2000 and Mahrwald 2009). These studies have mainly focussed on specific characteristics such as: economic issues, legal issues, social propositions, the impact on national development, and the relationship to policy making. Theoretical considerations of corruption have emphasised econometric modelling, game theory, and similar mathematical approaches. These approaches, to be analytically tractable, have addressed only particular subsets of a systematically corrupt system (Dudley 2000).

Pakistan is listed as one of the corrupt countries in the world,[2] but it is now going through a transition period that may allow reform to be more easily introduced. In Pakistan, the 1999 National Accountability Ordinance set up a new agency specifically to fight corruption. In October 2002, Pakistan's Cabinet approved a National Anti-Corruption Strategy (NACS) that identified areas of pervasive corruption and recommended measures and reforms to combat corruption. Under the legislation, giving and accepting bribes are criminal acts punishable by confiscation of property, imprisonment, recovery of ill-gotten gains, dismissal from governmental service, and reduction in governmental rank. Yet, corruption still remains widespread in Pakistan, especially in the areas of government procurement, international contracts, and taxation.

In this paper we try to understand the issue of corruption in depth by using System Dynamics Modelling (SDM) by using qualitative research methods to analyse the data and provide a foundation for the SDM.[3] Themes that come from qualitative data analysis are operationalised in a SDM. The main objective of this study is to develop a logical theoretical framework which can be used to study corruption dynamics. An attempt has, therefore, been 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 modelling to explore how the social system of corruption develops its stable macro-state. The conceptualisation of corruption used in this paper 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 more depth:

- How can our understanding of corruption be extended by using a system dynamics approach?

[2] According to the Transparency International ranking, Pakistan is ranked 135th out of 183 countries ranked from best to worst, while New Zealand is cleanest country using the 2011 Corruption Perception Index.

[3] For more detailed qualitative analysis, please see our paper presented at the 29th International Conference of the System Dynamics Society, Washington DC, USA. Retrieved from http://www.systemdynamics.org/conferences/2011/proceed/papers/P1223.pdf

- 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 work 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, reform itself seems unlikely.

System dynamics models mainly depend on three sources of information: a) numerical data, b) the written database (reports, operations manuals, etc), and c) the expert knowledge of key participants in the system. The numerical database is very small as compared to the written database which is quite large, and the expert knowledge of key participants is vast. System dynamicists mainly use all three sources, with particular consideration to the expert knowledge of key participants. Through the use of available data and verbal descriptions provided by experts, the system dynamics modelling process brings new concepts and/or previously unknown but significant variables.

The paper is organised in six sections. Section 2 describes transition of first author from econometric modelling to system dynamics modelling. In the next section a high level diagram of system dynamics model has been developed. It also describes feedback loops and presents behaviour over time diagrams. Section 4 formulates the model for simulation, while section 5 presents the analysis and a discussion of the simulation results with model validation. Section 6 rounds off the paper as a whole by providing brief summary of major findings, theoretical and practical contributions of this study, as well as recommending opportunities for further research that this study has opened up.

2 Econometric Modelling to System Dynamics Modelling

Few years ago, when the researcher (The first author of this paper) was toiling as an economist, the researcher was working on corruption, income inequality and economic growth using quantitative data and hardcore econometrics techniques to develop the relationship between corruption, social, economic and political factors. The researcher suggests different models of corruption with economic growth and income inequality. Following the empirics of Mauro (1995), the researcher develops and modifies the growth model of corruption. Mauro does not test, whether there is growth enhancing or growth reducing level of corruption, one wonders whether corruption still affect growth adversely if more policy controls are added. It is apparent from the linear specification used by Mauro's study that linear framework can only provide a partial test of the theory: only linear effect can be captured, and the growth maximising level of corruption is forced to lie in a corner.

The study empirically analyse the effects of institutional quality indicators, corruption indicator and other policy indicators on economic growth. This study empirically analyse these effects on economic growth through total factor productivity growth and determine corruption and institutional quality within the

model. The dynamic feature of the model arises from the inclusion of lagged dependent variable. The model given in Equation 2.1 attempts to capture both the growth enhancing and growth reducing effects of corruption on growth by estimating long run growth as a linear-quadratic function of corruption.

$$\mathbf{y_{it}} = \boldsymbol{\beta}_0 + \sum \boldsymbol{\beta}_j \mathbf{X_{itj}} + \sum \boldsymbol{\delta}_k \mathbf{X_{itk}} + \gamma \mathbf{y_{i,t-1}} + \boldsymbol{\alpha} \frac{\mathbf{K_{it}}}{\mathbf{L_{it}}} + \boldsymbol{\varepsilon}_{1it} \qquad 2.1$$

$\beta_{j's}$ are the coefficients of the conditioning variables, δ_K are the coefficients of variables measuring corruption and institutional quality, γ is the coefficient of lag of GDP per worker and finally, μ is the random error term. The above equation (2.1) includes conditioning variables and variables measuring corruption and institutional quality. These variables are government expenditure, indicator of external competitiveness, population growth rate, primary school enrollment rate, secondary school enrollment rate, foreign direct investment, risk to investment index, corruption index, bureaucratic efficiency index, political stability index, and institutional efficiency index. We attempt to capture both the growth enhancing and growth reducing effects of corruption on growth by estimating long run growth as a linear-quadratic function of corruption. $\beta_{j's}$ are the coefficients of the first seven conditioning variables, δ_K are the coefficients of eight variables measuring corruption and institutional quality, γ is the coefficient of lag of GDP per worker and finally, μ is the random error term.

According to Ullah et al. (2011, 2012), bureaucratic red tape and corruption are probably the most ancient and widespread diseases of bureaucracy. They have been observed in all societies; there is no reason to believe that they will soon disappear. Numerous attempts to fight either of them seem to have brought only limited results. One of the problems with corruption and red tape in bureaucracy is that they cannot be treated independently. Corruption in one part of a hierarchy may stem from corruption in another part; excessive red tape may emerge due to potential corruption; bribes may be extorted because of potentially high red tape. The following model was estimated to capture the impact of bureaucratic red tape on corruption:

$$\mathbf{Corr}_{it} = \boldsymbol{\alpha}_0 + \boldsymbol{\alpha}_1 \mathbf{Bqua}_{it} + \boldsymbol{\alpha}_2 \mathbf{Dacc}_{it} + \boldsymbol{\alpha}_3 \mathbf{Lsse}_{it} + \boldsymbol{\alpha}_4 \mathbf{Lpop}_{it} + \boldsymbol{\alpha}_5 \mathbf{Open}_{it} + \boldsymbol{\alpha}_6 \mathbf{Govt}_{it} + \boldsymbol{\alpha}_7 \mathbf{Corr}_{i,t-1} + \boldsymbol{\varepsilon}_{2it} \qquad 2.2$$

The above equation (2.2) includes variables: Corruption index, Bureaucratic quality index, Democratic accountability index, Secondary school enrolment rate, Population, Indicator of external competitiveness, Government spending, Lag of corruption index, Error term. α's are the coefficients of the variables, while *i* and *t* represents the country index and the time index respectively.

In another paper, Ullah and Ahmed (2006) also examine the impact of corruption on the income distribution, while including a number of control variables to minimise the omitted variable bias. These control variables include per capita income, trade openness, population growth rate, education, government expenditure, capital per-worker and past level of inequality. The

following model of income inequality was tested. β's are the regression parameters, ε is the random error term and *i* and *t* represents the country index and the time index respectively.

$$\mathbf{Gini}_{it} = \beta_1 + \beta_2 \mathbf{Corr}_{it} + \beta_3 \mathbf{y}_{it} + \beta_4 \mathbf{Open}_{it} + \beta_5 \mathbf{Gpop}_{it} + \beta_6 \mathbf{Lsse}_{it} + \beta_7 \mathbf{Govt}_{it} + \beta_8 \mathbf{Ln}\left(K/L\right)_{it} + \beta_9 \mathbf{Gini}_{i,t-1} + \varepsilon_{3it} \quad 2.3$$

β's are the coefficients of the variables and ε is the error term in the equation 2.3. *i* and *t* represents the country index and the time index respectively. These three models of economic growth, income inequality and endogenous corruption (Equations 2.1, 2.2 and 2.3) suggest a system of simultaneous equations where corruption is endogenous and affects both economic growth and income inequality. One of the limitations with this approach is that it does not explicitly tell whether certain variables should be related, as suggested by theory. One question that needs to be asked, however, is whether a variable should be regarded as endogenous or exogenous, or what the precise mathematical relationship between the variables should be. According to Moore (1985), sometimes, "econometric models tend to include large numbers of variables with few lag terms. With models of this size, and with the comparatively short lengths of the time series which are usually available for economic variables, there is a high risk that the model will be over-parameterised". The author further explains that econometric models usually fit past data better than do time series models; whereas they often do not forecast as well.

Winz et al. (2009) suggest that "holistic problem understanding is not possible based on quantitative data and black box modelling. A move towards integrative models will require the use of qualitative data, either on its own through qualitative modelling or in combination with quantitative simulation". Dudley (2000) argues that system dynamics modelling should offer an ideal approach for examining corruption dynamics in any country/society because it avoids the necessity of setting up models in a purely mathematical manner. The author further suggest that initial models can be presented in an logical format for discussion with those who will have valuable input into subsequent model alteration leading to a better understanding of corruption.

2.1.1 Why System Dynamics Modelling

According to Radzicki (2007), there are three principle ways that system dynamics is used for economic modelling. These three approaches are briefly discussed below.

1. The first approach involves translating an existing economic model into a system dynamics model,
2. The second method involves creating an economic model from scratch by following the rules and guidelines of the system dynamics paradigm. Many researchers like, Forrester (1958) and Richardson and Pugh (1981) gives extensive details about these guidelines and rules. A number of studies have found that the former approach is valuable because it enables well-known economic models to be represented in a common format, which makes comparing and contrasting their

assumptions, concepts, structures, behaviours, etc., fairly easy (Radzicki 2007, and Sterman 2000). The latter approach is valuable because it usually yields models that are more realistic and that produce results that are "counterintuitive" (Forrester 1991) and thus thought-provoking,

3. The third way that system dynamics can be used for economic modelling is a "hybrid" approach in which a well- known economic model is translated into a system dynamics format, critiqued, and then improved by modifying it so that it more closely adheres to the principles of system dynamics modelling. This approach attempts to blend the advantages of the first two approaches, although it is more closely related to the former.

In general, existing economic models that can be translated into a system dynamics model can be divided into four categories: a) written, b) static (mathematical), c) difference equation, and d) ordinary differential equation. Existing economic models that have been created in either a difference equation or an ordinary differential equation format can be translated into system dynamics models in a fairly straight-forward manner (Radzicki 2007). Compared with the traditional black-box econometric models, in this thesis, we try to develop a system dynamics model which shows clearer and more direct relationship between social, economic, political, cultural and judicial factors by adopting third approach discussed above which transformed economic model into system dynamics format, and then improved it further by modifying it.

3 A High-level Diagram of System Dynamics Model

Based on the literature review and qualitative data analysis, we developed qualitative system dynamics model of corruption, which includes social, economic, cultural, political and judicial variables. There are several feedback loops in a high-level diagram of corruption model. The primary task identifying the systems approach to modelling 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 3.1, there are a whole range of potentially significant joint dependencies (and feedback dynamics) that capture overall system behaviour and performance over time rather than one 'dependent variable', which is different from traditional social sciences. It is therefore essentially a systemic framework of analysis that provides a useful mechanism for understanding 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.

A social system occupied by increasingly complex and bureaucratic organisational structures, market-based capitalism (possibly a more accurate description would be the institutions and organisations that consist of the marketplace) requires gradually complex regulation and socio-political interference, not only to ensure increased accountability, transparency and control but, more importantly, to ensure market efficiency. Such demands, whether a product of government interference and/or market-based principles, nonetheless promote a greater dependency on systems – a trust in systems – in order that: governments ensure sufficient regulatory control of an increasingly

complex marketplace is maintained, and market regulators ensure right levels of market confidence are maintained in extant regulatory procedures (Situngkir et al. 2004).

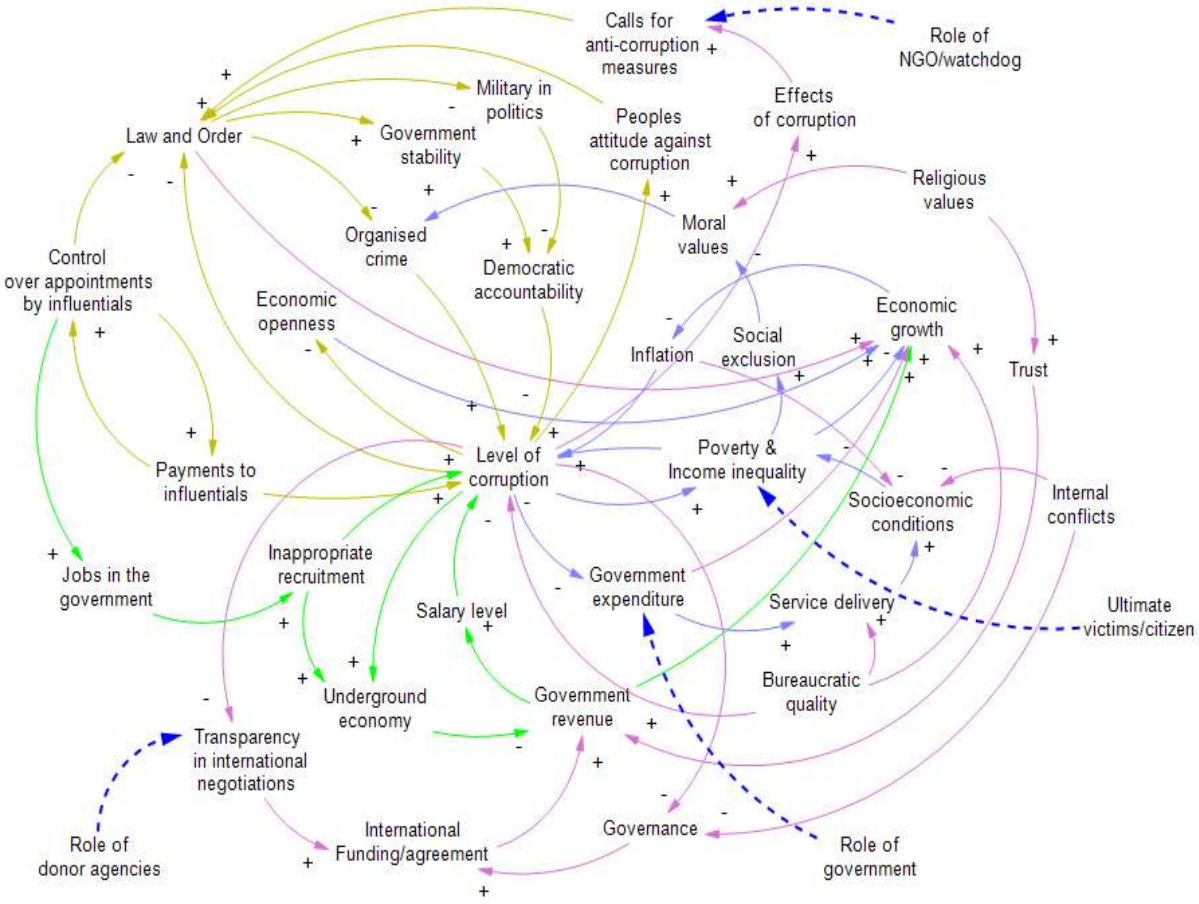

Figure 3.1: High-level Diagram of System Dynamics Model of Corruption

The most devastating consequences of bribery are usually not the cost of the bribes themselves, but the distortions they unleash within social, political and economic systems. For example, bribes compromise efficiency in the allocation of state resources (see Figure 3.1). Examples of this arise in awarding of government contracts or privatising state industries, as corruption favours those with connections over efficiency. Other inefficiencies can arise if officials increase regulations, delays and unnecessary requirements as a means of inducing additional payoffs. High levels of bribery increase the costs, risks and unpredictability of doing business. This work will explore this deeper understanding of corruption, its impacts in areas such as social, economic, political and cultural aspects, and its implications for the principle of the rule of law.

Almost all countries in the world have an informal economy (Cobb and Gonzalez 2007), it can be defined as that part of the total economy in the country that neither registers with the government nor pays taxes on any business transaction. Informal economies (as a per cent of the Gross National

Product) range from an estimated minimum of 3% (Canada) to a maximum of 93% in countries whose national government has collapsed like Benin and Somalia (Sundquist 2008). If the size of an informal economy is greater, the tax base for sales and corporate, individual income taxes that are withheld by employers will be smaller. Ultimately, it causes a reduction in government revenue. To increase tax base, government will attempt to offset this loss of revenue by (a) increasing taxes in the formal economy, or (b) increasing import duties. Either response by the government is likely to force even more businesses out of the formal economy. As a result, the amount of money available to pay salaries of government employees decreases. When a government is suffering in decrease in funds for salaries, it will either reduce the number of government sector jobs or reduce salaries. As actual wage rate falls below the acceptable levels, government employees have even less incentive to refrain from corrupt practices, and competent workforce begin to leave government service.

Eventually, as businesses observe that business taxes and fees are supporting a corrupt and incompetent government, they will start to leave the formal economy and move into the informal economy and those that are already in the informal economy will be hesitant to formalise their businesses. This last step closes the loop. This process describes the effect of increases in the informal economy on corruption, by the intermediary step of lower revenues for the government. These effects are self-reinforcing, meaning that once it starts it will continue to perpetuate itself.

The role of donor agencies can be seen in high-level diagram (see Figure 3.1) of the model which deals with the constructs of international funding and transparency in international agreements. Developing countries often incur some cost in negotiations with multinational funding agencies, and in bilateral negotiations with more powerful nations. Whenever the negotiations are carried out without transparency, corruption becomes a likely factor in this poor performance. If there is a closed door negotiation between funding agency and government organisation, it offers broad prospects for secret side-agreements between participants. The effect of these agreements is that more of the economic benefits of the agreement go abroad, and fewer remain at home. This further decreases the benefits for the country, and, either directly or indirectly, diminishes the income of the government (Dudley 2000, Marcus et al. 2007, and Cobb et al. 2007). As in previous case, it will ultimately decrease total funds for government salaries, and further increase in the corruption in government sector. It will cause in decrease in transparency in future international negotiations. In developing countries badly needed development funding is often quite small. Projects funded by international development agencies appear to provide easy targets for corruption possibly because these funds are believed to be as coming ‘from external sources’ and are matter of relatively small external monitoring (Vogl 1998, and Lambsdorff 1997).

The role of non-governmental organisations can be seen in the section of the model which deals with the construct of ‘calls for anti-corruption measures’ (see Figure 3.1). As corruption increases, adverse effects of corruption on economic and social development are felt, this includes erosion of trust,

suboptimal use of resources, insecurity and deterioration of the legal system (Stulhofer et al. 2007, 2008).

3.1.1 System Dynamics Modelling – Drilling Deeper

Figure 3.1 presents the high-level diagram of overall model of corruption (includes social, cultural, political, and economic variables). These eight feedback loops are explained in further detail to give insight into each system working in this model.

3.1.1.1 Feedback Loops – Economic and Social Factors

Based on the literature review and qualitative data analysis, Figure 3.2 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 investment result and consequently slowed growth and development, which also increases poverty levels and distort income inequality. Bureaucratic malpractice manifesting 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 may also lead to misallocation of those funds. It will further lower quality services provided by government (see Figure 3.2). I may also believe that organised crime can be dissipated by inculcating moral values to achieve corruption free society (Feedback loop R_4). Feedback loop R_5 signify role of imports and exports (economic openness) that affect economic development positively. Moreover, R_5 also signifies the role of economic development in to control high inflation rate in an economy. There is a positive correlation between inflation and corruption, as inflation causes increase in cost of living and thus people use illegal means to increase their earnings.

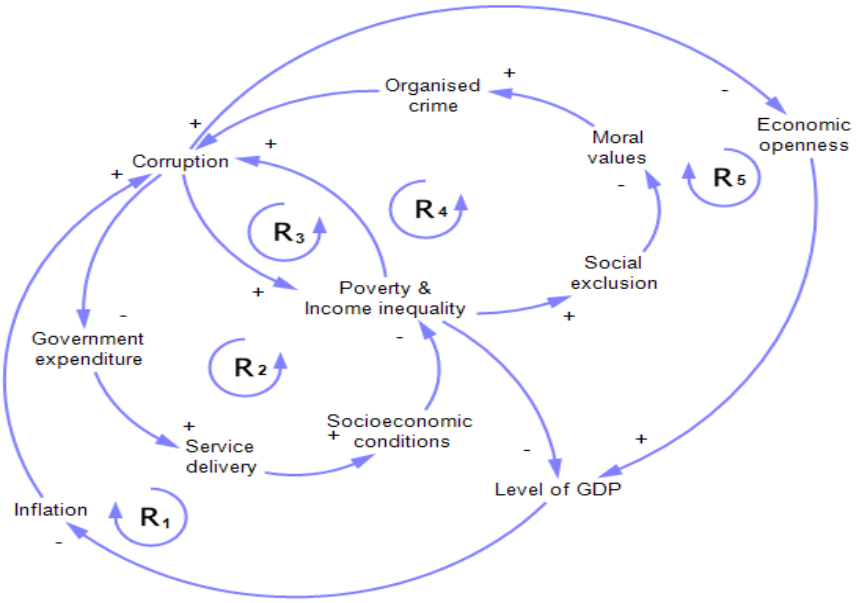

Figure 3.2: Feedback Loops of Economic and Social Factors

3.1.1.2 Feedback Loops – Legal and Political Factors

It can be seen from feedback loop R_7 (see Figure 3.3), 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 defence at the expense of other budget allocations, 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 their policy or cause its replacement 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 do 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 the widespread corruption and government instability diminish the effectiveness of accountability system. The role of judiciary can be seen in the section of the model which deals with the construct of law and order (see Figure 3.3). Negative effects of corruption increase calls for anti-corruption measures which causes a strengthening of the legal system. In particular, an effective judiciary can fulfil its role as institutional guarantor of the rule of law. The criminal justice system deal effectively with

crimes committed, in countries with low levels of organised crime (Feedback loop B_1).

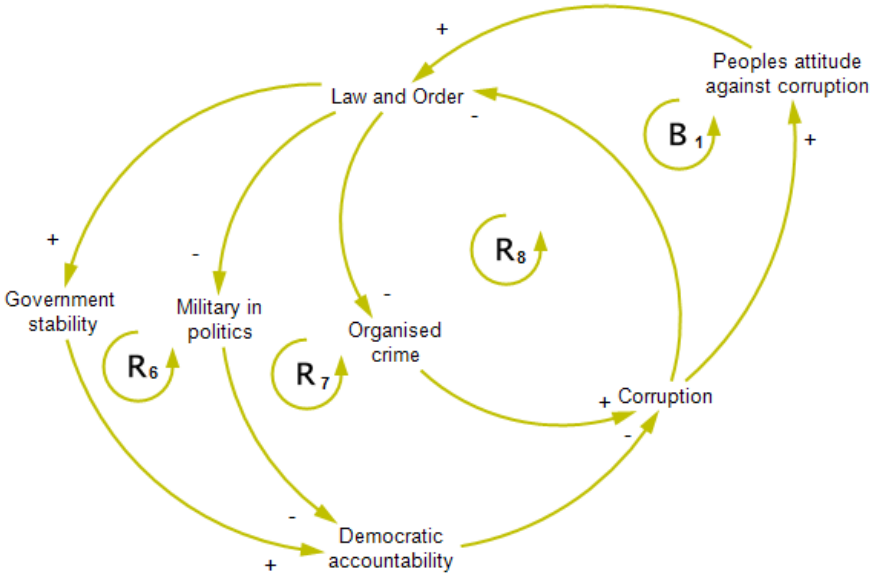

Figure 3.3: Feedback Loops of Legal and Political

3.1.2 Behaviour over Time

As discussed in previous section, in order to assess the social, political, economic and cultural issues in Pakistan, there are a number of key variables that need to be considered. Over the last 27 years, the corruption trend in Pakistan and variation in political and juridical factors can be seen in Figures 3.4 to 3.7.

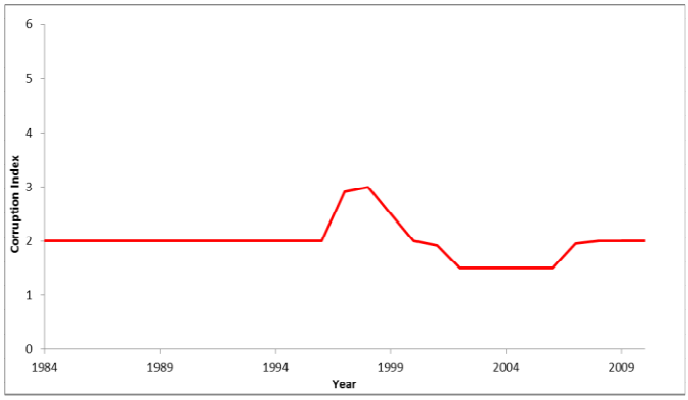

Figure 3.4: Corruption Trend in Pakistan 1984-2010) (Source: Political Risk Services and Transparency International)

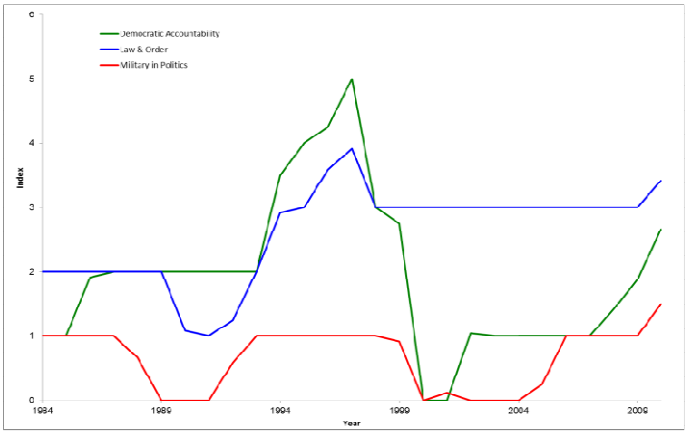

Figure 3.5: Trend of Political and Economic Risk Indices in Pakistan (Source: International Country Risk Guide, Political Risk Services)

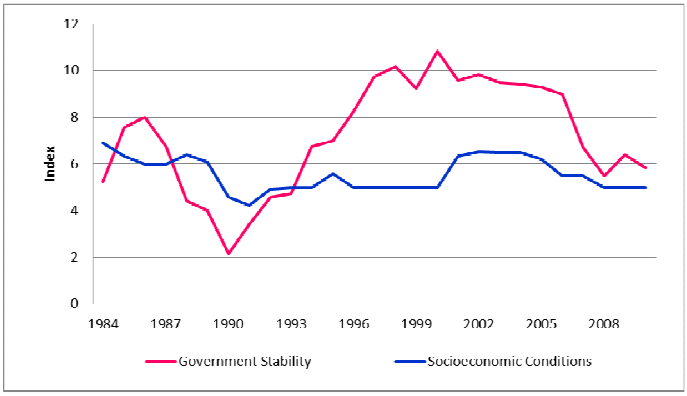

Figure 3.6: Trend of Political Risk Indices in Pakistan (Source: International Country Risk Guide, Political Risk Services)

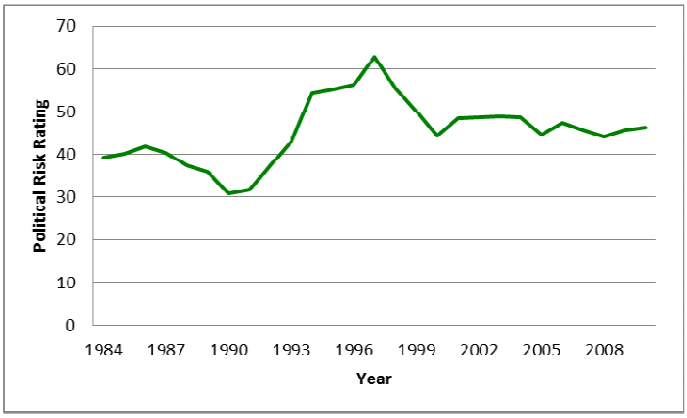

Figure 3.7: Overall Political Risk Rating for Pakistan (Source: International Country Risk Guide, Political Risk Services)

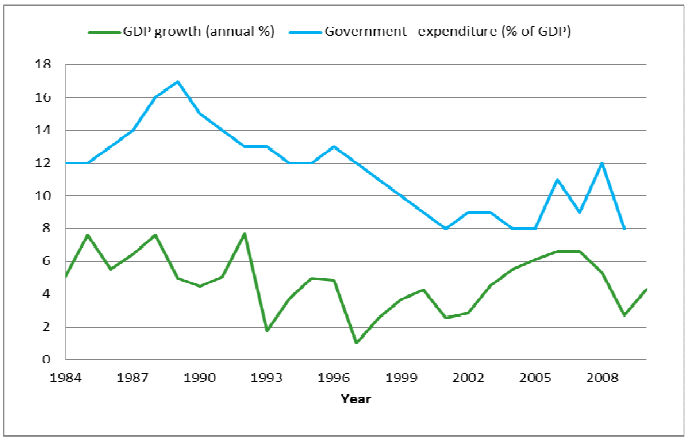

Figure 3.8: Economic Growth and Government Expenditure in Pakistan (Source: World Development Indicator, World Bank)

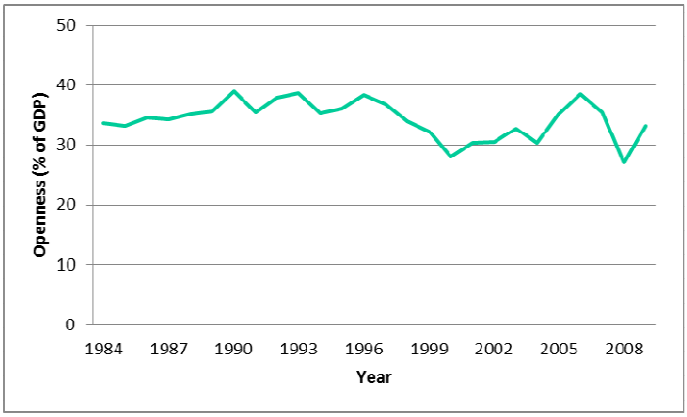

Figure 3.9: Openness of Pakistan's Economy (Source: World Development Indicator, World Bank)

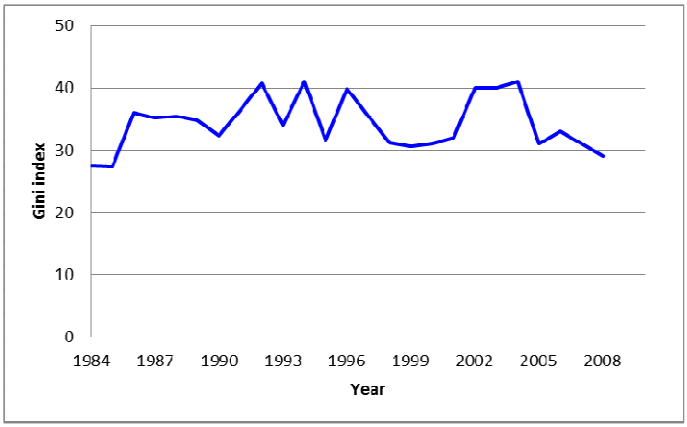

Figure 3.10: Income Inequality Trend in Pakistan (1984-2010) (Source: World Development Indicator, World Bank)

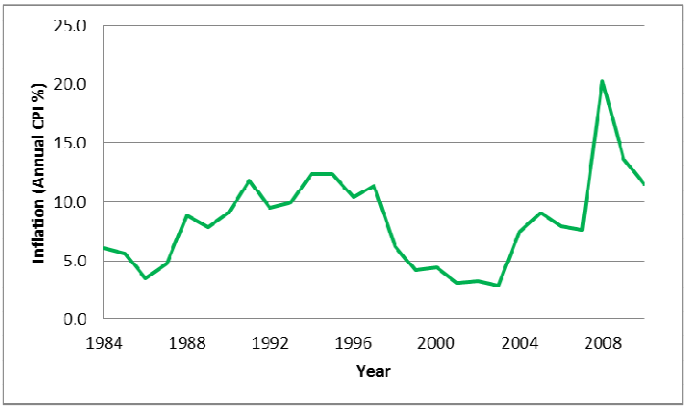

Figure 3.11: Inflation in Pakistan (1984-2010) (Source: World Development Indicator, World Bank)

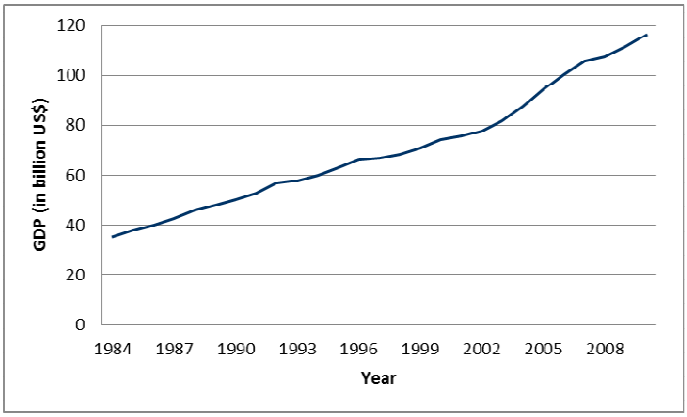

Figure 3.12: Gross Domestic Product Trend in Pakistan (Source: World Development Indicator, World Bank)

The growth rate of GDP and government expenditure as percentage of GDP in Pakistan from 1984-2010 can be seen in Figures 3.8 and 3.12. Trends in openness of Pakistan's economy, income inequality and inflation can be seen over the last 27 years (1984-2010) in Pakistan in Figures 3.9 to 3.11. In the next section, we will endeavour to formulate the system dynamics model of corruption using stock and flow diagram for simulation purpose.

4 Formulating the Model

In the system dynamics modelling process, computational tools support the 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 corruption model given in Figure 4.1 and 4.2 are transformed to a 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 variable should end up with the depiction of a known state of the system in the same period (Sterman 2000).

For system dynamics modelling this study used iThink™ software which supported model design in stock and flow diagram, following the same relation of the causal loop model of Figure 3.2 and Figure 3.3. The corruption model consists of thirteen stocks: Level of Corruption (Dmnl), Democratic Accountability (Dmnl), Law and Order (Dmnl), Peoples Attitude against Corruption (Dmnl), Government Stability (Dmnl), Military in Politics (Dmnl), Government Spending (US dollar per year), Organised Crime (Dmnl), Level of Gross Domestic Product (GDP, US dollar per year), Income Inequality (Dmnl), Economic Openness (Dmnl), Inflation (per cent per year) and Socioeconomic Conditions (Dmnl). Each of these stocks is structured so as to have a range from zero to 6, 10, 12 and 100. A higher value is the best possible for the stocks, while zero is the worst possible value for these stocks. The data are sourced from the publication of Political Risk Services (PRS 2011) "International Country Risk Guide" (ICRG) and World Bank's World Development Indicators (World Bank 2011) henceforth WDI.

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 behavioural validity. The initial values of stocks in system dynamics models can be determined in a variety of ways. The values are often known or knowable and the analyst needs only to investigate available data sources to find out. In the case of corruption model presented here, we obtained the values for the stock variables from ICRG and WDI for the year 2010 (see Table 4.1). The initial values for most of the stock parameters were obtained from Ullah (2006) study on corruption, economic growth and income inequality, for some variables we estimated the parameter using the available dataset from 1984-2010.

According to Qureshi (2009), the system dynamics models are causal models and these models should generate the right behaviour for right reasons. The general direction of these functions is based on corruption literature and interviews from experts for this study. Time constants for the flows are constant per year for the simulation. It is likely that the democratic accountability not only

affects corruption directly by removing corrupt persons, but also operates via a variable 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 and Dudley 2000). Figures 4.1 and 4.2 present the interrelations among the 13 stock variables measuring social, economic, political, judicial and cultural factors collectively. It is also evident that high level of corruption deteriorates law and order situation. Moreover, corruption of public officials, including law enforcement like police department and judiciary, is a common characteristic of organised crime that allows criminal organisations to secure survival and minimise the risk of being arrested and prosecuted.

Variables	Stock Value	Unit of Measurement
Democratic accountability	1.00	Dimensionless
Economic openness	3.70	Dimensionless
Government spending	12.00	US dollar per year
Government stability	5.25	Dimensionless
Level of Gross Domestic Product	35.24	GDP, US dollar per year
Income inequality/Poverty	34.50	Dimensionless
Inflation rate	6.09	per cent per year
Law and order	2.00	Dimensionless
Level of corruption	1.00	Dimensionless
Military in politics	1.00	Dimensionless
Organised crime	84.00	Dimensionless
Peoples attitude against corruption	5.00	Dimensionless
Socioeconomic conditions	6.92	Dimensionless

Table 4.1: Model Initial Values

As described in the stock and flow diagram in Figures 4.1 and 4.2, if the economy suffers from corruption activities, foreign investment process will imply a bribes payment. Corruption reduces the level of foreign direct investment and, consequently, it will affect the economic growth. An increase in level of corruption increases the complexity of the feedback structure of the economic system since they add new causal relationships connected to those affected by unequal distribution of resources and going into poverty trap. The whole feedback structure can fully explain why the corruption activities influence the

socioeconomic conditions in the country as well as the wealth of citizens (Soto-Torres et al. 2007).

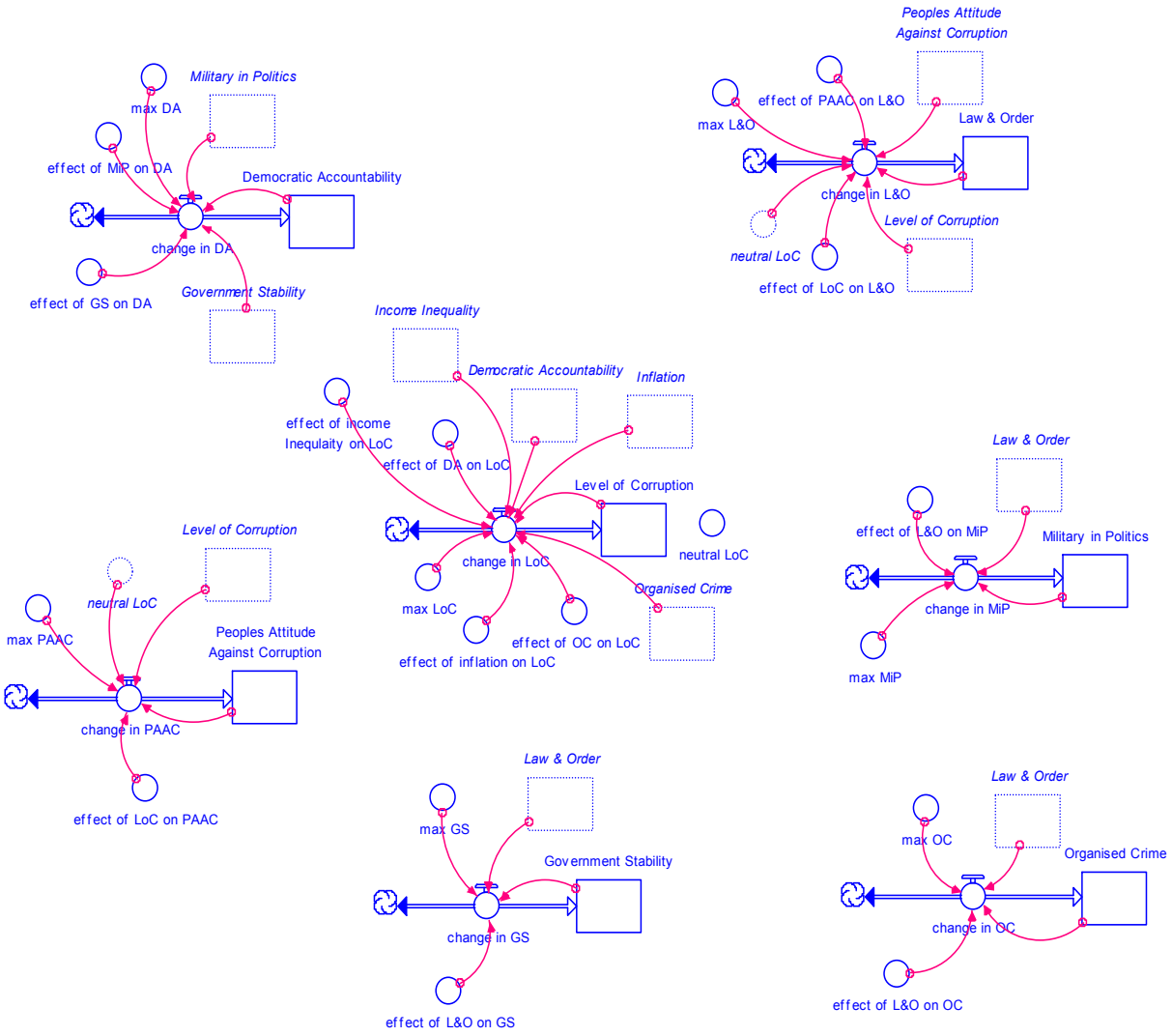

Figure 4.1: Stock and Flow Diagram of Corruption Model with Political and Judicial Factors[4]

[4] DA=Democratic Accountability, GS=Government Stability, LoC=Level of Corruption, L&O=Law and Order, MIP=Military in Politics, and PAAC=Peoples Attitude Against Corruption.

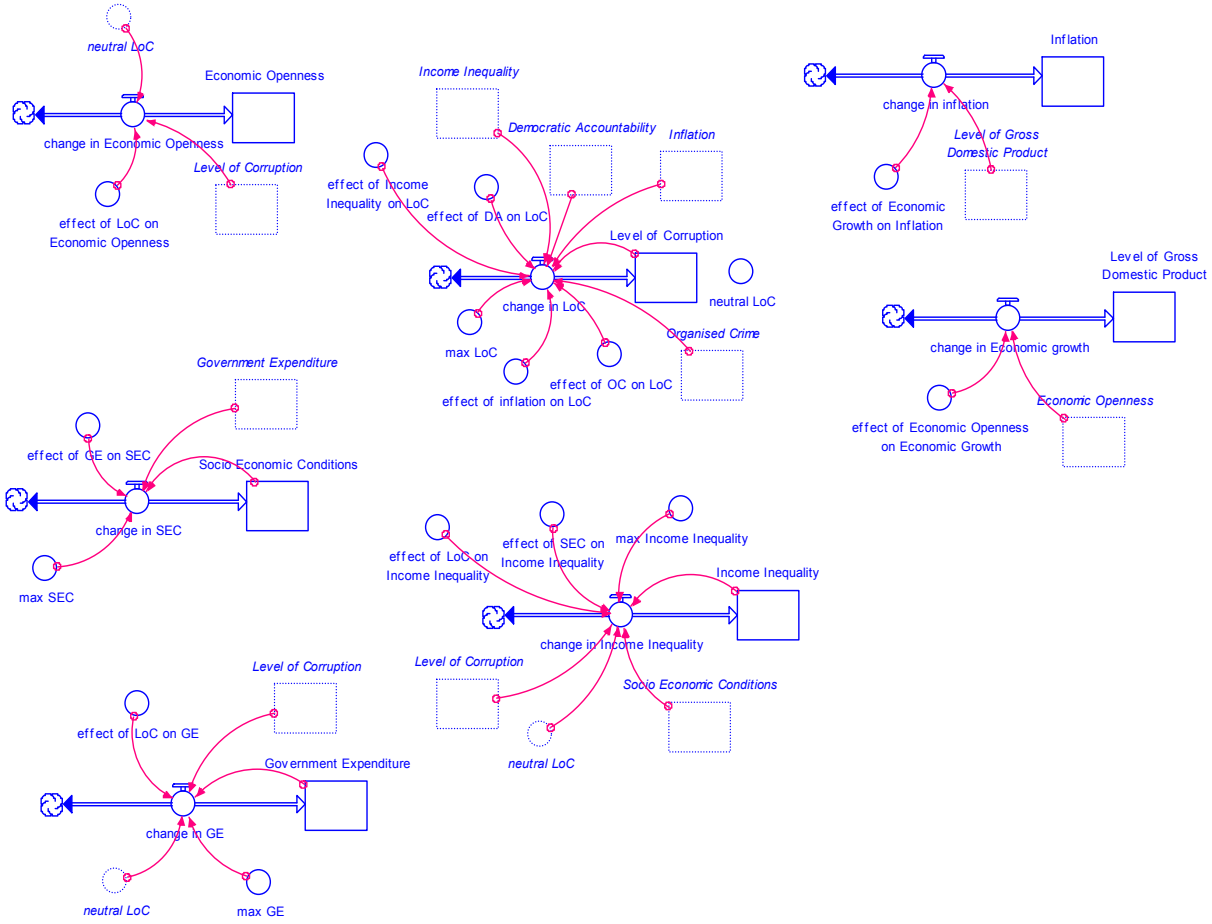

Figure 4.2: Stock and Flow Diagram of Corruption Model with Social and Economic Factors[5]

The so-called "Reference Mode" depicts the dynamic behaviour 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 the level of corruption, level of GDP and income inequality in the country, are shown in Figures 4.3, 4.4, and 4.5, respectively. Moreover, the focus of these simulations is to analyse the impact of different anti-corruption measures on different indicators of interest.

The model assumes that government income distribution improves, the level of corruption in the economy will go down. It seems realistic to assume that if corruption increases then income distribution in the economy deteriorates. As discussed earlier, income inequality has 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

[5] GE=Government Expenditure, LoC=Level of Corruption, and SEC=Social and Economic Conditions.

up of economies to international trade is generally viewed as an effective strategy for accelerating economic growth.

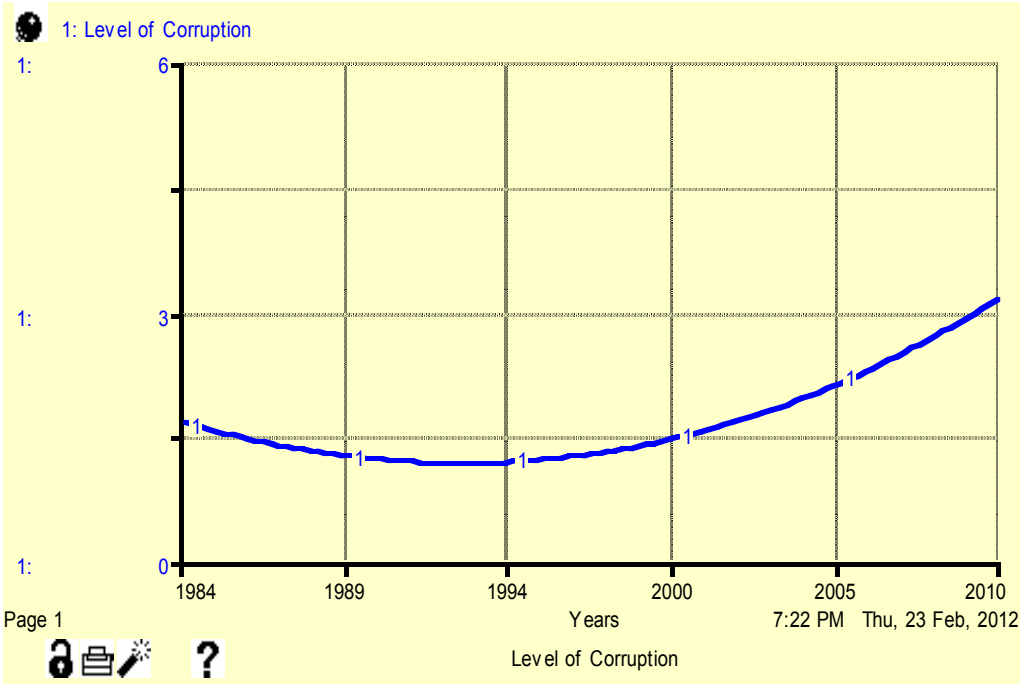

Figure 4.3: Reference Mode for Level of Corruption

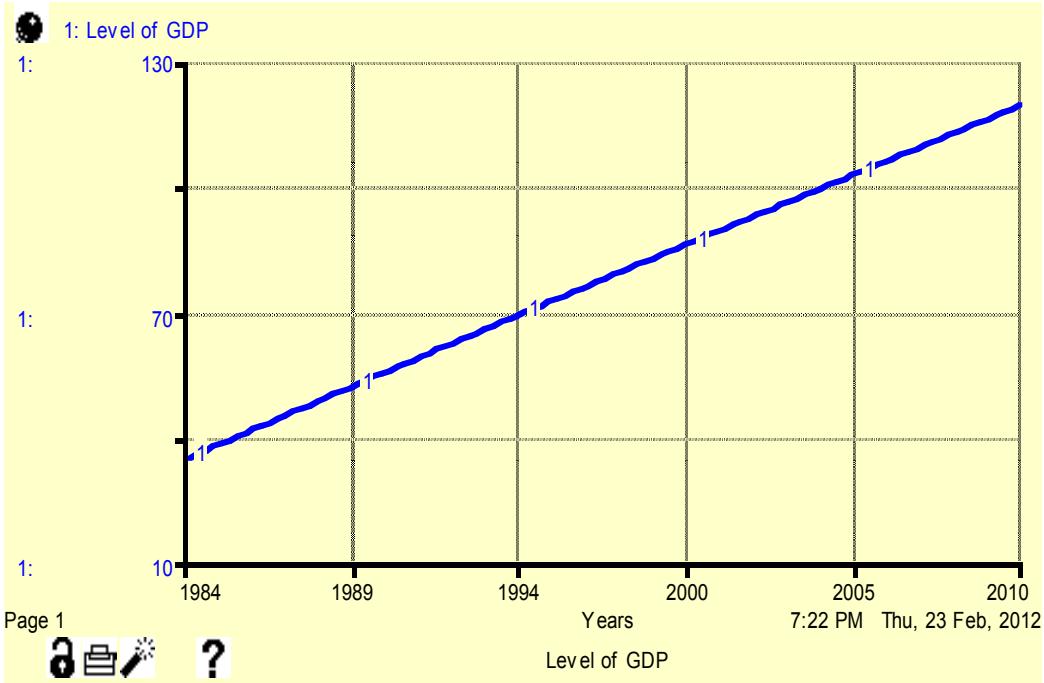

Figure 4.4: Reference Mode for Level of GDP

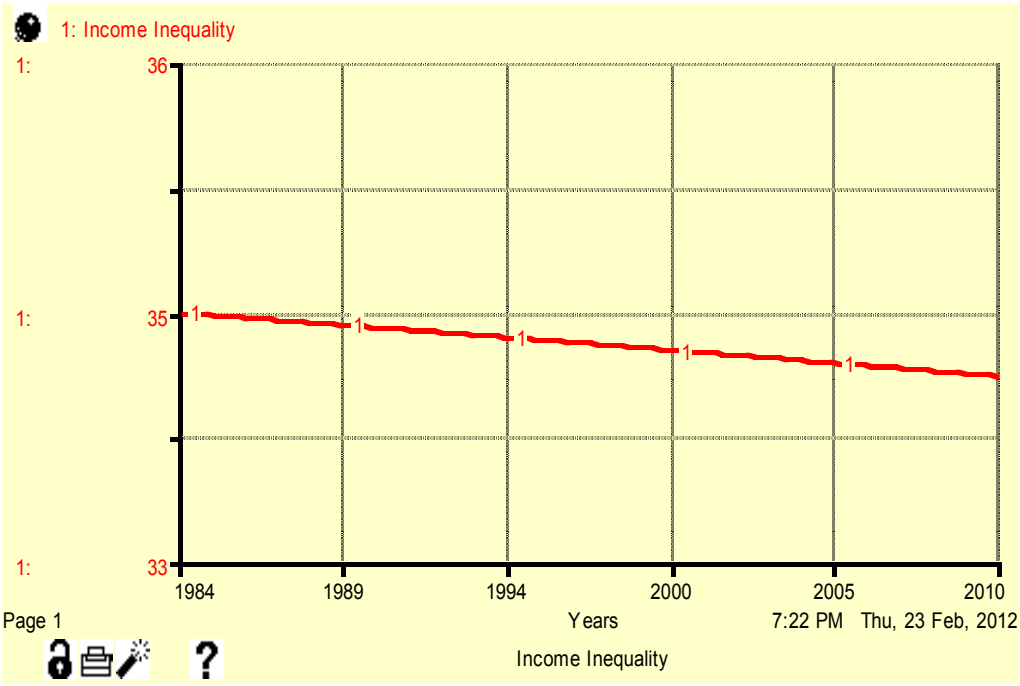

Figure 4.5: Reference Mode for Income Inequality

Next section develops five future scenarios in case of policy variables i.e., Level of Corruption, Level of GDP and Income Inequality and assesses the outcomes. The behaviour of these variables are assessed changing the parameter value by 10, 5, 0, -5, and -10 per cent over the next 15 years (2011-2025). Additionally, the following section comments the assumptions related to data fed into the model during forecasting. The system dynamics model used iThink™ also for scenario planning.

5 Policy Analysis

The dynamic behaviour of corruption model can be studied through simulations by varying the parameters of the model. First the model needs to be placed in equilibrium (see Appendix I). At the equilibrium, the model does not generate any dynamic behaviour, i.e. nothing changes over time, and it lies at the equilibrium unless otherwise disturbed. The focus of these simulations is to analyse the impact of different policies on different indicators of interest.

As initialised the model, we simulate the model with reference mode which reflects the status quo. Stocks will approach their highest or lowest value if one or more of the stocks parameter is pushed up or down, although the rapidity of that change is dependent on extent of the push. In other words, when pushed off stocks parameters the model approaches either a very corrupt system or a very clean system (Figure 5.1). This is the most important stage of the modelling process. At this point, scenario planning is made and the results are drawn from the model. This is an extraordinary guidance to anti-corruption policy for the government, since outcome can base their decision-making process towards focussing on important factors to target corrupt activities. This thesis tests the results of the model in the following combination of scenarios: at the different scenarios focus on changes in variables affecting level of corruption, level of GDP and income distribution. The system dynamics model

enables the projection of several different scenarios. As mentioned earlier, the time horizon is selected equal to 15 (2011-2025) years which is a period sufficiently long for showing how corruption is affected by change is some important variables like democratic accountability, distribution of income in the country, inflation rate, and organised crime as well as for verifying the necessity to fight against corruption.

Overall, the results show that under the defined circumstances, corruption climbs eventually, with the poor judicial system. Social economic conditions deteriorate as a result of corruption, which worsens income inequality. As income inequality increases, people's attitude against corruption goes up. Along with NGO's involvement, the people are applying pressure to lower the level of corruption through various means (not specified in this model). As a result, the level of corruption is controlled, which in turn improved the effectiveness of the judicial system, which reinforces the reduction in the level of corruption, thus, the betterment of social economical conditions. With such improvements, income inequality is reduced, and we can see that the people's attitude against corruption is also reduced. Given some changes in the 'effect' converters, and a longer simulation period, we may see an increase in corruption again sometime in the future? Since attitudes towards corruption play a critical role in the persistence of corruption. If people's attitude against corruption went high then the level of corruption would be decreased over time. According to Cameron et al. (2005), peoples' attitudes towards corruption are shaped by the social, political, legal and economic systems of the countries they live in as well as their everyday experiences of corruption.

Figure 5.2 depicts five different scenarios that yield highest to lowest level of GDP wherein policies that improve economic openness increased level of GDP in the economy. This finding indicates that Pakistan's economic potential if it could improve socioeconomic conditions and political and security situation in the country for the foreign investors. Even though increase in its GDP may be a better alternative. A comparison of scenario 5 with reference mode (Scenario 3) suggests that Pakistan can achieve low level of inflation even if increased level of GDP. Further, level of GDP remain quite low (Scenario 1 and 2) if country's import and export remains low due to high level of corruption.

The results, as shown in Figure 5.3, indicate that in scenario 1 and 2 decreases due to improvement in corruption index and socioeconomic conditions over the next 15 years (2011-2025). A comparison of scenario 3 with reference mode suggests that Pakistan can achieve better income distribution even if decreased level of corruption is resulted from very low improvement in socioeconomic conditions in the country. If we look into scenario 4 and 5, where income distribution is increasing at rapid rate, it is caused by high level of corruption and deteriorating socioeconomic conditions due to lack of accountability and political instability.

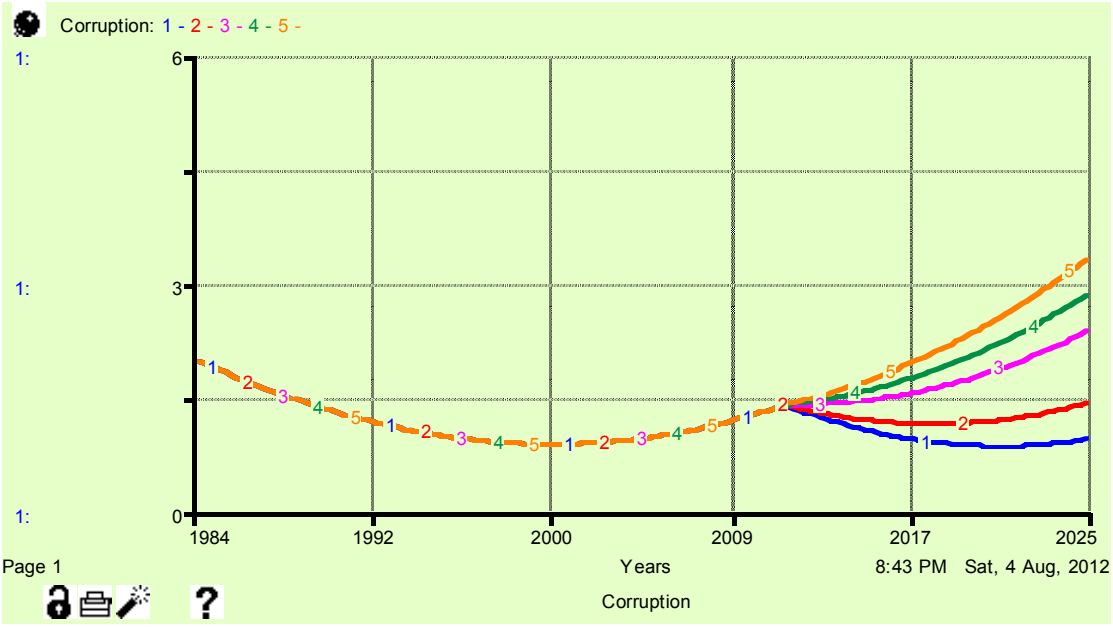

Figure 5.1: Level of Corruption[6]

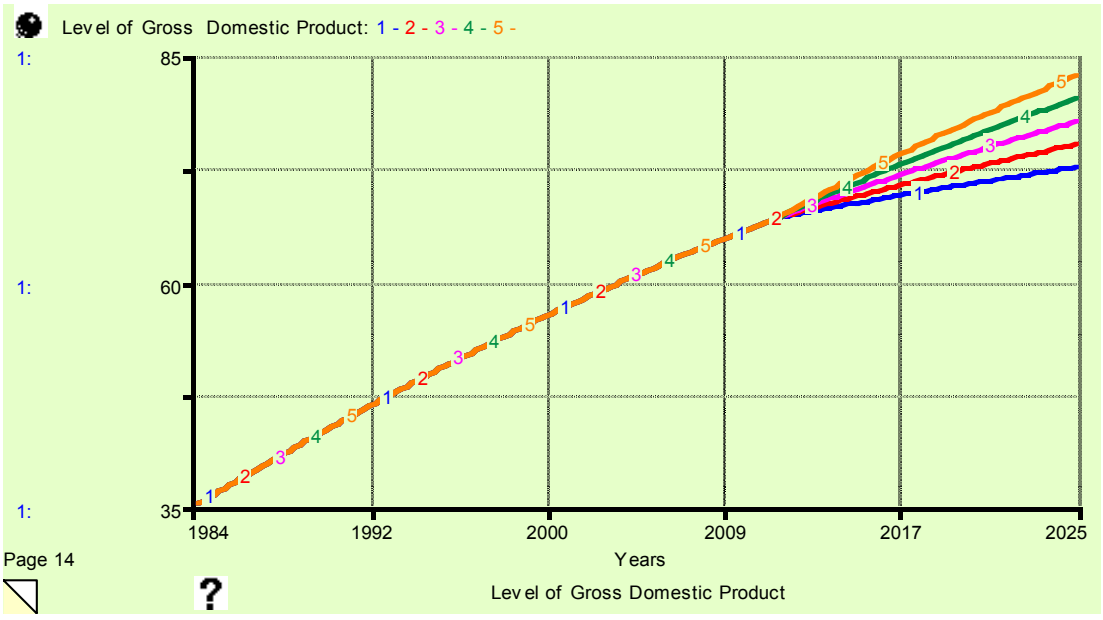

Figure 5.2: Level of Gross Domestic Product (Measure of Economic Wellbeing)[7]

[6] Level of Corruption: Lines1, 2, 3, 4, and 5 represents -10, -5, 0, 5 and 10 per cent change in corruption index.
[7] Level of Gross Domestic Product: Lines1, 2, 3, 4, and 5 represents -10, -5, 0, 5 and 10 per cent change in GDP level.

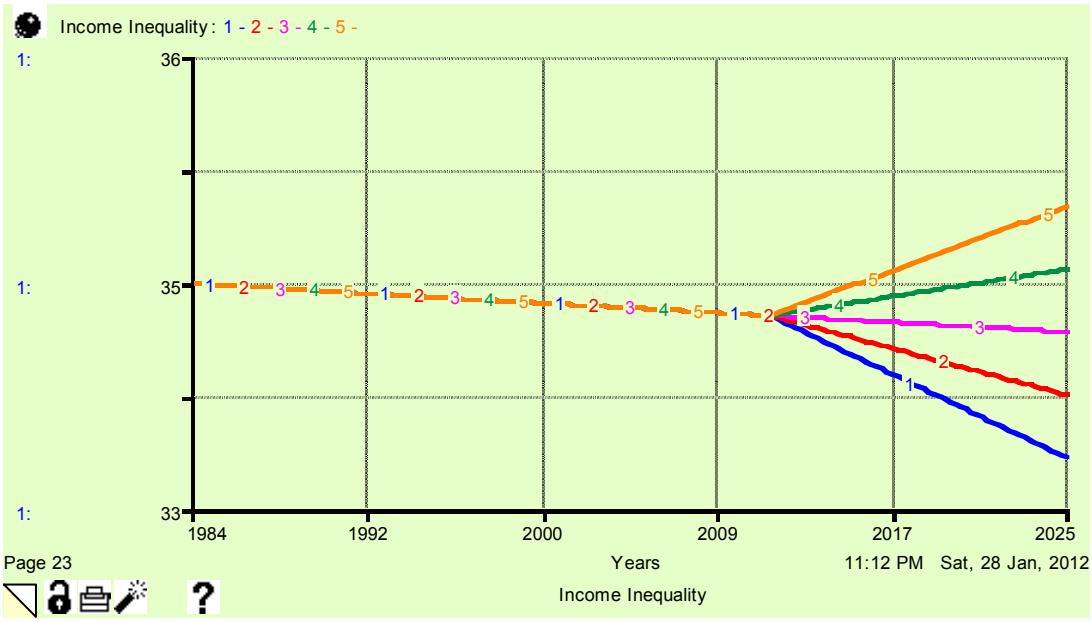

Figure 5.3: Income Inequality (Measure of Social Wellbeing)[8]

5.1.1.1 Model Validation

The corruption model has been subjected to the following tests, which are briefly summarised 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 3.2 and 3.3 does correspond to the problem statement and illustrated in the behaviour over time (BOT) diagrams in Figure 3.4 to 3.12. Confirmation that the causal loop diagram does correspond to the problem statement is also reinforced by the qualitative analysis of the feedback loops in the feedback loops section.

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 Figure 3.2 and 3.3) matched the direction of relationships in the simulation model in iThink^{TM}. However, it must be mentioned that the causal loop diagrams contains less variables than the stock and flow diagram, 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.

[8] Income Inequality: Lines1, 2, 3, 4, and 5 represents -10, -5, 0, 5 and 10 per cent change in gini index.

d) Numerous extreme conditions tests were conducted and equations are sensible at extreme values. For example, when the level of GDP was set to zero, the model became completely static (see Appendix I).

In summary, 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 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 better picture by giving five different scenarios to control corruption. The behaviour of income distribution and level of GDP lead to changes in the level of corruption. On the other hand, changes in economic openness of a country for international trade substantially improve level of GDP. Moreover, future scenarios were planned with different combinations of inputs, simulating for different level of corruption in the country. The present results are significant in at least major two respects: a) Firstly, we have attempted in this study to define characteristics of a causal loop diagram and reference mode and how it is distinguished from historical data, both qualitative and quantitative. “A reference mode is an abstract concept considering past as well as inferred future behaviour. It is important to mention here that a reference mode is an end product of learning process that is similar to the process involved with building model and analysing it” (Saeed 1991), b) Secondly, simulation model in this section provided the model builder with a clearer and more stable picture of the corruption dynamics than a thematic analysis of qualitative data.

6 Conclusion and Policy Implications

The present study was designed to extend our understanding of corruption by using system dynamics approach. 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 case of any developing country, which can be applied with some modifications for developed world. In this we try to determine 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 past. Returning to the question posed at the beginning of this study, it is now possible to state that problem of corruption is studied in a broader perspective by using system dynamics methodology. Moreover, the study has gone some way towards enhancing our understanding of corruption by using two SDM.

While significant amounts of corruption modelling 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 modelling, while efforts mostly have focused on supporting theories with linear approaches of analysis. System dynamics offers an opportunity to understand and communicate these systems with its approach to non-linearity (Forrester 1987, Sterman 2000). Moreover,

"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" (Dudley 2000). Most importantly, qualitative data analysis also provides input as well as foundation for a system dynamics model of corruption for this study.

The present study confirms previous findings and contributes additional evidence that suggests the problem of corruption in societies is undoubtedly very complex and involves different economic, political, social, cultural and even religious aspects that were incorporated in the system dynamics model of corruption. "System dynamics proposes to construct a useful understanding of a situation via the elaboration, validation, exploitation and interpretation of a simulation model, based heavily on mental models" (Soto-Torres et al. 2007). One of the more significant findings to emerge from this study is that the simulation results indicate an increase in level of GDP in the short-run in scenario 4 and 5 but in the long-run these prove to be the most effective to better manage economic indicators like foreign investment and economic openness.

In summary, in recent years and especially in the 1990s, a phenomenon broadly referred to as corruption has attracted a great deal of attention. In countries developed and developing, large or small, market-oriented or otherwise, governments have fallen because of accusations of corruption, prominent politicians (including presidents and prime ministers) have lost their official positions, and, in some cases, whole political classes have been replaced (Johnston 1997). According to Tanzi et al. (1997), if any government wants to root out corruption then their leadership must show zero tolerance and honest and visible commitment. Moreover, the level of corruption can be reduced by increasing public sector salaries, increasing incentives toward honest behaviour, and instituting effective checks and balances on public officials.

This study addresses the issues of corruption in specific contexts where research work was limited so far. For this reason, this research shows significance from both the theoretical and practical perspective. Because corruption belongs to a class of complex social problems, we expect useful insights from this study will be applicable in new areas. From the obtained results, we judge this research demonstrates value from both theoretical and practical perspectives. The present study, however, makes several noteworthy contributions to by merging of different models, which can assist in clarifying the way in which corruption works and ways in which it can be limited. However, it is possible that, with this modelling effort, the system dynamics approach can overcome few limitations, where significant amount of work on corruption modelling have been carried out using various econometrics and mathematical approaches, and the model developed in this study can be improved further by adding more variables which this study did not take in to account for simulation.

The issue of corruption is very wide and the study of particular questions or approaches to fight against it undoubtedly provides new ways for its study. In

particular, the proposed model admits refinements. Some of them would be merely technical and others would be related to the introduction of new questions that will lead to consideration of new variables. Among the first ones there are various alternatives. For example, the model can be improved by adding variables that we excluded in this study. Among the second ones, it would be possible to compare the effects of corruption on countries with a different level of development.

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Appendix I – System Dynamics Model at Equilibrium

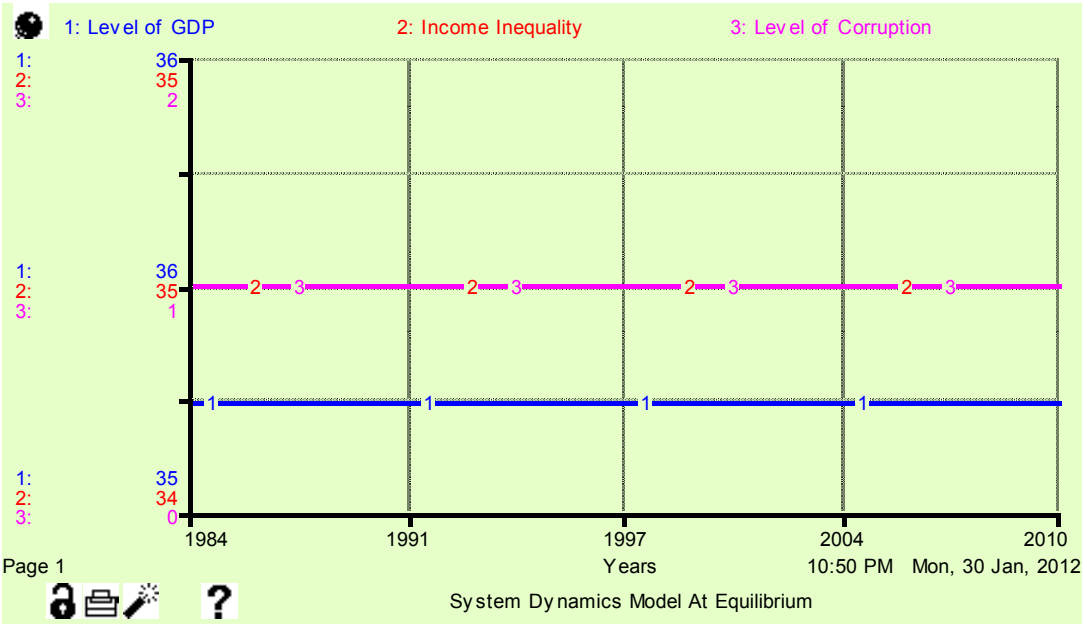

Figure A4.1: System Dynamics Model at Equilibrium