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**Using Monte Carlo Simulation in a System for  
Project Risk Appraisal: Options for  
Government and Private Practitioners**

*by*

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## **ABSTRACT**

This study is an offshoot of a project on the estimation of contingent liabilities of the Philippine government. The Monte Carlo simulation method adopted for estimating exposure (or expected losses) to NG-assumed risks in many Build-Operate-Transfer infrastructure projects makes it possible for policymakers to classify and rank projects according to risk, and set risk-adjusted guarantee fees, helping to mitigate many adverse selection and moral hazard problems in the project appraisal, approval, and monitoring process. Six projects (not explicitly identified) are analyzed for risk, and risk indicators are constructed for each to facilitate comparison and classification. Projects for which government bears excessive risk may be restructured before approval, while contingency financing may be arranged for projects that have already commenced operations. In addition, expected losses serve as an input into the calculation of actuarially-fair guarantee premia.

## **I. Introduction**

This paper is a condensed version of previous work done by the author (2000b) in the use of stochastic or Monte Carlo simulation methods for cashflow applications, with emphasis on developing risk management tools for infrastructure projects. Monte Carlo simulation is a process of generating pseudo-random numbers from a probability distribution. The parameters of the probability distribution (usually the mean and standard deviation) may be determined from historical data (historical simulation), or may be defined by the user ex ante (ex ante simulation). Within the framework of project risk appraisal, the pseudo-random numbers are outcomes of the various risk factors affecting the cashflow of a project (e.g., annual change in the exchange rate, passenger or car traffic, fare and passenger growth, etc.).<sup>1</sup>

The analytical tools presented here are meant to enrich the process of project analysis, augmenting conventional approaches of project appraisal with newly developed techniques for simulation-based exposure and risk appraisal. They are based on the seminal work done for monitoring risk and exposure in the financial sector. They may be applied at the Department of Finance (DoF) for the purpose of analyzing whether a guarantee should be provided or not, and at NEDA and other line agencies, to augment their existing tools for project appraisal. The use for government notwithstanding, the methods and analytical tools presented here for analyzing risk and exposure are applicable to a broader range of institutions, including banks, investment banks, and firms engaged in infrastructure projects and project financing.

The tools and framework espoused in this paper were developed in conjunction with the author's recent work in using stochastic simulation in estimating the National Government's (NG) exposure to expected losses relative to guarantees provided for Build-Operate-Transfer (BOT) projects and government-owned-and-controlled corporations (GOCC's). A need for analysis of this type arose because of NG's growing portfolio of guarantee exposures to projects and the pursuit of a more sustainable guarantee policy.

## **II. What is the Value-Added of This Study?**

One of the primary motivations for the author's recent study for the Department of Finance was the need to monitor government's exposure to claims made by BOT project proponents on various guarantees provided by the former in BOT contracts (see **Annex 1**).<sup>2</sup> A second motivation was the need to properly price guarantees. A government guarantee in any aspect of a project is equivalent to a provision of insurance (Reside, 2000a). It is in this regard, therefore that the provision of government guarantees may be afflicted with the same information asymmetry problems present in insurance and credit transactions: moral hazard and adverse selection.

Moral hazard is the impact of insurance on the incentive of the insured party to ensure that losses do not occur. On the other hand, adverse selection is the tendency for high risk projects to seek insurance/guarantees. The solution to the moral hazard problem involves

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<sup>1</sup> For an introduction to the use of simulation methods in estimating contingent liabilities of government, see Lewis and Mody (1998), and Reside (1999, 2000a, 2000b).

<sup>2</sup> A more comprehensive review of the types of guarantees government may provide may be found in World Bank (1998), and Reside (1999, 2000a).

pricing guarantees properly, proper monitoring of projects, and improving the design of the contract – optimal risk-sharing arrangements must be pursued.

On the other hand, the solution to the adverse selection problem is to:

- a) Develop risk classification schemes which enable government to accurately discriminate between high risk and low risk insureds – (this is addressed by making distinctions based on computed expected losses using the simulation methodology); and
- b) Charge risk-based premiums, which also reduce moral hazard by rewarding safe behavior and penalizing risky behavior (with high guarantee premia).

Knowing the amount of risk the government assumes and pricing it properly will help reduce the moral hazard and adverse selection problem in the provision of guarantees and the assumption of risk. The aim is ultimately to produce better projects, attract the best project proponents, screen out high risk projects, and reduce government exposure to costly risks in the process.

In principle, to be actuarially fair, the guarantee premium to be charged should cover the present discounted value of NG's expected losses/expected claims within a period. If guarantee fees are set too low relative to expected loss, investors will choose to fully insure, but NG will not be sufficiently compensated for risks being assumed. On the other hand, if guarantee fees are set too high, then investors might be discouraged from pursuing projects. Guarantee premiums that cover the discounted value of expected losses ensure that the provision of guarantees is financially sustainable. In addition, premia computed in this way are adjusted for risk, since riskier guarantees will have correspondingly higher expected losses.

Risk-adjusted guarantee fees contribute to reducing adverse selection and moral hazard in any activity that involves guarantee or insurance provision. Properly priced premiums discourage investors from undertaking overly risky investments. The discipline provided by risk-adjusted premiums should lead to projects that are sound, sustainable and better-structured.

### **III. Monte Carlo Simulation Applied in Conventional Modes of Measuring Exposure**

Monte Carlo simulation refers to the technique of generating a sample of random or pseudo-random numbers from a probability distribution. A wide variety of algorithms are available for generating random samples from different types of probability distributions.

Monte Carlo sampling techniques are entirely random - that is, any given sample may fall anywhere within the range of the input distribution. Samples, of course, are more likely to be drawn in areas of the distribution which have higher probabilities of occurrence. With enough iterations, Monte Carlo sampling "recreates" the input distributions through repeated sampling. When Monte Carlo simulation is applied to cashflows of projects for this study, the a range of values of expected losses are computed by iterating thousands of times, the calculation of the cashflow model. When simulating, not all of the elements in the cashflow are stochastic. Best judgment is used to determine and isolate only the most uncertain

elements (such as traffic growth, changes in the exchange rate, frequency of cost overruns, and delays, etc.). Thus, the values of most variables remain fixed throughout the simulation.

@RISK software monitors three convergence statistics on each output distribution during a simulation. During monitoring, @RISK calculates a set of statistics for each output at selected intervals (such as every 100 iterations) throughout the simulation. These statistics are then compared with the same statistics calculated at the prior interval during the simulation. The amount of change in statistics due to the additional iterations is then calculated. As more iterations are run, the amount of change in the statistics becomes less and less until they "converge" or change less than a threshold percent you set. The statistics monitored on each output distribution are 1) the average percent change in percentile values (0% to 100% in 5% steps), 2) the mean and 3) the standard deviation. The number of iterations required for output distributions to converge is dependent on the model being simulated and distribution functions included in the model. More complex models with highly skewed distributions will require more iterations than simpler models.

The use of stochastic simulation for estimating risk and exposure has its origins in conventional Value-at-Risk (VaR) methodology, which has gained wide international acceptance as a framework to be used by financial institutions in measuring risk and exposure. In addition to its use as a tool in measuring risk, VaR measures of exposure have also been used by international financial regulators in determining the amount of risk-based capital to be set aside versus losses.<sup>3</sup>

In the standard VaR paradigm, the tails of the probability distribution of the next-period returns to a portfolio of financial instruments are examined to determine returns or payoffs (usually, losses) under the most extreme (and rarest) scenarios (risk). For conventional financial instruments with payoffs that are linear functions of prices of underlying assets, such as portfolios comprised of shares of stock and bonds, one-period returns are assumed to follow a lognormal distribution. In this case, the determination of exposure, or returns at the tail of the distribution, becomes a straightforward exercise since the standard normal distribution table may be used to determine the extreme tail exposures. In cases where the instruments have payoffs that may or may not be linearly related to asset prices (such as options), the only way to generate a distribution of one-period-ahead returns is to simulate them using Monte Carlo simulation. Similarly, the cashflow of (any) project may or may not be a linear function of its risk factors, such as the exchange rate, passenger or car traffic, fare growth, etc. Thus, the cashflow of any project may be simulated using Monte Carlo simulation methods. If the NG has provided a contractual guarantee to support a project financially, then Monte Carlo simulation generates a range of outcomes, the tail of which represents government's extreme exposure (risk of loss) to the project. A mixture of historical and ex-ante stochastic simulation techniques is used to simulate the value of risk factors that determine the payoffs to government from guarantees.

Historical simulation entails gathering information about the uncertain risk factors affecting the value of an asset (such as the exchange rate or the price of a share of a share of stock), and then building synthetic probability distributions which will then be used to generate a large number of scenarios of the underlying risk factor. These scenarios will in turn determine the expected value of the payoff.

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<sup>3</sup> In the same vein, the results of the stochastic simulation of project cashflows may be used by government to determine an amount to be set aside as reserve (budgeted) in case of losses.

Ex-ante simulation, on the other hand, entails formulating hypotheses and gathering best expert judgments about the underlying risk factors in order to assign subjective probabilities to outcomes when building probability distributions to be used in simulation.

Ex-ante simulation is the preferred method to use when there is a lack of data or when observations about the actual outcomes of underlying risk factors are unavailable

The proposed risk simulation and exposure evaluation exercise for all types of projects with NG guarantees involves the following steps:

- (1) Review of BOT contracts, identifying sections where contingent liabilities exist and real liabilities can be triggered by guarantees assumed by government;
- (2) Complete a table on trigger events and payoffs for projects;
- (3) Using information from the contract and the financial model of the project, determine the logic of how payoffs (losses) are determined, and model these in Excel spreadsheets. Identify the relevant risk factors for each risk. These are the variables whose movements have the greatest impact on the amount of the payoff, whether positive or negative;
- (4) (Using BESTFIT software) Build probability distributions of the underlying risk factors using historical data or assignment of subjective probabilities. The distributions to be used should be constructed in such a way that they reasonably mimic the stochastic process generating outcomes of the underlying risk factors within the period in which reserves are to be set aside (The probability distribution data set is already being constructed for GOCC's and BOT projects);
- (5) In simulating the payoffs (using @RISK software), the computer generates many thousands of scenarios of the one-period-ahead outcome of these risk factors (one at a time, or in combinations with others);

Note that there are many ways to produce a one-period-ahead outcome (that can occur 1 or 5 percent of the time) of the risk factors (use an economic model, or just use the probability distribution of the risk factor itself – in the conventional value-at-risk methodology, the latter is used to model one-period-ahead returns);

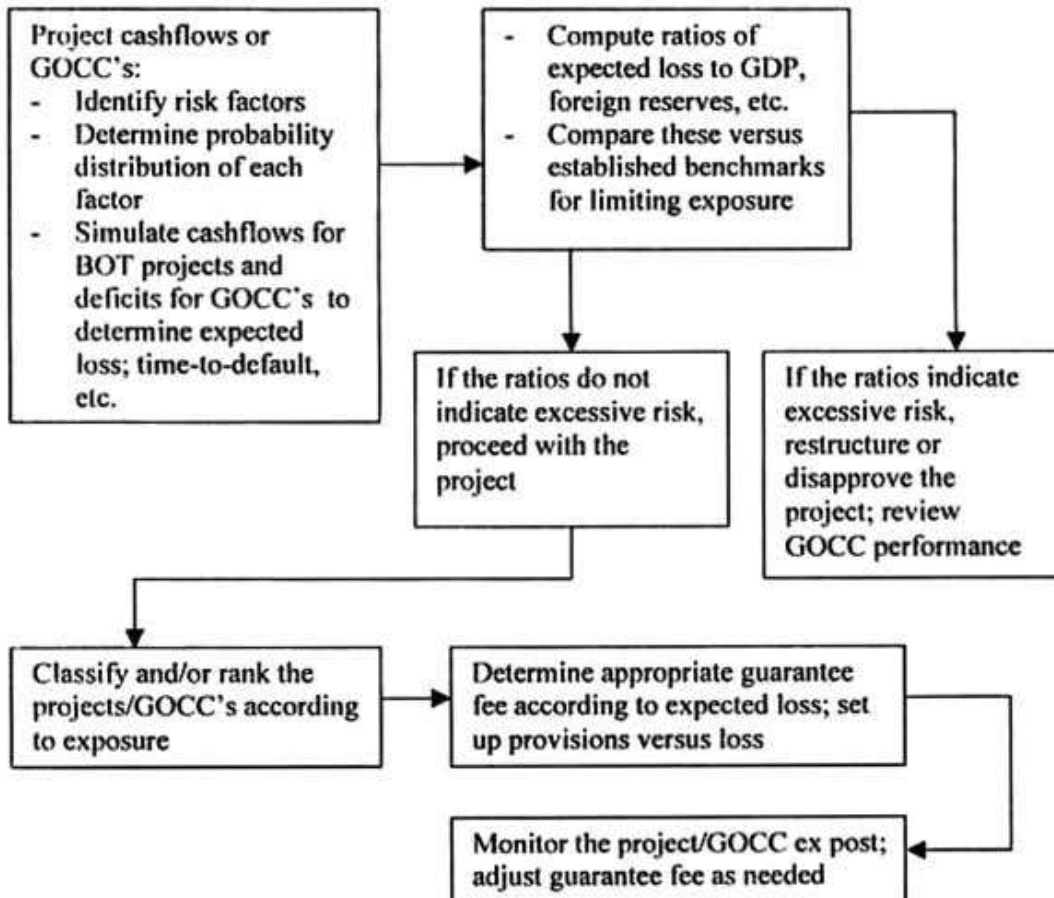
- (6) The computer uses the logic constructed by the risk analyst in Excel to translate each of the thousands of scenarios into thousands of scenarios of the one-period-ahead financial payoff to the government, accumulating statistics on this payoff. In this manner, we are able to cull information from all of the iterations to derive a separate distribution for the payoffs to each of the risks assumed (keeping other risks fixed), or to any combination of risks;
- (7) Rank the payoffs from worst to best, and select that payoff above which x% of all other payoffs lie (that is, the payoff at the  $(100 - x)$ th percentile). There is a  $(100 - x)$  percent chance that the payoff (loss) will be larger than this in the succeeding period;

- (8) The value of  $x$  (the degree of confidence) will be user-defined, and it will depend on one's attitudes towards risk. The DoF's risk managers will have to decide on what this will be.
- (9) The payoff at the  $(100 - x)$ th percentile, may be the amount of loss for which reserves may be set aside. In the banking paradigm, this is usually the first percentile for purposes of conservatism. Capital may be set aside by the bank to cover the loss at the first percentile of all possible payoffs ranked from worst to best. Alternatively, the mean expected loss may also be used as the basis for setting aside reserves.

Note that the higher the risk manager defines  $x$ , the higher could be the adverse payoff for which capital is set aside. If computed in this manner, the amount of capital, or reserves set aside to cover against expected loss will depend on: (a) the time horizon for which exposure is computed; and (b) the degree of confidence chosen by the risk manager. Also note that the payoff at the  $(100 - x)$ th percentile is not the mean, or expected payoff. The mean payoff is the average payoff.

#### IV. A Suggested System for Measuring Expected Loss and Exposure to Risks Assumed by NG

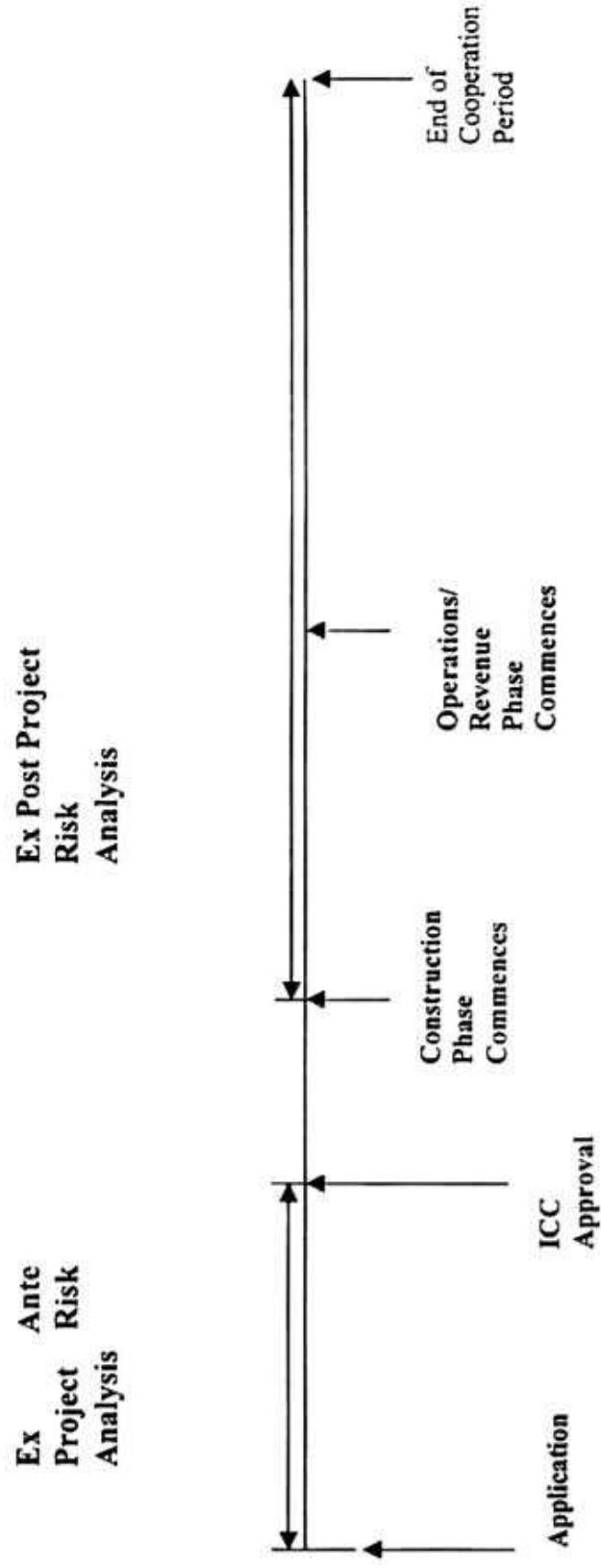
A crucial component of the study focuses on the estimation of exposure to loss, or expected loss (EL). Given the discussion in Part III, the vision espoused is for the following model to be applied in measuring exposure and managing risk:



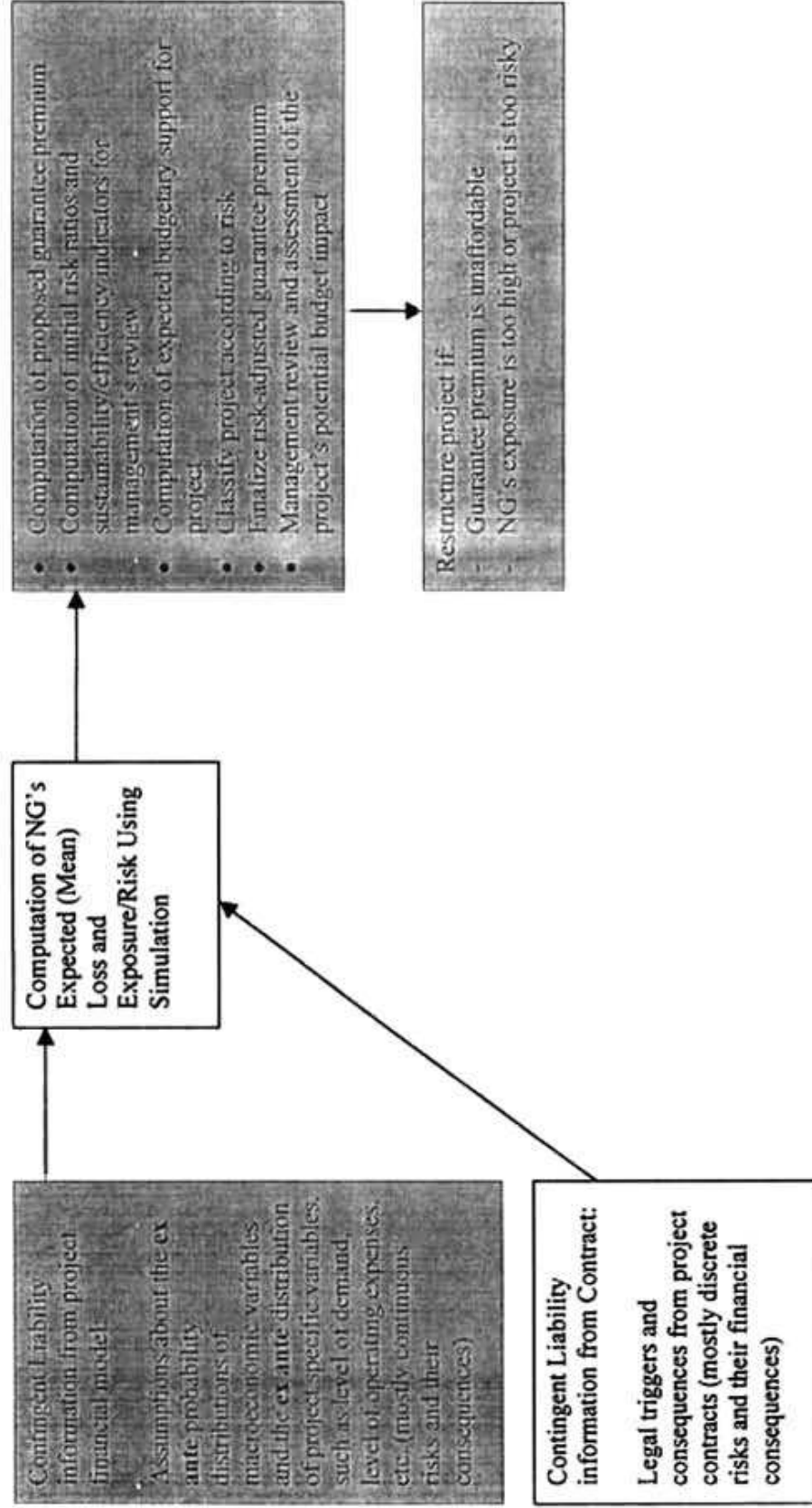
The following pages describe in more detail a framework that NG can adopt to better manage risk and exposure. The model requires:

- the use of ex ante risk analysis (estimating NG exposure and risk in the project appraisal stage) and ex post risk analysis (estimating NG exposure and risk after a project has commenced) (see **Figures 1 – 3**); and
- the use of various risk management tools created for this project. These are described in greater detail in the succeeding section.

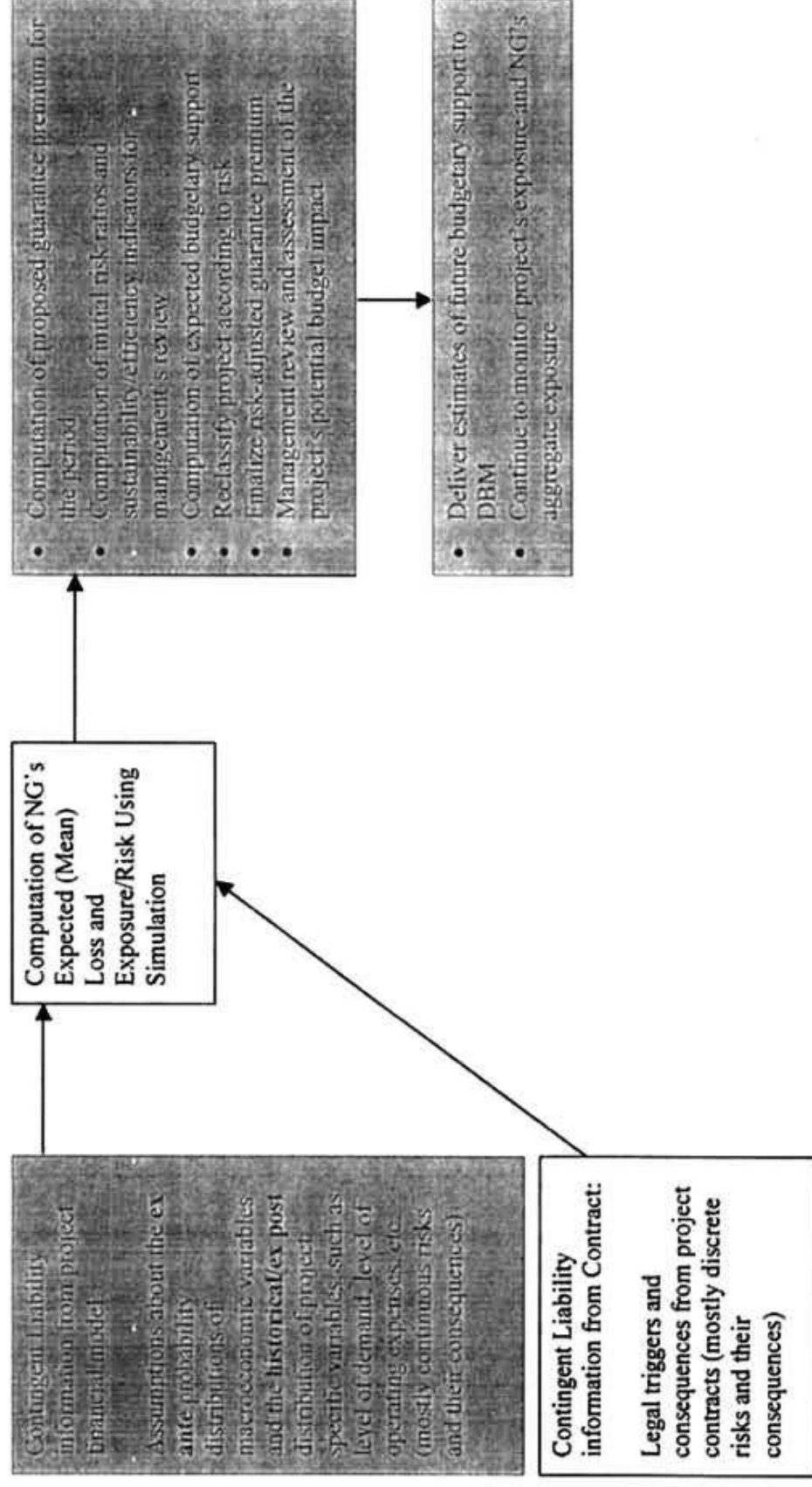
**Figure 1: Types of Risk Analyses Used in Contingent Liabilities Study**



**Figure 2: The Process of Ex Ante Risk Analysis in This Study**



**Figure 3: The Process of Ex Post Risk Analysis in This Study**



## **A. Ex Ante Project Risk Analysis**

As **Figure 1** indicates, ex ante risk analysis is conducted during the project appraisal stage. In order to run detailed ex ante risk analysis using Monte Carlo simulation methods espoused by this study, one needs to accumulate past historical data on means, variances, and correlations of the relevant risk factors in a project, and then run simulations of cashflows to determine the extent, if any, of the expected fiscal support to be provided by government to the project in case of default or shortfalls in meeting debt and equity obligations.

Ex ante risk analysis for various BOT projects are conducted as part of the study (see **Annex 1**). **In order not to prejudice government, projects and/or their cashflows have been renamed or re-scaled.** What the study emphasizes is the method of analysis, not the accuracy of the figures. Detailed risk analysis includes determining expected time-to-default, or the timing of the initial default of payments to creditors (or equity stakeholders) in BOT projects, as well as the amounts defaulted.

Note from **Annex 2** that for each project:

- 1) Mean exposures as well as extreme (tail) exposures have been computed; and
- 2) Risk ratios are constructed to motivate a more in-depth analysis of project risk.

These figures serve as the basis for assessing project risk.

## **B. Summary Results of Ex Ante Risk Analysis**

**Table 1** presents a summary of the relevant results from the conduct of ex ante estimation of NG expected losses for various BOT projects. These expected losses are divided by variables such as GDP and project costs to produce risk ratios that may be used for monitoring and limiting risk and exposure. The last two columns of **Table 1** are the key risk ratios because they are indicators of sustainability (Power Project 1 having the most costly expected loss) and efficiency (Transport Project 1 having the greatest NG exposure per peso investment). Benchmarks have to be established for these indicators for them to be more meaningful tools in risk analysis.

In terms of sheer financial magnitude, NG's largest ex ante expected loss is the expected loss relative to the Power Project 1 power project (0.6750% of GDP). A determination must be made as to whether such an expected loss is sustainable. Perhaps this may be done by comparing this ratio to established benchmarks for the budget deficit, the current account deficit, and other objective criteria.

Although not bearing the greatest expected financial loss, the riskiest project from ex ante analysis appears to be Transport Project 1, for which the government expects to lose approximately 75.14 pesos for every peso invested in it (see last column of **Table 1**). This is interpreted to mean that for Transport Project 1, the relative quantity of risk assumed by government is greatest. This seems to imply that the structure of the contract and financial agreements to which the government has chosen to adhere, appear to be more onerous relative to other projects. For this reason, the ratio of expected loss to project cost is deemed an efficiency indicator, since it indicates the quantity of risk carried per peso investment.

Following the principles outlined for actuarially fair guarantee pricing in Reside (2000b), the proposed guarantee premium for each BOT project will be a function of expected loss, administrative expense loading and net positive externalities generated by the project. If the criteria for setting guarantee premia is to be based purely on expected financial costs, then Transport Project 1 should be charged with the highest premia, followed by Power Project 1, Power Project 2, Toll Road 1, Power Project 3, and Toll Road 2. If net positive externalities are factored in for each project, the ranking could change. **Table 2** provides other indicators of exposure. **Table 2** suggests that Transport Project 1 also has the highest exposure to *rare and extreme* losses (large losses that occur 1% or 5% of the time). **Figures 4 – 5** provide further results useful for analysis.

**Table 1: Selected Exposure Figures and Risk Ratios**

| Projects            | Sustainability Indicator:<br>Ratio of Expected Loss to GDP | Efficiency Indicator:<br>Ratio of Expected Loss to Project Cost (Expected loss per peso invested in project) |
|---------------------|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Toll Road 1         | 0.0335%                                                    | 8.51%                                                                                                        |
| Transport Project 1 | 0.6005%                                                    | 75.14%                                                                                                       |
| Power Project 2     | 0.14%                                                      | 11.77%                                                                                                       |
| Power Project 1     | 0.6750%                                                    | 31.04%                                                                                                       |
| Power Project 3     | 0.0094%                                                    | 7.80%                                                                                                        |
| Toll Road 2         | 0.0092%                                                    | 3.80%                                                                                                        |

**Table 2: Selected Exposure Figures and Risk Ratios**

| Projects            | There is a 1% probability that the ratio of the PV of the total expected loss to GDP will exceed | There is a 1% probability that the ratio of the PV of the total expected loss to project cost will exceed | There is a 5% probability that the ratio of the PV of the total expected loss to GDP will exceed | There is a 5% probability that the ratio of the PV of the total expected loss to project cost will exceed |
|---------------------|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Toll Road 1         | 0.09%                                                                                            | 28.29%                                                                                                    | 0.07%                                                                                            | 21.53%                                                                                                    |
| Transport Project 1 | 1.04%                                                                                            | 179.23%                                                                                                   | 0.89%                                                                                            | 153.92%                                                                                                   |
| Power Project 2     | 0.25%                                                                                            | 21.75%                                                                                                    | 0.21%                                                                                            | 17.84%                                                                                                    |
| Power Project 1     | 1.35%                                                                                            | 62.29%                                                                                                    | 1.07%                                                                                            | 49.29%                                                                                                    |
| Power Project 3     | 0.01%                                                                                            | 16.67%                                                                                                    | 0.01%                                                                                            | 13.38%                                                                                                    |
| Toll Road 2         | 0.03%                                                                                            | 15.02%                                                                                                    | 0.02%                                                                                            | 11.53%                                                                                                    |

Figure 4

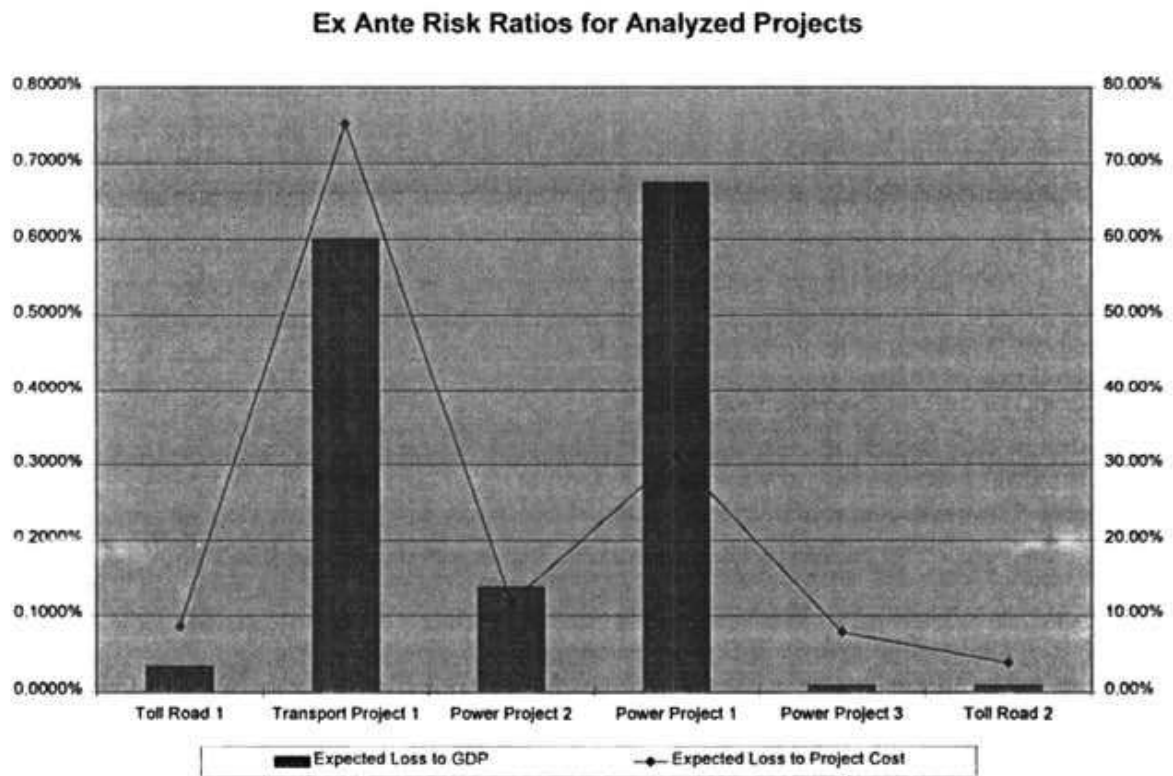
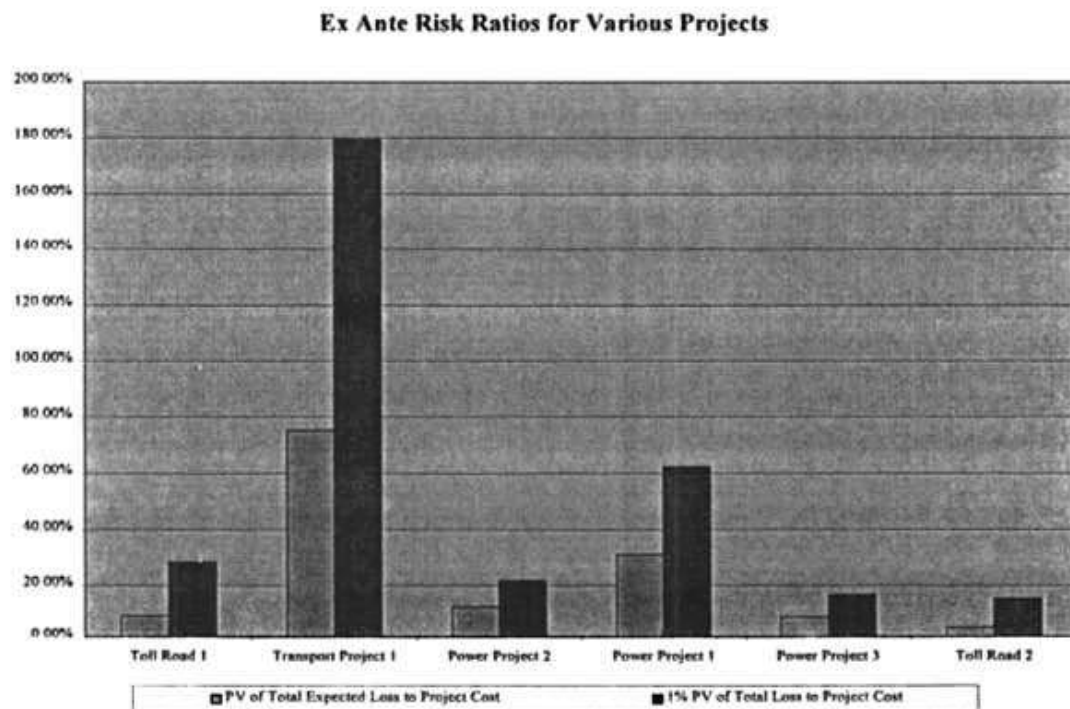


Figure 5



### C. Sensitivity of Expected Losses to Underlying Risk Factors

Figures for expected losses (the risk variables) computed in the previous section are functions of variables (risk factors) that are both stochastic (uncertain in value) and deterministic (certain in value). Since stochastic variables such as the exchange rate, levels of traffic, etc., have a range of outcomes, then it follows that an analysis can be conducted to determine the sensitivity of these risk variables to the underlying risk factors. The sensitivity of the PV of expected losses for Transport Project 1 is presented in **Table 3** below.

Sensitivity analyses performed on the present value of total expected losses for the project and their associated risk factors may use either multivariate stepwise regression analysis or a rank order correlation. Regression analysis attempts to estimate the best linear relationship between expected loss and the risk factors.

In the regression analysis, two statistics are noteworthy: the regression's  $R^2$  and the estimated coefficient of each risk factor. The  $R^2$  value listed at the top of the third column of **Table 3** is a measurement of the percentage of variation in the expected loss that is explained by the distribution of particular risk factors. The lower the fit the less stable the reported sensitivity statistics. If  $R^2$  is less than 60% then the linear regression may not sufficiently explain the relationship between the inputs and outputs - an identical simulation with the same model could give a different ordering of risk factor sensitivities. *Since the  $R^2$  for Transport Project 1 is 94%, then it follows that the risk factors listed in Table 3 explain a great proportion of the variation in the expected loss.*

The number listed beside each risk factor in the third column of **Table 3** is the coefficient of that risk factor. A coefficient value of 0 indicates that there is no significant relationship between the risk factor and expected losses, while a regression value of 1 or -1 indicates that if a 1 percent change in the risk factors occurs, expected loss changes by 1 or -1 percent. From **Table 3**, the risk factor with the highest coefficient is average daily ridership in the initial year of operations. *A one percent change in initial volume leads to a 0.637 percent change in total expected loss.* The impact of initial ridership (in year 2000) on total expected loss is profound, since succeeding volume levels are determined by applying growth rates to levels in the previous years. Thus, the impact of a lower-than-expected initial passenger level is compounded over time. Note that changes in the exchange rate (currency risk) accounts for much of the rest of expected loss.

The sensitivity analysis using rank correlations is based on the Spearman rank correlation coefficient calculations. With this analysis, the rank correlation coefficient is calculated between the expected losses and samples for each of the distributions of the risk factors. The higher the correlation between the risk factor and the expected loss, the more significant the risk factor is in determining the value of expected losses.

The coefficient is a value between -1 and 1 which represents the desired degree of correlation between the two variables during sampling. Positive coefficient values indicate a positive relationship between the two variables - when the value sampled for one is high, the value sampled for the second will also tend to be high. Negative coefficient values indicate an inverse relationship between the two variables - when the value sampled for one is high, the value sampled for the second will tend to be low.

The same pattern emerges between correlation and regression analysis. Correlation analysis also suggests a strong linear relationship between initial ridership and expected loss, with changes in exchange rates somewhat more weakly correlated to expected losses. Such sensitivity analyses can also be conducted for other projects.

**Table 3: Sensitivity of NPV of Total NG Loss to Top Ten Risk Factors in Transport Project 1's Cashflow**

| Rank | PV of Expected Losses is Most Sensitive to the Following Risk Factors | Regression Sensitivity Coefficients ( $R^2=0.941601$ ) | Rank Correlation Coefficient |
|------|-----------------------------------------------------------------------|--------------------------------------------------------|------------------------------|
| #1   | Avg. daily volume in initial year of operations                       | 0.637037                                               | 0.5956                       |
| #2   | Change in the exchange rate in 1996                                   | -0.21904                                               | -0.2015                      |
| #3   | Change in the exchange rate / 1997                                    | -0.21753                                               | -0.23156                     |
| #4   | Change in the exchange rate / 1999                                    | -0.21371                                               | -0.17643                     |
| #5   | Change in the exchange rate / 1998                                    | -0.21257                                               | -0.18424                     |
| #6   | Change in the exchange rate 2000                                      | -0.20046                                               | -0.14815                     |
| #7   | Change in the exchange rate / 2001                                    | -0.18445                                               | -0.15962                     |
| #8   | Change in the exchange rate 2002                                      | -0.18353                                               | -0.18143                     |
| #9   | O&M in initial year of operations                                     | -0.17725                                               | -0.15525                     |
| #10  | Change in the exchange rate 2003                                      | -0.17097                                               | -0.16945                     |

#### **D. Using Risk Indicators and Risk Ratios for Project Screening and Monitoring**

In this study, ex ante expected losses are determined via simulation. The challenge is to make these expected loss figures useful in policy making. This study suggests the computation of risk ratios to aid in the appraisal of project risk, in a manner similar to the way financial analysts use conventional liquidity and solvency ratios to assess the financial well-being of a firm. In addition, the construction of risk ratios facilitate the establishment of *objective* risk standards, limits and thresholds that government policymakers may decide. The creation of objective standards for project risk appraisal allows analysts and decision makers to distinguish high- from low-risk projects during the ex ante screening of projects. This mitigates the adverse selection problems mentioned earlier.

Specifically, estimation of ex ante expected loss and exposure (extreme outcomes) allows one to construct:

- 1) **Burden indicators** that serve as an aid in risk analysis and monitoring (see **Table 4**).
- 2) **Risk ratios**: Primarily expected loss divided by GDP (an indicator of the sustainability of expected losses and expected loss divided by project cost (an indicator of the efficiency of a project's risk structure), and other ratios (see **Table 5**). The former can be classified as a burden indicator specific to the project. The latter provides an indication of how many pesos a project can be expected to lose in a period per peso invested in them. Risk ratios are described in a later section of the study.

Along with the risk ratios, the burden indicators will provide the basis for determining the government's capacity to assume risk and absorb expected losses. The risk ratios and the indicators will serve an important function. They will serve as gauges of the relative burden of expected loss and contingent liabilities on a project, sectoral and aggregate basis. The government may set limits or thresholds on these gauges, to manage exposure more effectively. See **Table 4** for World Bank standards on debt burden indicators. Data to be generated by the risk analysis will be used to build *contingent liability burden indicators* similar to that of **Table 5**.

Objective standards for ex ante risk appraisal also facilitates project monitoring, which mitigates the moral hazard problem. After a project commences operating, risk factors may be recalibrated to reflect actual conditions of the risk factors (such as actual level of demand, operating expenses, etc.), and a project may be reclassified depending on a re-simulation of expected losses, and guarantee premia could be realigned to more closely reflect actual conditions.

**Table 4**

| <b>Suggested Contingent Liability Indicators and Critical Values</b>                                                                                              |                  |                  |                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------|------------------|
| <b>Stock of Existing NG Debt PLUS EXPECTED LOSSES or CONTINGENT LIABILITIES in last year to average GNP in the last 3 years PV/GNP</b>                            | <b>&gt; 80%</b>  | <b>&gt; 48%</b>  | <b>&lt; 48%</b>  |
| <b>Stock of Existing NG Debt PLUS EXPECTED LOSSES or CONTINGENT LIABILITIES in last year to average exports, including remittances in the last 3 years PV/XGS</b> | <b>&gt; 220%</b> | <b>&gt; 132%</b> | <b>&lt; 132%</b> |
| <b>Contingent Liability Burden</b>                                                                                                                                | <b>Severe</b>    | <b>Moderate</b>  | <b>Less</b>      |

**Table 5: Potentially Useful Risk Ratios**

| Mean Expected Loss or Extreme (Tail)<br>Loss Relative to |
|----------------------------------------------------------|
| Total Project Cost                                       |
| Total NG Tax Revenues                                    |
| Total NG Customs Collections                             |
| Total NG Total Revenues                                  |
| Exports                                                  |
| Imports                                                  |
| Current Account Balance                                  |
| GNP                                                      |
| GDP                                                      |
| Total NG Deficit                                         |
| Consolidated Public Sector Fiscal Position               |
| Public Sector Borrowing Requirement                      |
| Gross International Reserves                             |
| Net International Reserves                               |
| Total Foreign Exchange Liabilities                       |
| Total Liabilities of GOCCs                               |
| Total NG Domestic Debt                                   |
| Total NG Foreign Debt                                    |
| Total NG Debt                                            |
| Total RP Domestic Debt                                   |
| Total RP Foreign Debt                                    |
| Total RP Debt                                            |

### **E. Proposed Risk Classification System**

Given the PV's of the ex ante expected losses for each of the projects surveyed, we can construct the following **Table 6** to classify each project according to indicators for risk sustainability and efficiency. This classification system could serve as an alternative basis for charging risk-adjusted guarantee premiums. The classification system can also serve as a basis for ranking projects, proponents and project sponsors. The ability to rank projects on the basis of risk ratios mitigates the adverse selection problem, and aids significantly in the determination of an appropriate guarantee fee. In the long run, the aim is to review more projects to formulate rules-of-thumb: benchmark percentages that serve as general guides to policymakers to expedite decision-making. For example, if it is observed that toll road projects generally have an efficiency indicator of 5%, policymakers could say that any prospective toll road project exceeding this threshold should be reviewed. **Table 6** already contains a suggested classification scheme for projects.

**Table 6**

| <b>Name of Project</b>                 | <b>Total Ex Ante Expected Loss as a Percent of GDP in Year Prior to Start of Construction (Sustainability Indicator)</b> | <b>Classification</b> | <b>Expected Ex Ante Loss as a Percentage of Project Cost (Efficiency Indicator)</b> | <b>Classification</b> | <b>Project Cost (in USD)</b> |
|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-----------------------|-------------------------------------------------------------------------------------|-----------------------|------------------------------|
| Power Project 1                        | 0.67%                                                                                                                    | High                  | 31.04%                                                                              | High                  | 1,300,000,000.00             |
| Transport Project 1 Operations Phase   | 0.60%                                                                                                                    | High                  | 75.14%                                                                              | Very High             | 655,000,000.00               |
| Power Project 2                        | 0.14%                                                                                                                    | Intermediate          | 11.77%                                                                              | Intermediate          | 700,000,000.00               |
| Toll Road 1                            | 0.03%                                                                                                                    | Low                   | 8.51%                                                                               | Intermediate          | 361,000,000.00               |
| Power Project 3                        | 0.01%                                                                                                                    | Low                   | 7.80%                                                                               | Intermediate          | 100,000,000.00               |
| Toll Road 2                            | 0.01%                                                                                                                    | Low                   | 3.80%                                                                               | Low                   | 198,710,553.10               |
| Transport Project 1 Construction Phase | 0.03%                                                                                                                    | Low                   | 2.70%                                                                               | Low                   | 655,000,000.00               |
| Other Transport Project (Year 1)       | 0.01%                                                                                                                    | Intermediate ?        | 6.73%                                                                               | High?                 | 100,000,000.00               |

Note that expected loss as a percentage of GDP provides an indication as to the capability of government to sustain losses. Based on the hypothetical figures, NG tends to incur larger losses in projects that cost more.

Note that expected loss as a percentage of project cost provides an indication as to which project NG expects to lose more for every peso investment in it. As such, it provides an indication of the risk, the extent of government guarantees provided, the efficiency of risk-taking by government, as well as the quality of the project pursued or to be pursued. The classification system is meant to guide decision-making and ex ante/ex post project screening, to reduce moral hazard and adverse selection.

Other indicators may be potentially useful. These include the ratio of expected losses in a particular year to the expected amount of cash the Treasury expects to have in deposit at the BSP (a liquidity indicator).

#### **F. Monitoring Economy-wide and Project-Specific Exposure and Establishing Criteria for Limiting Losses**

Assuming that the risks assumed by NG in the Transport Project 1 project exceed the amount of risk that the NG can tolerate in a specific project within one year, we may take the risk ratios generated by Transport Project 1 and use them as benchmarks against which to evaluate other projects, with an end to limiting exposure. Tables 7 – 8 presents several

suggested benchmarks, based on Transport Project 1's expected default loss. Using these figures, the suggested decision rule would be to disapprove the project if, at any time during the project, the risk ratio exceeded the benchmarks. Other decision criteria could be used.

**Table 7: If to be Based on Transport Project 1's YEAR 1 Expected Loss, These are Suggested Benchmark Criteria for Evaluating Expected Losses/Exposure to a Single Project**

| Exposure/Expected Mean or<br>Extreme Loss Relative to | Must not Exceed this Benchmark Risk<br>Ratio |
|-------------------------------------------------------|----------------------------------------------|
| Total Project Cost                                    | 8%                                           |
| Total NG Revenues                                     | 0.4%                                         |
| Exports                                               | 0.125%                                       |
| GNP                                                   | 0.07%                                        |
| GDP                                                   | 0.07%                                        |
| Net International Reserves                            | 0.40%                                        |

**Table 8: Benchmarks Based on Other Criteria**

| Item                             | Criteria                                                        |
|----------------------------------|-----------------------------------------------------------------|
| Time-to-Default                  | Should not occur before the expected end of construction period |
| Frequency of Default             | As few as possible                                              |
| Probability of Default in a Year | Not more than 70% on any given year                             |
| Cost of Demand Risk              | Not more than x% of project cost or total exposure              |
| Cost of Currency Risk            | Not more than x% of project cost or total exposure              |

The possibility that risk ratios may be constructed to help quantify exposure to loss suggests that projects can be classified according to several criteria. The relative costs of demand, and currency risks may be compared across projects, and projects can actually be ranked according to exposure not just ordinally, but even cardinally. Risk ratios may be used to place hard limits on exposure to specific projects, specific sectors, and on the economy as a whole. If expected losses represent expected NG's future borrowing requirements, then expected losses could be added to the existing stock of NG debt and a Table based on **Table 4** could be constructed. *The debt burden ratios that would result after contingent liabilities or expected losses are added to existing debt would indicate whether or not NG has any further capacity to assume risks in projects.* In light of the fact that recent international currency crises have taken on the character of crises in foreign exchange liquidity, *foreign currency liquidity-based* indicators could also be used for monitoring purposes.

The analysis above suggests that the construction of a thorough risk classification system is possible, and should serve as a basis for the future charging of guarantee premia, reducing adverse selection in projects. Meanwhile, the ability to use such indicators to monitor projects on an ex ante basis should reduce moral hazard.

## G. Ex Post Project Risk Analysis

As Figure 3 indicates, ex post risk analysis is necessary for calibrating the risk ratios constructed during the ex ante phase. Ex post risk analysis will help the government monitor the level of risk and exposure being assumed as a project enters its operations phase. Ex post risk analysis may also be used in appropriating reserves against expected losses on guarantees provided for BOT projects (an example of how ex post simulation can be applied to Transport Project 1, in order to determine what amount of funds are to set aside as reserves, is provided in Reside (2000b)). Thus, a menu-based approach could be implemented that could provide greatest flexibility in meeting the costs of future claims:

**Table 8**

| Project Phase                                           | Project Appraisal                                                                                                                                                                                                  | Construction                                                                                                                                                                                                                                                                                                  | Operations/Revenue                                                                                                                                                                                                                                                        |
|---------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Certainty of losses or deficits                         | Uncertain                                                                                                                                                                                                          | Less certain compared to the operational phase                                                                                                                                                                                                                                                                | More certain as time passes by and actual losses are incurred, so an actual loss history is built                                                                                                                                                                         |
| Risk Appraisal – Method for computing risk exposure     | <ol style="list-style-type: none"> <li>1. Rule-of-thumb (no simulation required)</li> <li>2. More detailed simulation method</li> </ol> <p>Both methods will rely on inputs from the detailed financial model.</p> | <ol style="list-style-type: none"> <li>1. Rule-of-thumb</li> <li>2. More refined and precise simulation method</li> </ol> <p>Both methods will rely on inputs from the detailed financial model.</p> <p>DOF should monitor progress of construction and begin to assess whether cost overruns will occur.</p> | <ol style="list-style-type: none"> <li>1. Rule-of-thumb</li> <li>2. More refined and precise simulation method</li> </ol>                                                                                                                                                 |
| Budgeting procedure – Amount budgeted could be based on |                                                                                                                                                                                                                    | <ol style="list-style-type: none"> <li>1. Constant proportion of project cost (arbitrary)</li> <li>2. Rule-of-thumb</li> <li>3. More detailed simulation method</li> </ol>                                                                                                                                    | <ol style="list-style-type: none"> <li>1. Projected loss computed by CAG or NEDA given more conservative projections and assumptions</li> <li>2. Actual loss from last period</li> <li>3. Rule-of-thumb</li> <li>4. More refined and precise simulation method</li> </ol> |

Note: Rule-of-thumb method has only been tested for urban rail project. It is explained further in Reside(2000b).

## **VI. Conclusion**

The results of the Monte Carlo simulation exercises can provide very useful inputs into any management's decision-making process. The simulation here provides a very rich source of analysis for national government in project appraisal. Work is presently on-going to refine the methods used and calibrate the probability distributions used as inputs into the analysis of project risk.

The risk management system proposed here addresses the adverse selection and moral hazard problems inherent in any situation where insurance or credit is provided. The system serves to improve project screening and monitoring, as well as to determine the risk-adjusted premia to be charged for guarantees. As such, they are useful in reducing government's risk and exposure to more actuarially sound levels.

The methods discussed in the paper are applicable to a wide range of non-government applications as well. When used in banking applications, they may provide a basis for banks and other creditors to assess the credit risk of projects in the process of securing and pricing credit. They go a long way in deepening our understanding of risk and exposure in the project appraisal process.

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## ANNEX 1

For BOT projects, the following items need to be modeled based on the following important risk factors:

| Risk                                       | V. Relevant risk factors to be simulated or modeled using standard economic models to generate one-period-ahead forecasts |                                                                                         |  | VI. The level of risk is correlated with, or is influenced by the following factors   |                                                                                                                           |  |
|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|--|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|--|
|                                            | VII. models to generate one-period-ahead forecasts                                                                        |                                                                                         |  | VIII. The level of risk is correlated with, or is influenced by the following factors |                                                                                                                           |  |
| Currency risk                              |                                                                                                                           | Exchange rate<br>RP inflation rate<br>US Inflation rate                                 |  |                                                                                       | Macroeconomic conditions, current account and capital account conditions                                                  |  |
| Market risk                                |                                                                                                                           | Power: GWh of power generated by a plant in the next period; actual off-take by utility |  |                                                                                       | Macroeconomic conditions; GDP growth, prices of substitute goods and services                                             |  |
|                                            |                                                                                                                           | Transport: Number of riders                                                             |  |                                                                                       | Macroeconomic conditions; GDP growth, prices of substitute goods and services                                             |  |
|                                            |                                                                                                                           | Water: Actual water off-take by utility                                                 |  |                                                                                       | Macroeconomic conditions; GDP growth, prices of substitute goods and services                                             |  |
|                                            |                                                                                                                           | Others                                                                                  |  |                                                                                       |                                                                                                                           |  |
| Buyout                                     |                                                                                                                           | Frequency of force majeure                                                              |  |                                                                                       |                                                                                                                           |  |
| Other event risks                          |                                                                                                                           | Frequency of legal actions undermining project                                          |  |                                                                                       | Level of uncertainty with respect to the legal system                                                                     |  |
| Financial viability of the project company |                                                                                                                           | Frequency and timing of default                                                         |  |                                                                                       | Completion risk, price of relevant inputs and outputs, currency risk                                                      |  |
| Completion risk                            |                                                                                                                           | Frequency and length of project delays caused by various institutions                   |  |                                                                                       | Level of competency of institutions involved in the project or phase; quality of coordination among institutions involved |  |

|                                  |                                              |                                                                                 |
|----------------------------------|----------------------------------------------|---------------------------------------------------------------------------------|
| Price of relevant inputs         | Power: Coal prices, oil prices               | Currency risk, vendor or supply risk                                            |
|                                  | Transport: Price of electricity, coal or oil | Currency risk, vendor or supply risk                                            |
|                                  | Water: Price of electricity                  | Currency risk, vendor or supply risk                                            |
|                                  | Others                                       |                                                                                 |
| Price of relevant outputs        | Power: Wholesale price of power plant        | Degree to and flexibility with which regulators allow prices to adjust          |
|                                  | Transport: Train fare; toll                  | Degree to and flexibility with which regulators allow fares and tolls to adjust |
|                                  | Water: Price of water                        | Degree to and flexibility with which regulators allow water prices to adjust    |
|                                  | Others                                       |                                                                                 |
| Right-of-Way (Site availability) | Cost of right-of-way acquisition             |                                                                                 |

Based on initial inquiries with relevant stakeholders in BOT projects, the following risks appear to have the greatest potential impact on government exposure to contingent claims:

| Risk                                       | Adverse Financial Payoff                                                                     |
|--------------------------------------------|----------------------------------------------------------------------------------------------|
| Currency risk                              | Exchange rate depreciates beyond the rate expected in the financial model of a project       |
| Market risk                                | Demand for the service or good falls below the contractually-determined take-or-pay amount   |
| Buyout                                     | Present value of future stream of payments is paid in one installment                        |
| Financial viability of the project company | Amount of additional cash needed to pay off contractors or creditors in the event of default |
| Delays, cost overrun, completion risk      | Project, or parts of the project, are not completed on time, leading to cost overruns        |
| Right-of-way                               | Government is forced to pay for unexpected right-of-way acquisition cost                     |

## **ANNEX 2**

### **Applications: Expected Loss/Deficit and Exposure/Risk Analysis Using Methods Developed Under the Project**

#### **Part I: BOT Projects**

In measuring expected losses, and possibly setting aside a budget to cover exposure to risks assumed in BOT projects, the following general principles can be kept in mind:

- 1) Set aside a budget for expected (mean) loss. Provision for extreme (unexpected) exposures or losses.
- 2) In pricing guarantees, a basic principle from microeconomics can be followed. Assuming risk neutrality, the actuarially fair guarantee fee for the year should equal the expected loss/cost of assuming the risk for the year plus an allowance to cover for administrative expenses.

Results of the analysis are presented in the succeeding pages:

- 1) Transport Project 1 Construction Phase
- 2) Transport Project 1 Operations/Revenue Phase
- 3) Computing the Annual Budget to Be Set Aside for Transport Project 1 (should DoF decide to support the project yearly)
- 4) Power Plants: Power Project 1, Power Project 2, and Power Project 3
- 5) Toll Roads: Toll Road 1 and Toll Road 2
- 6) Other Transport

In order to provide a baseline measure of exposure and expected loss, we assume that all discrete risks in contracts have a zero probability of occurring, so expected NG loss with respect to force majeure, buyout, and other discrete event risks, equals zero. Departures from these assumptions can be easily accommodated in any of the cashflow models being simulated.

## 1. TRANSPORT SECTOR PROJECT: Transport Project 1

Based on the work of the Legal Team on contracts, as well as upon examination of the Transport Project 1 financial model, the following risk matrix was constructed for Transport Project 1.

**Table A.1: Risk Matrix of Transport Project 1 Based on Matrix Completed by Legal Team**

| Nature of Risk    | Construction Phase                                                                         | Operations Phase                                                               | Method for Determining Expected Loss |
|-------------------|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|--------------------------------------|
| <b>Discrete</b>   | Default to contractors due to cost overruns<br><br>ROW<br><br>Termination/Buyout<br>Delays | Force majeure<br>Political risk<br>Termination/<br>Buyout/Just<br>Compensation | Simulation<br>Expected Value         |
| <b>Continuous</b> |                                                                                            | Currency risk<br>Demand risk                                                   | Simulation<br>ROT                    |

In the analysis that follows, ROW and discrete event risks in the operations phase are assumed to have probabilities of ZERO, so that their expected costs are also zero.

### a. Construction Phase – Ex Ante Risk Analysis

The most important sources of project risk in the construction phase of a project are delays, cost overruns and other discrete risks. In the Transport Project 1 case, the actual cost overrun prompted the government to facilitate additional (NG-guaranteed) borrowing in the order of around P 16.0 million. In order to analyze the expected loss from cost overruns, the default risk Excel template developed for this project was used. The template was copied unto the financial model of Transport Project Firm from February to December 2000. The template was modified to handle monthly cashflow projections, in order to predict when Transport Project Firm will be unable to pay its contractors. The resulting worksheet was simulated 5000 times using stochastic simulation. Results of the simulation exercise are presented below:

**Table A.2: Results of Simulation of Transport Project Firm's cashflow from February to December 2000**

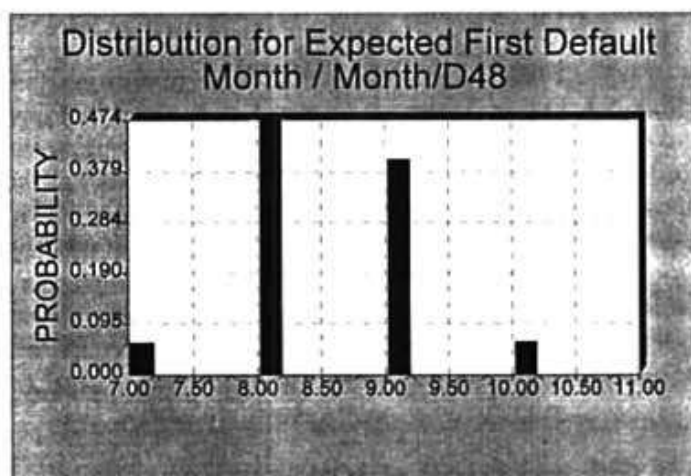
| Name      | Expected Default Month | First Expected Default (In Million USD) | First Total Number of Months in Default | Total Amount in Default for the Period (In Million USD) |
|-----------|------------------------|-----------------------------------------|-----------------------------------------|---------------------------------------------------------|
| Minimum = | 7 (August)             | -5,530.81                               | 0                                       | -55,408.2                                               |

|                                                          |                          |           |               |           |
|----------------------------------------------------------|--------------------------|-----------|---------------|-----------|
| Maximum =                                                | 11(December)             | -0.81     | 5 (months)    | 0         |
| Mean =                                                   | 8.468573 (Mid-September) | -2,029.11 | 3.45 (months) | -17,662.2 |
| There is a 5 percent chance that the outcome will exceed | 7                        | -4,504.81 | 2             | -34,958.2 |

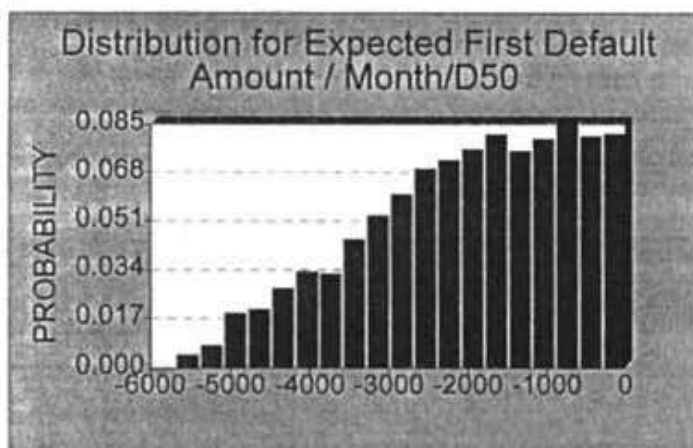
An analysis of the circumstances surrounding the Transport Project 1 project suggests that except for default to contractors and delays, none of the discrete risks appear to be highly likely to be called. *Thus, for the construction period, the expected cost to NG of assuming all discrete risks, except for default and delay, equals zero.*

According to the results of the simulation of construction period cashflows, the mean default month is mid-September, the mean expected cost of the first default to contractors, is about USD 2 million in the first month of default, while the total assistance required by Transport Project Firm to remain current in its payments to contractors during the construction period is about USD 17.7 million. All of these results compare favorably with the actual outcomes. A graph of the probability distribution of the expected first default month (see **Figure A.1**) suggests that default is most likely in the eighth and ninth months in the model (September and October, 2000, respectively), and the probability of default falls sharply thereafter. **Table A.2** also suggests that NG's loss will rarely exceed USD 34.958 million (the upper bound for NG's loss). *This type of analysis and information is very valuable in project appraisal, as well as in setting aside budgeted funds to coincide with the timing of the initial default.*

**Figure A.1: Distribution of Expected Month of Initial Default**

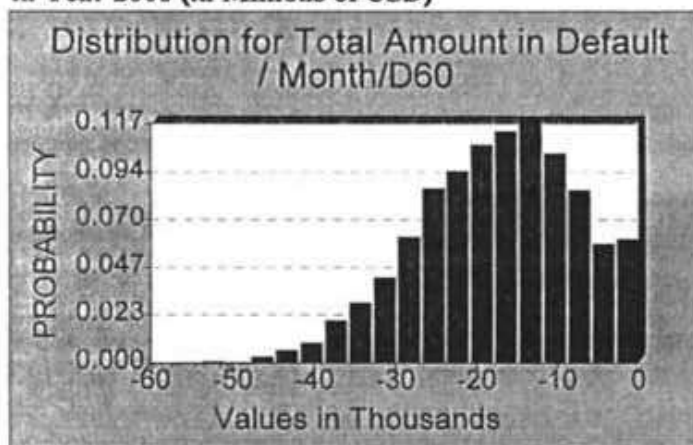


**Figure A.2: Distribution of Expected Amount of Initial Default  
(in Thousand USD)**



The distribution of the expected first default amount in **Figure A.2** suggests that most of the likely losses will not exceed about USD 3 million in the month of the first default. **Figure A.3** suggests that the total amounts of financial support to be provided by NG to Transport Project Firm is expected to be within the range of USD 10 to USD 20 million, again, valuable information for ex ante project analysis.

**Figure A.3: Distribution of the Total NG Support to Transport Project Firm  
in Year 2000 (in Millions of USD)**



**Table A.3: Ex Ante Summary for Construction Phase (in thousands of USD)**

|                                                                                                                 |                                                    |            |
|-----------------------------------------------------------------------------------------------------------------|----------------------------------------------------|------------|
| Average/Mean NG Loss in Construction Period                                                                     | - USD 17,662.2 Thousand for Year 2000              |            |
| Monte Carlo Simulation: There is a ___% probability that the actual loss in the construction period will exceed | 5.0%                                               | - 34,958.2 |
|                                                                                                                 | 2.5%                                               | - 38,208.2 |
|                                                                                                                 | 1.0%                                               | - 42,056.0 |
|                                                                                                                 | 0.5%                                               | - 43,808.2 |
| Actuarially Fair Risk-Adjusted Guarantee Premium to Cover Construction Period                                   | - USD 17,662.2 Thousand plus Admin Expense Loading |            |
| Expected Month of Initial Default                                                                               | Mid-September                                      |            |
| Expected Amount of Initial Default                                                                              | - USD 2,029.11 Thousand                            |            |
| Risk Ratios: Mean Expected Loss                                                                                 | To GDP                                             | 0.02659%   |
|                                                                                                                 | Project Cost                                       | 2.69652%   |

**b. Transport Project 1 Operations/Revenue Phase – Ex Ante Detailed Risk Analysis**

If the original parameters assumed by NEDA analysts in evaluating Transport Project 1 are used in this ex ante risk analysis exercise (see **Table A.4**), then simulating the financial model 5000 times using the default risk Excel template suggests that the initial default of Transport Project Firm will occur in the first quarter of the second year of operations (see **Table A.5**).

**Table A.4: Key Assumptions used in Ex Ante Detailed Risk Analysis (DRA) of Transport Project 1**

| Variable                        | Assumption                        |                    | Basis                                  |
|---------------------------------|-----------------------------------|--------------------|----------------------------------------|
| Initial exchange rate           | 26.50 (1996)                      |                    | Exchange rate prior to currency crisis |
| Effective revenue days per year | 330                               |                    | Investment Bank of Project Firm        |
| Initial fare                    | 20                                |                    | Investment Bank of Project Firm        |
| Fare growth rate                | 6 percent                         |                    | Investment Bank of Project Firm        |
| Annual change in exchange rate  | Gamma(1.88,4.07) + -2.66          |                    | Historical data                        |
| Initial passenger traffic       | Discrete probability distribution |                    | Best judgment (NEDA)                   |
|                                 | <b>Traffic</b>                    | <b>Probability</b> |                                        |
|                                 | 300,000                           | 25%                |                                        |
|                                 | 400,000                           | 50%                |                                        |

|                                             |                                              |             |                                        |
|---------------------------------------------|----------------------------------------------|-------------|----------------------------------------|
|                                             | 450,000                                      | 25%         |                                        |
| Annual growth rate in passenger traffic     | Normal probability distribution (0.05,0.025) |             | Best judgment (Transport Project Firm) |
| Initial Operations and Maintenance Expenses | Discrete Probability Distribution            |             | Best judgment                          |
|                                             | Amount (M USD)                               | Probability |                                        |
|                                             | 26.253                                       | 50%         |                                        |
|                                             | 30.000                                       | 50%         |                                        |
| Initial Real Estate Revenues                | Discrete Probability Distribution            |             | Best judgment                          |
|                                             | Amount (M USD)                               | Probability |                                        |
|                                             | 5.845                                        | 80%         |                                        |
|                                             | 0                                            | 0           |                                        |

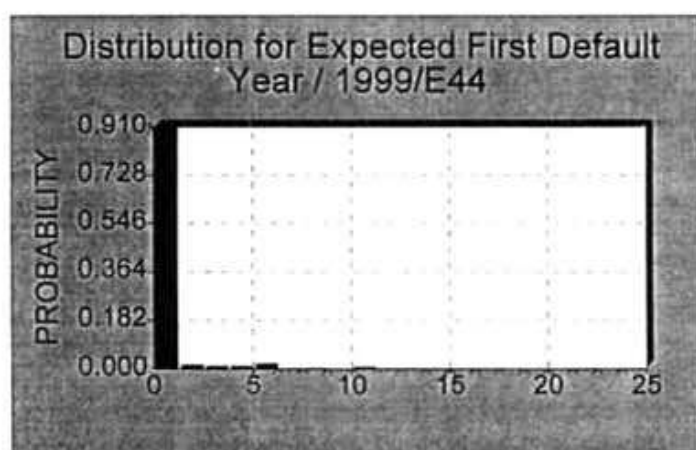
**Table A.5: Ex Ante Summary Expected Loss for Operations/Revenue Phase (Amounts in US Dollars)**

|                                                                                                                |                                                                      |                  |
|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|------------------|
| PV of NG's Expected Losses in Entire Period                                                                    | -492,170,400.00                                                      |                  |
| NPV of Project                                                                                                 | -219,584,800.00                                                      |                  |
| Monte Carlo Simulation: There is a ___ % probability that the actual loss in the operations period will exceed | 5.0%                                                                 | 1,008,158,000.00 |
|                                                                                                                | 1.0%                                                                 | 1,173,982,080.00 |
| Exposure to Other Discrete Event Risks                                                                         | Baseline assumption                                                  | Zero             |
| Expected Year of Initial Default                                                                               | 1.23 <sup>rd</sup> Year (First Quarter of second year of operations) |                  |
| Expected Amount of Initial Default                                                                             | -23,464,680.00                                                       |                  |
| Risk Ratios: Ratio of Expected Loss                                                                            | To GDP                                                               | 0.60%            |
|                                                                                                                | To Project Cost                                                      | 75.14%           |

**Table A.6: NG Expected Losses in First Five Years (In USD)**

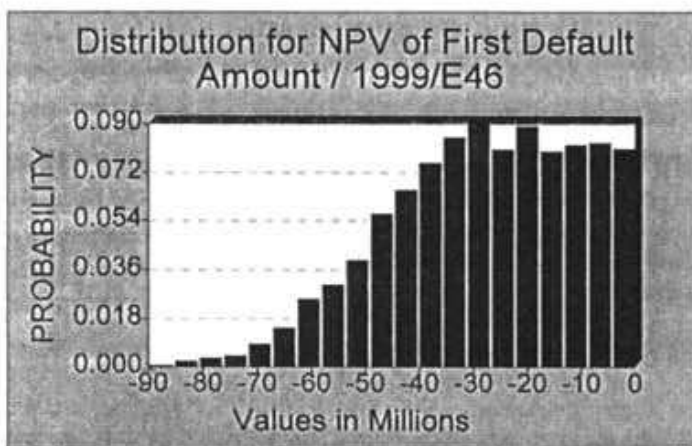
| Year/Percentile | Mean Expected Loss | There is a 5% chance that the loss will exceed | There is a 1% chance that the loss will exceed |
|-----------------|--------------------|------------------------------------------------|------------------------------------------------|
| 1               | -23,007,300.00     | -46,957,190.00                                 | -53,522,984.00                                 |
| 2               | -20,125,480.00     | -45,697,960.00                                 | -52,402,564.00                                 |
| 3               | -18,551,700.00     | -45,862,480.00                                 | -53,493,768.00                                 |
| 4               | -25,387,300.00     | -55,787,220.00                                 | -64,539,180.00                                 |
| 5               | -25,319,770.00     | -57,881,360.00                                 | -67,337,032.00                                 |

**Figure A.4: Probability Distribution of Expected Year of Initial Default**

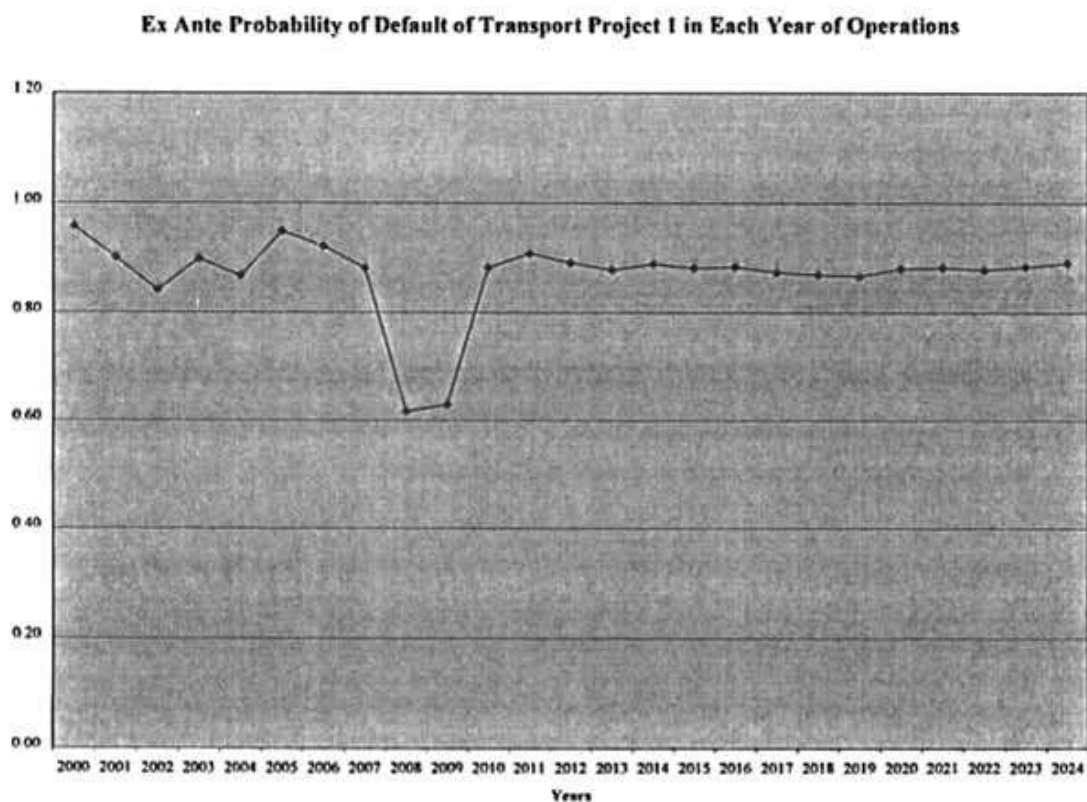


**Interpretation:** In all of the iterations of the cashflow of Transport Project 1 where a default occurs, 91% of the time, the default occurs in the first year.

**Figure A.5: Probability Distribution of Expected Amount of Initial Default (in USD)**



**Figure A.6**



Note from the ex ante simulation results that the project is almost always predicted to default within the first year of operations (there is about 96% probability of default in the first year based on **Figure A.6**), even under more favorable demand conditions. Had the

simulation results been known ex ante, DoF would have been very much aware of the financial stress the project could generate in even the very first year of operations. Provisions could have been made for losses at a very early stage, and a determination could be made as to whether the DoF could afford to absorb such losses. Risk ratios constructed below add further substance to the risk analysis.

The ex ante simulation analysis suggests that there is a 1% probability that NG's loss in the first year of Transport Project 1 operations will exceed USD 53.5 million. **In light of the government's admission that it will have to subsidize Transport Project Firm to the tune of about USD 76 million in Year 2000, the results of detailed risk analysis suggests that the current subsidy being provided by NG to Transport Project 1 covers an extreme loss indeed.**

**Table A.8: Risk Ratios**

| <b>Ratio of Mean Present Value of NG Loss to</b> | <b>Percent</b> |
|--------------------------------------------------|----------------|
| Total NG Tax Revenues                            | 3.82%          |
| Total NG Customs Collections                     | 15.08%         |
| Total NG Total Revenues                          | 3.05%          |
| Exports                                          | 37.34%         |
| Imports                                          | 41.35%         |
| Current Account Balance                          | 180.07%        |
| GNP                                              | 0.42%          |
| GDP                                              | 0.44%          |
| Total NG Deficit                                 | 11.68%         |
| Consolidated Public Sector Fiscal Position       | 12.98%         |
| Public Sector Borrowing Requirement              | 9.45%          |
| Total Foreign Exchange Liabilities               | 24.98%         |
| Total Liabilities of GOCCs                       | 0.72%          |
| Total NG Domestic Debt                           | 1.33%          |
| Total NG Foreign Debt                            | 1.78%          |
| Total NG Debt                                    | 0.76%          |
| Total RP Domestic Debt                           | 0.81%          |
| Total RP Foreign Debt                            | 0.77%          |
| Total RP Debt                                    | 0.39%          |

## APPLICATION OF METHODS DEVELOPED TO OTHER PROJECTS

### POWER SECTOR

#### POWER PLANT 1

##### Operations/Revenue Phase – Ex Ante Detailed Risk Analysis

##### Measuring the Cost of Bearing Demand Risk

It is well known that the government's electric utility, National Power Corporation (NPC), has assumed substantial demand risks by entering into minimum off-take contracts with independent power producers (IPP's). Under a minimum off-take contract, NPC purchases power from IPP's whether demand is prompted by central dispatch or not. In order to estimate the cost of assuming demand risk, a procedure adopted by Reside (1999) was utilized. For each IPP, the method measures the amount of contracted capacity that NPC pays for (take-or-pay), but does not utilize.

**Table A.16: Assumptions Used in Computing Demand Risk - Plant Factor and Plant Load**

| Input/Fuel     | Assumed Plant Factor in Contract                   | Assumed Present Plant Load |
|----------------|----------------------------------------------------|----------------------------|
| Diesel         | 85%                                                | Intermediate               |
| Bunker C       | 85%                                                | Peaking                    |
| Hydro          | 30%                                                | Variable                   |
| Geothermal     | None; mostly covered by minimum offtake agreements | Baseload                   |
| Coal           | 75%                                                | Baseload                   |
| Naptha         | 85%                                                | Intermediate               |
| Combined Cycle | 85%                                                | Intermediate               |

Source: NPC

This is the methodology used in computing the historical cost (i.e., defined as excess capacity payments) assumed by NPC in bearing demand risk.

- 1) Consider gross generation figures of plants operated by IPP's, and from the figures provided, compute implied plant capacity factors based on actual energy generation for each plant using the following formula:

##### Implied Plant Capacity Factor in Percentage Terms (IPCF)

$$= (\text{Gross Generation} \times 1,000) / (8,760 \times \text{Contracted Capacity})$$

- 2) Based on IPCF's, reckon whether sufficient or excess capacity payments were made for each year following the following procedure:

- a) Compared the IPCF of each plant in the sample with the plant factor that can reasonably be assumed to have been contracted (CPCF) given the type of plant and fuel input used;
  - b) If  $IPCF < (>) CPCF$ , the plant is assumed to be operating below (above) the CPCF;
  - c) If the plant is operating below (above) the CPCF, this suggests that an excess (sufficient) capacity payment has been made;
  - d) The difference between the IPCF and the CPCF is considered the percentage excess capacity of the plant;
- 3) Segregate the DoF data on capacity payments:
- a) Pre-1999 payments may be used in computing the historical cost of assuming market risk and pricing this risk;
  - b) Post-1999 payments may be utilized in computing the stranded costs associated with buying out IPP contracts.
- 4) Segregated the data from 3 (a) into:
- a) Payments covered by minimum off-take agreements (mostly contracts with PNOC-EDC); and
  - b) Contracts with other IPP's.
- 5) Reconciled payments data from 4 (a) and 4 (b) with gross generation figures from NPC;
- 6) Multiplied capacity payments for each plant in each year by the percentage excess capacity to determine the historical value of excess capacity payments. The historical total of excess capacity payments given by NPC to IPP's is the cost of the assumption of demand risk by NPC.
- 7) For a sample of 22 IPP's with BOT contracts whose capacity payments and gross generation were known with certainty, the historical cost from of assuming market risks from 1992-1998 was computed. For each plant in the sample, the average annual excess capacity payment was computed. The ratio of this variable to total investment in the plant was also computed. Demand risk is the cost of paying for excess capacity (i.e., capacity that is contracted an paid for, but not dispatched.
- 8) A decision is made as to whether excess plant factor for the period in which risk analysis is to be conducted is to be based on the average excess plant factor or the last period's excess plant factor recorded for the power plant. For the power plants surveyed in this study, the latter has been adopted. Thus demand risk for Power Project 3, Power Project 1 and Power Project 2 are all based on the last period's excess plant factor.

The figures in Table A.17 suggests that many of the IPP's are saddled with substantial excess capacity. It appears that based on historical dispatch data and computed excess plant factors, NPC has assumed a substantial amount of demand risk. Note, however, that Power Project 3 and Power Project 2 power plants have substantially less demand risk than the other plants. Power Project 2's excess plant factor of 1.75% in 1998 is used as the basis for measuring its demand risk in Table A.19. Since Power Project 1 is a recently-built coal-fired power plant like Power Project 2, it was assumed that the excess plant factor of 1.75% is applicable to Power Project 1 power plant (see Table A.20). Power Project 3 power plant is assumed to have zero demand risk since data reveals that it is being dispatched *above* levels of contracted capacity.

**Table A.17: Difference Between Contracted Plant Factor and Actual Plant Factor (= Excess Plant Factor)**

| IPP                                      |         | 1991   | 1992   | 1993   | 1994   | 1995   | 1996   | 1997   | 1998   | Average |
|------------------------------------------|---------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| Navotas Gas Turbine                      |         | 52.87% | 38.47% | 30.15% | 54.29% | 77.77% | 80.60% | 80.22% | 78.30% | 61.58%  |
| Navotas Gas Turbine Station 2            |         | 85.00% | 85.00% | 42.56% | 40.38% | 69.74% | 79.29% | 85.00% | 85.00% | 66.99%  |
| Ibaang 215MW                             |         | 85.00% | 85.00% | 85.00% | 76.19% | 14.49% | 29.41% | 31.64% | 48.96% | 40.14%  |
| Enron-Pinamucan                          |         | 85.00% | 85.00% | 49.12% | 0.00%  | 0.00%  | 12.48% | 14.57% | 19.92% | 15.66%  |
| Subic Diesel                             |         | 85.00% | 85.00% | 27.51% | 43.41% | 67.06% | 84.59% | 82.48% | 85.00% | 65.01%  |
| Clark 50MW                               | Diesel  | 85.00% | 78.84% | 53.49% | 55.09% | 54.18% | 73.58% | 79.87% | 78.04% | 67.69%  |
| Gas Turbine Power Barges 270MW           |         | 85.00% | 85.00% | 67.71% | 66.82% | 78.78% | 82.67% | 85.00% | 85.00% | 77.66%  |
| Batangas Diesel Power Barges Calaca 90MW |         | 85.00% | 85.00% | 85.00% | 53.29% | 22.34% | 35.91% | 85.00% | 85.00% | 56.31%  |
| Mindanao Diesel Power Barge              |         | 85.00% | 85.00% | 85.00% | 70.33% | 55.95% | 56.97% | 33.60% | 20.44% | 47.46%  |
| Mindanao Diesel Iligan 50MW              |         | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00%  |
| Mindanao Diesel Iligan 40MW Station II   |         | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00%  |
| Naga 203MW                               | Thermal | 72.46% | 66.72% | 57.33% | 64.42% | 63.80% | 63.41% | 62.26% | 69.46% | 64.98%  |
| Navotas Diesel Power Barges 120MW        |         | 85.00% | 85.00% | 85.00% | 59.60% | 28.68% | 31.06% | 41.49% | 42.98% | 40.76%  |
| North Harbor Diesel Barges               |         | 85.00% | 85.00% | 66.35% | 11.18% | 13.46% | 28.43% | -3.41% | 1.36%  | 19.56%  |
| Engineering Island Barges 105MW          |         | 85.00% | 85.00% | 85.00% | 83.63% | 58.29% | 67.65% | 75.63% | 78.85% | 72.81%  |
| Cavite Diesel EPZA Plant 63MW            |         | 85.00% | 85.00% | 85.00% | 78.89% | 60.31% | 40.67% | 42.65% | 32.53% | 51.01%  |
| Bataan Diesel EPZA Plant                 |         | 85.00% | 85.00% | 85.00% | 76.73% | 58.04% | 69.45% | 54.31% | 61.43% | 63.99%  |
| Gen Santos Diesel                        |         | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 56.30% | 56.30%  |
| Zamboanga Diesel                         |         | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 84.13% | 69.85% | 76.99%  |
| Malaya 650MW                             | Thermal | 23.85% | 31.79% | 56.78% | 54.49% | 40.04% | 44.13% | 40.27% | 42.48% | 41.73%  |
| Subic Bay                                |         | 85.00% | 85.00% | 85.00% | 6.03%  | 1.84%  | 18.18% | 27.61% | 28.49% | 16.44%  |

|                             |         |         |         |         |         |         |         |         |         |
|-----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| (109MW)                     |         |         |         |         |         |         |         |         |         |
| Makban Binary Geo 15.73MW   | 85.00%  | 85.00%  | 85.00%  | 63.23%  | 61.78%  | 53.07%  | 52.78%  | 67.73%  | 59.72%  |
| Toledo Cebu Coal            | 75.00%  | 36.39%  | 15.22%  | -9.06%  | -29.61% | -31.89% | -31.92% | -10.44% | -8.76%  |
| Power Project 3 Hydro 100MW | -16.23% | -14.98% | -18.86% | -10.75% | -6.07%  | -15.32% | -11.32% | 2.11%   | -11.43% |
| Power Project 2             | 75.00%  | 75.00%  | 75.00%  | 75.00%  | 75.00%  | 32.03%  | 3.23%   | 1.75%   | 12.34%  |
| Bataan Combined Cycle       | 85.00%  | 85.00%  | 67.76%  | 38.92%  | 33.00%  | 37.76%  | 30.37%  | 24.27%  | 38.68%  |
| NMPC                        | 85.00%  | 85.00%  | 70.32%  | 71.60%  | 64.73%  | 84.53%  | 37.80%  | -2.47%  | 54.42%  |
| Average                     |         |         |         |         |         |         |         |         | 48.81%  |

Below are assumptions and selected results of detailed risk analysis of Power Project 1, Power Project 2, and Power Project 3 Power Plants:

**Table A.18: Assumptions used in Ex Ante Detailed Risk Analysis (DRA) of Power Project 1 Power Plant**

| Variable                       | Assumption                                        | Basis                                                   |
|--------------------------------|---------------------------------------------------|---------------------------------------------------------|
| Initial exchange rate          | 26.50                                             | Exchange rate prior to currency crisis                  |
| Excess plant capacity factor   | Normal probability distribution (0.0175,0.02)     | Best judgment from historical data on coal power plants |
| Annual change in exchange rate | Gamma(1.88,4.07) + -2.66                          | Historical data                                         |
| Annual change in price of coal | Normal probability distribution (0.0519,0.024595) | Historical data                                         |

**Table A.19: Assumptions used in Ex Ante Detailed Risk Analysis (DRA) of Power Project 2 Power Plant**

| Variable                       | Assumption                                        | Basis                                                   |
|--------------------------------|---------------------------------------------------|---------------------------------------------------------|
| Initial exchange rate          | 26.50                                             | Exchange rate prior to currency crisis                  |
| Excess plant capacity factor   | Normal probability distribution (0.0175,0.02)     | Best judgment from historical data on coal power plants |
| Annual change in exchange rate | Gamma(1.88,4.07) + -2.66                          | Historical data                                         |
| Annual change in price of coal | Normal probability distribution (0.0519,0.024595) | Historical data                                         |

**Table A.20: Assumptions used in Ex Ante Detailed Risk Analysis (DRA) of Power Project 3 Power Plant**

| Variable                       | Assumption               | Basis                                                                 |
|--------------------------------|--------------------------|-----------------------------------------------------------------------|
| Initial exchange rate          | 26.50                    | Exchange rate prior to currency crisis                                |
| Excess plant capacity factor   | Zero                     | Best judgment from historical data on the Power Project 3 power plant |
| Annual change in exchange rate | Gamma(1.88,4.07) + -2.66 | Historical data                                                       |

Below are the results of ex ante detailed risk analysis for Power Project 1, Power Project 2, and Power Project 3 power plants. Note that:

- In general, the more expensive the investment cost, the greater the PV of expected losses;
- Consistent with the fact that Power Project 1 and Power Project 2 are baseload plants, they get dispatched more often and this therefore minimizes the demand risk assumed by NPC. Consequently, the cost of currency risk is greater than the cost of demand risk for these plants; and
- The present value of the cost of assuming fuel risk is the PV of the incremental costs of buying fuel when coal prices rise. Thus, fuel risk is minimal, since coal prices do not tend to display very volatile behavior (and are not expected to do so in the future). In the case of Power Project 3, there is no fuel cost, since Power Project 3 is a hydroelectric power plant.

It should be emphasized again that most or all of these costs are passed onto the public through the pricing mechanism. In practice, therefore, neither NPC nor NG assumes the costs of these risks. The usefulness of this exercise, however, is in knowing how much risk the IPP *actually* passes onto other stakeholders in the sector.

**Table A.21: Power Project 1 Power Plant (Amounts in Pesos)**

|                                                | NPV                 | Percentage |
|------------------------------------------------|---------------------|------------|
| PV of Expected Losses in Years of Operations   | -20,175,720,000.00  | 100.00%    |
| Currency Risk                                  | -14,514,440,000.00  | 71.94%     |
| Demand Risk                                    | -5,639,852,000.00   | 27.95%     |
| Fuel Risk                                      | -21,428,430.00      | 0.11%      |
| There is a 1% chance that the loss will exceed | - 40,486,416,384.00 |            |
| There is a 5% chance that the loss will exceed | - 32,039,100,000.00 |            |

**Table A.22: Power Project 2 Power Plant (Amounts in Pesos)**

|                                                | NPV                | Percentage |
|------------------------------------------------|--------------------|------------|
| PV of Expected Losses in Years of Operations   | - 4,120,521,000.00 | 100.00%    |
| Currency Risk                                  | -2,581,845,000.00  | 62.66%     |
| Demand Risk                                    | -1,533,793,000.00  | 37.22%     |
| Fuel Risk                                      | -4,883,237.00      | 0.12%      |
| There is a 1% chance that the loss will exceed | -7,612,145,152.00  |            |
| There is a 5% chance that the loss will exceed | -6,243,574,000.00  |            |

**Table A.23: Power Project 3 Power Plant (Amounts in Pesos)**

|                                                | Result           | Percentage |
|------------------------------------------------|------------------|------------|
| PV of Expected Losses in Years of Operations   | - 204,499,100.00 | 100.00%    |
| Currency Risk                                  | - 204,499,100.00 | 100.00%    |
| Demand Risk                                    | 0                | 0.00%      |
| Fuel Risk                                      | 0                | 0.00%      |
| There is a 1% chance that the loss will exceed | - 436,969,344.00 |            |
| There is a 5% chance that the loss will exceed | - 350,915,200.00 |            |

## TOLL ROADS

Detailed risk estimation was also conducted for the Toll Road 1 and Toll Road 2 toll road projects. Below are assumptions used in these projects, as well as results of detailed ex ante analysis:

### Toll Road 1

Below are assumptions and results for detailed ex ante analysis conducted on the Toll Road 1 project. The results suggest that ex ante, the Toll Road 1 is expected to default for the first time around the first half of 1997 (see **Table A.25** - primarily due to cost overruns in the construction stage of the project). Based on **Figure A.7**, the probability that the project will default for the first time is greatest in the second and third years. **The situation in which the project suffers tremendous financial stress during the transition from construction to operations phase mirrors that of Transport Project 1 analyzed earlier.**

**Figure A.8** suggests that ex ante, the probability of default is greatest in 1997, and declines thereafter. The probability of default again spikes up in 2003, when a large bullet payment is to be made to creditors. This information is important to the government, since a standby letter of credit exists at a certain commercial bank, which may be drawn upon by creditors in case of default. The actual loss for government occurs whenever it replenishes this LC.

**Table A.26** suggests that the PV of total ex ante expected losses are most sensitive to a variety of risk factors, such as construction costs, changes in the exchange rate, and cars on the elevated portion of the Toll Road 1 (in that order).

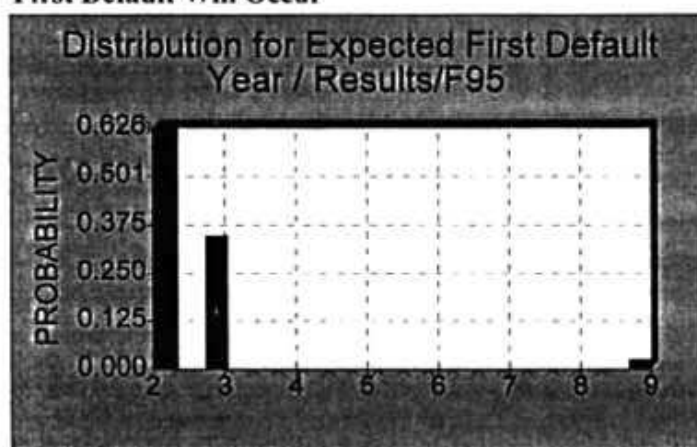
**Table A.24: Assumptions used in Ex Ante Detailed Risk Analysis (DRA) of Toll Road 1**

| Variable                             | Assumption                                                                                                                   | Basis                                                |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| Growth in vehicles                   | Normally distributed with mean of 0.10 and standard deviation of 0.05 in initial years. Later the figures are 0.06 and 0.03. | Conversation with investment bankers; best judgment. |
| Diversion factor in elevated portion | Normally distributed with mean of 0.30 and standard deviation of 0.15                                                        | Conversation with investment bankers; best judgment. |
| Construction costs                   | Discrete distribution; possible 2-year extension of duration                                                                 | Conversation with investment bankers; best judgment. |
| Annual change in exchange rate       | Gamma(1.88,4.07) + -2.66                                                                                                     | Historical data                                      |

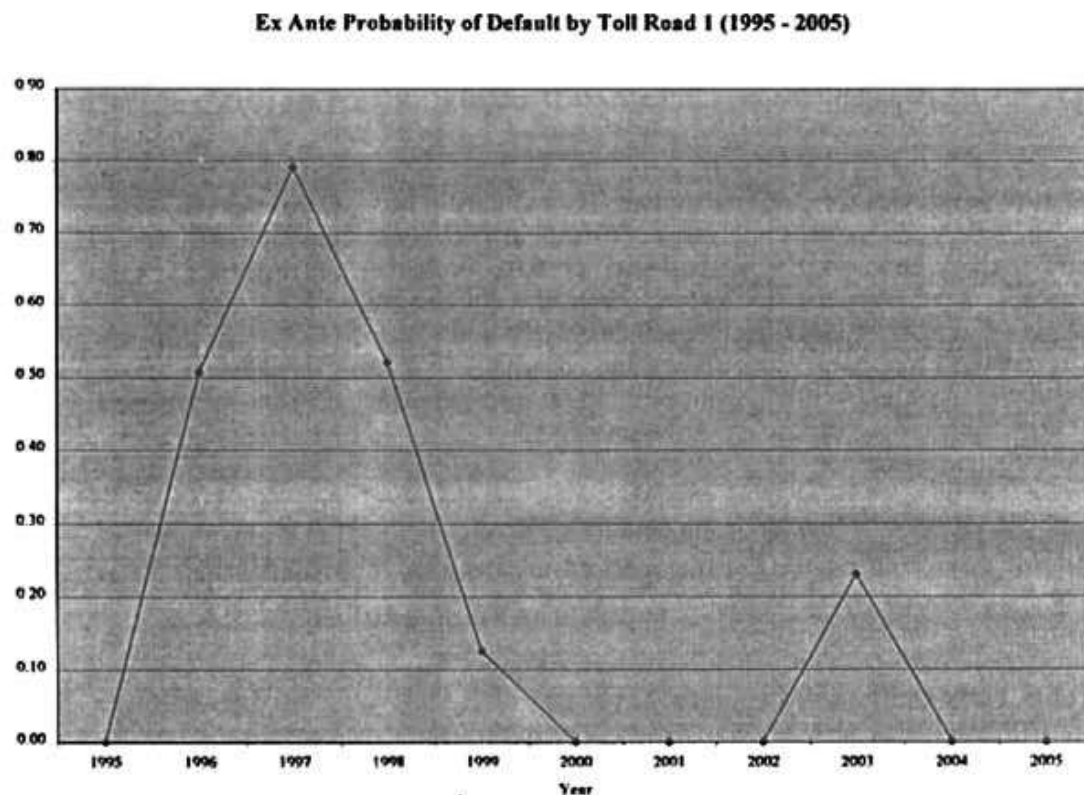
**Table A.25: Toll Road 1 (Amounts in Pesos)**

| Statistic                                      | Result (in Pesos)                                    |
|------------------------------------------------|------------------------------------------------------|
| PV of Total Amount in Default                  | 813,674,000.00                                       |
| There is a 1% chance that the loss will exceed | 2,706,387,200.00                                     |
| There is a 5% chance that the loss will exceed | 2,059,246,000.00                                     |
| Expected Year of Initial Default by Project    | 2.52 (Around the first half of the third year, 1997) |
| Expected Amount of Initial Default             | -428,674,800.00                                      |

**Figure A.7: Probability Distribution of the Year Toll Road 1's First Default Will Occur**



**Figure A.8**



**Table A.26: Sensitivity Analysis of PV of Total Expected Loss Ex Ante**

| Rank | Cell | Name                      | Sensitivity<br>(RSqr=0.9086052) | Rank Correlation<br>Coefficient |
|------|------|---------------------------|---------------------------------|---------------------------------|
| #1   | I83  | Project Construction Cost | -0.74008                        | -0.82837                        |
| #2   | H83  | Project Construction Cost | -0.53012                        | -0.46461                        |
| #3   | H3   | Change in Exchange Rate   | -0.12299                        | -0.11606                        |
| #4   | K83  | Project Construction Cost | -0.11677                        | -9.75E-02                       |
| #5   | I3   | Change in Exchange Rate   | -0.09778                        | -5.42E-02                       |
| #6   | N3   | Change in Exchange Rate   | -6.87E-02                       | -5.17E-02                       |
| #7   | O3   | Change in Exchange Rate   | -6.71E-02                       | -0.02826                        |
| #8   | O8   | Cars - Elevated           | 5.83E-02                        | 4.88E-02                        |
| #9   | K8   | Cars - Elevated           | 5.79E-02                        | 4.02E-02                        |
| #10  | J8   | Cars - Elevated           | 5.51E-02                        | 5.78E-02                        |
| #11  | J83  | Project Construction Cost | -5.14E-02                       | -4.64E-02                       |
| #12  | N8   | Cars - Elevated           | 5.12E-02                        | 1.90E-02                        |
| #13  | K3   | Change in Exchange Rate   | -5.06E-02                       | -2.37E-02                       |
| #14  | I8   | Cars - Elevated           | 4.99E-02                        | 0.113595                        |
| #15  | M3   | Change in Exchange Rate   | -4.98E-02                       | -1.11E-02                       |
| #16  | L8   | Cars - Elevated           | 4.01E-02                        | 3.25E-02                        |
| #17  | M8   | Cars - Elevated           | 3.25E-02                        | 3.99E-02                        |
| #18  | L3   | Change in Exchange Rate   | -3.16E-02                       | -3.04E-02                       |

|     |    |                         |           |          |
|-----|----|-------------------------|-----------|----------|
| #19 | J3 | Change in Exchange Rate | -3.00E-02 | 1.25E-02 |
| #20 | P3 | Change in Exchange Rate | -8.67E-03 | 1.82E-02 |

## Toll Road 2

**Table A.27: Assumptions used in Ex Ante Detailed Risk Analysis (DRA) of Toll Road 2 Toll Road**

| Variable                       | Assumption                                                   | Basis                                                |
|--------------------------------|--------------------------------------------------------------|------------------------------------------------------|
| Growth in vehicles             | Derived from financial model                                 | Conversation with investment bankers; best judgment. |
| Construction costs             | Discrete distribution; possible 2-year extension of duration | Conversation with investment bankers; best judgment. |
| Annual change in exchange rate | Gamma(1.88,4.07) + -2.66                                     | Historical data                                      |

**Table A.28: Toll Road 2 Toll Road (Amounts in Pesos)**

| Statistic                                      | Result                       |
|------------------------------------------------|------------------------------|
| PV of Total Amount in Default                  | -222,753,400.00              |
| There is a 1% chance that the loss will exceed | -879,857,344.00              |
| There is a 5% chance that the loss will exceed | -675,195,300.00              |
| Expected Year of Initial Default by Project    | 4.08 (First quarter of 1999) |
| Expected Amount of Initial Default             | 3.69 years                   |

**Table A.29: Toll Road 2 Toll Road Summary Statistics for Selected Output Variables**

| Statistic                                                  | Year of Initial Default by Project | Expected Amount of Initial Default Amount (in Pesos) |
|------------------------------------------------------------|------------------------------------|------------------------------------------------------|
| Minimum =                                                  | 1.00 (1996)                        | -588,835,400.00                                      |
| Maximum =                                                  | 10.00 (2006)                       | -31.91                                               |
| Mean =                                                     | 4.08 years (1999)                  | -142,100,100.00                                      |
| There is a five percent chance that the figure will exceed | 2.00 years (1997)                  | -507,249,000.00                                      |

Results of ex ante detailed risk estimation suggests that the project is expected to require financial assistance in the fourth year – the first year of operations, and that the probability of default in that year is greatest (the simulated cashflow yields a default 28.6% of the time – see **Figure A.9**). **Figure A.9** suggests that the probability of default is greatest in the second and fourth years, and then declines as years pass. The declining probability of default reflects increasing traffic along the toll road.

**Figure A.9: Probability Distribution of Year of Initial Default**

