Financial Risk Analysis of Project Finance in Indonesian Toll Roads

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Abstract: If a project is implemented using a project-finance approach, the debt service payment relies solely on the project cash flows and its assets. This paper identifies, quantifies, and evaluates major financial risks associated with project-financed toll road projects in Indonesia. Ordering payments by priority level, subject to cash availability, enables risk to be evaluated from the different perspectives of multiple parties involved. The paper makes use of Latin Hypercube simulations for risk analysis because they deal with problems involving large and complex systems. To better illustrate the concept, a case study is presented. A sensitivity analysis of the impact of delay-in-adjustment risk and of the adoption of a new regulation related to the toll adjustment is performed and discussed. Simulation results show that the project sponsor fares worse as delay-in-adjustment risk increases but that the creditor can fare better, given that the risk level is low or moderate. Output statistics also reveal that the adoption of the new regulation has negative impact on the project cash flows from both the project sponsor's and the creditor's perspectives under different scenarios associated with delay-in-adjustment risk.

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Introduction

The toll road program has been operative since 1978 in Indonesia. Traditionally, the toll roads were publicly funded and operated by a state-owned enterprise PT Jasa Marga (JM). Owing to stringent budgetary constraints the Government of Indonesia (GOI) called for private investment for some toll road developments in 1987. According to the Government Regulation No 40/1990, any entity is required to partner with JM when seeking to invest in the sector. A partnership can take on forms of joint venture (JV), joint operation with concession (JO), modified turnkey (MT), and revenue sharing (RS). JV and JO are implemented under the build, operate, and transfer (BOT) arrangement whereas MT and RS are under the build, transfer, and operate (BTO) arrangement. JV is different from JO in that the latter does not require JM involvement in a special-purpose-vehicle establishment. Under a JO arrangement the operation and maintenance (O&M) responsibility can rest with JM. The land acquisition was traditionally assumed by GOI but has been transferred to the private sector since 1994, following more limited public financial resources.

Most, if not all, BOT toll road projects in Indonesia were structured using project finance approach (also known as off-balance sheet financing). Under this approach, creditors rely on debt services on the project cash flows and its assets without or with only limited recourse to borrowing companies or parent companies (Ahmed and Xianghai 1999). Dailami et al. (1999) characterized a project-financed infrastructure with (1) high concentration of project risks in the early phase of project life cycle that is precompletion phase and (2) a risk profile that undergoes important changes as the project comes to fruition with a relatively stable stream of cash flows and that is subject to market and regulatory risks once the project is completed.

The present paper identifies and examines major financial risks associated with Indonesia's project-financed toll road projects. Several risks classified into project-specific risks (e.g., low traffic, lengthy right-of-way acquisition process, construction cost, and time overruns), sector-specific risks (e.g., unpredictable future tolls, change in legislation), and country-specific risks (e.g., high and volatile inflation and interest rate) are taken into consideration. Risk analysis is performed with the application of stochastic simulations using the Latin Hypercube sampling technique. Interested readers can consult Saliby and Pacheco (2002) for greater discussion on advantages of the technique over the traditional Monte Carlo sampling. Simulation approach is adopted because it deals with problems involving large and complex systems, which would be otherwise difficult to solve. The commercial software package @Risk 4.05 (2001). is employed as the analysis tool.

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Table 1. Summary of Previous Works on Stochastic Approach in Infrastructure Investment Evaluation

Author*(s)*	Sector	Key Areas	Remarks
Chee and Yeo (1995)	Power	The authors used the Monte Carlo simulation for risk analysis of a BOT power project. Risky variables include electricity generation, unescalated capital expenditure, tariff, O&M cost, etc.	The authors evaluated risk from both equity and project perspectives. No risk to the creditor is presented. It is unclear which assumption is used in setting the discount rate.
Seneviratne and Ranashinghe (1997)	Road	The authors conducted the Monte Carlo simulation to evaluate alternatives within transportation infrastructure financing. Risky variables include traffic volume at the start of operation, traffic growth, project cost, toll growth, and cost escalation rates.	The authors evaluated risk from equity perspective. In analyzing risk, the authors focused on standard deviation or expected value of the project's IRRs. No risk to the creditor is presented. It is assumed that debt service is made on an equal installment basis.
Javid and Seneviratne (2000)	Airport	The authors identified three risks associated with total investment risk in the parking facility development, namely project risk, competitive risk and market risk. The authors proposed the use of Monte Carlo simulation technique. Risky variables considered are demand, parking duration, parking charges, consumer price indexes, interest rate and total investment. Financial decisions were derived from NPV analysis.	The authors performed risk analysis from equity perspective. They applied the present value analysis and defined risk as the probability of the project's NPV being lower than the target value. No risk to the creditor is presented. It is assumed that debt service is made on an annual equal installment basis, which is then included to the total project expenditure.
Malini (1999)	Road	The author employed the Monte Carlo simulation for risk evaluation of BOT bridge projects. The simulation outputs include NPV, IRR and payback period. Risky variables include construction cost, O&M cost, and traffic volume. The author examined cash-flows adequacy under different scenarios related to options of project financing.	Risk analysis is performed from equity perspective. It does not address risk to the creditor. It is assumed that the debt repayment is to be made on an annual installment basis.
Kakimato and Seneviratne (2000)	Port	The authors identified three factors as determinants of financial risk, namely project risk, competitive risk and market risk. The authors conducted the traditional Monte Carlo simulation for risk analysis of port investment and evaluated risk under three different scenarios, namely low-risk, medium-risk, and high-risk scenarios.	The authors evaluated risk from equity perspective. They defined risk as the probability of the project's IRRs being lower than the target return. In their work, the application of the CAPM theory in determining the MARR of an investment, referred to as cost of equity or the hurdle rate, is also discussed.
Ye and Tiong (2000)	General	The writers developed the NPV at risk method that incorporates the weighted average cost of capital and dual risk-return methods. This method is applied in decision-making of investment appraisal of projects under uncertainty. The work presents a clearer definition over the used discount rate. Risk variables include construction cost, completion time, O&M cost, market demand, etc.	The use of WACC for discounting cash flows indicates that the risk evaluation is performed from the project perspective. The NPV at risk method is one of criteria available in the financial decision-making under uncertainty. Alternative methods include: mean-variance, mean lower confidence, mean semivariance, mean-aspiration, mean-entropy, and stochastic dominance (Kira and Ziemba 1977). In some respects, Ye and Tiong's method resembles mean-lower confidence or mean-aspiration.

Note: BOT=build operate transfer; O&M=operation and maintenance; IRR=internal rate of return; NPV=net present value; CAPM=capital asset pricing model; and WACC=weighted average cost of capital,

Simulation Cash Flow Model

Comparison with Previous Studies

The use of simulation technique in the financial decision making under uncertainty in the infrastructure investment has appeared in many scientific journals and technical reports. To name a few are those by Chee and Yeo (1995); Seneviratne and Ranasinghe (1997); Dailami et al. (1999); Malini (1999); Javid and Seneviratne (2000); Ye and Tiong (2000); and Kakimoto and Seneviratne (2000). Table 1 summarizes key features of these works. A common feature found is that there is an exclusive concentration on the risk evaluation from equity perspective and project perspective (without taking into account the effects of financial decision such as interests, taxes). Little effort has been devoted to evaluate risk from the creditor's perspective whereas the creditor may have a very different risk profile simply because of different ranking in the payment claim. It is often intrinsically assumed that the debt service payment is certain in the sense that the debt service obligation can always be made irrelevant to what happens to the project. This implies that there must be recourse to the borrowing project sponsor or its parent company other than the project cash flows or its assets if the net operating income is insufficient to meet the obligation. In this case, debt must be relatively riskless and the borrowing rate therefore should be not much different with the riskless rate. Otherwise, the project will be a money machine to the creditor. An advanced study is perhaps required to explain why a borrowing rate of riskless debt significantly differs from the riskless rate. One of the intents of the present work is to propose a simple financial model of a project under uncertainty that does not violate the nonrecourse concept but allows risk to be evaluated from different perspectives by means of ranking claim of payments made for involved parties subject to cash availability.

Sources of Major Uncertainties in Toll Road Investment

- Construction cost. Cost overruns are not uncommon in private infrastructure projects. Some relevant examples include the Channel Tunnel, the Chinese Guangzhou-Shenzen project, and a Malaysian toll road project (Fishbein and Babbar 1996; Kumaraswamy 1997; Estache et al. 2000). der Ven (1996) argued that cost overruns have been a serious issue in a number of countries (Mexico in particular, and also in France during the early years of the toll road development program), but so far not in Indonesia.
- Construction schedule. In the case of Indonesia's toll roads, one of the primary factors causing completion delays is delayed land acquisition. Project sponsors need often undergo difficult negotiations on pricing of land acquisition. The consequences are threefold. First, lengthy and protracted negotiation can escalate prices. Based on past experience, the cost of land acquisition is believed to have increased by a factor of 10% and 70% because of delay in implementation itself (Yuwono 2000). Second, a delay in the facility completion reduces length of the operating period under a fixed concession term. Third, discounted cash flows can be reduced because operating revenue generation occurs later.
- Initial and future tolls. Initial toll levels in Indonesia's toll road industry are uncertain because they are often set not at the financial close stage but rather in near completion of a project. Unpredictable future toll levels have long been an element of the Indonesian toll road industry. There is no automatic toll adjustment mechanism because both the regulation and concession contracts oblige a project sponsor to obtain a prior approval from the president before it can raise toll levels. A problem emerges because the GOI cannot guarantee the approval to be given in a timely manner. Past experience attests that entire tolls have experienced significant delays in adjustments. Four out of five private toll road operators reportedly posted losses of Indonesian Rupiah (Rp) 1.13 trillion (equivalent to U.S. \$125.6 million under the assumption that U.S. \$1 is priced at Rp. 9,000).
- Traffic volume. Engel et al. (1997) argued that traffic forecasts are notoriously imprecise; it is difficult enough to make accurate traffic predictions for the short run and much harder for the long run. Traffic usage has been found to be even more difficult to forecast in the case of new toll roads, especially those which are not additions to an existing toll facility system because there is no existing traffic to use as an actuarial basis (United Nations 2001). Estimates of future growth depend on various factors such as the country's economy, population size, fuel prices, land use patterns, etc. Problems with lower-than-expected traffic levels are not uncommon, as cases in the Hungarian M1/M14, the Malaysia-Singapore Second Crossing, and other selected Asian toll roads demonstrate (World Bank 1999; Asian Development 2000). A study by Standard & Poor's revealed that of 32 analyzed case studies, 28 forecasts overpredicted traffic (Bain and Wilkins 2002). In the updated study that included more than twice as many samples, 68 case studies, optimism bias remains a consistent trend in toll road traffic forecasting (Bain and Plantagie 2003).
- Macroeconomic conditions. Macroeconomic conditions in Indonesia are unstable and prone to external fluctuations as was evidenced by the aftermath of the 1997 financial crisis. The World Bank (1999) reported that interest rates have increased from 19 to over 60% per annum during 1997–1998, Rupiah currency freely fell to under 1/6 or 1/7 times the value of the U.S. dollar and the consumer price index was expected to increase 80% in 1998, as compared with an 11% increase in the previous year.

Basis Assumptions

For the sake of simplicity, the following conditions are assumed:

- Depreciation is applied to both initial investments and any additional investments made during the concession period;
- Both equity and debt are denominated in local currency;
- There is zero price elasticity;
- Total traffic is not allowed to exceed the facility's traffic capacity;
- Construction escalation rate is equivalent to domestic inflation rate;
- Traffic composition is constant over the project's life;
- JM has no equity investment; and
- Priority for the use of cash flows in any period is as follows: operating cost (including land and building tax payment as well as payment to JM under a revenue-sharing arrangement, if appropriate), interest payment, income tax payment, debt principal repayment, and equity payment.

Basic Relationships

The first step in modeling cash flows is to determine the total project cost that consists of construction and land acquisition costs

$$\mathrm{TPC}_i = \mathrm{CON}_i + \mathrm{RWC}_i, \quad i = 0,\ldots,C \tag{1}$$

where TPC_i=total project cost in year i; CON_i=construction cost (in nominal term) in year i; RWC_i=land acquisition cost in year i; and C=construction duration, which is uncertain. The construction cost uncertainty can be modeled as

$$\mathrm{CON}_i = \mathrm{COR}_q \prod_{k=q}^{i} (1 + F_k), \quad i = 0,\ldots,C \tag{2}$$

where COR_q=construction cost in real term in a given year q; F_k=inflation rate in year k; and F_k=0 if q=i. The land acquisition in a given year i is given as

$$\mathrm{RWC}_i = \mathrm{RWC}_q \prod_{k=q}^{i} (1 + \alpha_k), \quad i = 0,\ldots,C \tag{3}$$

where RWC_q=land acquisition cost estimated in a given year q; α_k=escalation rate for land acquisition in year k; and α_k=0 if q=i. Let D_i be the debt drawing in year i, equity capital required in year i, EQT_i, is

$$\mathrm{EQT}_i = \mathrm{TPC}_i - D_i, \quad i = 0,\ldots,C \tag{4}$$

The outstanding debt at end of construction duration is estimated as

$$\mathrm{DEB}_C=\sum_{i=0}^{C} D_i \prod_{k=i}^{C}(1+R_k), \quad i=0,\ldots,C \tag{5}$$

where R_k=borrowing rate in year k; and $R_k=0$ if $i=C$. If revenue is dependent on traffic volume and toll levels, operating revenue in year j, REV_j should be

$$\mathrm{REV}_j=\sum_{t=1}^{u} P_{tj} V_{tj}, \quad j=C+1,\ldots,N \tag{6}$$

where P_{tj}=toll level of vehicles type t in year j; V_{tj}=traffic volume of vehicles type t in year j; and N=concession period. Under the assumption that the traffic composition by type of vehicles is constant, Eq. (6) can alternatively be written as

$$\mathrm{REV}_j=V_j \sum_{t=1}^{u} \chi_j P_{tj}, \quad j=C+1,\ldots,N \tag{7}$$

where V_j=total traffic volume in year j and χ_t=percentage of traffic type t in total traffic. Let DEL_m be delay (in years) of the mth toll adjustment, the mth adjustment can be expressed as

$$Y_m=Y_{m-1}+\lambda+\mathrm{DEL}_m, \quad m=1,2,\ldots \text{ subject to } Y_m \leqslant N \tag{8}$$

where Y_m=year of the mth toll adjustment; Y_{m-1}=year of the $(m-1)$th toll adjustment; λ=periodical review under a concession contract; and $Y_0=C+1$. The Indonesian toll road industry adopts price-cap systems in which future toll levels are indexed to the domestic inflation rate. There is normally an additional requirement that the prevailing tolls should not exceed a certain percentage of vehicle operating cost savings (VOC) of using a toll facility as compared with alternative toll-free roads. Mathematically, the uncertainty of future toll levels according to most concession contracts can be expressed as

$$P_{tj}=\begin{cases} P_{tj-1} & \text{if } Y_m \leqslant j < Y_{m+1} \\ \min\left[\varpi\,\mathrm{VOC}_{tj}; P_{tj-1}\dfrac{\prod_{j=C+1}^{Y_{m+1}}(1+F_j)}{\prod_{j=C+1}^{Y_m}(1+F_j)}\right] & \text{if } j=Y_{m+1} \end{cases} \qquad \begin{matrix} j=C+1,\ldots,N \\ t=1,\ldots,u \end{matrix} \tag{9}$$

where ϖ=percentage of toll levels of VOC; VOC_{tj}=VOC of vehicle type t in year j; and P_{t0}=toll level of vehicles type t at the start of operation. Although the toll adjustment has normally been stipulated in concession contracts, the GOI promulgated the Regulation No. 40/2001 on a new tariff. Under the new regulation, toll levels are to be linked to a percentage of domestic inflation rates and be reviewed at every 3 years with a maximum increase of 25%. The future tolls under the new regulation can mathematically be written as

$$P_{tj}=\begin{cases} P_{tj-1} & \text{if } Y_m \leqslant j < Y_{m+1} \\ \min\left\{\varpi\,\mathrm{VOC}_{tj}; P_{tj-1}\min\left[1.25; 1+\theta\left(\dfrac{\prod_{j=C+1}^{Y_{m+1}}(1+F_j)}{\prod_{j=C+1}^{Y_m}(1+F_j)}-1\right)\right]\right\} & \text{if } j=Y_{m+1} \end{cases} \tag{10}$$

Traffic uncertainty is modeled as

$$V_j=\min\lfloor V_{j-1}(1+g_j)(1+\varepsilon_j); \phi\rfloor, \quad j=C+1,\ldots,N \tag{11}$$

where V_j=total traffic in year j; g_j=traffic growth rate in year j; ϕ=facility's traffic capacity; and ε_j=traffic forecasting errors in year j. Under a revenue sharing arrangement, if any, JM receives annual payment with the amount being in a fixed percentage of operating revenue. In practice, there is sometimes an additional profit-cap arrangement related to higher-than-expected traffic volume. For instance, if actual traffic exceeds a certain upper limit, the resulting excessive revenue will be shared between JM and the project sponsor. Taken together, the annual payment to JM can be modeled as

$$\mathrm{SHA}_j=\begin{cases} s_j V_j \sum_{t=1}^{u} \chi_t P_{tj} & \text{if } V_j < \varphi_j \\ s_j \varphi_j \sum_{t=1}^{u} \chi_t P_{tj} + w_j (V_j-\varphi_j) \sum_{t=1}^{u} \chi_t P_{tj} & \text{if } V_j \geqslant \varphi_j \end{cases} \qquad j=C+1,\ldots,N \tag{12}$$

where s_j=percentage of operating revenue paid to JM under a revenue sharing arrangement; w_j=percentage of excessive revenue paid to JM in year j under a profit-cap arrangement; and φ_j=upper limit of traffic in year j. Net operating revenue in year j, NET_j is

$$\mathrm{NET}_j = \mathrm{REV}_j - \mathrm{COM}_j - \mathrm{LBT}_j - \mathrm{SHA}_j, \quad j = C+1,\ldots,N \tag{13}$$

where LBT_j=land and building tax paid in year j; COM_j=O&M cost in year j; and SHA_j=payment to JM made in year j. The interest payment is dependent on the project financial performance and is, therefore, uncertain. A full interest payment obligation can only be met if the net operating revenue is equal to or higher than the interest; otherwise, the creditor receives what remains whereas any unpaid interest will be accounted for in the next year's debt balance calculation. Mathematically,

$$\mathrm{INT}_j = \min(\mathrm{NET}_j; R_{j-1}\mathrm{DEB}_{j-1}), \quad j = C+1,\ldots,N \tag{14}$$

where INT_j=interest payment made in year j and R_{j-1}=interest rate in year $j-1$. If a concession contract requires an additional investment during concession, the incurred cost is depreciable. Let ADD_k be the cost of an additional investment made in year k, depreciation in year j DEP_j is

$$\mathrm{DEP}_j = \frac{\mathrm{TPI}}{N-C} + \sum_{j>k} \frac{\mathrm{ADD}_k}{N-k}, \quad j = C+1,\ldots,N \text{ and } k = C,\ldots,N-1 \tag{15}$$

where TPI=total project investment. The total project investment is the total project cost for all construction years plus interest during construction. It can be computed by summing the debt balance at the end of construction DEB_C and total equity drawing (assuming that no returns are available to the project sponsor during the construction). The income tax amount that the project sponsor must pay equals

$$\mathrm{TAX}_j = \max[0; \tau(\mathrm{NET}_j - \mathrm{INT}_j - \mathrm{DEP}_j)], \quad j = C+1,\ldots N \tag{16}$$

where TAX_j=income tax payment made in year j; τ=income tax rate. If net operating income does not suffice to cover the additional investment cost, the required additional capital in year j, CAP_j is

$$\mathrm{CAP}_j = \max(0; \mathrm{TAX}_j + \mathrm{INT}_j + \mathrm{ADD}_j - \mathrm{NET}_j), \quad j = C+1,\ldots,N \tag{17}$$

The next step is to calculate the debt principal repayment whose amount can be written as

$$\mathrm{REP}_j = \min[\mathrm{DEB}_{j-1}; \max(0; \mathrm{NET}_j - \mathrm{TAX}_j - \mathrm{INT}_j - \mathrm{ADD}_j)], \quad j = C+1,\ldots,N \tag{18}$$

If any gap between available net operating income and additional investment cost will be bridged with a new debt, the outstanding debt in year j must be:

$$\mathrm{DEB}_j = \mathrm{DEB}_{j-1} + R_{j-1}\mathrm{DEB}_{j-1} - \mathrm{INT}_j + \mathrm{CAP}_j - \mathrm{REP}_j, \quad j = C+1,\ldots,N \tag{19}$$

Payment to equity is allowed only if entire payment obligations have been satisfied. That is,

$$\mathrm{DIV}_j = \mathrm{NET}_j - \mathrm{INT}_j - \mathrm{TAX}_j - \mathrm{REP}_j, \quad j = C+1,\ldots,N \tag{20}$$

where DIV_j=payment to equity made in year j. The net present value from the project sponsor's cash flows is

$$\mathrm{PVP} = -\,\mathrm{EQT}_i \prod_{k=0}^{i} (1+\delta_k)^{-1} + \mathrm{DIV}_j \prod_{k=0}^{j} (1+\delta_k)^{-1}, \quad i = 0,\ldots,C; j = C+1,\ldots,N \tag{21}$$

where PVP=project sponsor's net present value; δ_k=discount rate in year k; and δ_0=0. Under a JO scheme with the O&M responsibility being assumed by JM, the net present value (NPV) from the corporation's perspective (PVJ) can be formulated as follows:

$$\mathrm{PVJ} = (\mathrm{SHA}_j + \mathrm{COF}_j - \mathrm{COM}_j) \prod_{k=0}^{j} (1+\delta_k)^{-1}, \quad j = C+1,\ldots,N \tag{22}$$

where COF_j=fee for taking O&M responsibility in year j. The net present value from the creditor's cash flows (PVL) is

$$\mathrm{PVL} = -\,D_i \prod_{k=0}^{i} (1+\delta_k)^{-1} + (\mathrm{INT}_j + \mathrm{REP}_j - \mathrm{CAP}_j) \times \prod_{k=0}^{j} (1+\delta_k)^{-1}, \quad i = 0,\ldots,C, j = C+1,\ldots,N \tag{23}$$

Choosing the Right Discount Rate

Choosing the appropriate discount rate for present value analysis of a project under simulated environments remains the subject of international debates. There is no substantial consensus whether the risk-free rate or the opportunity cost of capital, which can also be the opportunity cost of debt or the cost of equity if dealing with source of financing, should be chosen. Malini (1999), for instance, implicitly suggested the use of the opportunity cost of equity, which includes a risk premium and the borrowing rate of long-term debt. In developing the NPV at risk method, Ye and Tiong (2000) used the weighted average cost of capital (WACC). They stated that the capital asset pricing model (CAPM) and arbitrage pricing theory suffer from the difficulty in determining appropriate beta. The authors believed, however, that determining WACC is no less difficult because a financial manager needs to estimate the cost of debt and the cost of equity, the principal components of WACC, which are sometimes derived from CAPM. Additionally, the use of WACC is based on the assumption that the firm can maintain a constant leverage ratio, thus requiring rebalancing capital structure over the project's life. This requirement is difficult to meet in project finance where it typically means very high debt ratio from the beginning, with most or all of a project's early cash flows committed to debt service, meaning that equity investors have to wait (Brealey and Myers 2000). Savvides (1994) and Hacura et al. (2001) believe that the appropriate discount rate for calculating the present value of a project in the stochastic appraisal is that used in the deterministic appraisal. On the contrary, Brealey and Myers (2000) argue that the risk-free rate instead of the opportunity cost of capital should be used in order to avoid prejudging risk because if the opportunity cost of capital is known, simulation is not necessary except for helping forecast cash flows. In another context, Handa (1995) and Byrne (1996) applied the risk-free rate for project valuation

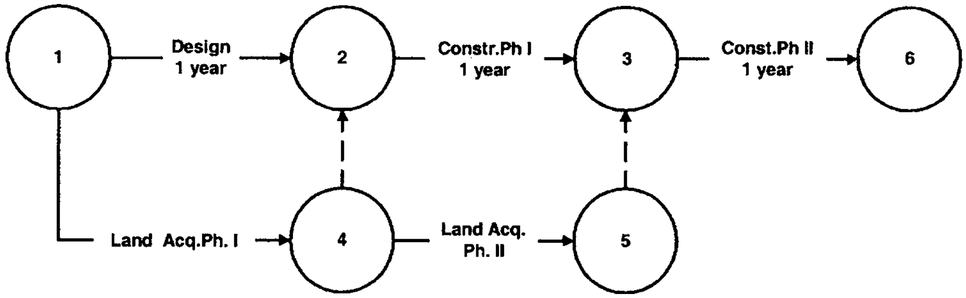

Fig. 1. Simplified project's schedule network

under uncertainty using variance analysis where risk is let to reside in cash flows, which are then discounted at the risk-free rate. In this case, the project's NPV itself is considered a random variable. This is a very different approach from that of single value estimates (deterministic) to risk analysis in which the discount rate needs to be adjusted as risk changes. In the present work, the risk-free rate is used to discount uncertain cash flows of involved parties so that analysis can be made on similar basis. The authors use the yield of the Bank Indonesia promissory note (*Sertifikat Bank Indonesia*=SBI) as the risk-free rate.

Case Study

The case study is taken from a real-life toll road project that has been in operation. It is worth noting that all figures given are only examples and do not necessarily reflect the real project sponsor's business plan. The 7 km project is undertaken under a JO arrangement with the length of concession on the scheme being 28 years. The toll facility is designed to carry a maximum of 160,000 vehicles a day. Total project investment cost is estimated at Rp 270 billion: total construction cost of Rp 128 billion, land cost of Rp 115 billion and interest during construction of Rp 27 billion. Both the facility construction and the land acquisition are phased into two stages. Fig. 1 presents the simplified project's schedule network. The project is financed at a debt to equity ratio (DER) of about 76:24 (this DER is close to average leverage in the Indonesian toll road industry, which is about 74:26). For taking the responsibility of O&M, JM is paid with 18.25% of operating revenue fixed during concession [in this case COM_j in Eq. (13) is replaced with COF_j]. Annual O&M cost at the start of operation is estimated at Rp 6.0 billion and would increase following consumer price indexes. Apart from this O&M fee, JM receives annual payment of 0% (Years 1–8 of the operation period), 4% (Years 9–14), 9% (Years 15–20), and 12% (Year 21–end) of operating revenues. An additional investment whose cost is estimated at Rp 64 billion should be made in Year 14 from the start of operation. The creditor is prepared to provide an additional loan to cover the incurred cost if net revenue in that year is insufficient. The land acquisition cost will be financed with debt and the creditor is committed to providing a stand-by loan that can be exercised any time in agreed time frame and amounts. The creditor charges a 1% commitment fee of the actual drawn amount of loan used to finance land acquisition. Interest rates during construction and operation are assumed to float at a 300-basis point spread over the Jakarta Inter Bank offered rates (JIBOR). Traffic is classified into three categories: Class I for small vehicles (e.g., sedan, jeep, mini and medium sized bus, passenger car), Class IIA for medium vehicles (e.g., small truck or bus with two axles) and Class IIB for heavy vehicles with a traffic composition of 85, 10, and 5%, respectively, and a toll rate index of 1.0: 1.5: 2.0. The initial base toll is set at Rp 300 per km. VOC at the start of operation for traffic I, IIA, and IIB are estimated at Rp 5,350, 7,350, and 9,100, respectively.

It is assumed that inflation rate, SBI rate, and JIBOR at the start of concession period are 8.17, 12.75, and 13.50, respectively. Traffic at the first year of operation is estimated to be 37,790 vehicles a day. Traffic is expected to grow at a rate of 8% in Year 2 of commercial years of operation, 6% in Years 3–7 and 5% in Year 8–end. If actual traffic exceeds 120,000 vehicles a day, the excessive revenue will be shared 50/50 between the project sponsor and JM. The land and building tax and the income tax rates are assumed to be 1 and 30%, respectively. The escalation rate for the land acquisition is estimated to be 20% a year. The base scenario is that toll levels are assumed adjusted at every 2 years [λ in Eq. (8) equals 2 years] without delay and future toll levels are subject to formula given in Eq. (9) with ϖ set at 0.7. Single value estimates (deterministic analysis based on expected values) yield the project's internal rate of return (IRR) as 18.92%. If it is assumed that industry beta equity in the Indonesia's toll road sector is 0.80 and risk premium is 7.50%, the CAPM-based cost of equity is 18.75%. Discounting the project sponsor's cash flows at this cost of equity results in a NPV of Rp 1.19 billion.

Modeling Risky Variables

The volatilities of SBI rates, JIBOR, and inflation rates are assumed to be time dependent under the so-called square root of time rules. A 1 year volatility is mathematically defined as the standard deviation of natural logarithm of ratio of a variable in a given year to the previous year's variable. It is expected that future values are equal to today's values but are subject to greater volatilities if predictions are made over longer periods. This uncertainty model is considered more realistic than models that assign equal uncertainty levels of variables irrespective of forecasting horizons. For example, future inflation rates are modeled as

$$F_j(j) = F_0 e^{N(0;\sqrt{j}\sigma_1)}, \quad j = C+1,\ldots,N \tag{24}$$

where F_j=inflation rate in a given year j; F_0=current inflation rate; e=natural logarithmic base; and σ_1=1 year volatility of inflation rate using log returns. In this study, the 1 year volatility of inflation rate, JIBOR, and SBI rates are assumed to be 11.3, 6.8, and 3.5%, respectively. Delay in the mth toll adjustment is assumed to follow a geometric distribution with parameter p whose probability density function can be written as follows:

$$f(\mathrm{DEL}_m) = p(1-p)^{\mathrm{DEL}_m}, \quad \mathrm{DEL}_m = 0,1,2,\ldots \tag{25}$$

The mean of the geometric distribution is

$$E(\mathrm{DEL}_m) = p/(1-p) \tag{26}$$

Under this assumption, the length of delay is analogized with the number of failures and a toll adjustment with a success event. If p equals 1.0, toll levels experience no delay in adjustment as is assumed under the base case scenario. Because the impact of delay is to be examined, various parameters p are varied from the original case of 1.00–0.50, 0.33, 0.25, and 0.20, which correspond to expected delay of 1, 2, 3, and 4 years to reflect different degrees of delay-in-adjustment risk. The assumed probability distribution and the corresponding parameter of other risk factors are given in Table 2. The following are additional assumptions made for evaluating risk of the case study:

- Ramp-up effect has been incorporated in traffic forecasts;
- Daily traffic is annualized by a factor of 330; and
- Vehicle operating cost savings increase following the increase of inflation rate.

Table 2. Modeling Risky Variables

Risky variables	Assumed Distribution	Parameter
Initial toll base (Rupiah/km)	Triangular	275; 300; 325
Land acquisition time phase I (years)	Beta subjective	0.0; 0.5; 1.0; 3.0
Land acquisition time phase II (years)	Beta subjective	0.0; 0.5; 1.0; 3.0
Error of land acquisition cost phase I (%)	Normal	0; 10
Error of land acquisition cost phase II (%)	Normal	0; 10
Error of 1st year traffic (%)	Normal	0; 30
Error of later years' traffic (%)	Normal	0; 5
Construction cost I (Rupiah billion)[a]	Normal	28.7; 1.4
Construction cost II (Rupiah billion)[a]	Normal	53.3; 2.7
Additional investment (Rupiah billion)	Normal	63.6; 3.2

[a]Construction costs are in real terms.

Simulation Results and Discussions

A Latin Hypercube simulation of 5,000 iterations is applied. Table 3 contains listing of key output statistics. With no recourse to external sources other than the project cash flows, the full debt service payment can expectedly be made in Year 18 of the concession period. This figure is the mean of all possible earliest years at which B_j according to Eq. (19) is 0. If a value of 1 denotes the event that B_N is greater than 0 and 0 otherwise, the probability of unpaid debt taken as the mean of entire possible outcomes is about 0.12. Simulation results show that the project is very safe to the creditor because the probability of the creditor's NPVs being negative from Eq. (23) is as low as 0.02. The reported negative skew of the creditor's NPVs—indicating that NPVs have a long tail in the negative direction—can be explained by the fact that the creditor's return was capped at the borrowing rate while it may experience significant negative return if, from the creditor's perspective, the project is running poorly.

The project sponsor is at the greatest uncertainty because it ranks the lowest in the payment claim but can enjoy windfall payment if the project is running very successfully. For this reason the project sponsor's NPVs presents a large standard deviation relative to their mean. As indicated by the sign of the skewness, the project sponsor's NPVs posses a long tail in the positive direction. This is because the project sponsor has no risk of negative cash flows during the operation period as O&M risk has been transferred to JM. A positively skewed asset is perhaps favorable to most investors but it is not adequate for the project sponsor to accept the project because the project is too risky. It is reported that the probability of the project sponsor's NPVs being negative [from Eq. (21)] can be as high as 0.22. In some respects, JM is not much different from the project sponsor because it also shares both success and failure of the project. While the project sponsor is exposed to risk associated with equity payment, JM faces only O&M risk but not equity payment risk. The probability of JM's NPVs being negative according to Eq. (22) is about 0.05.

A sensitivity analysis is performed to identify the most critical input risk factors to the outputs. The software package provides two options for sensitivity analysis, namely, step-wise regression analysis and correlation analysis. Due to available limited space, only the correlation analysis results are presented, as shown in Table 4. A value of 1 indicates a complete positive correlation between two variables and a value of −1 indicates a complete reverse correlation between two variables (Palisade 2001). Clearly, the project sponsor's NPV is very sensitive to traffic, particularly the first-year traffic as it determines subsequent years' traffic levels and the land acquisition time phase I, which ranks the second in the list. Critical inputs to the creditor's NPVs are dominated by JIBORs but the most important input is also the first-year traffic. Sensitivity analysis results reveal an interesting issue that risk factors except discount rates affect the project sponsor's and the creditor's NPVs in a reverse direction. While the project sponsor expects that the debt service payment be made as early as possible, the creditor wishes to maintain as long as possible its claim on net cash flows and this is possible only if the debt has not been fully serviced. In addition to the project risk level, the use of a low discount rate may explain this possibility where a longer-lived asset may have a higher NPV (although its IRR is lower).

Table 3. Key Output Statistics under Base Case Scenario

	Net present value at risk free rate		
Statistics	Project sponsor	Jasa Marga	Creditor
Minimum	−87.7	−80.3	−171.2
Maximum	433.5	327.9	146.1
Mean	83.4	75.4	39.2
Standard deviation	91.9	52.7	25.6
Skewness	0.3	0.6	−0.5
Kurtosis	2.4	3.4	9.4
Mode	−49.5	55.2	31.9
5th percentile	−52.3	1.4	12.1
50th percentile	80.7	67.0	36.2
95th percentile	238.5	174.5	84.1

Note: All units are in Rupiah billion except the dimensionless skewness and kurtosis.

Table 4. Ten Most Critical Inputs to Net Present Value under Base Case Scenario

	Project sponsor		Jasa Marga		Creditork	
Rank	Risk factor	Coefficient	Risk factor	Coefficient	Risk factor	Coefficient
1	1st traffic	0.84	1st traffic	0.85	1st traffic	−0.41
2	1st land time	−0.16	3rd traffic	0.15	6th JIBOR	0.22
3	3rd traffic	0.13	5th traffic	0.13	8th JIBOR	0.22
4	4th traffic	0.12	4th traffic	0.13	7th JIBOR	0.21
5	2nd traffic	0.12	2nd traffic	0.13	1st land time	0.18
6	5th traffic	0.12	6th traffic	0.12	9th JIBOR	0.17
7	Initial tolls	0.11	8th traffic	0.12	2nd land cost	0.16
8	2nd land time	−0.11	12th traffic	0.12	10th JIBOR	0.12
9	6th traffic	0.10	7th traffic	0.11	11th JIBOR	0.10
10	8th traffic	0.10	9th traffic	0.11	8th SBI	−0.09

Note: JIBOR=Jakarta Inter Bank offered rates and SBI=Sertifikat Bank Indonesia.

Impact of Delay-in-Toll-Adjustment Risk

The top row of Table 5 shows the percentage change of statistics for the project sponsor's NPVs and the creditor's NPVs under different scenarios associated with delay-in-adjustment risk relative to that under the base case scenario. A decrease in mean, 5th percentile, and 95th percentile values may indicatively suggest that the project sponsor is faring worse as delay risk increases. Although a delay-in-adjustment risk has a significant impact on the project sponsor's NPVs, it has no remarkable impact on the creditor's NPVs. Delay in adjustment brings a slightly greater uncertainty to the creditor. This shift is indicated by a decrease in the 5th percentile value and an increase in the 95th percentile. The mean of their NPVs is higher in case a delay-in-adjustment risk exists, however. Interestingly, at a low or moderate risk level, statistics indicate that the creditor fares better. For instance, if the expected delay is 1 year, the entire presented statistics show an increase. In some respects, the creditor may even benefit from delay in toll adjustment as their claim over the project cash flows becomes longer. As the delay risk increases more, however, the creditor tends to fare worse. For example, among the statistics, only the median value is reported to be higher under a 4 year expected delay scenario than under a 3 year scenario. The creditor must also now be aware of high potential financial loss if toll risk is high.

Financial Impact of the New Tariff Regulation

Under the new regulation, the future toll uncertainty follows Eq. (10) with θ being set at 0.7 and $\lambda=3$ years. The middle row of Table 5 presents the percentage of change of statistics of the project sponsor's NPVs and the creditor's NPVs if toll levels are to be adjusted following the new regulation under different scenarios associated with delay-in-adjustment risk relative to statistics under base case scenario. Clearly, the project sponsor fares worse if toll levels are to be adjusted following the formula. A negative financial impact is more observable if delay-in-adjustment risk rises. Two factors can explain these results. First, the maximum allowable toll increase of 25% implies that the project sponsor must partially assume inflation risk, which was traditionally passed on to end-users. According to Eq. (10), the allowable maximum inflation rate that can be transferred to users is about 11% per annum whereas, skyrocketing inflation rates in the aftermath of the 1997 crisis aside, two-digit rates are not uncommon in the country. Indonesia is one of most inflationary developing countries in the world. Second, the extension of the periodical review implies a financial loss to the project sponsor because it is not allowed to increase tolls as frequently as before. As with the project sponsor, the creditor appears to be worse off under the new regulation and can even no longer benefit from any delay risk. The new regulation particularly exposes the creditor to a higher potential financial loss. As shown, the 5th percentile values of the creditor's NPVs drastically decrease as the toll risk increases.

Transfer of Land Acquisition

The sensitivity analysis results exhibit that the land acquisition risk is among highest ranked risks. Land acquisition risk is theoretically best assumed by the public sector because the risk is under its control. It is assumed presently that if the GOI undertakes the land acquisition at the project sponsor cost, the acquisition time is zero or, in other words, the land issue has been resolved before construction. Simulation results reveal that the project sponsor's cash flows are considerably enhanced. The bottom row of Table 5 presents the percentage change of statistics for the project sponsor's NPVs and the creditor's NPVs under different scenarios associated with toll risk if the land acquisition can successfully be resolved before facility construction starts. Statistics clearly exhibit that the project sponsor is better off under different toll risk scenarios. This occurs because the project sponsor is no longer exposed to risk of land price unnecessarily increasing while in-time completion is secured. On the contrary, the creditor appears to fare worse in many respects. This happens because the project sponsor requires less debt for financing land acquisition; this change implies that the creditor's investment is reduced. The creditor can only benefit from the transfer of land acquisition insofar as the creditor faces less risk of financial loss, as indicated by an increase in the 5th percentile value.

Conclusion

The present paper presents a financial risk analysis of project-financed toll road projects in Indonesia, making use of Latin Hypercube simulation. The simulation approach was adopted because it deals well with problems of large and complex systems, which would be otherwise difficult to solve. Several major risks associated with Indonesia's toll roads are identified. Ordering payments by priority level subject to cash availability enables risk to be evaluated from the different perspectives in particular those

Table 5. Change of Statistics Relative to Base Case Scenario's Statistics

	Project sponsor					Creditor				
Statistics	0	1 year (%)	2 years (%)	3 years (%)	4 years (%)	0 (%)	1 year (%)	2 years (%)	3 years (%)	4 years (%)
					Change in delay risk					
Mean	0	−19	−37	−51	−61	0	2	4	4	2
5th percentile	0	−2	−4	−4	−7	0	1	−20	−46	−122
50th percentile	0	−20	−39	−59	−72	0	2	5	6	7
95th percentile	0	−11	−17	−25	−30	0	1	4	3	1
					Change in regulation					
Mean	−81	−102	−115	−123	−126	−6	−12	−21	−27	−34
5th percentile	−7	−9	−11	−11	−12	−165	−281	−357	−413	−493
50th percentile	−89	−118	−137	−149	−154	1	0	−5	−8	−12
95th percentile	−48	−60	−68	−72	−74	−7	−9	−13	−16	−18
					Transfer of land acquisition					
Mean	22	1	−17	−30	−42	−12	−10	−7	−7	−7
5th percentile	8	6	5	3	2	1	0	0	−9	−21
50th percentile	24	3	−17	−32	−45	−15	−10	−8	−8	5
95th percentile	7	9	5	9	8	−12	−10	−11	−11	−10

Note: % change=(new statistic–old statistic)/old statistic if old statistic is positive and % change=(old statistic–new statistic)/old statistic if old statistic is negative.

of the project sponsor and the creditor. A developed simulation cash flow model is applied to a case study project. Different scenarios related to delay-in-adjustment risk, the country's new toll road regulation, and transfer of land acquisition are discussed. Conclusions can be drawn from the case study project are as follows.

- The project sponsor, the creditor, and JM are exposed to payment uncertainty but at different degrees. The creditor is exposed to payment risk because off-balance sheet financing does not allow the creditor to seek recourse other than the project cash flows. The project sponsor is at the greatest uncertainty because the sponsor ranks the lowest in the payment claim but has an opportunity to experience windfall returns. Because O&M risk has been transferred to JM, the project sponsor is only exposed to uncertainty related to equity payment where the project sponsor can receive nothing during the commercial years of operation if all cash has to be used for meeting financial obligations. In some respects, JM's position is similar to the project sponsor's position because the corporation shares both project success and failure.
- Sensitivity analysis shows that traffic particularly at the first year of operation have a significant impact on cash flows of all parties involved. Interestingly, risk factors identified as important may have a reverse effect on the project sponsor's NPVs and the creditor's NPVs. Although the project sponsor expects that the debt be serviced as early as possible, the creditor wishes that the debt continues such that the creditor continues to have a claim on the net operating revenue. This is possible if the discount rate is low and the risk extent is low or moderate.
- Delay-in-adjustment risk severely impacts the project sponsor's cash flows and JM's cash flows. At a low and moderate level of delay risk, the creditor can potentially even benefit from the risk, but tends to fare worse as the risk continues to rise. This occurs because the project debt service capacity can be seriously threatened as risk increases.
- The promulgation of the Regulation No. 40/2001 has negative impact on the project viability. The statistics reported here indicate that the project sponsor, the creditor, and JM all fare worse. The negative impact is further aggravated if coupled with increasing delay-in-toll adjustment risk. It has also been shown that the creditor can no longer enjoy any toll adjustment delay.
- If the GOI can help expedite the land acquisition process, the project sponsor's cash flows will generally be improved because land price risk and completion risk in terms of project schedules are reduced.

Although these findings should not be generalized and applied to all project-financed toll roads in Indonesia, they present very relevant information. In this context, the GOI may adopt some political actions to make a toll road project that will be implemented under a BOT arrangement more attractive. These actions may include helping expedite the land acquisition process that can be very difficult for private sector investors and honoring its commitment to raise toll levels as agreed. The GOI is also strongly recommended to carefully examine the financial impact of any new regulation from different perspectives and angles before issuing it.

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