

The impact of public-private partnership in the energy field on economic growth

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Abstract: *Under pressure to solve a multitude of problems, the public authority is looking for new and additional sources of funding capable of participating in meeting social needs, involving different private sectors by participating in the provision of public services that best meet the needs of the community. Public-private partnership (PPP) expresses a way of cooperation between the public authority and the private sector, in order to provide public services with high quality. Fundamentally, the public-private partnership provides the public service entirely or in part, depending on the private funds attracted and draws on the know-how of the private sector. The main goal of this study is to analyze the short-run impact of increasing the value of public-private partnership in energy on economic growth, based on a panel of emerging economies. The outcomes suggest that an increase in the value of public-private partnership leads to an increase in GDP growth but only across extreme quantiles. This suggests that public-private partnership in energy is beneficial to economic development, but only during periods of economic booms.*

Keywords: *public-private partnership, economic growth, energy.*

JEL Classification: *H57, O47, P18*

Introduction

The concept of public-private partnership (PPP) expresses a way of cooperation between the public authority and the private sector, respectively non-governmental organizations, associations of businessmen, or companies to provide public services with high quality. Fundamentally, the public-private partnership provides the public service entirely or in part, depending on the private funds attracted and draws on the know-how of the private sector.

The cooperation between the public and private sectors can take various forms, from the simple relationship between the buyer and the seller of a good to joint ventures with a complex structure. It should also be noted that complex interdependencies govern the relations within the public sector, connected to the development of public services. A PPP is

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primarily a transaction that transfers overall responsibility for the provision of a public service or for making a commercial investment to a private company, while the competent public authority retains its political responsibility, becoming a partner in profit and loss.

The main goal of this study is to empirically investigate the short-run impact of increasing the value of public-private partnership in energy on economic growth, based on a panel of 18 emerging economies. More to the point, after controlling for inflation, unemployment, foreign direct investment, government spending, government effectiveness and political stability, we estimate a conditional quantile regression model to evaluate the impact of the public-private partnership on economic growth.

The results suggest that an increase in the value of public-private partnership leads to an increase in GDP growth, but only across extreme quantiles. This suggests that public-private partnership in energy is beneficial to economic development, but only during periods of economic booms. For other representative quantiles we fail to report significant evidence linking the positive trend in economic growth to public-private partnership in energy.

In this way we contribute to the literature by providing a panel analysis on the impact of PPP on economic growth by accounting for the distributional characteristics of the dependent variable. This type of analysis was eluded until now into the PPP literature.

The remainder of the paper has the following structure: Section 2 lays out the data, Section 3 presents the methodology, Section 4 highlights the results, while Section 5 concludes the paper.

Literature review

The literature investigating the PPP is quite limited and mainly suggests that these types of contracts have led to an increased efficiency in the construction projects (Naoum, 2003). Moreover, it led to an improvement in innovation and learning in several construction projects as Chan et al. (2010) pointed out. In comparison to stratified governance, PPPs were more effective in generating flexible, creative and innovative solutions to a series of issues such as environmental protection (McQuaid, 2010), creating knowledge and building capacity (Pattberg et al., 2012).

PPP's are known as a potential vehicle for reaching key elements in sustainability (Lenferink et al., 2013), wherein participants are involved in joint decision making and network governance. However, Adebayo et al. (2021) show that renewable energy consumption and technological innovation are diminishing the CO₂ emissions, while PPP investment in energy and economic growth increase CO₂ emissions. In addition, Ahmad and Raza (2020) reveal that the PPP investment in energy is worsening the environmental quality by increasing CO₂ emissions in the long run. Furthermore, Akinsola et al. (2021) revealed that economic growth and PPP investment in energy are detrimental to the environment, while it is mitigated by both renewable energy and financial development.

Anwar et al. (2021) explore the impact of PPP investments in the transport sector, renewable energy consumption and urbanization on transport-induced carbon emissions in China. According to them, the PPP investments have diverse influences on transport-induced CO₂ emission. This is also confirmed by Khan et al. (2020) or by Shahbaz et al. (2020) which have shown that, in the long term, PPP investment and technological innovation cause consumption-based carbon emissions in China.

Methodology

In this study, we consider a balanced panel with annual data, from 2000 to 2020 using a sample of 18 emerging countries, namely Brazil, Colombia, Czech Rep., Hungary, Indonesia, India, Israel, Mexico, Malaysia, Peru, Philippines, Poland, Singapore, Thailand, Turkey, South Africa, Chile, and China. We chose this sample because the issue of public-private partnership is a much more important issue in emerging countries compared to developed ones (see Ahmad and Raza (2020), Akinsola et al. (2021), Khan et al. (2020) for details regarding PPP in emerging markets such as Brazil, China, India). Moreover, the choice of the 18 countries was influenced by the availability of data. A detailed description of the variables we use in this study is presented in Table 1.

Table 1. Data description

Variable	Definition	Source
GDP growth	It represents the annual percentage growth rate of GDP at market prices based on the invariable national currency. They are based on constant 2010 U.S. dollars. GDP is the amount of gross value given by all producers in the economy plus any merchandise taxes and minus any subvention not included in the value of the goods	World Bank Database
Inflation Rate (INF)	The annual percentage change in CPI (Consumer Price Index)	World Bank Database
Unemployment (UNMP)	The labor force that is out of a job but available for and seeking hiring	World Bank Database
Political stability (PSI)	It measures perceptions of the probability that the government will be destabilized or removed from power by unconstitutional or forceful means	World Bank Database
Foreign Direct Investments (FDI)	Direct investments involve long-term investment relationships between resident and non-resident entities that involve investors exercising significant managerial influence in the investee companies. Ownership of 10 percent or more of the ordinary shares of voting stock is the criterion for determining the existence of a direct investment relationship. Data is in current U.S. dollars.	The Global Economy

Variable	Definition	Source
Government Effectiveness (Gov Eff)	It captures perceptions of the quality of public services and the rank of its independence from political constraint, the quality of implementation and the credibility of the government's commitment to such policies	World Bank Database
Government spending (Gov Spend)	General government final consumption costs. It includes all government current costs for acquisition of goods and services (including compensation of employees). It also includes expenses on national defense and security but no government military expenses that are part of government capital formation. Data is in current U.S. dollars	World Bank Database
Public-private partnership in energy (PPP)	The value of investments in energy based on a public-private partnership	World Bank Database

When selecting the list of explanatory factors for economic growth, we considered variables such as Corruption Perceptions Index as proxy for political development, Health spending per capita, secondary education or Life expectancy as proxies for economic development. However, we removed them from the baseline specification after imposing a 50% threshold in absolute values for the correlation coefficient.

To investigate the linear relationship between two or more variables, standard regression techniques are focusing on the mean effect. However, in some situations the mean regression approaches such as OLS or GMM might provide an incomplete image when investigating for example, the link between economic growth and Public-private partnership in energy. This situation occurs when the data series are characterized by asymmetric distribution or are altered by extreme events such as a financial or health crisis. To overcome this potential issue, Koenker and Bassett (1978) developed the quantile regression method which can deliver robust estimates to outliers and heavy distributions and has the capacity to draw inferences on observations that rank above or below the life insurance density conditional mean.

Mathematically, at any level of τ , across the distribution of PPP density (y), given a set of explanatory variables denoted x , the conditional quantile $Q_y(\tau|x)$ shows $\inf\{k: T(k|x) \geq \tau\}$, with $T(*|x)$ being the conditional distribution function.

Considering our data structure, the most common approach for identifying the asymmetric response of economic growth to different covariates is the conditional quantile regression with fixed effects (Koenker, 2004), which has the following specification:

$$Q_{y_{i,t}}(\tau|x_{i,t}) = \alpha_i + x_{i,t}^T \beta(\tau). \quad (1)$$

In Eq. (1), $i = \overline{1, N}$ and $t = \overline{1, T}$, represent country and years, respectively, $y_{i,t}$ is the economic growth in country i and year t , $x_{i,t}$ incorporates the explanatory variables characterizing the country i and year t , $\beta(\tau)$ is the common slope while α_i is a pure location shift indicator on the conditional quantile of the response variable. The impact of the covariates can be sensitive to the quantile τ of interest but α_i does not. Moreover, the estimation procedure contains an intercept, which captures the common value taken to be the conditional central tendency of the response given a point identified by the centering of the other explanatory variables (Koenker, 2004). To capture the unobserved country heterogeneity Koenker's (2004) handles the fixed effects as nuisance parameters by including a penalty factor in the minimization algorithm:

$$\min_{(\alpha, \beta)} \sum_{k=1}^K \sum_{t=1}^T \sum_{i=1}^N w_k \rho_{\tau_k} (y_{i,t} - \alpha_i - x_{i,t}^T \beta(\tau_k)) + \lambda \sum_i |\alpha_i|. \quad (2)$$

In Eq. (2), K denotes the quantiles' index, ρ_{τ_k} represents the quantile loss function, while w_k captures the relative impact of the q quantiles $\{\tau_1, \dots, \tau_q\}$ when estimating the α_i parameters. The penalty term λ has the advantage of decreasing the individual effects to zero, which improves the quality of β considering the aforementioned estimation approach. In addition, when $\lambda \rightarrow 0$ we deal with a standard fixed-effects model and with a panel model without individual effects when $\lambda \rightarrow \infty$.

Results and discussions

Before performing the econometric regression, it is crucial to investigate the stationarity of the variables. Some very influential studies (Wen and Chang, 2015) argued that it is difficult to analyze specific interactions between different types of non-stationary factors in a panel data approach. For this reason, we have computed for each variable two panel unit root tests developed by Levin et al. (2002) – LLC test and Im et al. (2003) – IPS test (see Table 2 for the results).

Table 2. Panel Unit Root Tests

Dependent variables	LLC		IPS	
	Trend	No trend	Trend	No trend
INF	-6.0538 (0.0000)	-5.7474 (0.0000)	-4.1974 (0.0000)	-5.9700 (0.0000)
UNMP	1.2783 (0.8994)	-1.9690 (0.0245)	1.4066 (0.9202)	-1.6346 (0.0511)
PSI	-3.7707 (0.0001)	-3.7508 (0.0001)	-1.6562 (0.0488)	-1.7466 (0.0403)
FDI	-2.6352	-2.1536	-1.4529	-1.346

Dependent variables	LLC		IPS	
	Trend	No trend	Trend	No trend
	(0.0042)	(0.0156)	(0.0731)	(0.0890)
Gov Eff	2.0760 (0.9811)	0.0842 (0.5336)	1.5672 (0.9415)	0.5196 (0.6983)
Gov Spend	-0.1835 (0.4272)	0.4727 (0.6818)	1.4543 (0.9271)	3.5172 0.9998
PPP	1.0306 (0.8486)	-0.9257 (0.1773)	-1.2703 (0.1020)	-3.1773 (0.0007)

Note: The null hypothesis is that the series is a unit-root process; P-values in parentheses.

As we can see in Table 2, except for the inflation and Political Stability Index, the rest of the covariates exhibit a unit root at 5% level. To have a clear picture regarding the integration order of each variable we perform the same unit root tests, but for the first difference (see Table 3).

Table 3. Integration order of each variable

Dependent variables	Integration Order	Independent variable in regression
INF	I(0)	Level
UNMP	I(1)	First difference
PSI	I(0)	First difference
FDI	I(1)	First difference
Gov Eff	I(1)	First difference
Gov Spend	I(1)	First difference
PPP	I(1)	First difference

All the p-values for the first difference are lower than 1%, indicating the rejection of the null of non-stationarity.

To investigate the multicollinearity issues, we present in Table 4 the correlation matrix of the variables. As we can see, the correlation coefficients do not exceed the threshold level of 50%, indicating that multicollinearity is not present in the baseline specification.

Table 4. Correlation structure of the independent variables

	INF	UNMP	PSI	FDI	Gov Eff	Gov Spend	PPP
INF	100%	19.54%	33.0%	-1.07%	-0.46%	-3.72%	-2.00%
UNMP	19.54%	100%	-7.27%	13.75%	1.81%	-2.08%	3.13%
PSI	-33.01%	-7.27%	100%	3.75%	6.46%	-5.57%	-1.19%
FDI	-1.07%	13.75%	3.75%	100%	10.88%	20.95%	0.98%
Gov Eff	-0.46%	1.81%	6.46%	10.88%	100%	10.51%	2.99%
Gov Spend	-3.72%	-2.08%	-5.57%	20.95%	10.51%	100%	-0.25%
PPP	-2.00%	3.13%	-1.19%	0.98%	2.99%	-0.25%	100%

We move forward and present the quantile regression estimates in Table 5. We consider a selection of five quantiles (10th, 25th, 50th, 75th and 90th) as representative for the distribution of economic growth. The p-values are presented in parenthesis. To have a comprehensive view regarding the quality of the estimates and their ability to explain the economic growth dynamic, we also report the Pseudo R-squared value.

The results reported in Table 5 suggest that economic growth in the selected countries is not sensitive to inflation across lower and medium quantiles. Indeed, during episodes when the GDP has an above-average dynamic, the inflation is amplifying this trend (see the case of the 75th quantile).

Additionally, we observe that unemployment contributes negatively to economic growth, which is in line with the theoretical foundation. Interestingly, when economic growth reaches the 90th quantile, the impact becomes statistically insignificant. This fact indicates that during episodes of powerful production, the events in the labor market do not impact economic development.

Interestingly, the effectiveness of government policies as well as political stability exhibit a positive impact on economic growth but only during normal economic conditions (25th, 50th and 75th quantiles). Both cases the impact is statistically significant at 10% level at least. These estimates indicate that in order to obtain sustainable economic growth, a certain emerging country needs a stable political environment and additionally, clear political reforms.

Table 5. Quantile Regression results

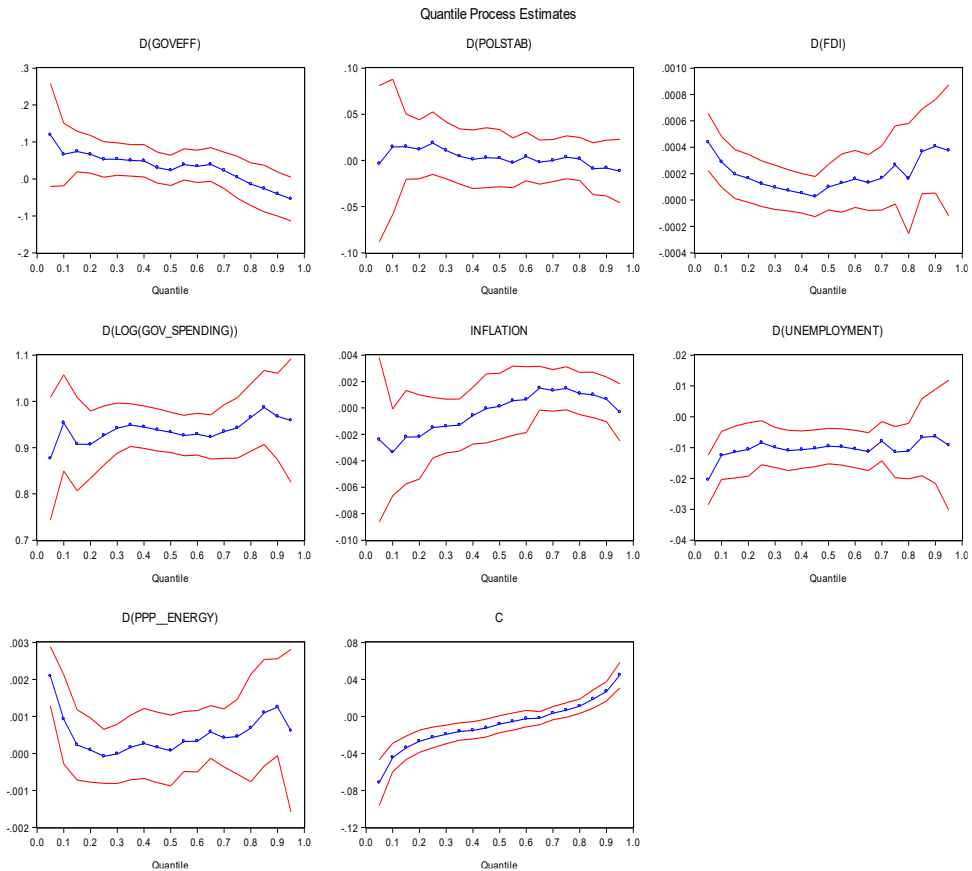
Variables	10th quantile	25th quantile	50th quantile	75th quantile	90th quantile
INF	-0.0027 (0.3924)	-0.0011 (0.4236)	0.0006 (0.6519)	0.0020 (0.0121)	0.0006 (0.3825)
UNMP	-0.0133 (0.0013)	-0.0092 (0.0145)	-0.0097 (0.0003)	-0.0102 (0.0131)	-0.0040 (0.5817)
PSI	0.0033 (0.6871)	0.0063 (0.1093)	0.0055 (0.0396)	0.0068 (0.0089)	0.0041 (0.1664)
FDI	0.0002 (0.0496)	0.0001 (0.3118)	0.0001 (0.4204)	0.0002 (0.4002)	0.0002 (0.4620)
Gov Eff	0.0731 (0.1183)	0.0639 (0.0198)	0.0339 (0.0769)	0.0148 (0.4736)	-0.0682 (0.0080)
Gov Spend	0.9356 (0.0000)	0.9357 (0.0000)	0.9247 (0.0000)	0.9589 (0.0000)	0.9853 (0.0000)
PPP	0.0010 (0.0865)	-0.0001 (0.8704)	0.0003 (0.4731)	0.0004 (0.2735)	0.0017 (0.0007)
R-Squared	0.6135	0.6356	0.6546	0.6554	0.6447
Observations	306	306	306	306	306

As expected, increasing government spending is amplifying economic growth. This situation occurs very often in emerging economies when the state involvement is more pronounced compared to industrialized countries.

Finally, the public-private partnership value in energy exhibits a positive impact on economic growth but only extreme quantiles. This suggests that during extreme events, regardless their nature (recessions or expansions) a higher value of contract in energy coming from public-private partnership can boost the economic growth in the selected emerging economies. However, during episodes of moderate growth or otherwise, the impact is statistically insignificant.

Overall, the reported R-squared suggests that all the regression has an above-average explanation power, indicating the validity of our conclusion. To have a more comprehensive view regarding the quantile process, we present all the values for 20 quantiles in Figure 1.

Figure 1. Quantile coefficients dynamic



Conclusions

In this study we consider a balanced panel with annual data, from 2000 to 2020 using a sample of 18 emerging countries, to empirically investigate the short-run impact of increasing the value public-private partnership in energy on economic growth, After controlling for inflation, unemployment, foreign direct investment, government spending, government effectiveness and political stability we show that an increase in the value of public-private partnership leads to an increase in GDP growth, but only across extreme quantile. This suggests that public-private partnership in energy is beneficial to economic development, but only during periods of economic booms or recessions. These findings have strong policy implications since governments can use those partnerships in energy to reach sustainable economic growth, especially during recession periods. *More to the point, the PPP investments must be strengthened and the guidelines regarding their implementation should be enhanced, in order to be as effective as possible.*

Since the present energy crises around the globe due to the Ukrainian war, among others, require additional investments, the public-private cooperation in energy sources should be encouraged by the government.

This could lead to extra jobs for residents and, as the results are pointing out, to regeneration of the financial system after crises. Finally, the selected sample and the variables on PPP were not enough to provide some valid robustness checks to the analysis. This limitation will be handled in the next research papers where I intend to expand the sample of countries and to account for other proxies for PPP investments in energy.

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References

- Adebayo, T. S., Genç, S. Y., Castanho, R. A., Kirikkaleli, D. (2021). Do public-private partnership investment in energy and technological innovation matter for environmental sustainability in the East Asia and Pacific region? An application of a frequency domain causality test. *Sustainability*, 13(6), 3039.
- Ahmad, M., Raza, M. Y. (2020). Role of public-private partnerships investment in energy and technological innovations in driving climate change: evidence from Brazil. *Environmental Science and Pollution Research*, 27(24), 30638-30648.
- Akinsola, G. D., Awosusi, A. A., Kirikkaleli, D., Umarbeyli, S., Adeshola, I., & Adebayo, T. S. (2021). Ecological footprint, public-private partnership investment in energy, and financial development in Brazil: a gradual shift causality approach. *Environmental Science and Pollution Research*, 1-14.

- Anwar, A., Sharif, A., Fatima, S., Ahmad, P., Sinha, A., Khan, S. A. R., & Jermittiparsert, K. (2021). The asymmetric effect of public private partnership investment on transport CO2 emission in China: Evidence from quantile ARDL approach. *Journal of Cleaner Production*, 288, 125282.
- Khan, Z., Ali, M., Kirikkaleli, D., Wahab, S., & Jiao, Z. (2020). The impact of technological innovation and public-private partnership investment on sustainable environment in China: Consumption-based carbon emissions analysis. *Sustainable Development*, 28(5), 1317-1330.
- Kirikkaleli, D., & Adebayo, T. S. (2021). Do public-private partnerships in energy and renewable energy consumption matter for consumption-based carbon dioxide emissions in India?. *Environmental Science and Pollution Research*, 28(23), 30139-30152.
- Chan, D.W.M., Chan, A.P.C., Lam, P.T.I., Wong, J.M.W. (2010). Empirical study of the risks and difficulties in implementing guaranteed maximum price and target cost contracts in construction. *Journal of Construction Engineering and Management* 136 (5), 495–507.
- Im KS, Pesaran MH, Shin Y (2003) Testing for unit roots in heterogeneous panels. *Journal of Econometrics* 115: 53–74.
- Koenker, R. (2004). Quantile regression for longitudinal data. *Journal of Multivariate Analysis* 91(1), 74–89.
- Koenker, R., Bassett, G.J. (1978). Regression quantiles. *Econometrica*. 46, 33–50.
- Lenferink, S., Tillema, T., Arts, J., 2013. Towards sustainable infrastructure development through integrated contracts: experiences with inclusiveness in Dutch infrastructure projects. *International Journal of Project Management* 31 (4), 615–627.
- Levin A, Lin C-F, Chu CSJ (2002) Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics* 108: 1–24.
- McQuaid, R.W. (2010). Theory of organisational partnerships: partnership advantages, disadvantages and success factor. In: Osborne, S.P. (Ed.), *The New Public Governance?: Emerging Perspectives on the Theory and Practice of Public Governance*. Taylor and Francis Group, London, pp. 127–148
- Naoum, S., 2003. An overview into the concept of partnering. *International Journal of Project Management* 21 (1), 71–76.
- Pattberg, P., Biermann, F., Chan, S., Mert, A. (2012). *Public-Private Partnerships for Sustainable Development: Emergence, Influence and Legitimacy*. Edward Elgar Publishing, Cheltenham, UK.
- Shahbaz, M., Raghutla, C., Song, M., Zameer, H., & Jiao, Z. (2020). Public-private partnerships investment in energy as new determinant of CO2 emissions: the role of technological innovations in China. *Energy Economics*, 86, 104664.
- Wen J, Chang CP (2015) Government ideology and the natural disasters: a global investigation. *Natural Hazards* 78 (3): 1481–1490.
- https://www.theglobaleconomy.com/indicators_list.php
- <https://www.worldbank.org/en>