Application of Asset Pricing Model in the Determination of Public-Private Partnership (PPP) in the Energy Sector: Role of Monetary Policy

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ABSTRACT

The study is to gain a better understanding of how the asset pricing model interacts with Public Private Partnership (PPP) in the larger domain of monetary policy. We employ monetary policy components that include a Panel least square test, and we apply it to the panel data set that contains 131 countries and 15 years of data on investment in the energy sector. According to the findings, the Policy rate is a critical factor in determining the minimum annual required rate of return that an investor earns on their investment. The viability gap refers to the difference between the estimated return on investment from a public-private partnership project and the required rate of return of investors that is calculated by using the capital asset pricing model. This study benefits governments, private firms, and ultimately the public of a country. The paper shows how monetary policy can use to fill the issue of viability gaps in the case of public-private partnership investment projects.

Keywords: Public-Private Partnership (PPP), Capital Asset Pricing Model-CAPM, Monetary Policy, Viability Gap

JEL Classification: E6, E62, G1, G12, H5, H54

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1. Introduction

With expanding populations in developing countries like Pakistan, infrastructural needs surpass financial means. Public-private partnerships (PPP) are suitable procurement and funding mechanisms for tackling large infrastructure deficits in developing nations (Anunciação, 2014). Public-private partnerships (PPP) are government-private sector alliances used to finance, operate, and build projects including public transit networks, parks, energy plants or other energy-related projects and convention centres. A building’s infrastructure includes essential amenities and systems that support homes and businesses. PPPs efficiently build, finance, and run projects.

PPPs are effective for private capital resources in the unit of latent for core and non-core income mobilization, especially in developing countries where only PPPs are formed. PPPs can pose budgetary risks that must be addressed. Governmental familiarity with PPP legislative and institutional reforms that create technically advanced PPP ecosystems that locate, structure, and
track PPP proposals can help with the following problems. These methods improve taxpayer value-for-money (VfM). From identification to implementation, the following ecosystems enable PPP transactions to be relevant to the development and fiscally responsible.

Pakistani federal and provincial governments have encouraged private sector participation in development projects and invested in public infrastructure and related services since the 1990s (Matsumoto, et al., 2021)((Axis Law Chambers, n.d.)). The federal government's 2006 Infrastructure Project Development Facility (IPDF) was replaced by the PPP Authority. The 2020 PPP Ordinance, announced by the president on July 7, 2020, compensates the federal PPP Act for building a more facilitative regulatory model and assures that private enterprises invest in development projects.

The Independent Evaluation Group of Nations Bank predicts that PPP accounts for 15–20% of infrastructure investment in the developing world (Observer & 2018, n.d.). The poorest developing countries use PPPs even less. Global support for infrastructure PPPs is stronger than ever. In the past decade, G20 meetings have stressed the need for large-scale infrastructure investments in emerging countries, particularly low-income countries. PPPs have a lot of excitement for development, but they take a more leisurely approach to research, which led to several successful and failed ventures (Andres et al., 2016).

Many Asian developing countries use PPPs, which can be described into three described based on completed projects. China and India lead the PPP mature countries category. According to (Endo & Seetharam, 2021) India and PRC had 1,052 ($139 billion) and 861 ($314 billion) projects between 1990 and 2016. Indonesia, Philippines, Thailand, and Viet Nam comprise the intermediate PPP application group. The Philippines has 119 PPP projects worth $57 billion, similar to other nations (Zhongming et al., 2019). The third group, "PPP less developed nations," comprises Myanmar and Cambodia with few completed projects. This group denotes growing Asian nations with comparatively higher incomes, excluding India, that aims to integrate PPPs in line with global trends. Most PPP initiatives are performed in middle- and high-income emerging countries with more developed markets, less chaotic governments, and more stable macroeconomic conditions. In this way, global infrastructure PPP support appears stronger than previously. In recent decades, emerging countries, particularly low-income ones, have placed greater emphasis on infrastructure investment (Yurdakul et al., 2022). This covers sizable, regional, and international infrastructure projects that receive private funding and are managed internationally. (Oktavianus & Mahani, n.d.).

2. Research Problem

Due to fixed deposit rates, monetary policy's fundamental issue is funding cost. Small savings rates remain higher than bank rates. Bank deposits decreased. Inflation risk is key to stabilising the economy through monetary policy (169. Snower, D. P., (2014). Peter Praet: Current... - Google Scholar, n.d.). Many tools and methods are used to hold requirements, discounted rates, and open market operations. This paper will solve a major research gap. Few research use asset pricing models to narrow the viability gap.

3. Aims &Objective

The paper examines how the asset pricing model affects Public Private Partnerships in the context of monetary policy. However, the principal research goal determines several aims which are as follows.
• To comprehend the application of the asset pricing model in the determination of Public-Private partnership.
• To rectify the role of monetary policy associated with PPP.
• To determine the viability gaps and mitigate them for economic projects.
• To examine the components of monetary policy.
• To provide appropriate and relevant recommendations for improving and adjusting monetary policy for better growth of the economic projects.

4. Research Questions
• What is the role of monetary policy that is affiliated with Public-Private Partnerships (PPPs)?
• What are the viability gaps and how can they be mitigated for the economic projects?

5. Significance
The current study examines public-private partnerships and monetary policy. This study focused on asset pricing model application. The following research determines the real interest rate, return on the deposit, return on lending, and interest rate spread taken as the components of monetary policy. This study benefits governments, private firms, and the people of the country. The study shows how monetary policy reduces the viability gap of PPP projects. Currently, revenue, cost, capital, and tax approaches use as an administrative measures for addressing the viability gap of PPP projects. Thus, the ministry of finance, the accountant general of the country, the federal board of revenue, land and other departments are involved.

6. Novelty
The study could aid future academics, investors, governments, the ministry of finance, and federal bodies. The government can use the study's policies and acts to create new policies based on changes and needs over time. However, people can benefit and make judgements based on the criteria presented. Students can learn and benefit from examining a new approach that bridges the viability gap by changing monetary policy.

7. Literature Review
According to (Arribas & Alfaro, 2018), investors are referred to as individuals or other entities who oblige capital with the expectation of receiving financial returns. The purpose of the investors is to lower risk and increase return. They willingly focus on investing in risky assets with the hopes of attaining higher profits. Investors are categorized into three main types which include pre-investors, passive investors and active investors (Çelik & Isaksson, 2014). investment product falls into the category of financial as well as non-financial assets. Financial assets could be categorized into market-linked products and fixed-income products. Infrastructure and private asset classes also limit liquidity (Munim & Schramm, 2018). It includes transportation, utility, pipeline, and satellite networks. Without infrastructure, society cannot carry commodities, powerhouses, travel, or communicate. (Jomo et al., 2016) states that infrastructure development has used PPP.

Long-term contracts between the public and private sectors are one of the aspects envisioned for the project's success as a PPP, according to (Liang et al., n.d.). (Matos et al., n.d.) indicates that Contracting agencies are resolving PPP projects. Kenyan infrastructure projects had a potential worth of $5 billion, and the private sector invested $99 million in December 2019. PPP has helped Kenya build high-quality energy and road infrastructure. Brazil, PRC, India, Poland, and Russia have developed institutional frameworks and other manuals and resources to promote PPP development.
and public officials. Public authorities have trouble developing and implementing projects without institutional arrangements and resources. Instead of legal frameworks, authors emphasise on partner engagement (Vecchi et al., n.d.). PPP, on the other hand, is a perpetual discussion between partners. Energy is the wide sector which holds two significant yet distinct industries involving the oil, gas and power sectors (Cervantes, & Zuniga, 2016 Public-Private - Google Scholar, n.d.). In this regard, PPP provides an efficient tool, if it is integrated properly which leads the leadsmen access to private sector capital, technology and expertise (Cervantes, & Watanabe, 2014).

As it has been observed that there is a range of power projects including power generation systems, hydropower plants and combustion engine power plants, through PPP in the power sector that comes in different shapes, and structures (Amović et al., 2020). Renewable Energy (RE) is important as it helps in providing reliable power supplies as well as fuel diversification that possess towards improving energy security, fewer risks of the spills of fuel along with minimising the need for other country fuels. On the other side, (Morrissey & Udomkerdmongkol, 2012), The National Renewable Energy Targets outline the legally mandated share of electricity generation that must come from renewable energy sources, as well as the timeframe in which this share must be achieved. Feed-in tariffs (FiTs) ensure the purchase of renewable energy at a predetermined rate for a specified time period. Utilities are required by quota obligations or renewable portfolio standards (RPS) to get a set percentage of their energy from renewable resources. There are claims of negative externalities at several phases of the development of equipment used in renewable installations. (Cedrick & Long, 2017a). A public good is something that everyone can use without excluding anyone else or reducing their own access to the good. Constant claims are made, as shown by the renewable externalities, that using renewable energy has public benefits such as better health care, more educational opportunities, and reduced costs associated with maintaining and operating schools. (Anyanwu, 2009)

Furthermore, the study conducted by (Alloisio & Carraro, 2015) illustrates that economic recession has constrained the spending provided by the national budget along with the commercial banks of India by lending capacities in terms of the infrastructure projects in the energy development field, transmission and distribution. It has been recognised that PPPs have the capability for accessing finances and minimising the capital expenditure of energy infrastructure projects at present time, by modest savings in construction where financial resources are being enfolded and therefore, it has broadened the gap between public and private funding (Hoffman, 2003). Moreover, in order to reduce capital expenditure with the help of trying modular construction provides a practical way in terms of saving time and minimising the expenditures of construction (Madeline, 2016). With the help of PPP, the private and public sectors could reach towards equally beneficial agreement. Here, the private and public sectors have the guarantee of facing several risks that are entailed by limited time gaps within the project planning stage and its genuine integration (Pukhova et al., 2021).

It is further determined that there are several successful as well as failed projects in energy in different countries. For example, in India, The National Highway Authority of India though, certain power and port projects have successfully utilised the PPP model that is more engaging in the private sector (Gheewala, 2019). Apart from it, the other projects include Krishnapatnam Ultra Mega, L&T Hyderabad Metro Rail Private Ltd. and KSK Mahanadi Power Co Ltd. (Cedrick & Long, 2017b). Moreover, the most common type of PPP that is used in private sectors of India in operator designs, buildings, finances along with facilities that are functioning commercially for the concession period
are DBFOT and BOT.

8. Hypothesis
   - There is a significant impact of the risk-free rate (policy rate) of return on viability gap.
   - Public-private partnership Investment dependent on the risk-free rate of return.

9. Data and Methodology.
9.1 Theoretical Model.
   Viability Gap
Description of Variables

<table>
<thead>
<tr>
<th>Dependent Variables (i)</th>
<th>Independent Variables (j)</th>
<th>Controlled Variables (m)</th>
<th>Dummy Variables (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = Investment in Energy</td>
<td>1 = Deposit Interest Rate</td>
<td>1 = Foreign Direct</td>
<td>1 = Economies in</td>
</tr>
<tr>
<td>2 = Investment in Energy – PPP</td>
<td>2 = Lending Interest Rate</td>
<td>Investment</td>
<td>transition</td>
</tr>
<tr>
<td></td>
<td>3 = Real Interest Rate</td>
<td>2 = Gross Domestic</td>
<td>2 = Technologically</td>
</tr>
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<td></td>
<td>4 = Interest Rate Spread</td>
<td>Product – PPP</td>
<td>Advanced Countries</td>
</tr>
</tbody>
</table>

9.3 Main dependent Variables.

Investment: Public-private partnerships (PPP) across industries depend on investment. PPPs have improved energy access and encouraged renewable energy investment (Wolsinek, 2022). PPPs have also improved water and sanitation infrastructure and service delivery (Van & Carter, 2018). PPPs have been used to improve road infrastructure and transportation system investment (Cigu et al., 2018) and (Garcia-Murillo & Lago, 2019).
9.4 Main independent Variables (Monetary Policy Tools)

**Deposit Interest Rate**: Deposit interest rates are an important independent variable to consider when evaluating the potential for public-private partnerships (PPP) in the financial sector. Higher deposit interest rates can encourage increased investment in savings and other low-risk financial instruments, which can provide a stable source of funding for PPP projects (Menezez & Vieira, 2022; Akomea et al., 2023).

**Lending Interest Rate**: Lending interest rates are a critical independent variable in evaluating the feasibility and potential risks associated with public-private partnerships (PPP) in the financial sector. Changes in lending interest rates can impact the cost of borrowing for both public and private entities involved in PPP projects, which can affect the overall financial viability of the project (Conca, 2015; Akomea et al., 2023).

**Real Interest Rate**: Real interest rates are an important independent variable to consider when evaluating the feasibility and potential risks associated with public-private partnerships (PPP) in the financial sector. Real interest rates, which are adjusted for inflation, can impact the cost of borrowing and the overall financial viability of PPP projects (Conca, 2015; Akomea et al., 2023).

**Interest Rate Spread**: Interest rate spread is an important independent variable to consider when evaluating the feasibility and potential risks associated with public-private partnerships (PPP) in the financial sector. Interest rate spread refers to the difference between lending and borrowing interest rates, and can impact the profitability of banks and other financial institutions (Kose, Prasad, & Terrones, 2003).

9.5 Controlled Variable

**Foreign Direct Investment**: Foreign direct investment (FDI) has become an increasingly important source of economic growth and development for many countries around the world. FDI is defined as the acquisition of foreign assets or the establishment of new facilities by foreign investors in a country (UNCTAD, 2021; Blomstrom, Lipsey, & Zejan, 1994; Lipsey, 2002; Borensztein, De Gregorio, & Lee, 1998).

**Inflation**: Inflation refers to the rate at which the general level of prices for goods and services is increasing, and the subsequent decrease in purchasing power of a currency. Inflation is an important factor to consider when evaluating the potential benefits and risks associated with public-private partnerships (PPP). (KABANDA, 2022).

**Logistic Performance Index**: The Logistics Performance Index (LPI) is an indicator of the efficiency and effectiveness of a country’s logistics system, including the quality of infrastructure, the competence of logistics services providers, the ability to track and trace shipments, and the frequency with which shipments reach their destination on time (World Bank, 2019).

**Market Capitalization**: Market capitalization refers to the total value of a company’s outstanding shares of stock, calculated by multiplying the current market price per share by the total number of outstanding shares (Investopedia, 2021; Laufer & Wolak, 2021; OECD, 2008).

**Political Certainty**: Political certainty issues refer to the degree of certainty and risk associated with the political climate and the rule of law within a country. Political certainty issues...
are important factors to consider when evaluating the potential benefits and risks associated with public-private partnerships (PPP) (Grimsey & Lewis, 2004; Flyvbjerg, 2007).

9.6 Dummy Variables

**Economies in transition:** In econometric analysis, the economies in transition dummy variable is a variable that takes on a value of one or zero to indicate whether an observation belongs to a certain economy or not. Economy dummy variables are important to consider when evaluating the potential benefits and risks associated with public-private partnerships (PPP). (Tongia, 2012).

**Technologically Advanced Countries:** Technologically advanced countries as a dummy variable refer to countries with a high level of technological advancement and innovation. Technologically advanced countries may have a more favourable environment for PPP projects, (OECD, 2016). However, it is important to evaluate the potential risks associated with PPP projects in technologically advanced countries, including high costs associated with advanced technology and the potential for technology to become outdated quickly (Akintoye & MacLeod, 1997).

9.7 Econometric Model

9.7.1 Capital Asset Pricing Model

Investment boosts the economy. It also discusses economic investment-boosting elements. According to (Liljeblom et al., n.d.). Graham and Harvey (2001) agree that most US corporations utilise CAPM to calculate the required rate of return on equity. He found that 73.5% of respondents use CAPM regularly. (Liljeblom et al., n.d.) also believe most organisations apply the internal rate of return (IRR) to evaluate investments. The investor invests in the project if its IRR exceeds the required rate of return.

According to the capital asset pricing model, the investor’s required rate of return depends on the risk-free rate, the asset’s risk compared to the market’s risk, and the market risk premium. The estimated project’s return is less than the investor’s required return. The viability gap is the discrepancy (VG). The viability gap determines public-private partnership investment (VG). Investors won't invest in projects with estimated returns below the required rate. It indicates that public-private partnership investment depends on the viability gap, which is determined by the required rate of return, \( \beta \) (Sensitivity or risk associated with investment), \( R_m \) (Market return), and \( R_f \) (risk-free rate of return).

The corporate financial income statement shows the following mechanism for the calculation of estimated earning of an investor which is the estimated return \( (R_E) \) from the investment during a financial year. Mathematically it can be expressed as:

\[
\text{Estimated Operating Income (I}_{\text{OP}}) = \text{EBIT} = \text{Sale} - (\text{Cost} + \text{Exp}_{\text{op}})
\]

\[
\text{I}_{\text{OP}} = \text{EBIT} = S - \{C + E_{\text{OP}}\}
\]

\[
\text{EBT} = \text{I}_{\text{OP}} - \text{IntExp}
\]

\[
\text{EBT} = S - \{C + E_{\text{OP}}\} - \text{IntExp}
\]

If the applied tax is expressed as “\( \tau \)”

\[
\text{EAT} = \text{EBT} - \tau
\]

\[
\text{EAT} = S - \{C + E_{\text{OP}}\} - \text{IntExp} - \tau
\]
The estimated return from the PPP project is \( EAT \) which is the outcome of the investment \( I \) in the project. Therefore, the estimated return will be as:

\[
R_E = \frac{EAT}{I}
\]  

Before the investment, the entrepreneur calculates the required amount of return based on \( \beta \) (Sensitivity or risk associated with investment) and \( R_m \) (Market return) and \( R_f \) (risk-free rate of return). This return is calculated by using the capital asset pricing model (CAPM).

According to CAPM:

\[
R_i = R_f + \beta \{E(R_m) - R_f\}
\]

Where
- \( R_i \)  Investor’s required rate of return
- \( R_f \)  Risk-free rate of return
- \( E(R_m) \)  Expected market return
- \( \beta \)  Sensitivity or risk of the risky assets

In public-private partnerships (PPP), there is an issue related to the difference between the estimated and the required return from the project. This gap is termed as viability gap.

\[
VG = R_i - R_E
\]
\[
VG = R_f + \beta \{E(R_m) - R_f\} - R_E
\]

In this function of \( VG \), \( \beta \) (Sensitivity or risk associated with investment) and \( R_m \) (Market return) both are related to the market therefore changes are not possible. While \( R_E \) is the output of the operational activities. Therefore, it is derived that \( VG \) depends upon \( R_f \) (risk-free rate of return). This implies that the viability gap is a function of the risk-free rate of return.

\[
VG = f(R_f)
\]  

When the investor will get less than his required return, the investor is never interested to invest in the project. In other words, if the value of \( VG \) is positive, investment in PPP will not possible.

It shows that the investment \( I \) under PPP depends upon \( VG \). i.e Investment in PPP is a function of \( VG \).

\[
I = f (VG)
\]
\[
I = f(R_f)
\]

As \( R_f \) is also known as the policy rate of the central bank in any economy and consider one of the most important components of the monetary policy of the economy. Therefore, it is concluded that investment depends upon the policy interest rate.

### 9.8 Data Description

We use 15 years of annual data (from 2006 to 2020) for the following variables of 131
countries. There are around 131 countries where we found public-private partnership modes of investment across the globe, therefore, data from all 131 countries were taken in the study. Public-private partnership in the development of infrastructures initiates after the mid of 1990s. These infrastructure projects are usually long-term projects and need many years to complete. Therefore, after around 10 years many other countries start investing through public-private partnerships and data shows a considerable rise in investment in this mode of investment. For the same reason, here I took the data of the last 15 years from 2006 to 2020.

9.9 Data Source
We took all data from the official website of World Bank.

10. Statistical Analysis.

The panel data regression model is as follows:

\[ I_i = \alpha_i + \beta_{ij} r_{ij} + \sum_{m=1}^{9} \beta_m k_m + \sum_{n=1}^{2} \beta_n l_n + \epsilon_i \]

10.1 Pooled Regression Model (1)

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Model 1a.</td>
<td></td>
</tr>
<tr>
<td>Variables</td>
<td>Beta</td>
</tr>
<tr>
<td>Deposit Interest Rate (DIR)</td>
<td>0.11**</td>
</tr>
<tr>
<td>Logistic Performance Index - Overall (LPI_O)</td>
<td>2.99***</td>
</tr>
<tr>
<td>Technologically advanced country (TECAD)</td>
<td>-2.04***</td>
</tr>
<tr>
<td>Foreign Direct Investment in $ (FDI_$)</td>
<td>0.00*</td>
</tr>
<tr>
<td>Adjusted R Square</td>
<td>0.21064</td>
</tr>
<tr>
<td>F-Statistics</td>
<td>4.53571***</td>
</tr>
</tbody>
</table>

*** Significant at 1% significant level
** Significant at 5% significant level
* Significant at 10% significant level

The dependent variable is Energy Investment, whereas the independent variables are Deposit Interest Rate (DIR), Logistic Performance Index - Overall (LPI_O), Technologically advanced country (TECAD), and Foreign Direct Investment in $ (FDI_$). DIR's beta coefficient is 0.11, significant at 0.05, and t-value 2.04. DIR boosts energy PPPs. Economic theory says higher interest rates encourage investment. LPI_O's beta coefficient is 2.99, significant at 0.001, and t-value 4.43. Better logistic performance index improves energy PPP investment. PPP energy investment requires logistics infrastructure. TECAD's beta coefficient is -2.04 and significant at 0.001 with a -3.88 t-value. PPP energy investments lag technical progress. Due to other funding sources, high-tech countries invest less in energy through PPPs. FDI_’s beta coefficient is 0.00, significant at 0.1, and t-value is 1.66. $FDI and energy PPP investment have a weak positive association. Energy PPPs attract foreign investors but have little impact. Independent factors explain 21.06% of energy PPP investment variation. The regression model’s adjusted R-squared value is 0.21064. The regression model estimates energy PPP investment at 0.05 with an F-statistics of 4.53571. The table shows that
deposit interest rate and logistic performance index boost energy PPP investment, whereas technical advancement decreases it. Energy PPP investment benefits weakly from foreign direct investment.

**Model 1b.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Beta</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lending Interest Rate (LIR)</td>
<td>0.08***</td>
<td>4.06</td>
</tr>
<tr>
<td>Logistic Performance Index - Overall (LPI_O)</td>
<td>3.22***</td>
<td>4.61</td>
</tr>
<tr>
<td>Technologically advanced country (TECAD)</td>
<td>-2.20***</td>
<td>-4.01</td>
</tr>
<tr>
<td>Economy in Transition</td>
<td>-0.81*</td>
<td>-1.70</td>
</tr>
<tr>
<td><strong>Adjusted R Square</strong></td>
<td><strong>0.3338</strong></td>
<td></td>
</tr>
<tr>
<td><strong>F-Statistics</strong></td>
<td><strong>6.7335</strong>*</td>
<td></td>
</tr>
</tbody>
</table>

*** Significant at 1% significant level  
** Significant at 5% significant level  
* Significant at 10% significant level

The table shows energy investment regression and public-private partnerships. LIR, LPI_O, TECAD, and Economy in transition research. LPI_O positively and significantly affects energy investment with a beta coefficient of 3.22 and t-value of 4.61. Logistic performance indexes boost energy industry investment. TECAD reduces energy investment by 2.20-4.01. Tech-savvy nations get less energy investment. LIR has a beta coefficient of 0.08 and t-value of 4.06. Low borrowing rates stimulate energy sector investment. ECO's energy investment beta coefficient and t-value are low at -0.81 and -1.70. Energy investment is unaffected by market or transition economies. Model 1b's public-private energy investment has four variables. The four independent factors explain 33% of PPP energy investment. LIR boosts energy PPP investment. Lending rates boost PPP energy investment. Investors like higher rates. PPP energy investment strongly and positively correlates with LPI_O. Logistics boost PPP energy investment. Logistics helps private investors. Technologically advanced country (TECAD) energy PPP investment beta is -2.20 and t-statistic -4.01. Technology reduces PPP energy investment. Advanced nations may need fewer PPPs due to infrastructure and finance. ECO decreases energy PPP investment by 10%, with a beta coefficient of -0.81 and a t-statistic of -1.70. The negative coefficient may make transition economies invest less in energy PPPs than market economies

**Model 1c.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Beta</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Real Interest Rate (RIR)</td>
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<td>2.99</td>
</tr>
<tr>
<td>Logistic Performance Index - Overall (LPI_O)</td>
<td>3.71***</td>
<td>3.36</td>
</tr>
<tr>
<td>Technologically advanced country (TECAD)</td>
<td>-1.64***</td>
<td>-3.38</td>
</tr>
<tr>
<td>Economy in transition</td>
<td>-0.75**</td>
<td>-2.16</td>
</tr>
<tr>
<td>Political Certainty</td>
<td>-0.61***</td>
<td>-2.89</td>
</tr>
<tr>
<td><strong>Adjusted R Square</strong></td>
<td><strong>0.3221</strong></td>
<td></td>
</tr>
<tr>
<td><strong>F-Statistics</strong></td>
<td><strong>9.4999</strong>*</td>
<td></td>
</tr>
</tbody>
</table>

*** Significant at 1% significant level  
** Significant at 5% significant level  
* Significant at 10% significant level
This table shows Model 1c, which evaluates independent variables and energy investment in PPPs. RIR, LPI_O, TECAD, economy in transition, and political certainty are independent factors. Energy investment controls. RIR, LPI_O, and TECAD anticipate PPP energy investment. RIR increases energy investment. Real interest rates increase PPP energy investment. Higher interest rates may attract investors to PPPs. LPI_O positively and significantly affects energy investment. PPP energy investment rises with logistic performance. PPPs may attract investors if their logistics system reduces energy and transportation expenses. Energy investment is negatively correlated with TECAD's beta coefficient of -1.64 and t-value of -3.38. Technological progress reduces PPP energy investment. Technologically advanced nations may produce and distribute energy without PPPs. ECO and POLC forecast PPP energy investment. ECO's beta coefficient is -0.75 and t-value is -2.16. PPP energy investment decreases as economies go from planned to market. Energy investment may not necessitate PPPs in market economies.

**Model 1d.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Beta</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest Rate Spread (ISP)</td>
<td>0.05**</td>
<td>2.60</td>
</tr>
<tr>
<td>Logistic Performance Index -Overall (LPI_O)</td>
<td>3.14***</td>
<td>4.66</td>
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<tr>
<td>Technologically advanced country (TECAD)</td>
<td>-1.31**</td>
<td>-2.31</td>
</tr>
<tr>
<td>Inflation (%) (INFL)</td>
<td>0.10**</td>
<td>2.12</td>
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<tr>
<td><strong>Adjusted R Square</strong></td>
<td>0.2467</td>
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</tr>
<tr>
<td><strong>F-Statistics</strong></td>
<td>5.1488***</td>
<td></td>
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</tbody>
</table>

*** Significant at 1% significant level  
** Significant at 5% significant level  
* Significant at 10% significant level

Model 1d evaluates energy investment and independent factors such interest rate spread, logistic performance index (LPI), technologically advanced country, and inflation. This model's adjusted R-squared value is 0.2467, indicating that independent factors explain 24.67% of the dependent variable's variation. The model matches data well since the F-statistics value of 5.1488 is statistically significant at 1%. The first independent variable, interest rate spread (ISP), positively and significantly affects energy investment (Beta = 0.05, T = 2.60). Interest rate spread boosts energy investment. ISPs exhibit bank lending profitability. ISPs increase bank profits and energy investment. The second independent variable, logistic performance index (LPI_O), positively and significantly affects energy investment (Beta = 3.14, T = 4.66). Energy investment affects logistics efficiency, calculated by LPI_O. An efficient logistics company cuts transport costs, making energy projects more attractive to investors. Technologically advanced country (TECAD) negatively affects energy investment (Beta = -1.31, T = -2.31). Inflation boosts energy investment. Inflation diminishes money's purchasing power, making energy infrastructure more attractive. Model 1d shows interest rate spread, logistic performance index, technologically advanced country, and inflation effect energy investment. Logistical efficiency, interest rate spreads, and inflation might assist policymakers encourage energy investment. They can invest in less technologically advanced countries that use conventional energy sources and are more open to energy infrastructure investment.
### 10.2 Pooled Regression Model (2)

<table>
<thead>
<tr>
<th>Dependent Variable: Investment in Energy under Public Private Partnership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method: Pooled Least Square.</td>
</tr>
</tbody>
</table>

#### Model 2a.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Beta</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lending Interest Rate (LIR)</td>
<td>0.07***</td>
<td>3.02</td>
</tr>
<tr>
<td>Logistic Performance Index - Overall (LPI_O)</td>
<td>5.92***</td>
<td>3.86</td>
</tr>
<tr>
<td>Technologically advanced country (TECAD)</td>
<td>-2.98***</td>
<td>-5.18</td>
</tr>
<tr>
<td>Market Capitalization (MKTCAP)</td>
<td>0.00**</td>
<td>2.12</td>
</tr>
<tr>
<td>Adjusted R Square</td>
<td>0.4209</td>
<td></td>
</tr>
<tr>
<td>F-Statistics</td>
<td>8.9956***</td>
<td></td>
</tr>
</tbody>
</table>

*** Significant at 1% significant level  
** Significant at 5% significant level  
* Significant at 10% significant level

Model 2a examines public-private energy investment. Public-private energy partnership investment is dependant. LIR, LPI_O, TECAD, and MKTCAP are the model's four independent variables. All four independent variables strongly impact public-private energy investment. The independent variables explain 42.09% of the dependent variable's variation. The model fits well with an F-statistic of 8.9956. LIR enhances public-private energy investment by 0.07%. Energy projects attract investors when borrowing rates are high. Logistic Performance Index - Overall (LPI_O) improves energy investment under public-private partnership by 5.92% per point. Countries with better logistics attract greater public-private partnership energy investment. TECAD nations reduce public-private energy investment by 2.98%. This negative connection suggests investors may prefer less technologically advanced countries due to lower risks and costs. 1% market capitalization growth boosts public-private energy investment by 0.00%. Public-private energy projects attract high-market-capitalization firms. loan interest rate, logistic performance index, technological advancement, and market capitalization affect public-private energy investment. Technology decreases investment, but loan interest rates and logistic performance improve it.

#### Model 2b.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Beta</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Interest Rate (RIR)</td>
<td>0.05**</td>
<td>2.52</td>
</tr>
<tr>
<td>Logistic Performance Index -Overall (LPI_O)</td>
<td>4.02***</td>
<td>5.58</td>
</tr>
<tr>
<td>Technologically advanced country (TECAD)</td>
<td>-3.16***</td>
<td>-5.35</td>
</tr>
<tr>
<td>Inflation (%) (INFL)</td>
<td>0.12**</td>
<td>2.27</td>
</tr>
<tr>
<td>Adjusted R Square</td>
<td>0.4027</td>
<td></td>
</tr>
<tr>
<td>F-Statistics</td>
<td>9.3442***</td>
<td></td>
</tr>
</tbody>
</table>

*** Significant at 1% significant level  
** Significant at 5% significant level  
* Significant at 10% significant level

Model 2b assesses PPP energy investment and four explanatory factors. First, the RIR is independent. The second independent variable, the overall logistic performance index (LPI_O), measures a country's products supply chain efficiency. Third and fourth independent variables are TECAD and INFL. An adjusted R-squared of 0.4027 explains 40.27% of energy investment volatility.
under PPP. Four variables predict. 1% F-statistic indicates model significance. Under PPP, the real interest rate (RIR) boosts energy investment. Higher interest rates increase the opportunity cost of holding money and boost investment. The overall logistic performance index (LPI_O) has a positive and significant coefficient of 4.02, demonstrating that enhancing a country's product supply chain efficiency boosts PPP energy investment.

### Model 2c.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Beta</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spread (ISP)</td>
<td>0.04**</td>
<td>2.20</td>
</tr>
<tr>
<td>Logistic Performance Index -Overall (LPI_O)</td>
<td>3.93***</td>
<td>5.94</td>
</tr>
<tr>
<td>Technologically advanced country (TECAD)</td>
<td>-2.35***</td>
<td>-4.36</td>
</tr>
<tr>
<td>Inflation (%) (INFL)</td>
<td>0.14***</td>
<td>2.99</td>
</tr>
<tr>
<td>Market Capitalization (MKTCAP)</td>
<td>0.00*</td>
<td>1.67</td>
</tr>
<tr>
<td>Adjusted R Square</td>
<td>0.3527</td>
<td></td>
</tr>
<tr>
<td>F-Statistics</td>
<td>9.4851***</td>
<td></td>
</tr>
</tbody>
</table>

*** Significant at 1% significant level  
** Significant at 5% significant level  
* Significant at 10% significant level

PPP energy investment multiple regression Model 2c is shown in the table. ISP, LPI_O, TECAD, INFL, and MKTCAP are independent. Each independent variable has beta coefficients, t-statistics, modified R-squared, and F-statistics. ISP is the independent variable. 0.04 is significant. Spread improves PPP energy investment. The coefficient's 2.20 t-statistic exceeds 5% significance. LPI_O assesses logistics efficiency. 3.93 is 1% important. LPI_O improves PPP energy investment. The coefficient's t-statistic is 5.94, much above 1% significance. Third independent variable: TECAD. Predicted coefficient is -2.35, highly significant at 1%. PPP reduces energy investment in wealthier nations. The coefficient is very significant because the t-statistic is -4.36, significantly below 1%. Fourth independent variable: inflation. Expect 0.14 and 1%. PPP shows inflation boosts energy investment.

### Hypothesis Testing

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Accept/ Reject</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H1.</strong> there is the significant impact of the risk-free rate (policy rate) of return on viability gap in a public-private partnership</td>
<td>Accept</td>
</tr>
<tr>
<td><strong>H2.</strong> Public-private partnership Investment dependent on the risk-free rate of return</td>
<td>Accept</td>
</tr>
</tbody>
</table>

### 11. Discussion

The researcher analyzed that monetary policy plays an important role in public-private partnerships. The findings show that investment spending to interest rate changes is fundamental to stabilization policy analysis. Our findings are similar to the finding of (Hall et al., n.d.)conclude that the government's direct investment through public-private partnerships (PPPs) pricing of business securities and optimal investment methods share the investment's funds. Comparing pure private financing. ((Luo et al., 2020)). Investments are made without penalty for reversal, credit limits, or cost of correction. Marginal product + markup is what capital receives. As a second point, in markets where borrowing is not an option, capital and government bonds are suitable alternatives. The
marginal product of capital beyond the markup under our interest rate rule is independent of anything other than inflation. Frictions in the credit market and the non-perfect substitutability of capital and government debt will be the focus of future studies. In preliminary work (Theory & 2001, n.d.), We demonstrate that active rules can easily achieve indeterminacy with adjustment costs to aggregate investment that are consistent with empirical evidence, (Kurozumi et al., n.d.) our findings are linked to the findings of (Guerrieri et al., 2011) According to (Carlstrom and Fuerst 2005), monetary policy that sets interest rates based on expected inflation induces indeterminacy of equilibrium in the context of investment activity and price stickiness. They discover that inflation expectations become self-fulfilling due to a cost channel of monetary policy in a stochastic version of their model. Additionally, they show that even a forward-looking policy can create a locally unique non-explosive E-stable fundamental rational expectations equilibrium if the policy response to anticipated future inflation is large enough. (Beccarini, 2007) displays a hyperbolic (negative) relationship between capital expenditures and interest rates. (Papers Wuhan et al., n.d.) shows that interest rates and investment value communicated through the discount factor, there is a positive (interest rate variance) relationship communicated through the interest rate itself. (Muhammad et al., n.d.) found that nominal short-term interest rates and changes in the real rate of interest have little effect on investment. While government policies have shifted to focus on regulating money stock rather than working directly on interest rates, it appears that nominal long-term interest rates continue to have an impact on investment. Our results are linked and significant to previous studies on public-private partnerships linked to monetary policy and the viability gap.

12. Conclusion
With or without a public-private partnership, energy sector investment is strongly correlated with the various components of monetary policy, such as the deposit interest rate, lending interest rate, Real interest rate, and interest rate spread, which drive any country's policy rate. Public-private partnerships facing the same viability gap as administrative procedures can use the financial solution. Lowering the policy rate of return lowers the investor's necessary rate of return. The viability gap—the difference between a public-private partnership's expected return and investors' necessary return—is affected by the policy interest rate. The policy rate (risk-free rate of return) affects the needed rate of return and viability. Project funding would decrease as the viability gap narrowed or disappeared. This suggests that H1 will accept that the policy rate (risk-free rate of return) greatly affects the viability gap in any public-private collaboration. Policy rates strongly influence investors' required returns. The risk-free rate of return will alter with policy rate changes. The difference between the PPP project's expected rate of return and the necessary rate creates the viability gap. The PPP project must close the profitability gap.

13. Implication
The research will help in determining the role of interest rates (real interest rate, return on deposit and return on lending) in the calculation of the required rate of return of investors. This research is mainly valuable for governments and private firms. The study delivers the benefits of employing PPP by bringing necessary changes in monetary policy that help in fulfilling the viability gap. This study enables us towards providing another method that can easily fill the viability gap by regulating monetary policy.

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