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The Effect of Government Equity Participation on Infrastructure Projects

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Abstract

In this paper, we research the effect of government equity participation in infrastructure projects. We find evidence that government intervention contributes to infrastructure projects getting completed with the odds ratio of 1,1354. This implies, contrary to many other studies, that, in fact, government participation has a positive impact on infrastructure projects.

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1 Introduction

Infrastructure is the physical part established to serve a community. Examples include transportation, water, sewerage, electricity, and telecommunication. It facilitates the transportation of information, people, and goods. Infrastructure is one of the main drivers of economic growth (Agénor, 2010). The absence of developed infrastructure makes it challenging to grow the economy and for citizens to stay connected.

Infrastructure projects can be costly to develop and thereby require substantial funding (O'Brien & Pike, 2019). The financing of infrastructure projects can be done through public, private, or public and private partnerships. Private versus public companies is a hot topic and is debated all over the world. In many democracies, when voting in an election, the party you choose is often inclined toward private or public-driven services. From the private perspective, they develop infrastructure projects to generate profits, while the public actor is motivated by increasing the welfare for its citizens (Grimsey & Lewis, 2002).

The absence of successful infrastructure can significantly impact society. Previous research focusing on Africa has found several cases where economic growth is limited by poor infrastructure (Agénor, 2010). In Africa, only 16% of the roads are paved south of the Sahara, and less than 20% of Africans have access to electricity. Yoshino (2008) discovered that poor infrastructure quality and disruption in electricity provided in the south of Sahara had a negative impact on the export of goods. In Rwanda, they found that coffee farmers only receive 20% of their price from exporting their coffee; 80% of the price goes towards costs related to poorly developed roads (Yoshino, 2008). Another aspect that speaks to the importance of infrastructure is increased hygiene and health, through developing clean water and sanitation in developing countries (World Health Organization & UNICEF, 2015).

Infrastructure is undoubtedly essential as it impacts both economic development and at the same time plays a crucial role in the health of citizens, creating a decent standard of life.

Observing the importance of infrastructure, it is interesting to see if government involvement can increase the chance of completing infrastructure projects or not. Private and public ownership has its pros and cons; perhaps we can observe an

increased chance of completing projects if both parties are involved in the infrastructure projects? In our research, we use equity participation as a proxy for government involvement in infrastructure projects.

Our data points consist of a dependent variable that can take the value completed or not. The same goes for our independent variable equity participation. Binary logistic regression is the model of choice when regressing the two binary values. The output comes in the form of odds ratios and, with some simple calculations, states the probability of an event occurring.

Previous research on ownership points in different directions when looking into joint ownerships between government and the private sector. However, most of the existing literature emphasizes that corporations/firms with mixed ownership are worse off than companies with solely private ownership. This facilities for the following hypothesis:

"*When the government is involved with equity in infrastructure projects,*

there is a lower probability of completing the projects."

We have collected data from the Eikon Refeinitiv 360 Infrastructure database, consisting of 54.230 infrastructure projects and with the majority of data points stemming from the years 1990 to 2022. In the database, we selected four information labels: "Project status", "Government Support Type", "Project Sector" and "Project Finance Total Cost". Project status consisted of 34 text variables, government support type consisted of 14, and project sector 11. These text variables had to be turned into individual dummy variables. This was done by creating new columns in Excel and filling each column with the correct value, one or zero. After the data was cross-checked for duplicates and cells with missing variables, we ended up with 28.250 unique projects. The variable "Completed" consists of two variables from project status: "Completed" and "Operational", the former being finished projects, and the latter chosen due to projects being operational after completion. The only non-binary variable is "Project Finance Total Cost", being classified as a continuous variable.

Our main results indicate that when the government intervenes in infrastructure projects, the possibility of completing the projects is slightly higher than without government involvement. There is a 53,17% chance that the infrastructure project is completed if the government takes an ownership stake with equity involvement. On the opposite side, there is a 46,83 % chance that a project with government equity participation would not be completed. Hence, having government equity support slightly impacts the probability of completing the projects.

The main reason for this paper is to investigate whether government support through equity has an impact on the probability of completing infrastructure projects. Our results show that when government gets involved with equity in a project, there is a slightly higher probability that the projects will be completed. This contrasts with our hypothesis and existing literature, where we outline a negative relationship between government involvement and completed projects. Our findings emphasize the need for further research on the topic.

2 Literature Review

2.1 Introduction

Infrastructure is a crucial part of a country and affects society daily. Therefore, we found it interesting to see if government involvement affects the result of infrastructure projects. There are often both benefits and disadvantages when companies/projects are run by the private/public or a composition of both private and public ownership. There are numerous cases where infrastructure ownership has shifted hands between the private and public actors. In contrast to pure private or public ownership, we have the case where they co-operate on projects. In our research, we would like to see if there is a link between successful projects and government intervention, hence the effect of mixed ownership.

Government intervention could be done through various methods, equity ownership being one of those. In the section below, we will review previous research when there is joint ownership between private and public. Reviewing previous research will give us insight into what the literature points to regarding the effect of government intervention in projects.

Lastly, we will summarize the reviews of previous studies where there has been co-operation between private and public ownership.

2.2 Joint ownership between private and public actors

A game theory model by Huang & Xiao (2012), much like Shleifer & Vishny's (1994) game-theoretical model, evaluates firm performance with government intervention. The former evaluates the cost and benefits of government ownership on firm performance, while the latter addresses the issues of bribes between firms and the government. Both studies argue for a negative effect of government ownership. Hence, government ownership promotes a more significant efficiency loss and lower profitability due to regulations by politicians using their influence to pursue political objectives. A recent Vietnamese case study concluded with similar results using a static and dynamic game-theory model: government ownership hurts firm performance (Tran et al., 2014).

Recent research from Hu et al. (2020) looked at government equity participation through private-public-partnership. Their results show that it is optimal when the government contributes with equity to the projects. They also found that the optimal government ownership amount was around 20-29% of the total capital. This is supported by older studies, where researchers have found an U-shaped relationship between government equity participation; when it reaches 30%, it hits the inflection point (Tian, 2001).

Wehrheim et al., (2020) studied how mixed ownership affected decision-making in turbulent times. They studied different firms in the telecommunication industry, and their ability to respond to technological evolution. The result of this research is quite interesting. Firms with mixed ownership responds worse in turbulent times than firms without mixed ownership. The authors argue that when top managers are faced with conflicting views from owners on how to address challenges, it results in poor response and decisions, because of the conflicting views of owners.

A study conducted by Ghazali et al. (2022) looked at different firms and their performance in the different business life cycles. Their results show that firms in the growth and mature stage are more inefficient when the government is invested, compared to the firms without government ownership. The reason is due to increased rent-seeking activities taking place in these two stages of the business life cycle. This is because the government tends to exploit the firms' resources to achieve its political, economic, and social objectives.

In China, research showed mixed effects of government ownership. Liao & Young (2012) study presented an increase in firm value due to government ownership. Jiang et al., (2008) presented a positive impact on firm performance in cases when private ownership concentration was high. Conflicting with another studies findings, when government ownership increased, the labor productivity decreased (Xu & Wang, 1999). This last point is further supported by Qi et al., (2000), who found that when the government held company shares, it negatively impacted firm performance. WEI's (2007) research elaborates on this: when the amount of shares held by the state surpasses 50%, it negatively impacts firm performance. However, they concluded that a small government ownership enhances firm performance.

Majumdar (1998) studied the Indian industry to investigate if there are any differences in efficiency when comparing state-owned, privately owned, and joint ownership in corporations. Their proxy for efficiency was measured from 0-1 when comparing the three different types of ownership. Their results indicate that state-owned corporations had an average score of 0.658. For privately owned firms, they observed an average score of 0.975. For corporations with joint ownership between government and private actors, they observed an average score of 0.912. Purely private firms performed best, followed by joint ownership. The poorest performance measured by efficiency was the corporations with purely public ownership.

Backx et al. (2002) did a study in the airline industry comparing public, private, and joint ownership, finding support for the research on the industry in India. They found that airlines with private ownership performed best, with joint firms coming in second, followed by public companies. Profit level and labor productivity were two measures included in the research paper.

2.3 Outline

The literature review consists of varying results, but most of the findings seem to conclude that projects are worse off when the government has an ownership stake. The parameters measured as a form of success vary between profits, firm value, labor productivity, and ability to react to industry changes.

Reviewing previous studies, we find that most of the literature has a small sample size and has done research in a geographically concentrated area. Most papers also focus on just one type of industry. Our data consists of a larger sample size than most of the previous articles and is spread across the whole world. At the same time, we have 11 different project sectors included in our data.

With our research, we seek to contribute to this discussion. We will estimate the influence government ownership has on infrastructure projects getting completed. This motivates us, as there is no unified answer on how government involvement affects the infrastructure sector.

3 Methodology

For our thesis, we wish to estimate the effect government equity involvement has on an infrastructure project's probability of completion. As we worked with a binary response variable, the most suitable model is the logistic regression model. We use the statistical software Stata to perform our analysis.

3.1 Logistic regression

The binary logistic regression is the most fitting model as we dealt with a binary dependent variable, as it is bounded within an interval of (0,1), completion or not. We chose logistic over the probit model as model parameters are easier and faster to estimate as we don't have to evaluate an integral (Stock & Watson, 2011). Logistic regression is used the same way as multiple linear regression; it is used as predictive analysis. But the logistic regression will give us predicted probabilities that are easy to interpret. The following section describes the models used to answer our research question.

When using the multiple linear regression model to estimate a linear relationship between an independent and dependent variable, a general equation looks like this:

$$\mathrm{y} = a + a_1 x_1 + a_2 x_2 + \ldots + a_n x_n \; + b$$

Y is the dependent variable, x is the expected effect on y or regression coefficient, and b is the error term. As our dependent variable is binary, only taking the values 0 and 1, the best fit is the logistic regression. Below we present a general equation of logistic regression.

$$\ln \frac{p}{1-p} = a + a_1 x_1 + a_2 x_2 + \ldots + a_n x_n + b$$

P represents the likelihood or probability that our dependent variable y gets the value 1, x is the independent variable, b is the error term, and a is the regression effect x has on y.

The regression tries to explain variance and investigate the relationship between the variables and their significance - making it suitable for us as we try to explain it through empirical research. The data contains an exploratory variable that identifies whether infrastructure projects are being completed across the world, and for that reason, the method of regression is the most suitable.

3.2 Using odds ratio

We use the odds ratio as it is the easiest way to interpret the results when we use binary logistic regression. Separating odds and probabilities beforehand is essential as they are not the same in statistics (*The Difference Between "Probability" and "Odds,"* 2017). Probability is the chance that something could occur; if you toss a coin, there will be equal chances of it landing on heads or tails. Thus, there is an 0,5 or ½ probability of getting tails. Transferring this example to odds, one must divide the probability of something happening by the probability of something not happening. In the case of the coin toss, it would be 0,5/0,5 = 1, the odds of getting tails are one. Continuing that line of thought, the coin is now slightly different.

$$odds = \frac{p}{1-p}$$

The odds ratio is quite similar; it is the ratio between two odds. A basketball team is having a tryout, and 75% of the tall people get selected, and 60% of the short people get chosen for the team. Therefore, the odds for a tall person to join the group are 0,75/0,25 = 3, and 0,4/0,6 = 0.8 for the short person. The odds ratio between tall and short people making the team will therefore be 3/0,8 = 3,75, hence the odds of 3,75 that a tall person will make the team compared to the short person.

$$odds\ raito = \frac{odds}{bc}$$

3.3 Model specification

We ran two regressions, one with the dependent variable Completed and the independent variable Equity Participation. This is done to see equity's participation effect on the success of infrastructure projects by itself. We ran the regression as it is stated below.

$$Completed = \alpha + \beta_1 EP + \mu$$

Then we ran the same regression with control variables, including sector industries and the project's total cost. These are Leisure and Property (*LeisureandProperty*), Oil and Gas (*OilandGas*), Transportation (*Transportation*), Water and Sewerage (*WaterandSewerage*), and Total Project Finance Cost (*TotCost*). The point of these control variables is to examine whether the covariation between our dependent and independent variables of interest persists when influenced by other variables (Sung, 2007). The complete regression is stated below:

$$\begin{aligned} Completed = \alpha + \beta_1 EP + \beta_2 TotCost + \beta_3 LeisureProperty \\ + \beta_4 OilGas + \beta_5 Transportation \\ + \beta_6 WaterSewerage + \mu \end{aligned}$$

4 Theory and Hypothesis

4.1 Theory

Ownership theory argues that firms are there to answer to and create value for the shareholders' (Friedman, 1970). Many different corporate governance theories bring up other issues with the numerous ownership structures - large owner, small owner, government owner, etc. Different owners can have conflicting incentives which make it hard to cooperate and create efficiency.

4.1.2 Political influence

When the government intervenes in corporations, the corporation risks being negatively affected by political desires. There are times when the government tends to prioritize political objectives rather than maximizing the value of the corporations/projects (Shleifer & Vishny, 1998). Which means that projects could be undertaken with the purpose of scoring political points with short-term interest. Politicians seeking personal gains, protect certain groups, or make decisions based on what voters might like, can end up destroying the value of projects due to conflicting interests.

4.1.3 Cost of monitoring

A typical agency problem can occur due to conflicting interests between outside and inside ownership, especially when a significant shareholder is attached to a project. To mitigate the conflicting interest of the two parties, the outside owner could monitor the management. This creates a deadweight loss for the projects as the monitoring cost is transferred to the managers (Jensen & Meckling, 1976). Outside investors can monitor the corporation in several ways, for example through taking a seat on the board or requiring continuous reporting. This can consume both time and resources away from managers, resulting in reduced effort on the project.

The cost of having mixed private and public ownership can destroy value for infrastructure projects, negatively affecting the probability of completing infrastructure projects. The effect of political influence on decision-making and the cost of monitoring that comes with joint ownership, can be costly for the corporation/project that is formed.

4.2 Hypothesis

According to previous research, there are conflicting results on government equity participation. Hu et al. (2020) and Tian (2001) finds support for some degree of involvement. While Majumdar (1998) concluded a slight advantage to joint ownership over the public, private ownership performed the best. This is further supported by Backx et al. (2002), where private ownership in the airline industry outperformed public or co-owned companies when measuring productivity in the form of labor and productivity.

In our research, we study the effect of government intervention on the whole infrastructure sector. From the reviewed theory and literature, we expect the government to have a slight negative impact on the project being completed.

Hypothesis:

"*When the government is involved with equity in infrastructure projects, there is a lower probability of completing the projects.*"

5 Data

5.1 Data collection

We used data provided by Refinitiv Eikon to conduct our research, with a license to the database given to us by BI Norwegian Business School. In Eikon, we got specific information about infrastructure projects through the infrastructure 360 database. The database is continuously expanding: As of January 2022, the dataset is composed of 54.230 different projects.

These projects are spread across the world and over several decades. Most observations are from 1990 and onwards, with just a handful of outliers dated earlier than 1990. Eikon only makes it possible to export 10.000 observations each time, so we had to export the data in parts in order to analyze the total sample size.

5.2 Filtering and cleaning the dataset

In addition to some standardized variables such as ID, region, etc., we selected 59 variables of interest out of 2.438 possible variables. Then we exported the dataset to Excel for further investigation. First, we searched for duplicate values and removed the duplicates. Then we filtered the dataset to observe and remove extreme values and other data that did not make sense. After this, we used the "COUNTIF" command in excel and observed that almost half of the projects had few to no values for many variables of interest. Out of the 54.230 infrastructure projects, we were left with 28.250 unique projects with a total project finance cost of roughly 19 trillion USD. As the variables were text instead of binary outputs, we took each named variable and changed to binary outcomes. This allowed us to run the intended logistic regression in STATA.

5.3 Data limitations

Our dependable variable completed is one of 34 different values the project can be classified as. Other examples of classification are construction halted, inactive, relaunched, renewed, rewarded, under construction, and canceled. It would be interesting to cross-check our data with canceled projects to look at the straight opposite value of completed. Due to the sample size containing very few canceled projects, such a comparison is meaningless. The low representation of canceled projects might be due to underreporting, but this is not revealed in the database.

5.4 Data variables - defining status “Completed.”

Equity participation is our dependent variable and is one of the multiple variables we got from Eikon under the column government support type. This is a binary variable, as it can only take the values 0 or 1 - 1 if the government is involved through equity participation; 0 if not. If there has been a government intervention by equity, we cannot measure to what degree the government intervenes in the project, as the database does not provide such info.

Before we could run any regression, we had to cross-examine the dataset as it contained 34 different project statuses - as seen in appendix A. All these variables are mutually exclusive, meaning that no project can be classified as announced and under construction at the same time. To run the regression, we need to define what “Completed” is out of all 34 different variables. For the project to be “Completed,” it had to be completed, meaning the construction must be done. For the second success factor, we choose project status operational. The logic behind this is that projects are marked as completed when they are done. However, some projects may need continuous care, such as IT systems, water supply, toll stations, etc., so we chose the variable “operational” in addition to the former variable. Having defined these two factors as success, we merged the two cells to create one dependent variable defined as completed.

5.5 Control variable

From the dataset we used five different control variables we saw fit. These consisted of 4 different industry sectors and one non-binary as project total cost. Our industry control variables were sectors from Leisure and Property, Oil and Gas, Transportation, and finally, we used Water and Sewerage. In addition to the sector-specific control variables, we used Total Project Finance Cost, being our only continuous variable in the model.

6 Results and analysis

6.1 Introduction

In this chapter, we will discuss the results of running our regressions and the findings. First, we cleaned the data in Excel and then used the statistical software Stata for the calculations described in our methodology. We decided to use logistic regression to analyze how government intervention measured by equity participation affects the success of infrastructure projects. Our model of choice is binary logistic regression since our dependent variable is classified as a binary variable - completed or not completed.

6.2 Equity participation by government and completed projects

Our model consists of 28.250 unique infrastructure projects worldwide. Stata automatically omits variables that do not contain any values. In our case, however, we prefiltered the data, so we had all variables of interest in place. Since we previously cleaned and filtered the data, Stata included all the variables from our sample of 28.250 observations.

Firstly, we ran the logistic regression with our independent variable of interest, government equity participation. Our analysis showed that when the project is backed up by equity participation, we have an odds ratio of 1,1354. This tells us that if the government participates with an equity stake in the project, we see approximately a 53,17% chance of the project being successful. This is significant at a 1% significance level.

Table 6.1 Logistic regression with equity participation and completed project

The table displays the logistic regression results with the project being completed as our dependent variable. The independent variable is government support in the form of Equity. The light gray color and parentheses under the odds ratios and coefficients is the standard error.

Independent Variable	*Odds ratios*	*Coefficient*
Equity participation	**1.1354**	**0.127**
	(0.0306)	(0.0269)
Number of observations	28250	
Prob>chi^2	0.0000	

Then we ran the same logistic regression with different control variables. First, we added the project's total variable cost and saw that our variable of interest, Equity Participation, did not deviate much from our first regression. We proceeded stepwise by adding one by one of the variables classifying the different project sector types. We added five different control variables in our second regression (table 6.2).

The results show a slight decrease in the odds ratio when adding control variables in our model. In our first regression without added control variables, we had an odds ratio of 1,1354; after adding control variables, we ended up with an odds ratio of 1,307 for Equity participation. The projects will be completed if we have equity participation in approximately 53,06% of the instances. After adding control variables to our model, we still observe that equity participation is significant at a 1% significance level.

Table 6.2 Logistic regression with equity participation, total cost, and sector variables

The table displays the logistic regression results with the project being completed as our dependent variable. The independent variables consist of the different types of government support types; Equity participation, Total project cost, Leisure and property, Oil and Gas, Transportation, and Water and Sewerage. The light gray color and parentheses under the odds ratios and coefficients is the standard error.

Independent Variable & Control variables	*Odds ratios*	*Coefficient*
Equity participation	**1.1307**	**0.1228**
	(0.0320)	(0.0284)
Total project cost	**0.9999**	**0.0001**
	(0.0000)	(0.0000)
Leisure and Property	**1.7332**	**0.5500**
	(0.0583)	(0.0336)
Oil and Gas	**1.9340**	**0.6596**
	(0.1131)	(0.0585)
Transportation	**0.8142**	**-0.2055**
	(0.0334)	(0.0411)
Water and Sewerage	**1.8792**	**0.6309**
	(0.0992)	(0.0528)
Number of observations	28250	
Prob>chi^2	0.0000	

6.3 Summary

In this part, we will discuss the regression we ran containing government equity participation and completed projects as our dependent variable.

Observing the result from our regressions, we see that when the government uses equity to involve in infrastructure projects, the projects tend more frequently to be completed than those without equity support. This differs from our hypothesis, outlined in the theory section:

"*When the government is involved with equity in infrastructure projects, there is a lower probability of completing the projects.*"

Theories from previous research comes to different conclusions when analyzing the effect of government involvement. But overall, it tilts slightly towards mixed ownership being subpar to private ownership when measuring profits, firm value, labor productivity, and ability to react to industry changes. Our findings show that government involvement with equity is better than a non-government equity-supported infrastructure project.

7 Conclusion

The main reason for this thesis is to investigate whether equity involvement from the government in infrastructure projects affects the probability of completing the projects. To analyze the effect of government involvement, we used the binary logistic regression, the one with the highest relevance in our case since our outcome was either completed or not completed. Existing literature emphasizes that corporations with mixed ownership perform worse than companies without government involvement.

Our results indicate that for the infrastructure sector when governments are participating with equity, it has a slightly higher chance of being completed than those without government involvement through equity. This contrasts our hypothesis, where we outline a negative relationship between government involvement and completed projects. Our findings also emphasize the need for further research on the topic.

We admit that our paper has some limitations worth mentioning. First, our data sample reported only one type of government support for each project. For example, in addition to equity participation, we cannot rule out the possibility that other types of government support are used for the same project. This might affect the results, as different combinations of government involvement are used, and we cannot say that equity participation alone is the main reason for our result.

It is vital to notice that the degree of government ownership is essential for its performance; the higher the intervention, the worse it performs (Shleifer & Vishny, 1994). It would be interesting to analyze the degree of equity the government used compared to the total project funds for each project. When such information could be obtained, one could analyze the effect when the government is a significant owner or not. Therefore, gathering more detailed data about government ownership would be beneficial for further studies, in order to pinpoint more accurately the effect of government ownership.

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Appendix

Appendix A
Agreement Signed
Announced
Awaiting Government Approval
Bids Submitted
Cancelled
Commissoning
Completed + Operational
Construction Halted
Contract Awarded
Contract Signed
Feasibility Study
Government Approved
In Tender
Inactive
Letter of Intent Signed
Negotiations
Operational
Planning Permission Applied
Planning Permission Granted
Planning Permission Refused
Pre Qualification Bids
Preferred Bidder Stage (PBS)
Public Inquiry
Re-launched or Renewed
Request for Proposal (RFP)
Re-Tender
Rumoured
Sale Agreement Signed
Sale Completed
Section 36 Applied (UK)
Section 36 Approval(UK)
Section 36 Refused (UK)
Study & Design
Suspended
Under Construction