DOI: 10.32602/jafas.2021.012

JOURNAL OF ACCOUNTING, FINANCE AND AUDITING STUDIES

http://www.jafas.org

Assessment of a Value at Risk in Heavy Construction Equipment Energy Efficiency Projects

Vakhtang Berishvili[a]

[a] Caucasus University, Caucasus School of Business, vberishvili@cu.edu.ge

Keywords
Energy efficiency, Value at Risk, Investment valuation, Monte Carlo simulation,

Jel Classification
C53, Q42, G11.

Paper Type
Research Article

Received
08.01.2021

Revised
16.02.2021

Accepted
05.03.2021

Abstract

Purpose: Energy efficiency projects can save money for companies but are not always accepted with great enthusiasm. High risk may be the reason of hesitancy. Current research designed model that can assesses risk by considering volatile factors that affect value of the project and evaluated energy efficiency investments.

Methodology: Model calculated Value at Risk using Monte Carlo simulation. Financial risk of two heavy equipment energy efficiency projects in Georgia was evaluated.

Findings: Results indicated that if investment costs are high compared with present value of energy savings (90%) risk may be substantial but its level drops to the low level if investment costs are lower (70%).

Significance: Research and elaborated model can help manages to quantify risks and make thorough decisions regarding investment in energy efficiency projects.

1. Introduction

In present world, Energy Efficiency (EE) is important. Countries and companies understand that in the world of growing energy consumption and prices, energy efficient measures can decrease consumption and thus save money. Constantly increasing share of EE technologies and introduction of EE promoting legislation in increasing number of countries can serve as an evidence of this fact. (International Energy Agency, 2019; World Energy Council, 2016).

Nevertheless, some scholars observe reluctance and slow adaptation of EE technologies in projects, even where financial criteria is fully satisfied (like positive Net Present Value (NPV), short Payback periods or Internal Rates of Return (IRR) that exceed required rates). This fact is called “energy paradox” or “energy efficiency paradox”. (Jaffe et al., 1994). Paradox” is explained by several causes, like unwilling to adopt new (hence unproven) technology, increased initial investment costs, unwilling to invest in technology that might have no secondary market, etc. Most of the reasons can be attributed to risk aversion of companies. (Allcott & Greenstone, 2012; Jackson, 2010).

Conversation with representatives of several construction equipment vendors in Georgia and Georgian Leasing Company (GLC) revealed that “paradox” is observed in Georgia in projects that consider heavy equipment acquisition. According to them, consumers often choose to buy older second hand (or rarely new) equipment that has no EE features. This is true even for projects where normal case financial evaluation show certainly positive NPVs generated solely by energy savings. We can assume that there are significant factors that increase risk of the cash flows of projects and companies can expect negative NPVs in these projects with high probability.

Our intention was to produce adapted model that can be used by decision makers and vendors to check riskiness of investments in EE construction equipment. Model checks level of the risk in such projects, considering most of the volatile factors in Georgian economy that may affect cash flows. Two projects were studied. One project has 15% higher energy saving, but 67% less annual workload than another. Real life cases were provided by Energy Investment Consultants Ltd. (EIC) and Georgian Leasing Company Ltd (GLC).

Value at Risk (VaR) is calculated using Monte Carlo simulation. (Saunders & Cornett, 2008). VaR or Net-Present-Value-at-Risk measure riskiness of the projects by calculating values that can be lost during defined period with defined probability (or confidence). Such approach can easily be applied to EE projects. (Bagui & Ghosh, 2012; Dziadosz et al., 2015).

2. Research Methodology and Model Design

To evaluate riskiness of the projects Value at Risk at 99.99%, 99%, 98%, 95% and 90% confidence levels for whole length of the projects were calculated.

Having flexibility of the model in mind, was decided not to focus on one particular investment amount but to calculate VaR at several levels of investment costs compared to present values (PV) of energy savings in base case scenario. Calculations were made for cases when initial investment is 90%, 80%, 70%, 60% and 50% of PV of savings.

Equipment prices in Georgia usually are set in US dollars or Euro, while payments are made in GEL based on current exchange rate. Most of loan or lease obligations are denominated in mentioned currencies since companies prefer to borrow in USD or EUR because of lower interest rates in comparison to loans denominated in GEL. All expenses and inflows (including savings) generated from operations of Georgian companies are in GEL exposing them to GEL/USD or GEL/EUR exchange rate risk. For simplicity of calculations, we decided to focus USD, especially since EUR and other currencies exchange rates are defined as cross rates with USD.

Present value of savings was calculated by converting annual savings from GEL to USD and discounted.

Discount rate was derived from cost of capital of United States Engineering/Construction industry by adding Georgia Country Risk Premium (Damodaran, 2020).

For simulations changes of discount rate was obtained by finding volatility and mean of interest rate monthly percentage changes in Georgia from May 2009 until May 2020. Annualized parameters were used for simulations. Simulation was made only for the starting moment of the project, without considering changes in following years.

In the model, all local currency amounts are converted to USD. May 1, 2020 exchange rate (3.206 GEL for one USD) is used for base case calculations and as an initial seed for simulations.

Historical data starting from May 22, 2009, when Georgian lari was introduced on Bloomberg trading system, is used to calculate GEL/USD exchange rate daily percentage change mean and volatility (standard deviation). Daily data is annualized. Interest rate and exchange rate data is obtained from National Bank of Georgia. (*National Bank of Georgia*, n.d.).

Fuel price is calculated as an average of prices of three fuel retailers. Historical prices are denominated in GEL. Prices of "Euro Diesel" (as called by fuel companies) grade fuel are used. Fuel price of May 1, 2020 - 2.25 GEL per liter is used for base case calculations and as a starting point for simulations. Historical data starting from December 1, 2012 (from when prices of all three vendors are available) is used to calculate daily percentage change in prices (*Fuel Prices | Gulf*, n.d.; *Lukoil*, n.d.; *Prices | SOCAR Georgia Petroleum*, n.d.). Subsequently daily percentage change mean and standard deviation is calculated and annualized.

Annualization of mean and standard deviation are calculated by following formulas:

- Annual mean of change = (Daily mean + 1) number of days-1

- Annual standard deviation of change = Daily standard deviation X square root of number of days

In case of GEL/USD exchange rate number of days equal to 251 (number of currency trading days) and in case of fuel prices number of days equals to 365, considering that fuel is traded all days during a year. Number of months in a year was used instead of number of days for interest rates.

Simulation cases were generated in Microsoft Excel using Norm.Inv function with random probability and historical annualized standard deviation and mean parameters. One hundred thousand cases were obtained for random changes in exchange rate, fuel price and discount rate.

Random walk approach was used to simulate GEL/USD rates and fuel prices for each of ten years of the project. Factors for the year were calculated based on previous year (base case for Year1) factor and simulated change.

Considering, that even during the COVID19 pandemic lockdowns construction businesses were not stopped in country, model does not evaluate long time interruptions in project implementation. Only 5% of probability that equipment will not be used during one whole month during any particular year is built-in to reflected possible occasional pauses.

Total number of cases of projects' NPVs calculated based on simulations was one hundred thousand.

In addition to VaR, confidence level (percentile) at which all values are not negative (>=0) for each of the initial investment scenarios were computed.

Approach used during the research has several limitations. No single standard for level of a risk exists and relative measures should be used for comparison or interpretation. In general, risk should be measured according to the risk tolerance of interested party. Model does not consider some factors that are not directly related with EE, but can considerably change cash flows of any project, such as repair and maintenance costs or liquidity of second-hand equipment.

3. Description of cases

One project considered acquisition of CAT 330D2L Crawler Excavator (Project 1) and another SDLG L953F Wheel Loader (Project 2) as a replacement of older, non-EE machinery. According to base scenario data, both projects displayed positive NPVs and were implemented to the best of our knowledge. Information about projects is provided in Table 1.

Table 1 Project data (base case scenarios)

Data item	Project 1	Project 2
Equipment	Crawler excavator	Wheel Loader
Planned annual workload, hours	2,628	4,380
Average fuel consumption of new equipment, liter per hour	19.25	15.00
Average fuel consumption of old equipment, liter per hour	27.60	22.10
Annual Savings, liters	21,944	31,098
Annual savings, GEL	49,374	69,971
Annual Savings, USD	15,400	21,825
Project duration, years	10	10
Discount Rate	12.44%	12.44%

4. Results and discussion

For projected conditions (base case), present value of savings for Project 1 is $85,456 USD and for Project 2 is $121,106 USD. Simple decision rule says that if initial investment is less than this amount NPV will be positive and project should be accepted.

Present values of energy savings and NPVs for different investment costs are provided in Table 2.

Table 2 Present values of savings and NPVs of projects for different scenarios

Investment as % of PVs of savings	Present value of savings		NPVs	
	Project 1	Project 2	Project 1	Project 2
90%	$76,911	$108,995	$8,546	$12,111
80%	$68,365	$96,885	$17,091	$24,221
70%	$59,820	$84,774	$25,637	$36,332
60%	$51,274	$72,664	$34,183	$48,442
50%	$42,728	$60,553	$42,728	$60,553

Simulations allowed us to calculate VaR at different confidence level (probability). Results of simulations for the projects 1 and 2 are presented in Table 3. Negative amount represents VaR and positive numbers indicate that at given level of investment and probability simulation does not possess any risk.

Table 3 VaR at different investment costs and confidence level for Projects in USD

			VaR at Initial investment as % of PV of savings				
			90%	80%	70%	60%	50%
Confidence level	Project 1	99.99%	(35,026)	(26,480)	(17,934)	(9,389)	(843)
		99.00%	(25,105)	(16,559)	(8,014)	532	9,077
		98.00%	(22,852)	(14,306)	(5,761)	2,785	11,331
		95.00%	(19,369)	(10,823)	(2,278)	6,268	14,814
		90.00%	(16,159)	(7,613)	933	9,478	18,024
	Project 2	99.99%	(49,406)	(37,295)	(25,185)	(13,074)	(964)
		99.00%	(35,463)	(23,353)	(11,242)	868	12,979
		98.00%	(32,275)	(20,164)	(8,053)	4,057	16,168
		95.00%	(27,405)	(15,294)	(3,184)	8,927	21,037
		90.00%	(22,820)	(10,710)	1,401	13,511	25,622

Interpretation is simple. For instance, if investment cost are 90% of PV of savings, NPV will not be less than -$25,105 USD with 99% certainty for Project 1. Or, if investment costs are 70% of PV of savings NPV will not be less than -$3,184 USD with 95% probability for Project 2.

To assess level of the risk we can compare calculated VaR with NPVs from base case scenario. Results for projects are listed in Table 4.

Table 4 VaR as % of base case scenario NPV for Projects

			VaR fraction at Initial investment as % of PV of savings				
			90%	**80%**	**70%**	**60%**	**50%**
Confidence level	**Project 1**	**99.99%**	409.87%	154.93%	69.96%	27.47%	1.97%
		99.00%	293.78%	96.89%	31.26%	-	-
		98.00%	267.41%	83.70%	22.47%	-	-
		95.00%	226.65%	63.33%	8.88%	-	-
		90.00%	189.09%	44.54%	-	-	-
	Project 2	**99.99%**	407.96%	153.98%	69.32%	26.99%	1.59%
		99.00%	292.83%	96.41%	30.94%	-	-
		98.00%	266.50%	83.25%	22.17%	-	-
		95.00%	226.29%	63.14%	8.76%	-	-
		90.00%	188.43%	44.22%	-	-	-

Numbers indicate, that certain level of risk exist at any probability when investment costs are 90% of PV of savings, risks are considerably lower if investments are at 80% or 70% and with 99% confidence we can assume that there will be no losses in both projects, if initial investments are 60% of PV of savings.

Finally, we calculated probabilities at which values are not negative at different investment costs. Results are in Table 5.

Table 5 Percentile (confidence level) at which values are not negative at different investment costs

		Confidence level at Initial investment as % of PV of savings				
		90%	**80%**	**70%**	**60%**	**50%**
Confidence level	**Project 1**	41.36%	70.03%	91.62%	99.19%	99.99%
	Project 2	41.29%	69.84%	91.72%	99.21%	99.99%

Numbers indicate that, for example, for Project 1 that requires investment of 90% of PV of predicted savings could be 41.36% sure that project will end up with positive value and if investment costs are 60% of savings, certainty of positive outcome is 99.19%. Numbers for Project 2 are similar with slight differences.

5. Conclusions

The model can address several factors that affect cash flows and value of a project, assess certain risks, and so may help companies interested in selling or buying EE equipment to make a decision.

In addition, results indicate that for some heavy equipment EE projects in Georgia, given the volatility of factors influencing the value of the project, if the investment costs are high (90 or 80% of the energy saving PV) we can not presume that the risk is low. If the investment cost are around 60% of PV of the savings or less, the risk of losing company value because of EE project is relatively low; therefore, companies can be more courageous starting such projects. Whether possibility to identify such projects depends on the economic conditions, the development of EE technologies, and decrease of EE technology price, considering current trends, perspectives are optimistic.

Acknowledgments

The author expresses his deep gratitude to European Union's Horizon 2020 research and innovation programme funded project "Energy financing mix in order to activate private sector finance for increased investments in sustainable energy project" for provided support, as well as Georgian Leasing Company, and EIC for provided information.

References

Allcott, H., & Greenstone, M. (2012). *Is There an Energy Effi ciency Gap ? 26*(1), 3–28.

Bagui, S. K., & Ghosh, A. (2012). Road project investment evaluation using net present value (NPV) at risk method. *Jordan Journal of Civil Engineering*, *6*(2), 243–254.

Damodaran, A. (2020). Country Risk: Determinants, Measures and Implications – The 2020 Edition. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3653512

Dziadosz, A., Tomczyk, A., & Kapliński, O. (2015). Financial Risk Estimation in Construction Contracts. *Procedia Engineering*, *122*(Orsdce), 120–128. https://doi.org/10.1016/j.proeng.2015.10.015

Fuel Prices | Gulf. (n.d.). Retrieved October 12, 2020, from https://gulf.ge/en/fuel_prices

International Energy Agency. (2019). Energy efficiency [5]. In *International Energy Agency* (Vol. 66, Issue 46). https://webstore.iea.org/download/direct/2891

Jackson, J. (2010). Promoting energy efficiency investments with risk management decision tools. *Energy Policy*, *38*(8), 3865–3873. https://doi.org/10.1016/j.enpol.2010.03.006

Jaffe, B., Roberrr, N., & Stavins, N. (1994). *ECONOMICS B . Jaffe a and Robert* (Vol. 16, Issue 2).

Lukoil. (n.d.). Retrieved November 3, 2020, from http://lukoil.ge/index.php?m=316&lng=eng

National Bank Of Georgia. (n.d.). Retrieved December 28, 2020, from https://www.nbg.gov.ge/index.php?m=304

Prices | SOCAR Georgia Petroleum. (n.d.). Retrieved October 28, 2020, from http://www.sgp.ge/en/price

Saunders, A., & Cornett, M. (2008). Financial institutions management: A risk management approach 6th edition (2008). In *Financial institutions management: A risk management approach 6th edition (2008)*.

World Energy Council. (2016). *Energy Efficiency : a Straight Path Towards Energy Sustainability*. 1–152. www.worldenergy.org