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Reevaluating the economic benefits of the Lao People's Democratic Republic (Lao PDR)-People's Republic of China high-speed rail and its implications for fiscal stability of the Lao PDR

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**ADB Working Paper Series**

**REEVALUATING THE ECONOMIC  
BENEFITS OF THE LAO PEOPLE'S  
DEMOCRATIC REPUBLIC (LAO PDR)–  
PEOPLE'S REPUBLIC OF CHINA HIGH-  
SPEED RAIL AND ITS IMPLICATIONS  
FOR FISCAL STABILITY OF THE LAO  
PDR**

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**[1] Abstract**

This paper explores the challenges created by debt and fiscal stability in countries where major infrastructure investment is proposed. This paper specifically focuses on the Lao People's Democratic Republic (Lao PDR) and the \$6 billion Lao PDR–People's Republic of China (PRC) high-speed railway (HSR) that is currently under construction, which will be compared to a similar investment program in Mongolia. This paper uses two different modeling approaches, a comparison with a similar investment program in a different country and with different assumptions. The conclusions of this paper point to the Lao PDR–PRC HSR being unlikely to bring major economic benefits and having the potential to present a very large contingent liability for the Lao PDR. One of the modeling approaches derived from the recent literature supports the network analysis approach to identify the least cost path and it attempts to identify the increase in land value, which is the immobile factor of production due to the increased market access provided by new infrastructure. This has then been compared with a more traditional net present value approach, which should be equal but in practice has not been the case. Far from negating either modeling approach, these discrepancies have provided more actionable insights for policy makers.

**Keywords:** Lao People's Democratic Republic, People's Republic of China, high-speed railway, fiscal stability

**JEL Classification:** H54, H63, R42

## 2 Literature Review

### 2.1 Overview

This paper draws on a number of strands of economics and financial theory, including sovereign debt and debt burden; market integration and access; trade costs in terms of time and network analysis. However, the key papers for methodology are [21] and [SoyresF.MulabdicA.MurrayS.RochaN.andRuta2018], who use a network-based approach to evaluate the economic benefits of increased market access and reduced travel times (and by extension, costs).

### 2.2 Economic Development

Understanding economic development is more relevant than ever in the current environment. This is complex and often country or region specific topic. Presently, emerging economies are taking on extremely large amounts of dollar denominated debt as part of the "Belt and Road Initiative" (BRI). Poor judgment around the financing and uses of this debt could lead to future financial crises and, in the worst cases, reverse the significant gains in development that have been seen over the last two decades.

Debt financed economic growth and its ramifications for the wider economy is not a new topic [9]. When the money raised from debt is properly invested for economic growth, then does this aid economic development? However, economic development is a nuanced, complex and multi-faceted topic [19], and does not just focus on the growth of aggregate output [1]. Economic development includes the transformation of the economy, education of the workforce, and the development or transformation of the institutions vital to increasing aggregate output. Other issues that need to be addressed are geography, demographics, and the societal social structure. However, addressing all of these elements would be beyond the scope of this paper. Consequently, the channel for growth that will be assessed is government debt financed infrastructure.

### 2.3 The Gravity Model of Trade and Market Integration

The trade literature is extensive and is succinctly summarized by [10]; therefore, only a cursory overview is provided here. The principle academic theory of trade is that it allows heterogeneous agents to gain from trading with each other. According to [Dixit] in a neoclassical model, in an economy that admits a representative agent, this agent is made weakly better off when a region ceases to be autarkic and allows even minimal trade with other regions. The agent is made strictly better off if there is heterogeneity of preferences, technology, or relative endowments. The effects are further magnified in models with multiple agents and regions [14].

The neoclassical models proved difficult and did not provide sufficient insight into the gains from trade. Therefore, the models were further developed to "Gravity Models". These models allowed restricted tastes, endowment and other heterogeneous elements of the models. The original model by [Arkolakis2009] uses the value of the trade between two regions is equal to the value of the products minus the costs associated with trade and other specific determinants of trade between the trading pair (of countries or cities or regions). An important insight from gravity

models is the change in the representative agent's welfare due to trade. In simple one economy models, regardless of the reasons for the change in the trading environment, the change in welfare is simply the change in the extent to which a region trades with itself [10].

[4] extended this model from an ex-post to ex-ante analysis by imposing an additional restriction: all fixed costs associated with exporting are paid in the importing country, while the effect of any change in trade costs in any one of the endogenous variables such as welfare can be computed as the solution to a simple system of nonlinear equations. Importantly, the exogenous elements of this system involve only data on the regions' current trade flows and an empirically calculated (or given value) value for the elasticity of trade flows to trade costs,  $\theta$ , between the regions. An additional benefit of these models is that all of the necessary information is captured in the model. In addition, as long as all of the models use the same value for elasticity of trade, then they will all give a near identical output.

Multi-sector models can be extended if there is reason to believe that the underlying primitives (e.g., consumer tastes, technology and trade costs) are likely to differ across different sectors in the economy. The majority of multi-sector gravity models specify an environment in which production is separable across sectors (just as it is across varieties) and in which preferences take a particular functional form that is separable across sectors. A robust result is that adding multiple sectors increases the welfare gains from trade. This is unsurprising when cross-sectoral preferences are Cobb-Douglas because this mechanically lowers the substitutability between some pairs of varieties relative to the one-sector case with CES, elasticity greater than unity [10]. While these models are simplifications, they do produce tractable results and model the empirical data to a sufficient standard to enable meaningful insights and policy recommendations. [7] survey this extensive literature, and add an important finding: for their dataset, a return to autarky would reduce the welfare of the representative agents by up to 40% in some cases, and there was a material reduction in welfare in all cases.

The gravity models discussed in the previous section have been successfully applied to spatial economics. Economic integration both between and within nations, and the benefits of increasing connectivity have been successfully applied to North American provinces [3]. [3] also showed the gravity model to be a good fit for the empirical data, and a robust model for assessing spatial economics. [11] successfully applies this approach, using Cobb Douglas factors of production (and constant returns technology) and focuses only on the value of land, which is the immobile factor, to develop a gravity model that values in dollar terms the economic benefits of the construction of the North American Railways by calculating the increase in the value of agricultural land after the arrival of a railway. This approach demonstrates the strong predictive power of a parsimonious model. This approach also forms the basis of [21] (hereafter, RT), where this model is extended to all the Eurasian countries in the BRI to predict the increase in GDP per capita of the BRI projects. This is the basis of the methodology for this paper, and will be discussed in more detail later on in the methodology section.

## 2.4 Time Reductions of Trade

The approach of [11, 21] only values increased market access and not the value of the reduction in time. This is especially important for a number of industries with just in time (JIT) manufacturing. Time represents a cost in terms of spoilage, inventory depreciation and working capital tied up in stock [17]. There is a major cost differential between "fast" air transport and "slow maritime or rail", consumers are willing to pay a premium for this speed and this can be seen in the demand for air freight [18]. This forms the basis of the [SoyresF.MulabdicA.MurrayS.RochaN.andRuta2018] paper, which builds a GIS network model that is very similar to RT but calculates the economic benefits based on a reduction in time.

## 2.5 Summary, and Contribution to The Literature

This paper contributes to the literature in the following ways: it uses the RT model to compare to the Net Present Value (NPV) approach of valuing investment projects; it adds to the previous model by introducing actual time costs, actual transport costs as quoted by trade and logistics companies, and tariff costs based on original research; and this paper adds to the sovereign debt debate by valuing the benefits of an increase in sovereign debt and the choice between a short term "Keynesian" stimulus and long term fiscal stability. This paper also uses these models to provide tractable public policy guidance for decision makers.

## 3 Belt and Road Initiative: Lao PDR and Mongolia, an Overview

### 3.1 Introduction

At first glance, Lao PDR and Mongolia might appear to be very different countries and an unusual choice for a comparison. However, they are both emerging landlocked Asian countries that are currently at the risk of debt stress, in the case of Lao PDR, or who are currently receiving IMF support, in the case of Mongolia. In addition, both countries share similar debt profiles in terms of quantum and tenure. Both countries have chosen a "land-linked strategy" for infrastructure to drive economic growth and exports. Finally, both countries have very small dispersed populations, limited tax bases, and few export opportunities beyond natural resources. Nevertheless, these two countries differ significantly in their ability to pay for the BRI railway infrastructure projects. Mongolia has a large extractive resource sector, with significant high-quality deposits of copper and coal, and long term supply contracts to the PRC. In contrast, Lao PDR has significant hydropower resources but limited mineral resources to provide demand for (and thus gain revenue from) their railway to PRC. This difference in economic structure affects the feasibility of the railways and their rationale.

### 3.2 Belt and Road Initiative

The Belt and Road Initiative (BRI) is the largest foreign policy initiative and infrastructure investment program to date. However, it has been criticized for benefiting the PRC much more than the host nations and for forcing unprofitable projects with unsustainable levels of debt onto countries that are unable to manage complex mega projects or have the ability to service these debts [Bhattacharya, Go]. The reality is more nuanced, and this paper compares the experiences of Lao PDR and Mongolia to put these claims and accusations in to context. In addition, it aims to develop analytical insights to enable governments to better assess their needs and to make the most of this significant source of finance.

### 3.3 Lao PDR

Lao PDR is a large, sparsely populated country in South East Asia that borders Vietnam, Thailand, Myanmar, Cambodia, and the PRC. It has a population of just under 7 million, which is widely dispersed <sup>1</sup>. Until recently, it has enjoyed GNI growth rates of nearly 8 %, and Lao PDR was running a fiscal deficit of 4.3 % in 2019, down from 5.5 % in 2017. The tax base is limited and revenue collection remains weak <sup>2</sup>. This limited revenue collection combined with a significant increase in external debt, mostly denominated in Thai Baht and United States Dollars, has increased the debt to GDP ratio to a suspected nearly 60 % of GDP <sup>3</sup>. Consequently, Lao PDR has borrowed heavily on a bilateral basis from the PRC (a non-Paris

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<sup>1</sup><https://www.worldbank.org/en/country/lao>

<sup>2</sup><http://documents.worldbank.org>

<sup>3</sup><https://www.worldbank.org/en/country/lao/publication/maintaining-economic-stability-in-lao-pdr>



club lender) in United States Dollars to fund the new Lao PDR - the PRC HSR: \$7.2 billion loan from the state-owned Export-Import Bank of China, a sum that amounts to more the 60 % of Lao PDR's annual \$ 8.3 billion gross domestic product <sup>4</sup>. Currently, around a quarter of the population of Lao PDR live in poverty, with the highest rate of infant mortality in the region at 63 per 1000 <sup>5</sup>. A failure of the railway to become financially viable would pose a material risk to the poverty reduction targets of the Government of Lao PDR, World Bank and other multilateral lenders.

### 3.4 Mongolia

The only viable BRI projects in Mongolia at the time of writing are the the PRC-Mongolia-Russia Economic Corridor (CMREC), which follows the existing Trans-Mongolian railway and AH-3 Highway passing through Irkutsk, Ulan Ude, Altanbulag, Darkhan, Ulaanbaatar, Nalaikh, Choir, Zamiin-uud and finally in Erenhot in the PRC. The primary domestic route within PRC traverses Zhangjiakou (Hebei Province) en route to the port of Tianjin. This sub-initiative is called the "Prairie Road." The Mongolian railways derive their primary source of income from freight. This is mostly transit freight between Russia and PRC, and part of the "New Silk Road" to Europe, and exports of mining ores and coal. Rail freight is significantly more profitable than passenger transport ??, and the Mongolian railways derives 70 % of its revenue from freight [6]. At present, the future development of the railway network is funded by the mining companies and has the support of the PRC, with limited input from the Mongolian government.

The Mongolian economy is dependent on the export of natural resources such as coal, gold and copper <sup>6</sup>. The fiscal situation has improved significantly and the deficit has declined from 15.3 % of GDP in 2016 to a surplus of 2.6 % in 2018 and 3.4 % in H1 2019 <sup>7</sup>. However, this leaves the economy vulnerable to fluctuations in the prices of these commodities and, with the increase climate change awareness, the risk of a progressive decline in the demand for coal. Mongolian Government debt is currently 83.75 % of GDP <sup>8</sup>. The improved fiscal situation and IMF support has addressed the short term balance of payment issues, but this leaves little flexibility for the government to support infrastructure projects.

### 3.5 Summary

Lao PDR and Mongolia are currently in a stressed but stable economic situation, and they have both made good progress at achieving their development goals. The current difficult fiscal situation and large legacy debts leave little room for error, and especially not of the billion dollar size of failed infrastructure projects. These countries have different abilities to manage additional debt to pay for the infrastructure projects. However, Mongolia has the benefit of mining revenues and guaranteed traffic on its network, whereas there is no obvious revenue or clear commercial demand for the new HSR in Lao PDR.

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<sup>4</sup><https://china.aiddata.org/projects/33726>

<sup>5</sup><https://www.adb.org/countries/lao-pdr/poverty>

<sup>6</sup><https://mof.gov.mn/en/article/entry/mongol-uls>

<sup>7</sup><https://www.worldbank.org/en/country/mongolia/overview>

<sup>8</sup>IMF Debt Data Mapper Mongolia

## 4 Methodology and Data

### 4.1 Introduction

Our methodology closely follows [21] with some important developments, namely: we revalue the costs of border delays and associated reductions due to the BRI sponsored policies, we determine the actual freight costs for the relevant projects, and we compare the market access model to an NPV model. This paper specifically focuses on the Lao PDR - the PRC (Vientiane - Kunming) HSR and the "Prairie Road" in Mongolia. These are touched upon in RT, but will be examined in greater depth here.

### 4.2 Gravity Model

#### 4.2.1 Gravity Model Baseline Parameters

In a gravity model of trade, market size determines trade flows and by extension market access. The larger the market and the more connected it is, the greater the trade flows. As discussed in the literature review, a gravity model is a good approximation of empirical international trade data, and is relevant to a spatial economics context.

The base of the RT gravity model is a Cobb Douglas (constant returns) production function assuming fixed technology. Goods are produced with land, labor and capital to produce goods with land, labor and capital in each city. Each city in the network is index  $i = 1, \dots, n$  and each city trades with every other city as a trading pair. The share of city income,  $y_i$  that is paid to land is  $\alpha_i$ , labor is  $\beta_i$  and land is  $1 - \alpha_i - \beta_i$ . The factor shares are assumed to be constant across cities and across time. However, there is growing evidence to suggest that this assumption for labor and capital may not be entirely valid, such as [Bridgeman, Barkai], but is valid for land because the model is focused on cities. However, to enable a comparison with the previous papers, this assumption will not be challenged in this work but could be a source of future research.

As per the extensive literature on gravity models of trade, constant elasticity of substitution is assumed, where elasticity of trade flows over trade costs is expressed as  $1/\theta$  where  $\theta > 1$  is assumed. The lower the value of  $\theta$  the more productivity is dispersed indicating greater dispersion in comparative advantage and a higher response of trade in relation to a reduction in trade costs.

The baseline parameters for the model are taken from the literature, and there are differences between the parameters used in this model and RT.

The key parameter is  $\theta$  the elasticity of trade flows with respect to costs. This parameter is important because, for any trading pair, the estimate of the cost border effect or tariffs is inversely proportional to the elasticity of trade. Consequently, observed reductions in tariffs between the trading pair can explain practically all or near none of the growth in world trade, depending on the observed or assumed value of  $\theta$ .  $\theta$  is one of only two statistics that are needed to measure the welfare cost of autarky in the gravity models of international trade discussed in this paper. Therefore, this elasticity is key to understanding the size of the frictions to trade, the response of trade to changes in border effects or tariffs, and the associated welfare gains or losses. This parameter is difficult to estimate because gravity trade

models can rationalize small-trade flows with either large-trade frictions and small elasticities, or visa versa. The solution is to measure trade frictions independent of trade flows to estimate  $\theta$ .

A recent report by the National Bureau of Economic Research finds a lower value for  $\theta$  the RT of closer to 4 and not 5, with a range of 2.27 - 4.46 [28]. However, in RT, the sensitivity analysis did not materially change the results and it would be unlikely that for non-borderline viable projects that this should be the case. In this model a value  $\theta = 4$  will be used, and the range of values aforementioned will be tested in a sensitivity analysis.

As mentioned previously, the value of the labor share of income has been widely considered to be static. However, more recent research than used on RT not only gives a slowly declining value for labor share but also a lower absolute value at  $\beta = 0.51$  [8]. In this model, the value of  $\beta = 0.51$  will be tested against the RT value of  $\beta = 0.65$  in the robustness checks.

Finally, there was no significantly different value for  $\alpha = 0.05$  to warrant changing this input from the RT value.

#### 4.2.2 The Reed and Trubetskoy Gravity Model

Based on [Donaldson] the aforementioned assumptions, the price of land is a log-linear function of market access. The following equation captures all investments, and reductions in trade costs are captured by (an increase in) land value. The effect of reducing trade costs is to reduce both the cost of exporting for firms and the costs of importing for consumers. The effect of reduced costs for consumers is moderated by  $\beta$ , which is the fraction of income to labor. Using the returns to land as a money metric allows the quantification of the benefits of increased market access. The supply of land is fixed, so an increase in trade reduces the absolute costs of goods and increases the purchasing power of consumer. This drives demand: people move to the city as the relative wage has increased, and this in turn pushes the value of the fixed supply of land higher.

$$\ln(r_i) = k + \frac{1}{1 + \alpha\theta}(\ln(FMA_i) + B(CMA_i) + \epsilon_i) \quad (1)$$

The key terms:  $r_i$  is the annual rent to land,  $k$  is a constant,  $CMA_i$  and  $FMA_i$  refer to consumer and firm market access respectively with the subscript  $i$  referencing each city,  $\epsilon_i$  is the error term s an error term that is increasing in the city's underlying absolute productivity advantage and decreasing in the abundance of land.

For any trading pair (of cities)  $CMA_i$  and  $FMA_i$  are defined as follows:

$$FMA_i \equiv \sum_d \left(\frac{1}{\tau_i d}\right)^\theta y_d$$

$$CMA_i \equiv \sum_o \left(\frac{1}{\tau_o i}\right)^\theta y_o$$

Where  $o$  and  $d$  refer to origin and destination, and  $y$  is the city GDP, firm market access value of income in other markets, weighted by the inverse of cost of exporting to those destinations, and consumer market access the value of output (equal to income) in other markets, weighted by the inverse of cost of importing from those origins.  $\tau$  is the value of ad valorem trade cost and  $> 1$ .

Following on from equation (1), the change in value of land pre and post investment is as follows:

$$\ln(r_i^{post}) - \ln(r_i^{pre}) = \frac{1}{1 + \alpha\theta} (\ln(F\widehat{M}A_i) + B(C\widehat{M}A_i)) \quad (2)$$

Where "pre" and "post" refers to before and after BRI investment:

$$F\widehat{M}A_i \equiv \frac{FMA_i^{post}}{FMA_i^{pre}}$$

$$C\widehat{M}A_i = \frac{CMA_i^{post}}{CMA_i^{pre}}$$

Equation (2) assumes no externalities, positive or negative as  $\epsilon_i^{pre} = \epsilon_i^{post} = 0$ , this means that no agglomeration effects are captured. However, a key tenet of project financing modeling and structuring is to look at the lower bound of profitability and certainty of cash flows. Because the agglomeration effect is hard to quantify, it fits in well with the comparison of the NPV based on a project finance modeling approach (which will be discussed in more detail in the following section).

The supply of land in a given city,  $L_i$  is fixed, and the increase in value of the land  $V_i$  can be defined as follows:

$$V_i^{pre} = L_i r_i^{pre} = \alpha Y_i$$

where  $Y_i$  is the pre-BRI city GDP.

$$V_i^{post} = L_i r_i^{post} = L_i r_i^{pre} \frac{r_i^{post}}{r_i^{pre}} = \alpha Y_i (\widehat{M}A_i)^{\frac{1}{1+\alpha\theta}}$$

Where  $\widehat{M}A_i$  is as follows:

$$\widehat{M}A_i = \ln F\widehat{M}A_i + \beta (\ln C\widehat{M}A_i)$$

The distribution of additional land value per city is given by:

$$\Delta V_i \equiv V_i^{post} - V_i^{pre} = \alpha Y_i [(\widehat{M}A_i)^{\frac{1}{1+\alpha\theta}} - 1] \quad (3)$$

and the total increase in land value for a given project across all cities is given by:

$$\Delta V \equiv \alpha \sum_i Y_i [(\widehat{M}A_i)^{\frac{1}{1+\alpha\theta}} - 1] \quad (4)$$

$\Delta V$  from equation (4) can be directly compared with the net present value from the net present value analysis.

$$NPV \equiv \frac{\Delta V}{\rho}$$

where  $\rho$  is the discount rate, in this paper the weighted average cost of capital (WACC).  $\Delta V$  represents the value increase to the owners of land, the ability of the government to tax this is key in extracting value from these projects.

Apart from the baseline parameters, the model only needs geographic information on the routes and changes introduced by new infrastructure, cost savings from the new infrastructure, and city GDP. This paper will only focus on two distinct projects: the "Lao PDR- the PRC HSR" and the "Prairie Road"

### 4.2.3 Changes in Trade Costs Due to BRI Infrastructure Investments

The [11] model analyses at the changes in land value in the continental United States, and there is no fundamental difference in national and international models aside from the border costs in terms of tariffs, administrative costs, and costs associated with time and delays. In the network model of RT, the trade costs are as follows:

$$\hat{\tau}_{od} \equiv \begin{cases} \frac{1}{S} \sum_{j=i}^{|j|} \hat{c}^j d_{od}^j & k(o) = k(d) \\ \frac{1}{S} \left( \sum_{j=i}^{|j|} \hat{c}^j d_{od}^j + border_{k(o)}^{export} + border_{k(d)}^{import} \right) + tariff_{k(d)}^{import} & k(o) \neq k(d) \end{cases}$$

$j$  represents a transport route road, rail or maritime, and the aim is to find the least cost path i.e  $\hat{\tau}_{od}$  is minimized.  $o$  and  $d$  city of origin and the city of destination in the trading pair and  $\hat{c}^j$  is the actual (published) cost of transport paid to the transport companies. Border costs represents export costs and import costs, respectively, including all administrative and legal costs. Tariffs are observed between city (country) pairs.

$S$  is the average value of one shipping container, 1 TEU, a 20 foot equivalent unit, which is the average size of a shipping container and the standard unit for capacity measurement at logistics hubs and ports. The average value for 1 TEU (essentially one shipping container) is given as USD 50,000. However, upon consulting insurance valuations and analysis, the average should be between USD 23,000 to USD 27,000. Certain routes with high value trade such as the USA-Japan (which are not relevant here but are indicative) have values up to USD 77,000<sup>9</sup> per TEU and China-Italy were the average value is USD 38,000<sup>10</sup>.

### 4.2.4 Mode Switching

In theory, the mode of transport (road, rail, maritime) could be switched repeatedly to ensure the minimum of switching costs is added, RT uses 25 USD however actual costs vary from 105.00 USD from ship to shore in Vietnam<sup>11</sup> to 53.34 USD in the Republic of Korea for multi-modal logistics terminals<sup>12</sup>. In PRC and Mongolia, the values range from 76 USD in Mongolia and 130 USD in Northern PRC at the Port of Tianjin<sup>13</sup>. There does appear to be evidence that in a number of emerging markets, that the multimodal logistics terminals have less capital/ technological investment and that the stitching costs may be higher, and certain routes may be subsidized in line with political objectives<sup>14</sup><sup>15</sup>. RT used 200 USD for ports and 25 USD for multi-modal. In this model, 200 USD will be retained because it is a fair average but a higher value will be used for the switching costs of 50 USD.

<sup>9</sup>According to Swiss Re in 2008, although outdated the value is not used in calculations, it is indicative to the proportional range of values of cargo

<sup>10</sup>According to IHS Markit in 2016, based on their analysis of insurance premiums and claims analysis

<sup>11</sup><https://www.oocl.com/vietnam/eng/localinformation/localsurcharges/2017/Pages/LOCALSURCHARGES.aspx>

<sup>12</sup><https://www.mdpi.com/2071-1050/11/4/1209/pdf>.

<sup>13</sup>Asian Development Bank "Breaking Barriers, Leveraging Mongolia's Transport and Logistics Sector. September 2018

<sup>14</sup>RZD Tariff List N 10-01. Except for the "New Silk Road" routes where subsidies and handling preferences apply, there does not appear to be a huge divergence in the handling costs

<sup>15</sup>[https://www.joc.com/rail-intermodal/international-rail/new-china-europe-rail-routes-opening-volumes-rise\\_20190912.html](https://www.joc.com/rail-intermodal/international-rail/new-china-europe-rail-routes-opening-volumes-rise_20190912.html)

### 4.3 NPV Model

The NPV model is built upon the author's calculations, previous original work, and experience building models for bankable project finance investments in the EU, Maghreb, sub-Saharan Africa, Asia and the Commonwealth of Independent States. It builds on elements from leading investment banks, project finance banks, with additional functionality and design elements from a market leading financial modeling and model audit consultancy. The academic underpinnings for the valuation elements are based on Aswath Damodaran's extensive works in the areas of valuation and corporate finance [Damodaran].

The model is set up as a standard three sheet model, with an income statement, balance sheet and cash flow statement. The purpose of modeling the NPV in this way is to directly mimic the approach to valuation taken by the banks and the commercial set up of such a project. Net income from the income statement or profit and loss feeds in the cash flow statement as part of operating income, cash transactions are accounted for in the cash flow statement, and then the net cash position feeds in to the balance sheet. This is especially important because a simple DCF analysis often only replicates the profit and loss statement, and misses cash requirements and timings; which often increase the quantum of financing required [Damodaran]. In project finance, the asset is put in to a "Special Purpose Vehicle" (SPV) off balance sheet. This enables investors to invest with limited liability (i.e., anything that is put in to the SPV is at risk in the worst case scenario) but there are no further legal claims beyond the SPV. The SPV then behaves like a company and that is the reasoning for a more detailed three sheet statement model as opposed to just a simple cost benefit analysis.

One of the major issues in constructing a detailed NPV model for BRI projects is the lack of available information. One of the key hallmarks of BRI projects is the opaque financing structures [16]. However, the debt interest rate and quantum are publicly available and a range of equity ROI values (cost of equity), based on peer analysis [Damodaran] will be used to construct the Weighted Average Cost of Capital (WACC).

### 4.4 Data Summary

The inputs of the NPV models were collected from a variety of sources, including interviews with Mongolian and Lao PDR government officials. Where there was no data, for example on depreciation and maintenance schedules, these were taken from leading railway engineers at International engineering firms and state run rail monopolies. In particular, figures for Lao PDR were based on figures from the annual reports of China Railways<sup>16</sup> and Mongolia from either the Railway Control Centre (Mongolia) or Russian Railways<sup>17</sup>. Any remaining gaps, such as working capital, financing and other financial elements were based on the author's experience,

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<sup>16</sup><http://www.crecg.com/english/2699/index.html>. A key assumption was made that the management of the Lao PDR - the PRC HSR would be managed by Chinese Railways and that the best proxy for performance would be the actual figures from Chinese Railways

<sup>17</sup><https://ir.rzd.ru/>. Because there is a current commercial relationship between Mongolian and Russian Railways (RZD), these figures were cross referenced with the European Bank for Reconstruction and Development's analysis of Russian Railways during its extensive investment and advisory work with RZD

and on a consultation with lenders and financial institutions that would lend to or invest in such a project. In keeping with the risk adverse approach taken by project financiers, only the most conservative estimates were used.

The inputs for the RT model have been discussed previously and the rest of the inputs for these models are as per RT. To develop the RT model further, figures taken from commercial freight and logistics companies will be used to give a more realistic picture of the costs of trade and of the relative benefits of the new infrastructure.

## 5 Results

### 5.1 Introduction

The aim of this paper was twofold: to replicate the RT results, and to then compare the gravity model with an NPV model as described previously. The results are broken down into two sections: the replication of the RT model and then a simulation of this model with more realistic values derived from real world examples, followed by a comparison of the Gravity model with the NPV model. The full results are included in Appendices 6,1 and 6,2, and only the key insights or results are included in this section. The NPV model was run on excel on Mac OS Catalina 10.15.2, and the Market Access model was run in Python 3.0 on Ubuntu 180304 on a Virtual Box on Mac running the same operating system.

### 5.2 Gravity Model

The RT model was followed and the initial results were similar enough (assuming different operating systems and different coding approaches etc.) to move to the following simulation, where the time value of waiting and real world figures are added to the model.

The author uses a different, more conservative set of estimates. These estimates are taken from freight and logistics firms and give a lower overall number of viable projects and lower profitability than RT (see Appendix 1). Whilst there is some difference in monetary value of projects, the overall results show the same key dynamics: the benefits of these infrastructure projects are shared reasonably evenly between PRC and other countries. Importantly, most projects are unprofitable and there are only a few that are likely to be profitable enough to cover the cost of capital and thus be "viable".

An important observation that is pertinent to both Lao PDR, Mongolia and other land locked countries is that the countries that benefit the least are non-nodal countries; that is, countries that have the infrastructure running through them but are not the final destinations. As per gravity models, rich countries (high GDP), big countries (high population), and closer countries benefit the most from increased trading. Small countries and non-nodal countries do not benefit in any meaningful way, despite hugely increased market access.

A substantial gap in this modeling approach is that it does not have a term to value mineral or petroleum resources. The economic rationale for the Thai canal, for example, is based on fuel bunker cost savings for oil and gas tankers and LNG tankers heading to Japan, PRC, and South Korea <sup>18</sup>. The same applies to the

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<sup>18</sup><https://asia.nikkei.com/Economy/Influential-Thais-in-push-for-Kra-Canal-project2>. The fuel

Mongolian projects, which appear unprofitable but are significantly more profitable using the NPV approach to capture this element.

### 5.3 NPV Modelling

NPV modeling is especially insightful for the differences in the uses of the Lao PDR and Mongolian rail networks. The three statements for each scenario are included in Appendices 6,3 to 6,6 as abridged tables, where a number of years have been hidden to improve the clarity of the results.

The Mongolian planned investment to double their railway capacity is (see appendix) financially viable based on the value of 0.33 USD per KM run as the value of revenue generated per km one tonne is moved on its networks. This figure reflects that over 75% of the network is used to export coal or iron ore or copper to international markets, and 12% is through traffic between Russia and the PRC. Total passenger km for 2017 were 973,000,000 and tonne km were 6,434,000,000. Current figures and estimates were used for operations and maintenance costs, revenue and capacity utilization <sup>19</sup>. It is therefore financially viable and potentially interesting for commercial investors without any passenger revenue. However, the dominance of a few cyclical commodities could pose different issues, which are beyond the scope of this paper.

Three separate NPV scenarios were run for Lao PDR: the first is a base case, the second break even, and the third uses only passenger figures to attempt to capture the lack of mineral or manufactured goods exported from Lao PDR.

The first NPV scenario uses Chinese values for the turn over per passenger km and per tonne km, and Mongolian capacity figures as a starting point for comparison. Naturally the much lower value of tonne-km of 0.17 USD and 0.4 USD <sup>20</sup> per passenger km makes this completely unviable, mostly due to the much higher cost of 5.9bn USD vs 3.8bn USD. The purpose of this simulation was to find a baseline value from which to develop the simulations to attempt to find the break-even points with freight and with only passengers.

The second NPV model attempts to find the break-even point of the railway using Chinese Railways' figures and estimates. The break-even point using Chinese values requires around three times the current Mongolian passenger km and tonne km. Which given that the Mongolian railway is at capacity, with significant mineral exports. raises questions about the forecasts used in the actual viability.

The final NPV simulation assumes that only passenger trains are run, with no freight. This would require 8,800,000,000 passenger km. An average high speed train in PRC carries between 640 to 690 passengers <sup>21</sup> (all seats occupied). A round trip of a 650 seat train Kunming-Vientiane-Kunming is 854 km. The number of

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cost savings alone could be up to half a billion USD per year if all Singapore bound traffic went through the new canal. The increase in land values around this project would be minimal, and so appear as unproductive according to the market access methodology.

<sup>19</sup>These figures are taken from interviews with the Railway Traffic Control Centre for Mongolian Railways, Ulaanbaatar

<sup>20</sup>These figures were calculated from China Railways annual reports and were corroborated with interviews. One issue is the presence of subsidies on parts of the system for both passenger and freight

<sup>21</sup><https://www.railwaygazette.com/news/single-view/view//sleeper-emu-to-be-developed-under-co-operation-deal.html>. A number of different models and different configurations are used depending on the speed of the line and routes



passenger km for one round trip would be 227,550. This would require annually 31,706 fully loaded train trips, or 87 round trips per day (assuming 364 days per year). The majority of the route is single track, so the ability to physically move that number of trains on the track is questionable. As a comparison, there are 18 trains between London and Paris daily via Eurostar <sup>22</sup>, a global financial centre and one with a significant French community. The demand for such a service would also seem questionable.

## 5.4 Results Summary

Neither of these approaches delivers the same result as per the theory, this could be in part due to the lack of terms in the gravity to account for natural resources and the benefits of "good" policy in reducing trade frictions. However, the modeling of both approaches has provided important insights into the limitations and strengths of both approaches. Whilst the actual monetary value does not match, there are important insights that can be drawn from both approaches: the importance of transport cost savings such as fuel and time, the value of natural resources in developing infrastructure, and the very high break even-points of these investment projects. The most striking result from this is that approximately half of all BRI projects generate no economic value. While of the projects that do generate some positive economic value, only around 1 in 10 will generate enough revenue to break even, let alone cover the cost of equity. Both approaches demonstrate, in different ways, the very limited number of viable infrastructure projects and the material risks posed to governments from over-investment in these projects.

# 6 The Implications of BRI Debt for the Fiscal Stability of Lao PDR

## 6.1 Sovereign Debt Theory and Past Events

Whilst there is strong support for debt financed growth, there is naturally a maximum that any borrower can borrow before the "Debt Burden" in terms of interest and capital repayment service becomes too much, and the borrower defaults. [25] found a threshold of 90% debt-to-GDP ratio was the point at which any additional debt would have a negative effect on economic growth: "The Debt Overhang." This threshold has been the subject of much scrutiny and debate, with [15] not finding a 90% threshold and no sharp drop in growth after a 90% threshold. Meanwhile, [CecchettiS.MohantyM.andZampolli2011] found an 86% threshold, with [PadoanP.C.SilaU.andVanDenNoord2012, 5] also finding similar results. [13] identified a much wider range of thresholds ranging from 55% to 130% using the original approach of [25]. Under different modeling assumptions, thresholds as low as 20% were identified [12]. The relationship between debt and GDP growth is non-linear. These thresholds were also extremely sensitive to modeling approach and assumptions. A key insight that runs through this literature is that debt fueled growth is not unlimited and there is some point at which debt limits economic

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<sup>22</sup><https://booking.eurostar.com>. Some days have less than 18, there is also a degree of seasonality as well.

growth, which this could be as low as 20% in some cases. Emerging markets suffer from especially pro-cyclical debt cycles, [24] found that strong debt surges were almost always followed by a debt crisis.

In the event of a default or debt "event," the hysteresis effect on a country's economy could be long lasting by as much as eight years [22]. This low growth and debt overhang could have serious implications for social well-being, and the funding of other government programs if fiscal reduction measures (austerity as coined in the press post 2009 Lehman crisis) are put in place to fund the debt service. There is a long history from both developed and emerging markets to support this [27], and the effects are worryingly similar, regardless of time, region and state of economic development [26]. The policy responses for emerging market nations with non-domestic currency debt are particularly severe because even more pronounced trade offs required as the exchange rate also becomes a key factor [2]. To resolve a debt crisis, governments can raise taxes but only at the risk of increasing distortions in the market [20], or they can cut government spending, which is often politically difficult. Inflating the debt away is not possible for foreign currency denominated debt. Finally, the hardest method of managing high level of debt is to foster economic growth [23].

## 6.2 Lao PDR and Mongolia BRI Debt Analysis and Simulations

As the literature reveals, there is no real consensus on what the optimum level of government debt should be, although they do agree that the ability to pay is the most important element. Some countries struggle with a ratio at 20% debt to GDP, whilst Japan has a debt to GDP ratio of over 200 %. However, the IMF and the World Bank have general guidelines for debt sustainability <sup>23</sup>

From the simulations in Appendix 7, both Lao PDR and Mongolia are in breach of the IMF and World Bank recommended limits with the BRI debt. Whilst Mongolia is rapidly reaching the critical level (and did recently, and required IMF assistance <sup>24</sup>. Whilst there are similarities between Mongolia and Lao PDR, the difference in their ability to sustain BRI Infrastructure related debt is more evident: Mongolia has an internationally competitive mining industry with an exceptionally large market (the PRC) on its doorstep and the ability to act as a bridge between the PRC, Russia, and Europe. Although the Market Access model does not score these projects particularly highly, the value of Mongolian railways is its ability to export mineral products. In contrast, passenger services are a negligible part of the rail system (excluding the proposed Ulaanbaatar commuter system) and are essentially a social service. Further analysis of the non BRI debt would be warranted here because there is a reasonable commercial rationale for debt funded growth.

The debt to GDP ratio for Lao PDR has not dropped below 35%, which is the recommend level for a country with a similar profile to Lao PDR. However, if it had

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<sup>23</sup><https://www.imf.org/en/About/Factsheets/Sheets/2016/08/01/16/39/Debt-Sustainability-Framework-for-Low-Income-Countries>. Whilst this is only guidance and the full sustainability has not been calculated, the thresholds are used for indicative purposes.

<sup>24</sup><https://www.imf.org/en/News/Articles/2017/05/31/NA053117Mongolia-Turns-the-Corner-with-5-5-Billion-IMF-Led-Financing-Package>). There is an additional element to the analysis of Mongolia in regard to the dependence on cyclical commodities, but this is beyond the scope of this paper

not taken on this debt, then it would have a ratio of around 20%, leaving ample room for limited additional borrowing to focus on key areas such as health and education, and other targets as set out in the UN Millennium Development Goals. The economic rationale for taking on more debt is less clear in the case of Lao PDR. The additional debt could potentially force Lao PDR in to a potential debt event or default, and the commercial rationale for the railway is weak. Lao PDR has a tiny domestic market, with limited commercial logic for an expensive railway connecting a country of 6 million with a second tier city in PRC, with very limited natural resources (except for hydropower, which does not need a railway). The extension to Bangkok makes even less commercial or economic sense, particularly given that Bangkok can be reached easily from the PRC by sea, and the logic of a least cost path with time savings does not hold. Even if they can connect with Malaysia and Singapore, the costs will still outweigh any benefits.

By analysing both the sovereign debt ratios/quantum (see Appendix 7) with and without the BRI Infrastructure debt, the potential benefits of the BRI investment do not look like they outweigh the risks of the increased debt. Lao PDR will likely break the 55% threshold and that debt service will put further strain on the limited tax raising abilities of the government. The comparison to Mongolia is important because Mongolia can generate export revenues in hard currencies (US dollars, Japanese Yen etc.) from the sale of its commodities, which are traded in hard currencies, and could therefore potentially manage a higher debt burden (evidently the commodity cycle should be taken in to account).

## 7 Conclusions

Although the results of the gravity model and the NPV model not matching as per theory, this does not detract from the validity of the insights or ability to draw actionable conclusions from either approach. Understanding what may have caused the discrepancies can provide motivation for the development of the gravity model, while it also highlights a key limitation: namely that the gravity model and network analysis requires average values, which can reduce the ability of the model to accurately represent all real world situations. The average value of the cargo is an extremely important driver of viability, and it varies materially between different companies and routes. This is a fundamental challenge with generalized economic models: simplification to make a model tractable without losing too much of the predictive power. Whilst it was shown with the Thai canal project that one of the key drivers of its viability is the fuel cost savings for oil and LNG tankers headed to Japan and South Korea, this was not captured but the gravity model and this reduced its explanatory power. Hence, the need for additional terms in the equation. The model does capture key elements of the gravity model of trade: namely, rich countries, bigger countries and closer countries will benefit more from an increased ability to trade. This demonstrates the ability of the gravity model to still be relevant and developed further to capture the missing points mentioned previously. The gravity model was a compliment for the NPV approach to modeling. The NPV model is simply a calculator and is heavily dependent on inputs for it to be really useful. A cursory glance at some of the more prominent tech 'unicorn' valuations demonstrate the need to have verifiable and realistic inputs. The market access approach helps to bring realistic estimates to what the taxable economic benefits could

be from a project. The most pertinent result, I believe, is that approximately half of all BRI projects generate no economic value, and of the projects that do generate some positive economic value, only around 1 in 10 will generate enough revenue to break even, let alone be profitable. This is not a surprising result because there is a demonstrable appetite for infrastructure investment but there are increasing levels of "dry powder" or uninvested capital<sup>25</sup>. At the same time international financial institutions such as the Asian Development Bank are pushing infrastructure investment<sup>26</sup>. Whilst this is an undeniably important and key element of economic growth, overinvestment in unprofitable projects is clearly a risk. What the market access model and NPV model demonstrate is that most of the mega projects are unlikely to generate enough revenue to cover their costs, and hence the disconnect between money available for investment and the lack of investment. I believe that this multi-model approach provides more relevant insights for economists, policy makers and financiers on the dynamics, profitability and wider benefits of mega project infrastructure investment. This paper has strictly taken a numerically based approach to analysing this issue, to ensure unbiased and tractable policy recommendations. However, in reality politics often play an outside role in projects of this nature and an alternative could be to use a political economy approach to assess the Lao PDR and Mongolia cases. Whilst beyond the scope of this paper, this could help us to understand the motivations for some of these projects.

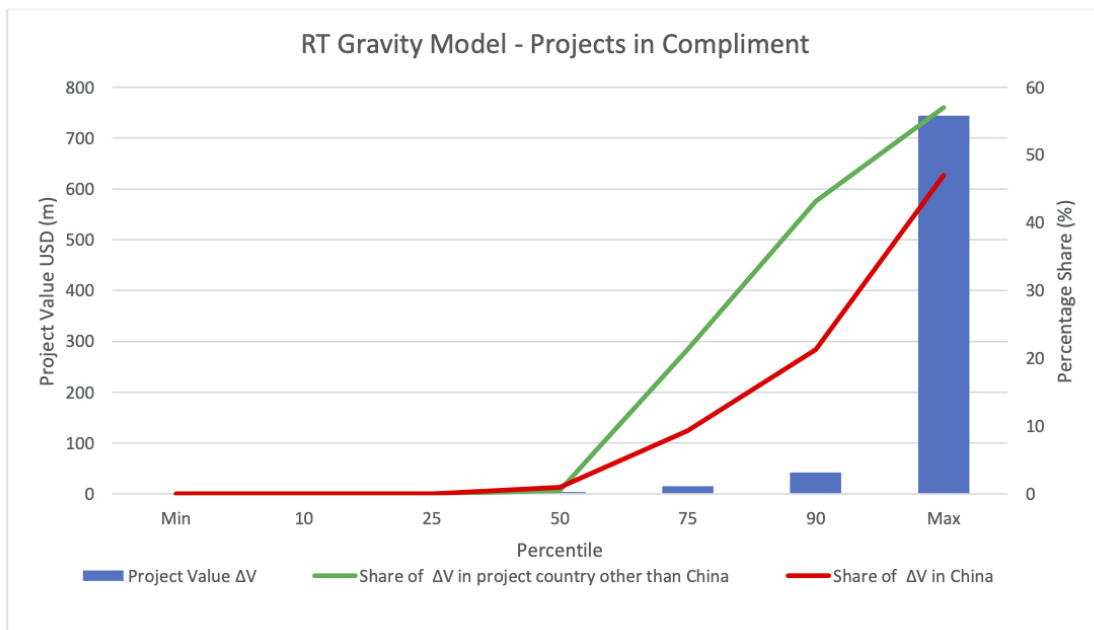
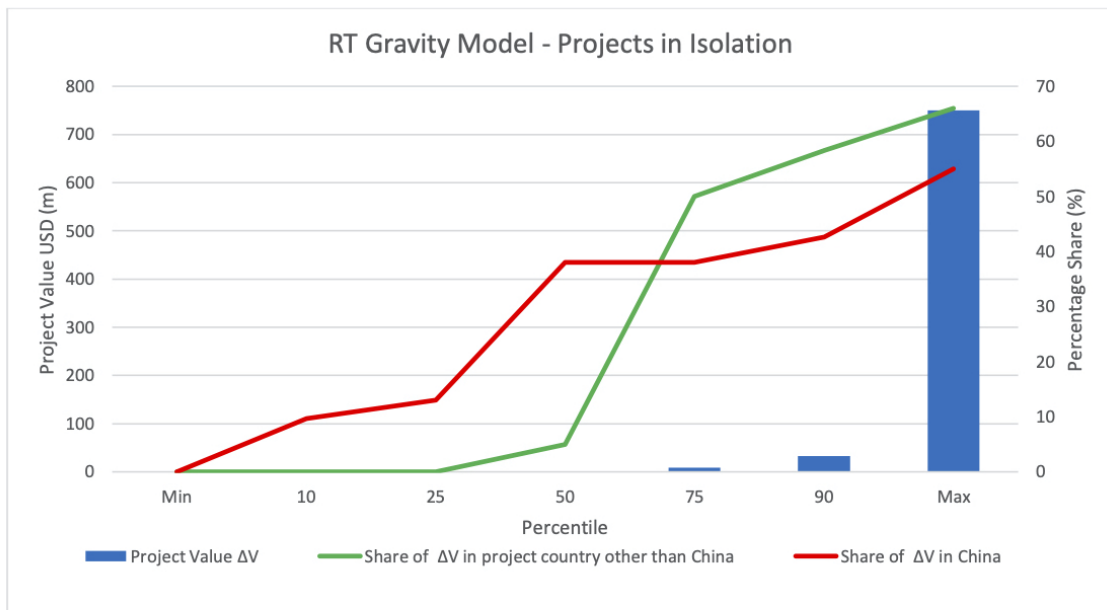
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<sup>25</sup><https://www.infrastructureinvestor.com/infra-investors-concerned-about-build-up-in-dry-powder/>. The uninvested capital in this sector is likely due to a lack of commercially viable projects coming forwards

<sup>26</sup><https://www.adb.org/about/infrastructure> This is one of many articles that is generally indicative of the endless push for more investment to drive economic growth, but does not address the observable fact of the significant amounts of committed but uninvested capital in some of the largest global investors

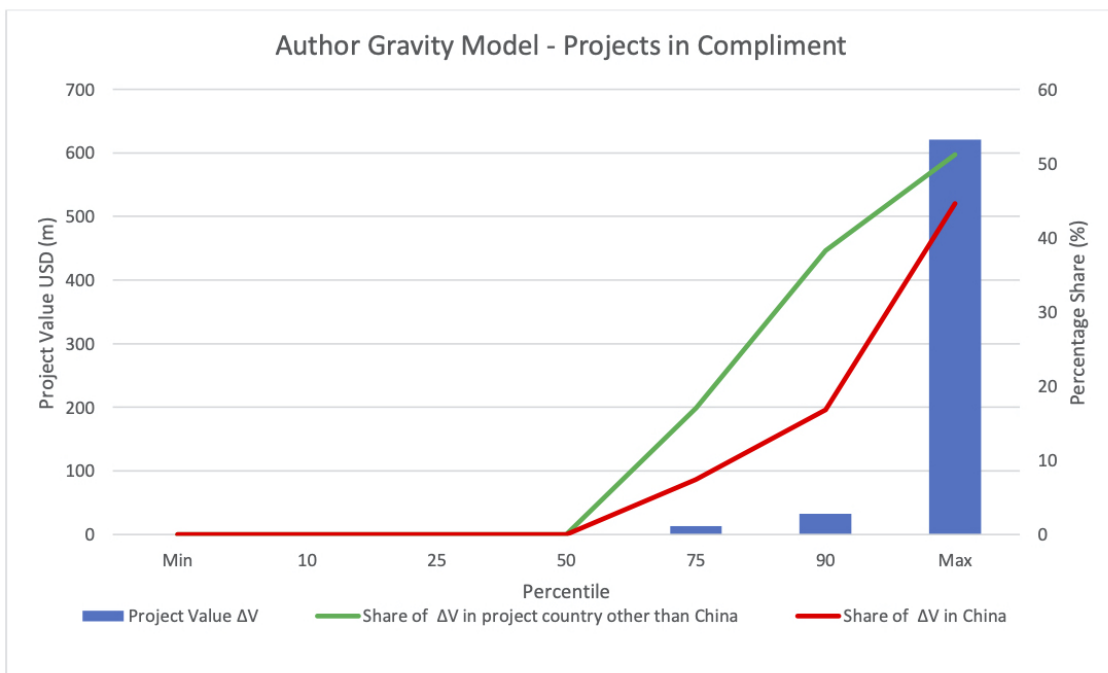
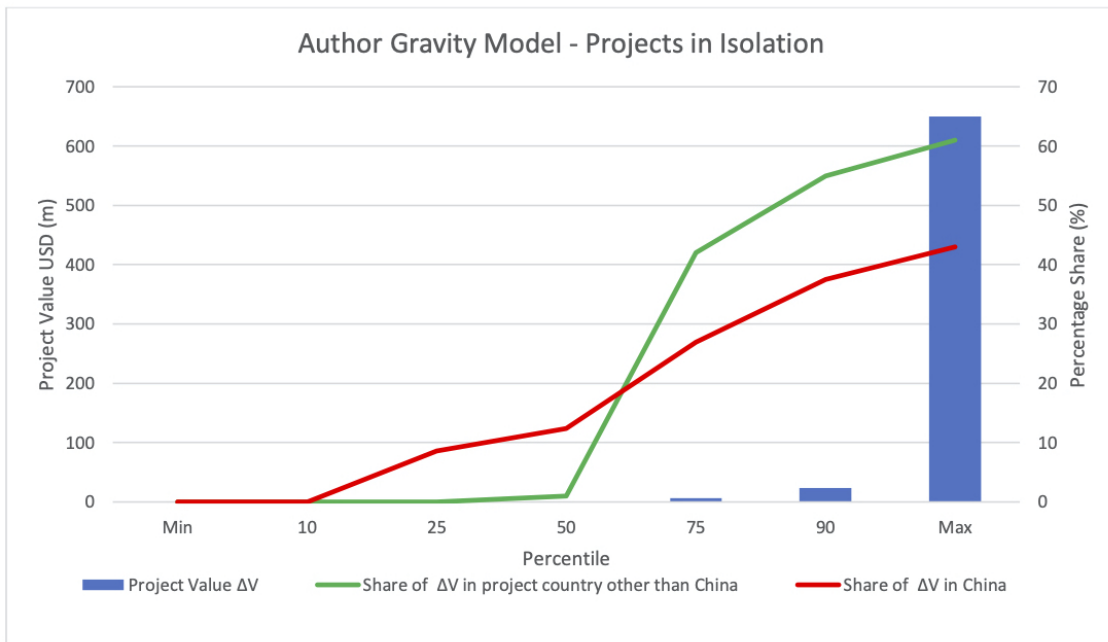
## 8 Appendix 1, Gravity Model Simulation Results

### 8.1 RT Simulation Results

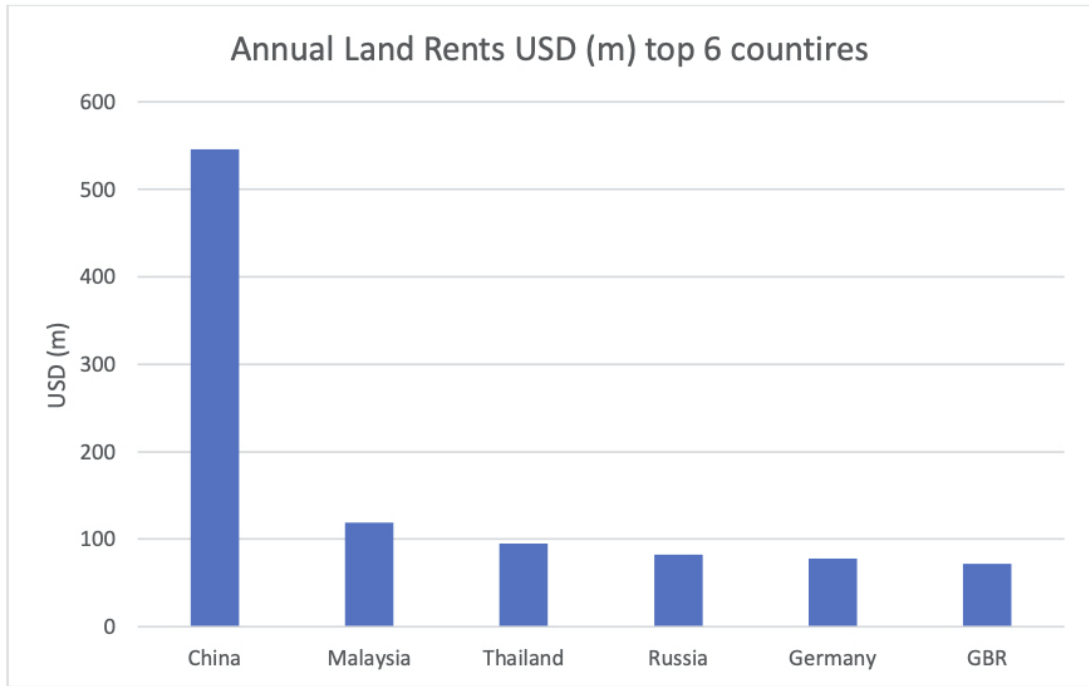


The key result is that a few projects are highly profitable, whilst most will not break even. The benefits, in terms of increased land rents, are not as one sided as some commentators claim. There is a marginal increase in projects built in compliment, i.e certain projects will only become profitable if other projects are built.

## 8.2 Author's Simulation Results



The results shown here very clearly follow that same dynamics as RT in the previous sections, with slightly different dynamics, and values due to the different values inputted to the model and addition of an extra term in the gravity equation.



The majority of benefits accrue to the PRC. This is in line with Gravity model theory, as bigger economies will benefit more from trade, but the balance of benefits, strictly in land rent terms, is reasonably evenly split between the PRC and other countries.

# 9 Appendix 2, Mongolian NPV

Timing	Year	-1	0	1	5	10	15	20	25	30	35	38
	Period start	T0	01/01/2018	01/01/2022	01/01/2027	01/01/2032	01/01/2037	01/01/2042	01/01/2047	01/01/2052	01/01/2055	
	Period end	31/12/2017	31/12/2018	31/12/2022	31/12/2027	31/12/2032	31/12/2037	31/12/2042	31/12/2047	31/12/2052	31/12/2055	
<b>Profit &amp; loss</b>												
<b>Revenue breakdown</b>												
Passenger Rev	USD	-	-	-	-	-	-	-	-	-	-	-
Freight Rev	USD	-	-	239,899,674	279,462,142	325,548,959	379,236,070	441,776,859	514,631,410	599,500,592	657,000,367	
Other	USD	-	-	-	-	-	-	-	-	-	-	-
<b>Total revenues</b>	USD	-	-	239,899,674	279,462,142	325,548,959	379,236,070	441,776,859	514,631,410	599,500,592	657,000,367	
<b>Departmental costs</b>												
Other	USD	-	-	11,994,984	13,973,107	16,277,448	18,961,803	22,088,843	25,731,571	29,975,030	32,850,018	
Personel	USD	-	-	7,196,990	8,383,864	9,766,469	11,377,082	13,253,306	15,438,942	17,985,018	19,710,011	
Reserve for Replacement	USD	-	-	7,196,990	8,383,864	9,766,469	11,377,082	13,253,306	15,438,942	17,985,018	19,710,011	
O&M	USD	-	-	95,959,870	111,784,857	130,219,583	151,694,428	176,710,744	205,852,564	239,800,237	262,800,147	
<b>Cost of sales</b>	USD	-	-	122,348,834	142,525,693	166,029,969	193,410,395	225,306,198	262,462,019	305,745,302	335,070,187	
<b>Gross profit</b>	USD	-	-	117,550,840	136,936,450	159,518,990	185,825,674	216,470,661	252,169,391	293,755,290	321,930,180	
<b>Overheads</b>												
SG&A	USD	-	-	(21,782,890)	(25,375,163)	(29,559,845)	(34,434,635)	(40,113,339)	(46,728,532)	(54,434,654)	(59,655,633)	
Other overheads	USD	-	-	(14,393,980)	(16,767,729)	(19,532,938)	(22,754,164)	(26,506,612)	(30,877,885)	(35,970,036)	(39,420,022)	
Construction costs uncapitalised	USD	-	-	-	-	-	-	-	-	-	-	
<b>Total overheads</b>	USD	-	-	(36,176,871)	(42,142,891)	(49,092,783)	(57,188,799)	(66,619,950)	(77,606,417)	(90,404,689)	(99,075,655)	
<b>EBITDA</b>	USD	-	-	81,373,969	94,793,559	110,426,207	128,636,875	149,850,711	174,562,974	203,350,601	222,854,524	
<b>Depreciation &amp; amortisation</b>												
Interest	USD	-	-	(60,000,000)	(60,000,000)	(60,000,000)	(60,000,000)	(60,000,000)	(60,000,000)	(60,000,000)	(60,000,000)	
<b>Profit before tax</b>	USD	-	-	(74,326,031)	(60,906,441)	(44,527,575)	(22,947,270)	5,125,937	41,213,645	87,157,655	120,362,749	
<b>Tax payable</b>												
	USD	-	-	-	-	-	-	-	-	-	-	
<b>Net profit</b>	USD	-	-	(74,326,031)	(60,906,441)	(44,527,575)	(22,947,270)	5,125,937	41,213,645	87,157,655	120,362,749	
<b>Balance sheet</b>												
<b>Fixed assets by type</b>												
Plant	USD	-	948,750,000	3,675,000,000	3,375,000,000	3,075,000,000	2,775,000,000	2,475,000,000	2,175,000,000	1,875,000,000	1,695,000,000	
Land	USD	-	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	
<b>Total fixed assets</b>	USD	-	953,750,000	3,680,000,000	3,380,000,000	3,080,000,000	2,780,000,000	2,480,000,000	2,180,000,000	1,880,000,000	1,700,000,000	
<b>Cash and equivalents</b>												
Cash	USD	-	2,846,250,000	27,082,273	(5,108,161)	(3,108,161)	(1,108,161)	891,839	2,891,839	4,891,839	6,091,839	
<b>Total current assets</b>	USD	-	2,846,250,000	27,082,273	(5,108,161)	(3,108,161)	(1,108,161)	891,839	2,891,839	4,891,839	6,091,839	
<b>Total assets</b>	USD	-	3,800,000,000	3,707,082,273	3,374,891,839	3,076,891,839	2,778,891,839	2,480,891,839	2,182,891,839	1,884,891,839	1,706,091,839	
<b>Long term liabilities by type</b>												
Senior Debt	USD	-	3,300,000,000	3,300,000,000	3,300,000,000	3,259,195,921	3,121,421,229	2,856,817,973	2,428,473,592	1,790,930,134	1,285,270,899	
Shareholder Creditors	USD	-	-	-	-	-	-	-	-	-	-	
Other	USD	-	-	-	-	-	-	-	-	-	-	
<b>Total long term liabilities</b>	USD	-	3,300,000,000	3,300,000,000	3,300,000,000	3,259,195,921	3,121,421,229	2,856,817,973	2,428,473,592	1,790,930,134	1,285,270,899	
<b>Shareholder equity by type</b>												
Accumulated profit and loss	USD	-	-	(92,917,727)	(425,108,161)	(682,304,082)	(842,529,390)	(875,926,133)	(745,581,753)	(406,038,295)	(79,179,060)	
Common Equity	USD	-	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	
<b>Total shareholder equity</b>	USD	-	500,000,000	407,082,273	74,891,839	(182,304,082)	(342,529,390)	(375,926,133)	(245,581,753)	93,961,705	420,820,940	
<b>Total liabilities &amp; shareholder equity</b>	USD	-	3,800,000,000	3,707,082,273	3,374,891,839	3,076,891,839	2,778,891,839	2,480,891,839	2,182,891,839	1,884,891,839	1,706,091,839	
Check	binary	-	-	-	-	-	-	-	-	-	-	
<b>Cash flow</b>												
EBITDA	USD	-	-	81,373,969	94,793,559	110,426,207	128,636,875	149,850,711	174,562,974	203,350,601	222,854,524	
Taxes	USD	-	-	-	-	-	-	-	-	-	-	
<b>Operating cash flows</b>	USD	-	-	81,373,969	94,793,559	110,426,207	128,636,875	149,850,711	174,562,974	203,350,601	222,854,524	
Capital expenditure	USD	-	(948,750,000)	-	-	-	-	-	-	-	-	
Land purchase	USD	-	(5,000,000)	-	-	-	-	-	-	-	-	
<b>Investing cash flows</b>	USD	-	(953,750,000)	-	-	-	-	-	-	-	-	
Equity investments	USD	-	500,000,000	-	-	-	-	-	-	-	-	
Capital reductions	USD	-	-	-	-	-	-	-	-	-	-	
Senior debt drawdowns	USD	-	3,300,000,000	-	-	-	-	-	-	-	-	
Senior debt interest	USD	-	-	(95,700,000)	(95,700,000)	(94,953,782)	(91,584,145)	(84,724,773)	(73,349,330)	(56,192,946)	(42,491,776)	
Senior debt repayments	USD	-	-	-	-	(15,072,425)	(36,652,730)	(64,725,937)	(100,813,645)	(146,757,655)	(179,962,749)	
Dividends paid	USD	-	-	-	-	-	-	-	-	-	-	
<b>Financing cash flows</b>	USD	-	3,800,000,000	(95,700,000)	(95,700,000)	(110,026,207)	(128,236,875)	(149,450,711)	(174,162,974)	(202,950,601)	(222,454,524)	
<b>Net free cash flows</b>	USD	-	2,846,250,000	(14,326,031)	(906,441)	400,000	400,000	400,000	400,000	400,000	400,000	
Opening cash balance	USD	-	-	41,408,303	(4,201,719)	(3,508,161)	(1,508,161)	491,839	2,491,839	4,491,839	5,691,839	
Change in cash balance	USD	-	2,846,250,000	(14,326,031)	(906,441)	400,000	400,000	400,000	400,000	400,000	400,000	
<b>Closing cash balance</b>	USD	-	2,846,250,000	27,082,273	(5,108,161)	(3,108,161)	(1,108,161)	891,839	2,891,839	4,891,839	6,091,839	



# 10 Appendix 3, Lao PDR Base Case

Timing	Year	0	1	5	10	15	20	25	30	35	38
	Period start	T0	01/01/2018	01/01/2022	01/01/2027	01/01/2032	01/01/2037	01/01/2042	01/01/2047	01/01/2052	01/01/2055
	Period end	31/12/2017	31/12/2018	31/12/2022	31/12/2027	31/12/2032	31/12/2037	31/12/2042	31/12/2047	31/12/2052	31/12/2055
<b>Profit &amp; loss</b>											
Revenue breakdown											
Passenger Rev	USD	-	-	36,608,309	42,645,479	49,678,254	57,870,822	67,414,447	78,531,936	91,482,838	100,257,213
Freight Rev	USD	-	-	172,736,985	201,223,483	234,407,762	273,064,545	318,096,317	370,554,394	431,663,466	473,065,514
Other	USD	-	-	-	-	-	-	-	-	-	-
<b>Total revenues</b>	USD	-	-	209,345,294	243,868,962	284,086,016	330,935,367	385,510,764	449,086,330	523,146,304	573,322,726
Departmental costs											
Other	USD	-	-	10,467,265	12,193,448	14,204,301	16,546,768	19,275,538	22,454,316	26,157,315	28,666,136
Personnel	USD	-	-	6,280,359	7,316,069	8,522,580	9,928,061	11,565,323	13,472,500	15,694,389	17,199,682
Reserve for Replacement	USD	-	-	6,280,359	7,316,069	8,522,580	9,928,061	11,565,323	13,472,500	15,694,389	17,199,682
O&M	USD	-	-	83,738,118	97,547,585	113,634,406	132,374,147	154,204,306	179,634,532	209,258,522	229,329,091
Cost of sales	USD	-	-	106,766,100	124,373,171	144,883,868	168,777,037	196,610,490	229,034,028	266,804,615	292,394,591
<b>Gross profit</b>	USD	-	-	102,579,194	119,495,791	139,202,148	162,158,330	188,900,274	220,052,302	256,341,689	280,928,136
Overheads											
SG&A	USD	-	-	(19,008,553)	(22,143,302)	(25,705,010)	(30,048,931)	(35,004,377)	(40,777,039)	(47,501,684)	(52,057,704)
Other overheads	USD	-	-	(12,560,718)	(14,632,138)	(17,045,161)	(19,856,122)	(23,130,646)	(26,945,180)	(31,388,778)	(34,399,364)
Construction costs uncapitalised	USD	-	-	-	-	-	-	-	-	-	-
<b>Total overheads</b>	USD	-	-	(31,569,270)	(36,775,439)	(42,840,171)	(49,905,053)	(58,135,023)	(67,722,219)	(78,890,463)	(86,457,067)
<b>EBITDA</b>	USD	-	-	71,009,924	82,720,352	96,361,977	112,253,276	130,765,251	152,330,083	177,451,226	194,471,069
Depreciation & amortisation	USD	-	-	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)
Interest	USD	-	-	(156,600,000)	(156,600,000)	(156,600,000)	(156,600,000)	(156,600,000)	(156,600,000)	(155,712,255)	(153,313,248)
<b>Profit before tax</b>	USD	-	-	(170,590,076)	(158,879,648)	(145,238,023)	(129,346,724)	(110,834,749)	(89,269,917)	(63,261,029)	(43,842,179)
Tax payable	USD	-	-	-	-	-	-	-	-	-	-
<b>Net profit</b>	USD	-	-	(170,590,076)	(158,879,648)	(145,238,023)	(129,346,724)	(110,834,749)	(89,269,917)	(63,261,029)	(43,842,179)
<b>Balance sheet</b>											
Fixed assets by type											
Plant	USD	-	1,473,750,000	5,725,000,000	5,300,000,000	4,875,000,000	4,450,000,000	4,025,000,000	3,600,000,000	3,175,000,000	2,920,000,000
Land	USD	-	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
<b>Total fixed assets</b>	USD	-	1,478,750,000	5,730,000,000	5,305,000,000	4,880,000,000	4,455,000,000	4,030,000,000	3,605,000,000	3,180,000,000	2,925,000,000
Cash and equivalents											
Cash	USD	-	4,421,250,000	(122,544,319)	(516,078,147)	(845,384,114)	(1,099,870,237)	(1,267,197,786)	(1,332,993,217)	(1,330,993,217)	(1,329,793,217)
<b>Total current assets</b>	USD	-	4,421,250,000	(122,544,319)	(516,078,147)	(845,384,114)	(1,099,870,237)	(1,267,197,786)	(1,332,993,217)	(1,330,993,217)	(1,329,793,217)
<b>Total assets</b>	USD	-	5,900,000,000	5,607,455,681	4,788,921,853	4,034,615,886	3,355,129,763	2,762,802,214	2,272,006,783	1,849,006,783	1,595,206,783
Long term liabilities by type											
Senior Debt	USD	-	5,400,000,000	5,400,000,000	5,400,000,000	5,400,000,000	5,400,000,000	5,400,000,000	5,400,000,000	5,348,049,136	5,245,905,913
Shareholder Creditors	USD	-	-	-	-	-	-	-	-	-	-
Other	USD	-	-	-	-	-	-	-	-	-	-
<b>Total long term liabilities</b>	USD	-	5,400,000,000	5,400,000,000	5,400,000,000	5,400,000,000	5,400,000,000	5,400,000,000	5,400,000,000	5,348,049,136	5,245,905,913
Shareholder equity by type											
Accumulated profit and loss	USD	-	-	(292,544,319)	(1,111,078,147)	(1,865,384,114)	(2,544,870,237)	(3,137,197,786)	(3,627,993,217)	(3,999,042,353)	(4,150,699,130)
Common Equity	USD	-	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000
<b>Total shareholder equity</b>	USD	-	500,000,000	207,455,681	(611,078,147)	(1,365,384,114)	(2,044,870,237)	(2,637,197,786)	(3,127,993,217)	(3,499,042,353)	(3,650,699,130)
<b>Total liabilities &amp; shareholder equity</b>	USD	-	5,900,000,000	5,607,455,681	4,788,921,853	4,034,615,886	3,355,129,763	2,762,802,214	2,272,006,783	1,849,006,783	1,595,206,783
Check	binary	-	-	-	-	-	-	-	-	-	-
<b>Cash flow</b>											
EBITDA	USD	-	-	71,009,924	82,720,352	96,361,977	112,253,276	130,765,251	152,330,083	177,451,226	194,471,069
Taxes	USD	-	-	-	-	-	-	-	-	-	-
<b>Operating cash flows</b>	USD	-	-	71,009,924	82,720,352	96,361,977	112,253,276	130,765,251	152,330,083	177,451,226	194,471,069
Capital expenditure	USD	-	(1,473,750,000)	-	-	-	-	-	-	-	-
Land purchase	USD	-	(5,000,000)	-	-	-	-	-	-	-	-
<b>Investing cash flows</b>	USD	-	(1,478,750,000)	-	-	-	-	-	-	-	-
Equity investments	USD	-	500,000,000	-	-	-	-	-	-	-	-
Capital reductions	USD	-	-	-	-	-	-	-	-	-	-
Senior debt drawdowns	USD	-	5,400,000,000	-	-	-	-	-	-	-	-
Senior debt interest	USD	-	-	(156,600,000)	(156,600,000)	(156,600,000)	(156,600,000)	(156,600,000)	(156,600,000)	(155,712,255)	(153,313,248)
Senior debt repayments	USD	-	-	-	-	-	-	-	-	(21,338,971)	(40,757,821)
Dividends paid	USD	-	-	-	-	-	-	-	-	-	-
<b>Financing cash flows</b>	USD	-	5,900,000,000	(156,600,000)	(156,600,000)	(156,600,000)	(156,600,000)	(156,600,000)	(156,600,000)	(177,051,226)	(194,071,069)
<b>Net free cash flows</b>	USD	-	4,421,250,000	(85,590,076)	(73,879,648)	(60,238,023)	(44,346,724)	(25,834,749)	(4,269,917)	400,000	400,000
Opening cash balance	USD	-	-	(36,954,243)	(442,198,499)	(785,146,090)	(1,055,523,513)	(1,241,363,037)	(1,328,723,300)	(1,331,393,217)	(1,330,193,217)
Change in cash balance	USD	-	4,421,250,000	(85,590,076)	(73,879,648)	(60,238,023)	(44,346,724)	(25,834,749)	(4,269,917)	400,000	400,000
Closing cash balance	USD	-	4,421,250,000	(122,544,319)	(516,078,147)	(845,384,114)	(1,099,870,237)	(1,267,197,786)	(1,332,993,217)	(1,330,993,217)	(1,329,793,217)

# 11 Appendix 4, Lao PDR Break Even Case

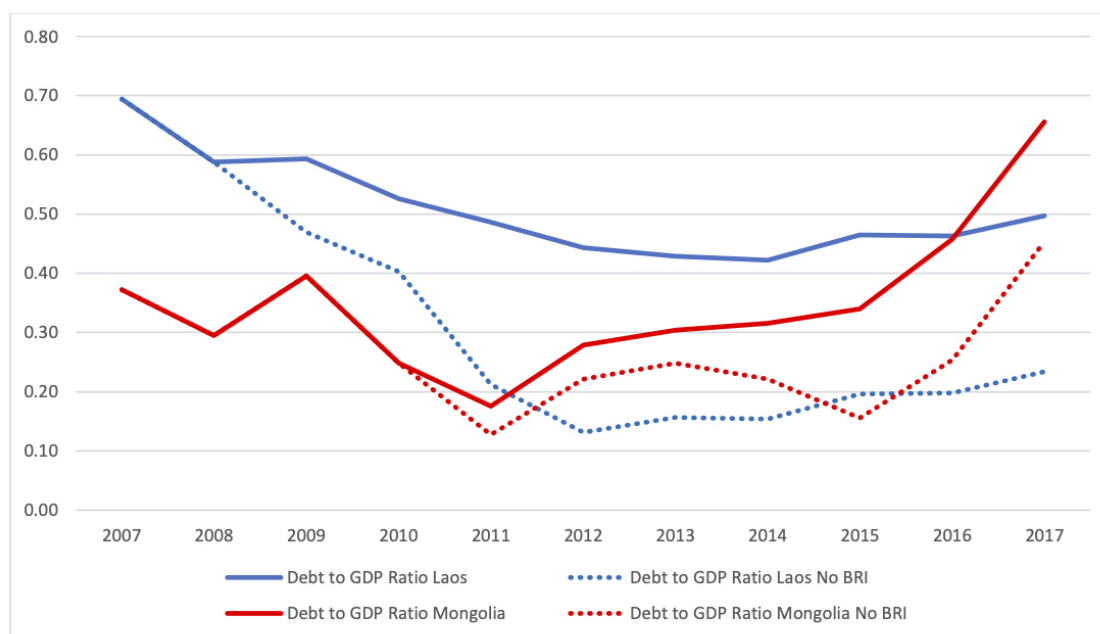
Timing	Year	0	1	5	10	15	20	25	30	35	38
	Period start	T0	01/01/2018	01/01/2022	01/01/2027	01/01/2032	01/01/2037	01/01/2042	01/01/2047	01/01/2052	01/01/2055
	Period end	31/12/2017	31/12/2018	31/12/2022	31/12/2027	31/12/2032	31/12/2037	31/12/2042	31/12/2047	31/12/2052	31/12/2055
<b>Profit &amp; loss</b>											
<b>Revenue breakdown</b>											
Passenger Rev	USD	-	-	36,156,355	42,118,992	49,064,942	57,156,367	66,582,170	77,562,406	90,353,420	99,019,469
Freight Rev	USD	-	-	364,953,206	425,138,572	495,249,261	576,922,083	672,063,778	782,895,534	912,004,838	999,477,767
Other	USD	-	-	-	-	-	-	-	-	-	-
<b>Total revenues</b>	USD	-	-	401,109,561	467,257,564	544,314,203	634,078,450	738,645,948	860,457,940	1,002,358,258	1,098,497,236
<b>Departmental costs</b>											
Other	USD	-	-	20,055,478	23,362,878	27,215,710	31,703,923	36,932,297	43,022,897	50,117,913	54,924,862
Personnel	USD	-	-	12,033,287	14,017,727	16,329,426	19,022,354	22,159,378	25,813,738	30,070,748	32,954,917
Reserve for Replacement	USD	-	-	12,033,287	14,017,727	16,329,426	19,022,354	22,159,378	25,813,738	30,070,748	32,954,917
Op&M	USD	-	-	160,443,824	186,903,026	217,725,681	253,631,380	295,458,379	344,183,176	400,943,303	439,398,894
<b>Cost of sales</b>	USD	-	-	204,565,876	238,301,358	277,600,244	323,380,010	376,709,434	438,833,549	511,202,712	560,233,590
<b>Gross profit</b>	USD	-	-	196,543,685	228,956,206	266,713,960	310,698,441	361,936,515	421,624,390	491,155,546	538,263,646
<b>Overheads</b>											
SG&A	USD	-	-	(36,420,748)	(42,426,987)	(49,423,730)	(57,574,323)	(67,069,052)	(78,129,581)	(91,014,130)	(99,743,549)
Other overheads	USD	-	-	(24,066,574)	(28,035,454)	(32,658,852)	(38,044,707)	(44,318,757)	(51,627,476)	(60,141,495)	(65,909,834)
Construction costs uncapitalised	USD	-	-	-	-	-	-	-	-	-	-
<b>Total overheads</b>	USD	-	-	(60,487,322)	(70,462,441)	(82,082,582)	(95,619,030)	(111,387,809)	(129,757,057)	(151,155,625)	(165,653,383)
<b>EBITDA</b>	USD	-	-	136,056,363	158,493,766	184,631,378	215,079,410	250,548,706	291,867,333	339,999,921	372,610,262
<b>Depreciation &amp; amortisation</b>	USD	-	-	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)
<b>Interest</b>	USD	-	-	(156,600,000)	(156,600,000)	(154,858,182)	(148,583,085)	(136,374,683)	(116,501,812)	(86,832,164)	(65,051,056)
<b>Profit before tax</b>	USD	-	-	(105,543,637)	(83,106,234)	(55,226,804)	(18,503,675)	29,174,023	90,365,521	168,167,757	222,559,207
<b>Tax payable</b>	USD	-	-	-	-	-	-	-	-	-	(53,414,210)
<b>Net profit</b>	USD	-	-	(105,543,637)	(83,106,234)	(55,226,804)	(18,503,675)	29,174,023	90,365,521	168,167,757	169,144,997
<b>Balance sheet</b>											
<b>Fixed assets by type</b>											
Plant	USD	-	1,473,750,000	5,725,000,000	5,300,000,000	4,875,000,000	4,450,000,000	4,025,000,000	3,600,000,000	3,175,000,000	2,920,000,000
Land	USD	-	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
<b>Total fixed assets</b>	USD	-	1,478,750,000	5,730,000,000	5,305,000,000	4,880,000,000	4,455,000,000	4,030,000,000	3,605,000,000	3,180,000,000	2,925,000,000
<b>Cash and equivalents</b>											
Cash	USD	-	4,421,250,000	52,099,907	13,830,725	15,830,725	17,830,725	19,830,725	21,830,725	23,830,725	25,030,725
<b>Total current assets</b>	USD	-	4,421,250,000	52,099,907	13,830,725	15,830,725	17,830,725	19,830,725	21,830,725	23,830,725	25,030,725
<b>Total assets</b>	USD	-	5,900,000,000	5,782,099,907	5,318,830,725	4,895,830,725	4,472,830,725	4,049,830,725	3,626,830,725	3,203,830,725	2,950,030,725
<b>Long term liabilities by type</b>											
Senior Debt	USD	-	5,400,000,000	5,400,000,000	5,398,506,234	5,310,564,100	5,057,458,346	4,588,801,254	3,842,338,344	2,741,444,806	1,989,394,853
Shareholder Creditors	USD	-	-	-	-	-	-	-	-	-	-
Other	USD	-	-	-	-	-	-	-	-	-	-
<b>Total long term liabilities</b>	USD	-	5,400,000,000	5,400,000,000	5,398,506,234	5,310,564,100	5,057,458,346	4,588,801,254	3,842,338,344	2,741,444,806	1,989,394,853
<b>Shareholder equity by type</b>											
Accumulated profit and loss	USD	-	-	(117,900,093)	(579,675,509)	(914,733,375)	(1,084,627,621)	(1,038,970,529)	(715,507,618)	(37,614,081)	460,635,873
Common Equity	USD	-	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000
<b>Total shareholder equity</b>	USD	-	500,000,000	382,099,907	(79,675,509)	(414,733,375)	(584,627,621)	(538,970,529)	(215,507,618)	462,385,919	960,635,873
<b>Total liabilities &amp; shareholder equity</b>	USD	-	5,900,000,000	5,782,099,907	5,318,830,725	4,895,830,725	4,472,830,725	4,049,830,725	3,626,830,725	3,203,830,725	2,950,030,725
<b>Check</b>	binary	-	-	-	-	-	-	-	-	-	-
<b>Cash flow</b>											
<b>EBITDA</b>	USD	-	-	136,056,363	158,493,766	184,631,378	215,079,410	250,548,706	291,867,333	339,999,921	372,610,262
<b>Taxes</b>	USD	-	-	-	-	-	-	-	-	-	(53,414,210)
<b>Operating cash flows</b>	USD	-	-	136,056,363	158,493,766	184,631,378	215,079,410	250,548,706	291,867,333	339,999,921	319,196,053
<b>Capital expenditure</b>	USD	-	(1,473,750,000)	-	-	-	-	-	-	-	-
<b>Land purchase</b>	USD	-	(5,000,000)	-	-	-	-	-	-	-	-
<b>Investing cash flows</b>	USD	-	(1,478,750,000)	-	-	-	-	-	-	-	-
<b>Equity investments</b>	USD	-	500,000,000	-	-	-	-	-	-	-	-
<b>Capital reductions</b>	USD	-	-	-	-	-	-	-	-	-	-
<b>Senior debt drawdowns</b>	USD	-	5,400,000,000	-	-	-	-	-	-	-	-
<b>Senior debt interest</b>	USD	-	-	(156,600,000)	(156,600,000)	(154,858,182)	(148,583,085)	(136,374,683)	(116,501,812)	(86,832,164)	(65,051,056)
<b>Senior debt repayments</b>	USD	-	-	(1,493,766)	(29,373,196)	(66,096,325)	(113,774,023)	(174,965,521)	(252,767,757)	(253,744,997)	
<b>Dividends paid</b>	USD	-	-	-	-	-	-	-	-	-	-
<b>Financing cash flows</b>	USD	-	5,900,000,000	(156,600,000)	(158,093,766)	(184,231,378)	(214,679,410)	(250,148,706)	(291,467,333)	(339,599,921)	(318,796,053)
<b>Net free cash flows</b>	USD	-	4,421,250,000	(20,543,637)	400,000	400,000	400,000	400,000	400,000	400,000	400,000
<b>Opening cash balance</b>	USD	-	-	72,643,544	13,430,725	15,430,725	17,430,725	19,430,725	21,430,725	23,430,725	24,630,725
<b>Change in cash balance</b>	USD	-	4,421,250,000	(20,543,637)	400,000	400,000	400,000	400,000	400,000	400,000	400,000
<b>Closing cash balance</b>	USD	-	4,421,250,000	52,099,907	13,830,725	15,830,725	17,830,725	19,830,725	21,830,725	23,830,725	25,030,725

# 12 Appendix 5, Lao PDR All Passanger Case

Timing	Year	0	1	5	10	15	20	25	30	35	38
	Period start	T0	01/01/2018	01/01/2022	01/01/2027	01/01/2032	01/01/2037	01/01/2042	01/01/2047	01/01/2052	01/01/2055
	Period end	31/12/2017	31/12/2018	31/12/2022	31/12/2027	31/12/2032	31/12/2037	31/12/2042	31/12/2047	31/12/2052	31/12/2055
<b>Profit &amp; loss</b>											
<b>Revenue breakdown</b>											
Passenger Rev	USD	-	-	397,719,903	463,308,909	539,714,365	628,720,041	732,403,870	853,186,464	993,887,625	1,089,214,161
Freight Rev	USD	-	-	-	-	-	-	-	-	-	-
Other	USD	-	-	-	-	-	-	-	-	-	-
<b>Total revenues</b>	USD	-	-	397,719,903	463,308,909	539,714,365	628,720,041	732,403,870	853,186,464	993,887,625	1,089,214,161
<b>Departmental costs</b>											
Other	USD	-	-	19,885,995	23,165,445	26,985,718	31,436,002	36,620,193	42,659,323	49,694,381	54,460,708
Personel	USD	-	-	11,931,597	13,899,267	16,191,431	18,861,601	21,972,116	25,595,594	29,816,629	32,676,425
Reserve for Replacement	USD	-	-	11,931,597	13,899,267	16,191,431	18,861,601	21,972,116	25,595,594	29,816,629	32,676,425
OK&M	USD	-	-	159,087,961	185,323,563	215,885,746	251,488,016	292,961,548	341,274,586	397,555,050	435,685,664
<b>Cost of sales</b>	USD	-	-	202,837,150	236,287,543	275,254,326	320,647,221	373,525,974	435,125,097	506,882,689	555,499,222
<b>Gross profit</b>	USD	-	-	194,882,752	227,021,365	264,460,039	308,072,820	358,877,896	418,061,367	487,004,936	533,714,939
<b>Overheads</b>											
SG&A	USD	-	-	(36,112,967)	(42,068,449)	(49,006,064)	(57,087,780)	(66,502,271)	(77,469,331)	(90,244,996)	(98,900,646)
Other overheads	USD	-	-	(23,863,194)	(27,798,535)	(32,382,862)	(37,723,202)	(43,944,232)	(51,191,188)	(59,633,257)	(65,352,850)
Construction costs uncapitalised	USD	-	-	-	-	-	-	-	-	-	-
Total overheads	USD	-	-	(59,976,161)	(69,866,983)	(81,388,926)	(94,810,982)	(110,446,504)	(128,660,519)	(149,878,254)	(164,253,495)
<b>EBITDA</b>	USD	-	-	134,906,591	157,154,382	183,071,113	213,261,838	248,431,393	289,400,849	337,126,682	369,461,443
<b>Depreciation &amp; amortisation</b>	USD	-	-	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)	(85,000,000)
<b>Interest</b>	USD	-	-	(156,600,000)	(156,600,000)	(155,076,768)	(149,089,893)	(137,255,991)	(117,864,084)	(88,806,287)	(66,829,110)
<b>Profit before tax</b>	USD	-	-	(106,693,409)	(84,445,618)	(57,005,655)	(20,828,055)	26,175,401	86,536,765	163,320,395	217,632,334
<b>Tax payable</b>	USD	-	-	-	-	-	-	-	-	-	(52,231,760)
<b>Net profit</b>	USD	-	-	(106,693,409)	(84,445,618)	(57,005,655)	(20,828,055)	26,175,401	86,536,765	163,320,395	165,400,574
<b>Balance sheet</b>											
<b>Fixed assets by type</b>											
Plant	USD	-	1,473,750,000	5,725,000,000	5,300,000,000	4,875,000,000	4,450,000,000	4,025,000,000	3,600,000,000	3,175,000,000	2,920,000,000
Land	USD	-	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
<b>Total fixed assets</b>	USD	-	1,478,750,000	5,730,000,000	5,305,000,000	4,880,000,000	4,455,000,000	4,030,000,000	3,605,000,000	3,180,000,000	2,925,000,000
<b>Cash and equivalents</b>											
Cash	USD	-	4,421,250,000	49,012,865	5,776,945	7,776,945	9,776,945	11,776,945	13,776,945	15,776,945	16,976,945
<b>Total current assets</b>	USD	-	4,421,250,000	49,012,865	5,776,945	7,776,945	9,776,945	11,776,945	13,776,945	15,776,945	16,976,945
<b>Total assets</b>	USD	-	5,900,000,000	5,779,012,865	5,310,776,945	4,887,776,945	4,464,776,945	4,041,776,945	3,618,776,945	3,195,776,945	2,941,976,945
<b>Long term liabilities by type</b>											
Senior Debt	USD	-	5,400,000,000	5,400,000,000	5,399,845,618	5,319,880,408	5,077,258,846	4,622,189,820	3,893,141,980	2,814,365,365	2,054,451,486
Shareholder Creditors	USD	-	-	-	-	-	-	-	-	-	-
Other	USD	-	-	-	-	-	-	-	-	-	-
<b>Total long term liabilities</b>	USD	-	5,400,000,000	5,400,000,000	5,399,845,618	5,319,880,408	5,077,258,846	4,622,189,820	3,893,141,980	2,814,365,365	2,054,451,486
<b>Shareholder equity by type</b>											
Accumulated profit and loss	USD	-	-	(120,987,135)	(589,068,674)	(932,103,464)	(1,112,481,902)	(1,080,412,875)	(774,365,036)	(118,588,420)	387,525,458
Common Equity	USD	-	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000	500,000,000
<b>Total shareholder equity</b>	USD	-	500,000,000	379,012,865	(89,068,674)	(432,103,464)	(612,481,902)	(580,412,875)	(274,365,036)	381,411,580	887,525,458
<b>Total liabilities &amp; shareholder equity</b>	USD	-	5,900,000,000	5,779,012,865	5,310,776,945	4,887,776,945	4,464,776,945	4,041,776,945	3,618,776,945	3,195,776,945	2,941,976,945
<b>Check</b>	binary	-	-	-	-	-	-	-	-	-	-
<b>Cash flow</b>											
<b>EBITDA</b>	USD	-	-	134,906,591	157,154,382	183,071,113	213,261,838	248,431,393	289,400,849	337,126,682	369,461,443
<b>Taxes</b>	USD	-	-	-	-	-	-	-	-	-	(52,231,760)
<b>Operating cash flows</b>	USD	-	-	134,906,591	157,154,382	183,071,113	213,261,838	248,431,393	289,400,849	337,126,682	317,229,683
<b>Capital expenditure</b>	USD	-	(1,473,750,000)	-	-	-	-	-	-	-	-
<b>Land purchase</b>	USD	-	(5,000,000)	-	-	-	-	-	-	-	-
<b>Investing cash flows</b>	USD	-	(1,478,750,000)	-	-	-	-	-	-	-	-
<b>Equity investments</b>	USD	-	500,000,000	-	-	-	-	-	-	-	-
<b>Capital reductions</b>	USD	-	-	-	-	-	-	-	-	-	-
<b>Senior debt drawdowns</b>	USD	-	5,400,000,000	-	-	-	-	-	-	-	-
<b>Senior debt interest</b>	USD	-	-	(156,600,000)	(156,600,000)	(155,076,768)	(149,089,893)	(137,255,991)	(117,864,084)	(88,806,287)	(66,829,110)
<b>Senior debt repayments</b>	USD	-	-	(154,382)	(27,594,345)	(63,771,945)	(110,775,401)	(171,136,765)	(247,920,395)	(250,000,574)	-
<b>Dividends paid</b>	USD	-	-	-	-	-	-	-	-	-	-
<b>Financing cash flows</b>	USD	-	5,900,000,000	(156,600,000)	(156,754,382)	(182,671,113)	(212,861,838)	(248,031,393)	(289,000,849)	(336,726,682)	(316,829,683)
<b>Net free cash flows</b>	USD	-	4,421,250,000	(21,693,409)	400,000	400,000	400,000	400,000	400,000	400,000	400,000
<b>Opening cash balance</b>	USD	-	-	70,706,274	5,376,945	7,376,945	9,376,945	11,376,945	13,376,945	15,376,945	16,576,945
<b>Change in cash balance</b>	USD	-	4,421,250,000	(21,693,409)	400,000	400,000	400,000	400,000	400,000	400,000	400,000
<b>Closing cash balance</b>	USD	-	4,421,250,000	49,012,865	5,776,945	7,776,945	9,776,945	11,776,945	13,776,945	15,776,945	16,976,945

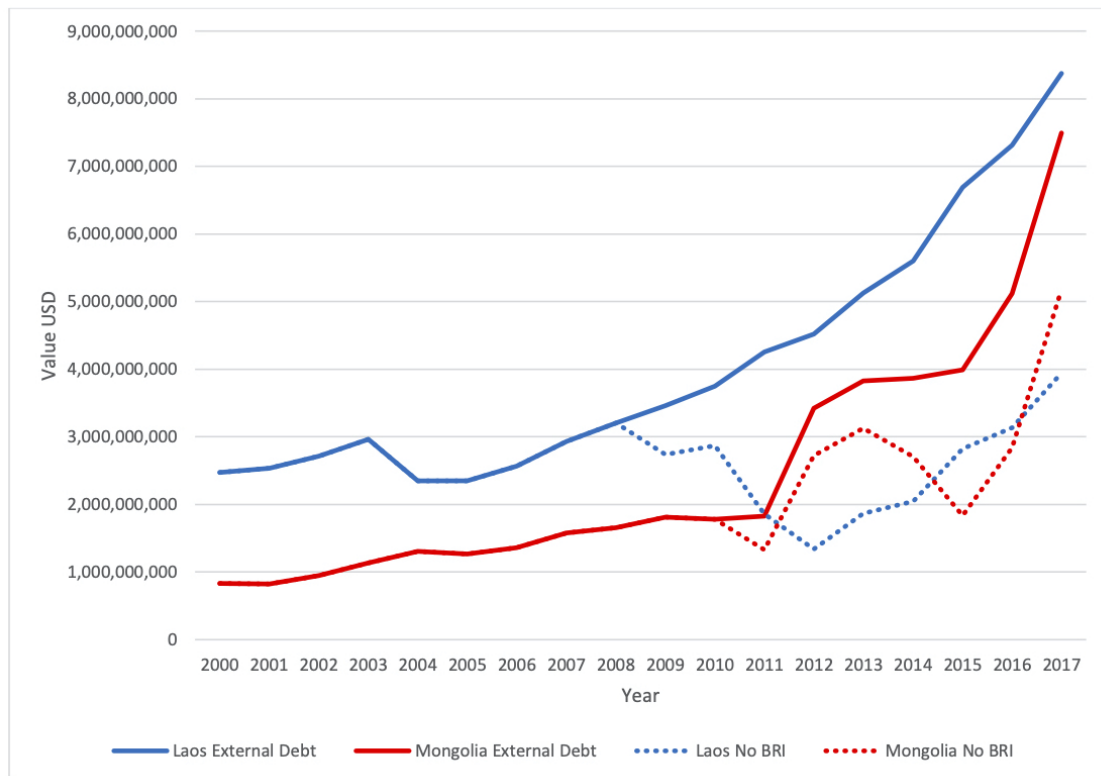
## 13 Appendix 6, Debt to GDP Ratios and Total Quantum Counterfactual Simulations

### 13.1 Debt to GDP ratios for Lao PDR and Mongolia with and without BRI debt



The solid lines represent the actual debt to GDP for Lao PDR and Mongolia, using the World Bank's International Debt Statistics 2020 book (<https://openknowledge.worldbank.org/handle/10986/32382>). The value of government debt is taken from the time series "DT.DOD.DECT.CD", which represents all debt, debt guarantees and arrears on interest payments. This particular index was chosen to best represent the current total, including contingent, liability of the governments. The dashed line shows the ratios for both countries had there been to BRI debt. The BRI debt for Lao PDR is the debt from the Lao PDR - PRC Railway, for Mongolia it is all debt associated with the Chinese and Railways investments. The value for both countries were cross-referenced against the database from: Horn, Sebastian, Carmen M. Reinhart, and Christoph Trebesch. 2019. "China's Overseas Lending." NBER Working Paper No. 26050.

## 13.2 Debt Quantum for Lao PDR and Mongolia with and without BRI debt



This chart is the same as 6.7.1, except the values are the total debt quantum and not ratios. The calculation was the same as 6.7.1

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