Governance Environment and the Public Investment – Private Investment Relationship

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Abstract

The study empirically investigates the role of the governance environment in the public investment – private investment relationship for a sample of 72 developing countries with bad governance environment and for a sample of 25 developed countries with good one over the period 2003 – 2016. The paper first develops an analytical framework to formulate empirical equations, then uses the difference GMM Arellano-Bond estimators for estimation and the FE-IV estimator for robustness check. More interestingly are the empirical findings. First, the public investment – private investment relationship strongly varies based on the quality of governance environment. Second, the governance environment strongly promotes private investment. These findings suggest some important policy implications in setting up the sound governance environment for the public investment – private investment relationship to governments in countries worldwide.

Keywords: governance environment, public investment, private investment, GMM estimators.

1. Introduction

The relationship between public investment and private investment is one of drastically debated topics among economists and policymakers. Starting from the seminal work of Aschauer (1989) a large strand of related literature has examined this relationship, attempting to test for complementarity or substitutability. However, no existing papers provide the empirical evidence to show that the public investment – private investment relationship is obviously determined by the quality of governance environment.

Private investment capital plays a crucial role in boosting economic growth, creating employment, and thus stabilizing the social security (Khan & Reinhart, 1990). Meanwhile, public investment capital importantly contributes to providing infrastructure and other public goods and services for economic activities and private sector's development. However, recent related literature has reported that public investment can crowd out/in private investment. As such what makes these studies to have contrary results? It would be institutions. Acemoglu, Johnson, and Robinson (2005) indicate that difference in institutional environment lead to difference in economic activities between countries. Under good governance environment, the sound policies can lead public investment capital into sectors/industries, which require a large amount of capital with a low profit, that private sector refuse to invest, or to cooperate with private sector under public-private partnership projects. Conversely, bad institutions can impede private investment and increase public investment at the same time (Cavallo & Daude, 2011). Under bad governance environment, public sector can directly compete with private sector in goods production or can use financial resources that are priority for private sector (Aschauer, 1989).

Given the relevance of this topic, the most important recent contribution to the literature is Cavallo and Daude (2011). Cavallo and Daude (2011) develop

a simple theoretical model to incorporate the quality of institutions into the public investment – private investment relationship. They argue that on the one hand, good institutions boost the effectiveness of public capital spending, raising the marginal product of private capital and consequently supplementing more private investment. On the other hand, bad institutions can rule out the positive impacts of public investment projects and substitute private investment. To demonstrate these arguments, Cavallo and Daude (2011) use the one-step system GMM estimators to examine the effect of public investment on private investment with the presence of governance quality for 116 developing countries over the period 1980 – 2006. They conclude public investment and the interaction term between public investment and governance quality hinder private investment, emphasizing "weak institutions hinder private investment and lead at the same time to an increase in public investment" (Cavallo & Daude 2011, page 72). In comparison with this work, this study shows two highlight aspects. First, we provide the empirical evidence to show that the public investment – private investment relationship strongly varies based on the quality of the governance environment. Second, this study uses the two-step GMM estimators for estimation. The two-step GMM estimators are more asymptotically efficient than the one-step GMM estimators (see more in Sub-section 3.1).

Highly consistent with the empirical results in Cavallo and Daude (2011) are Voss (2002), Badawi (2003), Mitra (2006) and Dash (2012). Innovations to public investment seem to crowd out private investment in the United States and Canada (Voss, 2002) while public capital spending reduces private investment in Sudan over the period 1970 – 1998 (Badawi, 2003). Meanwhile, Mitra (2006) shows that government investment crowds out private investment in India from 1969 to 2005 using a structural vector autoregression model (SVAR). Similar to Mitra (2006), Dash (2016) finds the crowding-out effect of public investment on private investment in India over the period 1970 – 2013 using ARDL

estimator. In contrast, Narayan (2004), Martinez-Lopez (2006), Ang (2009), Hatano (2010) provide the empirical evidence to support the crowd-in hypothesis. More recently, Andrade and Duarte (2016) affirm the existence of a complementarity between public investment and private investment rather than substitutability in Portugal over the period 1960 – 2013 using ADL models while Dreger and Reimers (2016) suggest that public investment stimulates private investment in 12 Euro area member states during the 1991 – 2012 period using error correction models (ECM). Lately, Muthu (2017) reports public investment capital tends to crowd in private investment in the long-run and the short run in India from 1951 to 2010 using an ARDL model. However, some researchers report the mixing results in the effect of public investment on private investment that depends on the investment sectors/industries or countries in the research sample. Pereira (2001) indicates that the effect of public investment on private investment is crowding-in in industrial equipment and transportation equipment, but crowding-out in information equipment in the United States from 1956 to 1997 using VAR models. Fujii, Hiraga, and Kozuka (2013) note that public investment has opposite effects on private investment, which depends on investment sectors in Japan over the period from 1983Q2 to 2008Q1 using FAVAR models. Similarly, Xu and Yan (2014) confirm that government investment in public goods China crowds in private investment, while government investment in private goods, industry and commerce crowds out private investment in China from 1980 to 2011 using VAR models. In regard with the factor of countries, Atukeren (2005) shows that both crowding-in and crowding-out effects of public investments occur in 25 developing countries using cointegration tests and probit analysis. It implies the relationship between public investment and private investment is dependent upon countries in the sample. In the same vein, Erden and Holcombe (2005) find that the effect of public investment on private investment is positive in 19 developing countries from 1980 to 1997 and

negative in 12 developed countries from 1980 to 1996 using pooled–ordinary least squares (OLS), fixed effect, random effect (GLS), and system two-stage least squares (2SLS). In particular, Bahal, Raissi, and Tulin (2018) show the difference in effect of public investment on private investment in India over the period 1996–2015 depends on the observed periods via Structural Vector Error Correction Models (SVECMs). Public investment reduces private investment from 1950 to 2012 while the opposite is true during the period from 1980 to 2015.

Motivated by the fact that the governance environment plays a crucial role in the public investment – private investment relationship, we highlight the important of taking governance into account for understanding of this relationship. Most of the related literature on private investment has either studied the relationship between institutions and private investment (Feng, 2001; Aysan, Nabli & Véganzonès-Varoudakis, 2007; Munemo, 2012) or the relationship between public investment and private investment (Aschauer, 1989; Erden & Holcombe, 2005; Dreger & Reimers, 2016). Therefore, this paper tests whether the relationship between public investment and private investment varies based on the quality of governance environment. Using public investment and private investment data from 72 developing countries with bad governance and 25 developed countries with good governance over the period 2003 to 2016 we find that public investment crowds out private investment under bad governance environment, but it crowds in under good one.

The structure of the paper is organized in the following way. Section 1 is the introduction while Section 2 develops an analytical framework to formulate the empirical equations. Section 3 presents the model specification and research data, which specially emphasizes the characteristic and appropriateness of difference GMM Arellano-Bond estimators. Section 4 is the empirical results and discussion. Finally, Section 5 concludes and suggests some important policy implications.

2. Analytical framework

Supposing the economy has two basic inputs, labor force *LAB* and domestic capital stock, which consists of private investment *PIN* and public investment *GIN*. Cavallo and Daude (2011) argue that the effective contribution of infrastructure and other public goods provided by the public sector to the economy is the combination of public investment and institutional environment *GOV* that is described by the function *H(GIN, GOV) = GINGOV*. The analytical framework will be started with a conventional Cobb-Douglas production function:

$$Y_t = A_t LAB_t^\alpha PIN_t^\beta [H(GIN, GOV)]_t^\gamma \tag{1}$$

where the subscript *t* represents the time period, Y_t real aggregate output, A_t a measure of productivity, α, β, and $\gamma \equiv 1 - \alpha - \beta$ are parameters.

From Equation (1), the marginal product of private investment is $\beta Y_t / PIN_t$. Meanwhile, the function *H(GIN, GOV) = GINGOV* is the combination of public investment *GIN* and institutional environment *GOV*. H(GIN, GOV) can be considered as the public capital spending. Thus, the marginal product of public capital spending is $\gamma Y_t / [H(GIN, GOV)]_t$. These marginal products will be equal to their respective interest rates in case the private sector and public sector optimally accumulate capital (Hatano, 2010). Assuming the interest rate of private sector is *s* and that of the public sector is *r*, then,

$$s_t = \beta Y_t / PIN_t \; ; \; r_t = \gamma Y_t / [H(GIN, GOV)]_t \tag{2}$$

Despite difference between two interest rates regarding risk premiums, they can move in parallel with each other due to the arbitrage pressure of the market (Hatano, 2010). Assuming that these two interest rates maintain the ratio σ such that the relationship $r_t = \sigma_t s_t$ always holds, so we can obtain:

$$PIN_t = (\sigma_t \beta / \gamma)[H(GIN, GOV)]_t = (\sigma_t \beta / \gamma)(GIN_t \times GOV_t) \quad (3)$$

Equation (3) implies that there is a long-run stable relationship between the marginal product of private investment and that of public investment with the variation of risk premiums.

We proceed a log-linear transformation for Equation (3) as follows:

$$lnPIN_t = (ln\beta - ln\gamma) + \rho_1 lnGIN_t + \rho_2 lnGOV_t + \rho_3 ln\sigma_t \quad (4)$$

We re-write Equation (4) in a form with a time series specification:

$$PIN_{it} = \rho_0 + \rho_1 GIN_{it} + \rho_2 GOV_{it} + \rho_3 \sigma_{it} + \varepsilon_{it} \quad (5)$$

where ρ_0 ($\rho_0 = ln\beta - ln\gamma$), ρ_1, ρ_2, ρ_3 are parameters and ε_{it} is the white noise.

In this study, we suppose that the risk premiums σ_{it} are subject to the macroeconomic shocks such as economic growth GDP_{it}, tax revenue TAX_{it}, labor force LAB_{it}, trade openness OPE_{it}, inflation INF_{it}, and infrastructure TEL_{it}:

$$\sigma_{it} = \tau_1 GDP_{it} + \tau_2 TAX_{it} + \tau_3 LAB_{it} + \tau_4 OPE_{it} + \tau_5 INF_{it} + \tau_6 TEL \quad (6)$$

where τ_1, ..., τ_6 are parameters.

We substitute Equation (6) into Equation (5), the following equation can be derived:

$$PIN_{it} = \pi_0 + \pi_1 GIN_{it} + \pi GOV_{it} + \pi_3 GDP_{it} + \pi_4 TAX_{it} + \pi_5 LAB_{it}$$
$$+ \pi_6 OPE_{it} + \pi_7 INF_{it} + \pi_8 TEL_{it} + \varepsilon_{it} \quad (7)$$

where π_0, ..., π_8 are parameters.

Subtracting PIN_{it-1} from Equation (7), we can obtain a dynamic equation as follows:

$$PIN_{it} = \theta_0 + \theta_1 PIN_{it-1} + \theta_2 GIN_{it} + \theta_3 GOV_{it} + \theta_4 GDP_{it} + \theta_5 TAX_{it}$$
$$+ \theta_6 LAB_{it} + \theta_7 OPE_{it} + \theta_8 INF_{it} + \theta_9 TEL_{it} + \varepsilon_{it} \qquad (8)$$

where θ_0, ..., θ_9 are parameters.

3. Model specification and data

3.1 Model specification

Based on Equation (8) in the analytical framework, our empirical equation is given by:

$$PIN_{it} = \beta_0 + \beta_1 PIN_{it-1} + \beta_2 GIN_{it} + \beta_3 GOV_{it} + X_{it}\beta' + \eta_i + \xi_{it} \qquad (9)$$

where subscript *i* and *t* are the country and time index, respectively. PIN_{it} is domestic private investment, PIN_{it-1} is proxy for initial level of domestic private investment, GIN_{it} is the public investment, and GOV_{it} is governance environment (six dimensions of governance). X_{it} is a set of control variables such as economic growth, tax revenue, labor force, trade openness, inflation, and infrastructure; η_i is an unobserved time-invariant, country-specific effect and ζ_{it} is an observation-specific error term; β_0, β_1, β_2, β_3 and β' are estimated coefficients.

Equation (9) will be used to assess the public investment – private investment relationship for the sample of 72 developing countries with poor governance environment and for the sample of 25 developed countries with good governance environment. In this study, we use six dimensions of governance, which are constructed by Worldwide Governance Indicators project (Kaufmann, Kraay, & Mastruzzi, 2011), to determine the quality of the governance environment. "Governance as the traditions and institutions by which authority in a country is exercised. This includes (a) the process by which governments

are selected, monitored and re-placed; (b) the capacity of the government to effectively formulate and implement sound policies; and (c) the respect of citizens and the state for the institutions that govern economic and social interactions among them" (Kaufmann et al. 2011, page 222). World Development Report (2017) defines "Governance is the process through which state and nonstate actors interact to design and implement policies within a given set of formal and informal rules that shape and are shaped by power" and "Power as the ability of groups and individuals to make others act in the interest of those groups and individuals and to bring about specific outcomes." (World Bank, 2017, page 3). Six dimensions of governance are measured in the standard normal units of the governance indicator, ranging from around –2.5 to 2.5. "The quality of governance is a direct measure of the incentives of governments to seek rents and to refrain from establishing institutions that would limit their ability to seek rents." (Keefer & Knack, 2007, page 567).

Hope Sr (2009) emphasizes the lack of good governance in most developing countries leads to adverse effects on the economic development perspective; thus, enhancing the governance environment in these countries plays a crucial role in the development agenda. He defines "…good governance is defined as the existence – within states – of political accountability, bureaucratic transparency, the exercise of legitimate power, freedom of association and participation, freedom of information and expression, sound fiscal management and public financial accountability, respect for the rule of law, a predictable legal framework encompassing an interdependent and credible justice system, respect for human rights, an active legislature, enhanced opportunities for the development of pluralistic forces including civil society, and capacity development…" (Hope Sr, 2009, page 730). Hope Sr (2009) insists that good governance significantly contributes to the creation of constructive governments with the capacity to implement development policies.

There are four serious problems of econometrics from estimating Equation (9). First, some variables such as economic growth and tax revenue may be endogenous. These variables can correlate with the error term η_i, which leads to the endogenous phenomenon. Second, some unobserved time-invariant, country-specific characteristics (fixed effects) like geography and anthropology can correlate with the independent variables. These fixed effects exist in the error term η_i. Third, the presence of the lagged dependent variable PIN_{it-1} results in a high autocorrelation. Finally, the panel data has a short observation length (T = 14) and a large unit of countries (N = 72). These problems may cause OLS estimator inconsistent and biased. Fixed effects model and Random effects model can not deal with endogenous phenomena and autocorrelation while PMG estimator (Pool Mean Group) and MG estimator (Mean Group) need a long observation length to estimate in both short-run and long-run. In addition, IV-2SLS estimator requires some suitable instrumental variables which are out of independent variables in the model. Therefore, we decide to select the difference GMM estimator (D-GMM) as suggested by Judson and Owen (1999).

The general method of moments (GMM) Arellano and Bond (1991) estimators are first proposed by Holtz-Eakin, Newey, and Rosen (1988). To estimate Equation (9), we take the first difference to remove country-specific effects. Then, the regressors in first difference are used as instrumented by their lags under the assumption that time-varying disturbances in the original models are not serially correlated (Judson & Owen, 1999). This strategy is D-GMM, which is well-known to be able to deal with simultaneity biases in regressions.

The two-step D-GMM estimators are more asymptotically efficient than the one-step D-GMM estimators. In fact, in D-GMM regressions on simulated panels, Windmeijer (2005) reported that in comparison with the one-step D-GMM, the two-step D-GMM performs somewhat better in estimating

coefficients, with lower bias and standard errors. Thus, two-step estimates with corrected errors seem modestly superior to cluster-robust one-step estimates. In addition, the two-step D-GMM estimators use both Sargan and Hansen statistics to test the endogenous phenomenon while the one-step D-GMM estimators only use Sargan statistic. However, the application of the two-step D-GMM estimators in small samples, as in our study, has some problems (Roodman, 2009). These problems are set up by the proliferation of instruments, which quadratically increase as the time dimension increases. It can cause the number of instruments to be very large relative to the number of provinces. To avoid it, the rule of thumb should be applied to maintain the number of instruments less than or equal to the number of panel units (Roodman, 2009).

The validity of instruments in the D-GMM is assessed through Sargan/ Hansen statistic and Arellano-Bond statistic. The Sargan/Hansen tests with null hypothesis H_0: the instrument is strictly exogenous, which means that it does not correlate with errors. The Arellano-Bond test is used to detect the autocorrelation of errors in first difference. Thus, the test result of first autocorrelation of errors, AR(1) is ignored while the second autocorrelation of errors, AR(2), is tested on the first difference series of errors to detect the phenomenon of first autocorrelation of errors, AR(1). Meanwhile, the FE-IV (Fixed-Effects Instrument Variables) estimator is the IV estimation of the fixed-effects panel data models with possibly endogenous regressors (Baum, Schaffer, & Stillman, 2003). The validity of instruments in the FE-IV estimator is also assessed through Sargan statistic. In this study, the one-step D-GMM and the FE-IV estimator are used to check the robustness of estimates performed by the two-step D-GMM.

3.2 Data

The main variables are public investment, private investment, six dimensions of governance, real GDP per capita, tax revenue, labor force (a ratio between working age people 15+ and total population), trade openness, inflation, and infrastructure (the number of telephone lines per 100 people). Data are taken from the World Bank World Development Indicators (WDI) and Worldwide Governance Indicators (WGI) database with exception of the public investment and private investment data, which are taken from the IMF Government Finance Statistics (GFS). The research sample contains a sample of 72 developing countries[1] and a sample of 25 developed countries[2] from 2003 to 2016.

The definition and descriptive statistics of data are presented in Table A1, Table A2 and Table A3 while the matrices of correlation coefficients are shown in Table A4, Table A5, Table A6, and Table A7 (see more in Appendix A). The results in Table A2 and Table A3 indicate that the quality of the governance environment in the sample of 72 countries is relatively low (mostly negative) as compared to that in the sample of 25 countries (all positive). Indeed, all countries in the sample of 72 countries are developing ones while most countries in the sample of 25 countries are developed ones. It shows that most developing countries have bad governance environment and developed countries have good governance environment. In particular, it is completely consistent with that in the approach of Li and Filer (2007) that most of developed countries are those with

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[1] Albania, Angola, Argentina, Armenia, Azerbaijan, Bangladesh, Belize, Benin, Bhutan, Bolivia, Bostawa, Brazil, Bulgaria, Burkina Faso, Cabo Verde, Cambodia, Chile, China, Colombia, Congo Rep., Cote d'Ivoire, Czech Republic, Republic Dominican, Arab Rep. Egypt, El Salvador, Fiji, The Gambia, Georgia, Ghana, Guatemala, Honduras, India, Indonesia, Islamic Rep. Iran, Jordan, Kazakhstan, Kenya, Lao PDR, Lebanon, Lesotho, Lithuania, Madagascar, Malaysia, Maldives, Mauritius, Moldova, Mongolia, Morocco, Namibia, Nepal, Nigeria, Pakistan, Paraguay, Peru, Philippines, Poland, Romania, Russian Federation, Sierra Leone, Slovak Republic, Sri Lanka, Swaziland, Thailand, Togo, Tunisia, Turkey, Uganda, Ukraine, Uruguay, Vietnam, Zambia.
[2] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Iceland, Ireland, Isreal, Italy, Japan, South Korea, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Singapore, Sweden, Switzerland, United Kingdom, United States.

good governance environment (rule-based governance), but most of developing countries are those with poor one (relation-based governance). Meanwhile, Table A4 shows public investment, economic growth, tax revenue, trade openness, and infrastructure are positively connected with private investment while labor force and inflation are negatively linked to it in the sample of 72 developing countries. Table A6 reports public investment, labor force, trade openness, and inflation are positively while tax revenue is negatively associated with private investment in the sample of 25 developed countries. Similarly, Table A5 and Table A7 indicate that the correlation coefficients between six dimensions of governance are relatively high. To eliminate the collinearity, therefore, these six dimensions of governance are separately used in the empirical equations.

4. Empirical results and discussion

The results are presented in Table 1 and Table 2. In all estimation procedures, we detect economic growth is endogenous, thus we use economic growth as instrumented in the GMM-style and the remaining variables (private investment, public investment, governance, tax revenue, labor force, trade openness, inflation, and infrastructure) as instruments in the IV-style. In order to assess the validity of these instruments and the serial auto-correlation of residuals, we performs the Sargan and Hansen tests (test of over-identifying restrictions with the null hypothesis "the instruments as a group are exogenous") as well as the Arellano-Bond test for serial correlation AR(2), which is applied to the difference residuals to purge the unobserved and perfectly auto-correlated. In Table 1 and Table 2 the Hansen and Sargan tests for over-identifying restrictions suggest that the instrument set turns out valid. Meanwhile, the Arellano-Bond AR(2) tests cannot reject the hypothesis of no autocorrelation of the second order. These results strongly support our model specification.

4.1 The public investment – private investment relationship under different governance environments

The results across all models for the sample of 72 developing countries with bad governance and for the sample of 25 developed countries with good governance are presented in Table 1 and Table 2, respectively. In the sample of 72 developing countries with bad governance public investment crowds out private investment, supporting the substitutability hypothesis. In contrast, public investment crowds in private investment in the sample of 25 developed countries with good governance, supporting the complementarity hypothesis. All these results are highly consistent for six dimensions of governance. These results imply that the relationship between public investment and private investment is strongly dependent upon the governance environment, which supports the arguments of Cavallo and Daude (2011). Cavallo and Daude (2011) emphasize "…good institutions raise the effectiveness of public investment, increasing the marginal product of private capital and therefore crowding-in more private investment." (page 68) and "…there is a significant difference between countries with bad institutions – where the impact of public investment is negative and significant – and countries with good institutions that show a significant crowding-in effect of public investment on private investment." (page 75). It means that the relationship between public investment and private investment is positive under good governance environment, but negative under bad one. The difference in the public investment – private investment relationship between developed countries and developing countries shows that the accountable and transparent governance environment will result in the positive effect of public capital in public projects on the investment of private sector. These findings also indicate that public investment in developing countries can lead to distortions in investment, which reduce private investment and in its turn impede

economic growth because the private sector plays a crucial role in the economy. The estimated results also imply that an increase in public investment should be accompanied by reforming governance environment, improving the transparency and accountability of public projects with the participation of people.

In both samples governance and economic growth significantly boost private investment. The positive impact of governance quality on private investment can be found in previous studies (Feng, 2001; Aysan et al. 2007; Munemo, 2012; McCulloch, Malesky, & Duc, 2013; Schomaker, 2014). A transparent and accountable governance environment will reduce the transaction costs of private sector, increase the profits and so stimulate more investment from the private sector. Erden and Holcombe (2005), Dreger and Reimers (2016) and Muthu (2017) provide the empirical evidence to confirm the positive impact of economic growth on private investment. It means that economic growth will enhance income, which leads to an increase in savings and investment.

Trade openness and inflation in the sample of 72 developing countries promote private investment. Jin and Zou (2005) argue that the potential benefit of inflation is to enhance savings and investment. Dash (2016) reports this finding in India. However, inflation can raise prices, create burdens on consumers and reduce economic growth which leads to instability in social security, so governments should be careful of this variable. Similarly, the positive impact of trade openness is also found in Mohsen (2015) for the case of Syria. The finding emphasizes that governments need to carry out reforms to open the economy and enhance the economic integration to boost the private sector's investment.

In the same vein, a growing labor force can hinder private investment, but tax revenue may promote it for the sample of 25 developed countries. Tax revenue can be negatively connected to tax rate. Cutting tax rate from governments

will increase companies' after-tax profits increase, which leads to production expansion and more investment from domestic companies. As a result, governments collect more tax revenue. In this case, an increase in tax revenue corresponding to a tax cut will lead to an increase in private investment. It holds under good governance environment in this study.

Table 1. Public investment, governance and private investment: two-step D-GMM, 2003-2016 (72 developing countries with bad governance environment)

Dependent variable: Private investment (% GDP)

Variables	GOV1	GOV2	GOV3	GOV4	GOV5	GOV6
Private investment (-1)	0.052 (0.041)	-0.010 (0.030)	0.010 (0.035)	0.035 (0.027)	0.050 (0.043)	0.065 (0.047)
Public investment	-0.371*** (0.090)	-0.277*** (0.071)	-0.302*** (0.080)	-0.445*** (0.067)	-0.368*** (0.094)	-0.382*** (0.098)
Governance	1.216** (0.520)	2.554** (1.106)	0.759** (0.347)	1.547** (0.610)	2.169** (0.856)	1.952** (0.784)
Economic growth	0.073*** (0.018)	0.086*** (0.017)	0.084*** (0.017)	0.075*** (0.020)	0.073*** (0.019)	0.075*** (0.018)
Tax revenue	-0.007 (0.045)	0.025 (0.039)	-0.014 (0.043)	0.199 (0.141)	-0.007 (0.045)	-0.013 (0.043)
Labor force	0.067 (0.060)	0.051 (0.063)	0.074 (0.061)	0.433 (0.291)	0.067 (0.062)	0.059 (0.059)
Trade openness	0.080*** (0.028)	0.074*** (0.028)	0.059** (0.024)	0.066** (0.029)	0.083*** (0.028)	0.080*** (0.028)
Inflation	0.102** (0.041)	0.085** (0.041)	0.106*** (0.039)	0.082** (0.032)	0.093** (0.040)	0.099** (0.039)
Infrastructure	-0.0001 (0.004)	0.002 (0.005)	0.0009 (0.004)	0.0004 (0.004)	-0.001 (0.004)	-0.001 (0.004)
Instrument	20	22	22	22	20	20
Country/ Observation	72/864	72/792	72/864	72/720	72/864	72/864

AR(2) test	0.127	0.125	0.117	0.204	0.136	0.152
Sargan test	0.543	0.738	0.438	0.103	0.517	0.474
Hansen test	0.779	0.774	0.449	0.454	0.658	0.669

Note: ***, ** and * denote significance at 1 percent, 5 percent and 10 percent respectively. Values of standard errors are shown in the parenthesis.

Table 2. Public investment, governance and private investment: two-step D-GMM, 2003-2016 (25 developed countries with good governance environment)

Dependent variable: Private investment (% GDP)

Variables	GOV1	GOV2	GOV3	GOV4	GOV5	GOV6
Private investment (-1)	0.204** (0.076)	0.171*** (0.058)	0.132** (0.052)	0.225*** (0.076)	0.213*** (0.076)	0.190*** (0.050)
Public investment	0.801* (0.402)	0.746* (0.422)	0.708* (0.381)	0.848** (0.364)	1.652*** (0.460)	1.258** (0.465)
Governance	5.389** (2.277)	1.829** (0.799)	0.102 (0.614)	4.118** (1.886)	-1.253 (0.895)	1.294** (0.610)
Economic growth	0.150*** (0.035)	0.119*** (0.031)	0.134*** (0.047)	0.080* (0.046)	0.101** (0.042)	0.119*** (0.030)
Tax revenue	1.741*** (0.231)	1.729*** (0.351)	1.709*** (0.339)	1.764*** (0.353)	2.137*** (0.385)	1.901*** (0.394)
Labor force	-1.794*** (0.488)	-0.870** (0.367)	-0.982 (0.588)	-1.028* (0.518)	-1.161** (0.560)	-0.914** (0.440)
Trade openness	-0.010 (0.018)	-0.005 (0.013)	-0.022 (0.013)	0.014 (0.016)	0.015 (0.015)	0.003 (0.011)
Inflation	0.153 (0.098)	0.129 (0.057)	0.197 (0.063)	-0.008 (0.041)	0.000 (0.048)	0.013 (0.044)
Infrastructure	0.007 (0.011)	0.000 (0.009)	0.000 (0.010)	-0.021 (0.028)	0.000 (0.010)	0.005 (0.010)
Instrument	23	23	22	23	21	22
Country/ Observation	25/250	25/250	25/250	25/250	25/250	25/250

AR(2) test	0.352	0.295	0.263	0.378	0.145	0.176
Sargan test	0.738	0.383	0.650	0.370	0.420	0.402
Hansen test	0.719	0.502	0.647	0.163	0.389	0.350

Note: ***, ** and *denote significance at 1 percent, 5 percent and 10 percent respectively. Values of standard errors are shown in the parenthesis.

4.2. Robustness check

To check the robustness of estimates, we re-estimate Equation (9) using the one-step D-GMM and the FE-IV estimator. The corresponding results across all models are reported in Table 3, Table 4, Table 5, and Table 6. In line with the two-step D-GMM estimates in Table 1 and Table 2, we find public investment crowds out private investment under poor governance environment (sample of 72 developing countries, Table 3 and Table 5), but crowds in it under good one (sample of 25 developed countries, Table 4 and Table 6). These results re-emphasize the dependence of the public investment – private investment relationship on the quality of governance environment. In addition, the estimated results of governance, economic growth, and trade openness in the sample of 72 developing countries (Table 3 and Table 5) and those of governance, economic growth, and tax revenue in the sample of 25 developed countries (Table 6) are also consistent with those in Table 1 and Table 2. All findings are confirmed by a battery of diagnostic tests shown at the bottom in Table 3 and Table 4 (Sargan tests and Arellano-Bond AR(2) tests) as well as in Table 5 and Table 6 (Sargan tests) suggesting that our one-step D-GMM and FE-IV estimates are relatively reliable.

Table 3. Public investment, governance and private investment: one-step D-GMM, 2003-2016 (72 developing countries with bad governance environment)

Dependent variable: Private investment (% GDP)

Variables	GOV1	GOV2	GOV3	GOV4	GOV5	GOV6
Private investment	0.075*	0.076*	0.036	0.066	0.048	0.073*
(-1)	(0.039)	(0.039)	(0.037)	(0.042)	(0.038)	(0.037)
Public investment	-0.477***	-0.489***	-0.464***	-0.474***	-0.470***	-0.480***
	(0.050)	(0.050)	(0.046)	(0.051)	(0.046)	(0.047)
Governance	9.250***	4.337**	1.277**	1.693*	3.121***	2.442***
	(3.338)	(2.044)	(0.519)	(1.023)	(1.121)	(0.913)
Economic growth	0.068***	0.063***	0.055***	0.080***	0.059***	0.059***
	(0.010)	(0.011)	(0.013)	(0.019)	(0.014)	(0.010)
Tax revenue	-0.039	-0.028	0.176	0.029	0.107	-0.043
	(0.062)	(0.064)	(0.196)	(0.226)	(0.216)	(0.062)
Labor force	-0.829	-0.248	0.002	-0.897	-0.131	-0.078
	(0.538)	(0.531)	(0.602)	(0.727)	(0.620)	(0.554)
Trade openness	0.060***	0.063**	0.036**	0.055	0.041***	0.071***
	(0.014)	(0.027)	(0.015)	(0.038)	(0.015)	(0.025)
Inflation	0.050	0.151***	0.092*	0.111*	0.087*	0.102**
	(0.055)	(0.0591)	(0.050)	(0.057)	(0.051)	(0.050)
Infrastructure	0.005	0.0009	0.002	-0.033	0.001	0.002
	(0.005)	(0.005)	(0.005)	(0.022)	(0.005)	(0.005)
Instrument	20	21	20	21	18	18
Country/ Observation	72/720	72/720	72/720	72/720	72/720	72/720
AR(2) test	0.109	0.133	0.104	0.130	0.109	0.109
Sargan test	0.247	0.950	0.243	0.246	0.126	0.146

Note: ***, ** and * denote significance at 1 percent, 5 percent and 10 percent respectively. Values of standard errors are shown in the parenthesis.

Table 4. Public investment, governance and private investment: one-step D-GMM, 2003-2016 (25 developed countries with good governance environment)

Dependent variable: Private investment (% GDP)

Variables	GOV1	GOV2	GOV3	GOV4	GOV5	GOV6
Private investment (-1)	0.403** (0.181)	0.275** (0.125)	0.382** (0.150)	0.329* (0.177)	0.366** (0.145)	0.286** (0.116)
Public investment	2.229* (1.269)	1.462* (0.845)	1.606* (0.950)	1.993* (1.201)	1.778* (0.978)	1.389* (0.820)
Governance	2.248 (2.600)	6.253* (3.656)	0.419 (3.127)	2.158 (6.118)	0.098 (6.733)	2.701 (2.036)
Economic growth	0.093 (0.164)	0.063 (0.080)	0.055 (0.133)	0.086 (0.113)	0.104 (0.109)	0.039 (0.074)
Tax revenue	2.319*** (0.603)	1.935*** (0.431)	1.977*** (0.474)	2.257*** (0.610)	2.034*** (0.524)	1.876*** (0.401)
Labor force	-3.245* (1.925)	-1.188 (0.996)	-2.294 (1.407)	-2.481* (1.468)	-2.589** (1.263)	-1.112 (1.011)
Trade openness	0.118 (0.095)	0.107 (0.069)	0.111 (0.079)	0.097 (0.077)	0.109 (0.083)	0.099 (0.064)
Inflation	-0.161 (0.134)	-0.092 (0.099)	-0.128 (0.109)	-0.140 (0.121)	-0.148 (0.119)	-0.089 (0.096)
Infrastructure	0.042 (0.032)	0.048 (0.046)	0.042 (0.029)	0.040 (0.030)	0.063 (0.066)	0.050 (0.046)
Instrument	20	24	22	22	23	23
Country/ Observation	25/250	25/250	25/250	25/250	25/250	25/250
AR(2) test	0.183	0.224	0.270	0.116	0.203	0.144
Sargan test	0.988	0.90	0.924	0.980	0.987	0.847

Note: ***, ** and *denote significance at 1 percent, 5 percent and 10 percent respectively. Values of standard errors are shown in the parenthesis.

Table 5. Public investment, governance and private investment: FE-IV, 2003-2016 (72 developing countries with bad governance environment)

Dependent variable: Private investment (% GDP)

Variables	GOV1	GOV2	GOV3	GOV4	GOV5	GOV6
Private investment (-1)	0.667*** (0.028)	0.668*** (0.028)	0.668*** (0.028)	0.657*** (0.028)	0.667*** (0.028)	0.668*** (0.029)
Public investment	-0.243*** (0.039)	-0.244*** (0.039)	-0.253*** (0.040)	-0.240*** (0.039)	-0.244*** (0.040)	-0.245*** (0.040)
Governance	1.198* (0.680)	0.746 (0.688)	0.623* (0.358)	1.129* (0.597)	0.454 (0.708)	0.316** (0.113)
Economic growth	0.015** (0.006)	0.015** (0.006)	0.015** (0.006)	0.013** (0.006)	0.015*** (0.006)	0.016*** (0.006)
Tax revenue	-0.064 (0.046)	-0.055 (0.046)	-0.050 (0.046)	-0.058 (0.046)	-0.051 (0.046)	-0.053 (0.046)
Labor force	0.090 (0.063)	0.087 (0.063)	0.091 (0.063)	0.089 (0.063)	0.087 (0.063)	0.084 (0.063)
Trade openness	0.031*** (0.008)	0.031*** (0.008)	0.031*** (0.008)	0.032*** (0.008)	0.030*** (0.008)	0.030*** (0.008)
Inflation	-0.007 (0.016)	-0.007 (0.016)	-0.004 (0.016)	-0.005 (0.016)	-0.007 (0.016)	-0.008 (0.016)
Infrastructure	0.001 (0.003)	0.001 (0.003)	0.001 (0.003)	0.001 (0.003)	0.001 (0.003)	0.001 (0.003)
Country/ Observation	72/864	72/864	72/864	72/864	72/864	72/864
Sargan test	0.850	0.115	0.243	0.145	0.133	0.286

Note: ***, ** and *denote significance at 1 percent, 5 percent and 10 percent respectively. Values of standard errors are shown in the parenthesis.

Table 6. Public investment, governance and private investment: FE-IV, 2003-2016 (25 developed countries with good governance environment)

Dependent variable: Private investment (% GDP)

Variables	GOV1	GOV2	GOV3	GOV4	GOV5	GOV6
Private investment (-1)	0.796^{***} (0.040)	0.795^{***} (0.040)	0.789^{***} (0.040)	0.770^{***} (0.043)	0.794^{***} (0.040)	0.797^{***} (0.040)
Public investment	0.175^{*} (0.094)	0.176^{*} (0.093)	0.182^{**} (0.053)	0.163^{**} (0.059)	0.182^{*} (0.095)	0.176^{*} (0.093)
Governance	0.298^{**} (0.102)	0.284^{**} (0.105)	0.462^{**} (0.158)	1.605^{**} (0.766)	0.282 (1.052)	2.538^{**} (1.027)
Economic growth	0.026^{**} (0.011)	0.024^{**} (0.011)	0.026^{**} (0.011)	0.021^{*} (0.013)	0.025^{**} (0.011)	0.025^{**} (0.011)
Tax revenue	0.322^{***} (0.077)	0.318^{***} (0.077)	0.323^{***} (0.077)	0.335^{***} (0.082)	0.324^{***} (0.077)	0.318^{***} (0.076)
Labor force	0.131 (0.088)	0.135 (0.089)	0.136 (0.088)	0.125 (0.098)	0.129 (0.088)	0.115 (0.087)
Trade openness	0.0002 (0.008)	0.001 (0.008)	0.0003 (0.008)	0.007 (0.008)	0.0003 (0.008)	0.002 (0.008)
Inflation	-0.082 (0.047)	-0.079 (0.047)	-0.080 (0.047)	-0.077 (0.050)	-0.081 (0.047)	-0.067 (0.047)
Infrastructure	0.001 (0.006)	0.001 (0.006)	0.001 (0.006)	0.003 (0.006)	0.001 (0.006)	0.002 (0.006)
Country/ Observation	25/325	25/325	25/325	25/325	25/325	25/325
Sargan test	0.849	0.639	0.243	0.231	0.872	0.852

Note: ***, ** and * denote significance at 1 percent, 5 percent and 10 percent respectively. Values of standard errors are shown in the parenthesis.

5. Conclusion and policy implications

Motivated by the fact that difference in governance environments can result in difference in public investment – private investment relationships, this paper empirically investigates the importance of the governance environment in the relationship between public investment and private investment for a sample of 72 developing countries with bad governance and for a sample of 25 developed countries with good governance over the period 2003 – 2016. Using two-step D-GMM, we estimate the effect of public investment on private investment for these samples. Then, we examine the effect of interaction term between governance and public investment on private investment. The robustness of estimates is checked by one-step D-GMM. Hence, the most contribution of this paper to related literature is to provide empirical evidence show that the public investment – private investment relationship varies based on the quality of governance environment.

Our study supports the arguments of Cavallo and Daude (2011) that the public investment – private investment relationship strongly depends on the governance environment. There is a strong correlation of the crowding in and crowding out with the good governance environment and the poor one, respectively. In particular, these estimates are highly consistent for six dimensions of governance. From these findings, we emphasize that any research on the public investment – private investment relationship without taking the role of the governance environment into account is likely to be a shortcoming.

The findings provide a case for more prudence in design, formulation and implementation of policies relating to the relationship between public investment and private investment. The implication is that the governance environment significantly determines the public investment – private investment relationship, and moreover, the good one not only promotes private investment but sets up

a helpful effect on this dynamic relationship as well. Therefore, governments should strongly implement governance reforms to provide a conducive environment for the public investment – private investment relationship, especially private investment. Improving governance environment can change the public investment – private investment from crowding-out to crowding-in.

Acknowledgements

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Appendix A. Data

Table A1. Data description

Variable	Definition	Type	Source
Private investment	Share of domestic private investment in GDP	%	Government Finance Statistics (GFS), IMF
Public investment	Share of public investment in GDP	%	
Real GDP per capita	Real GDP per capita (constant 2010 US$)	log	World Development Indicators (WDI), World Bank
Tax revenue	Share of government's tax revenue in GDP	%	
Labor force	Labor force participation rate, total (% of total population ages 15+) (modeled ILO estimate)	%	
Trade openness	Share of sum of exports and imports in GDP	%	
Inflation	Inflation, consumer prices (annual)	%	
Infrastructure	Fixed telephone subscriptions (per 100 people)	log	
Regulatory Quality	Dimensions of governance	level	Worldwide Governance Indicators (WGI), World Bank
Rule of Law		level	
Voice and Accountability		level	
Control of Corruption		level	
Government Effectiveness		level	
Political Stability		level	

Table A2. Descriptive statistics for the sample of 72 developing countries

Variable	Obs	Mean	Std. Dev.	Min	Max
Private investment (PIN)	1008	13.851	6.595	1.129	59.282
Public investment (GIN)	1008	5.186	4.062	0.077	51.380
GDP per capita (GDP)	1008	4168.30	3793.03	271.68	20479.2
Tax revenue (TAX)	1008	15.128	6.439	0.905	95.160
Labor force (LAB)	1008	63.919	10.324	39.953	89.046
Trade openness (OPE)	1008	84.636	36.574	21.852	220.407
Inflation (INF)	1008	7.346	13.495	-35.83	324.99
Infrastructure (TEL)	1008	11.787	9.965	0.189	38.333
Regulatory Quality (GOV1)	1008	-0.377	0.616	-1.522	1.592
Rule of Law (GOV2)	1008	-0.264	0.575	-1.553	1.275
Voice and Accountability (GOV3)	1008	-0.293	0.829	-2.810	1.283
Control of Corruption (GOV4)	1008	-0.175	0.595	-1.799	1.538
Government Effectiveness (GOV5)	1008	-0.346	0.606	-1.663	1.391
Political Stability (GOV6)	1008	-0.248	0.725	-1.775	1.292

Table A3. Descriptive statistics for the sample of 25 developed countries

Variable	Obs	Mean	Std. Dev.	Min	Max
Private investment (PIN)	350	17.939	4.293	7.875	36.544
Public investment (GIN)	350	3.200	1.416	0.667	8.917
GDP per capita (GDP)	350	46421.3	18085.2	15104.5	111968
Tax revenue (TAX)	350	20.789	6.582	7.935	35.093
Labor force (LAB)	350	62.994	5.980	47.873	76.857
Trade openness (OPE)	350	110.932	95.048	19.798	442.62

Inflation (INF)	350	2.136	1.688	-4.479	12.678
Infrastructure (TEL)	350	50.887	9.996	13.862	74.762
Regulatory Quality (GOV1)	350	1.732	0.560	0.051	2.469
Rule of Law (GOV2)	350	1.662	0.395	0.197	2.431
Voice and Accountability (GOV3)	350	0.935	0.584	1.623	1.760
Control of Corruption (GOV4)	350	1.481	0.337	0.530	2.098
Government Effectiveness (GOV5)	350	1.449	0.549	0.370	2.013
Political Stability (GOV6)	350	1.397	0.275	0.637	2.119

Table A4. Matrix of correlation coefficients for the sample of 72 developing countries

	PIN	GIN	GDP	TAX	LAB	OPE	INF	TEL
PIN	1.00							
GIN	0.210^{***}	1.00						
GDP	0.227^{***}	-0.055^{*}	1.00					
TAX	0.184^{***}	0.129^{***}	0.161^{***}	1.00				
LAB	-0.13^{***}	0.211^{***}	-0.51^{***}	-0.12^{***}	1.00			
OPE	0.099^{***}	0.256^{***}	0.193^{***}	0.335^{***}	-0.09^{**}	1.00		
INF	-0.11^{***}	-0.001	-0.022	0.076^{**}	0.008	0.038	1.00	
TEL	0.226^{***}	-0.118^{**}	0.791^{***}	0.177^{***}	-0.53^{***}	0.101^{***}	-0.10^{***}	1.00

Note: ***, ** and * denote significance at 1 percent, 5 percent and 10 percent respectively

Table A5. Matrix of correlation coefficients between governance indicators for the sample of 72 developing countries

	GOV1	GOV2	GOV3	GOV4	GOV5	GOV6
GOV1	1.000					
GOV2	0.821***	1.000				
GOV3	0.625***	0.528***	1.000			
GOV4	0.692***	0.820***	0.487***	1.000		
GOV5	0.881***	0.886***	0.637***	0.793***	1.000	
GOV6	0.635***	0.592***	0.475***	0.675***	0.674***	1.000

Note: ***, ** and *denote significance at 1 percent, 5 percent and 10 percent respectively

Table A6. Matrix of correlation coefficients for the sample of 25 developed countries

	PIN	GIN	GDP	TAX	LAB	OPE	INF	TEL
PIN	1.00							
GIN	0.453***	1.00						
GDP	-0.076	-0.081	1.00					
TAX	-0.19***	-0.31***	0.136**	1.00				
LAB	0.177***	0.200***	-0.038	-0.08*	1.00			
OPE	0.380***	0.379***	0.137**	-0.045	0.180***	1.00		
INF	0.187***	0.024	-0.03	0.231***	0.155***	0.013	1.00	
TEL	-0.049	-0.013	0.039	-0.18***	0.174***	-0.001	0.035	1.00

Note: ***, ** and *denote significance at 1 percent, 5 percent and 10 percent respectively

Table A7. Matrix of correlation coefficients between governance indicators for the sample of 25 developed countries

	GOV1	GOV2	GOV3	GOV4	GOV5	GOV6
GOV1	1.000					
GOV2	0.891***	1.000				
GOV3	0.602***	0.509***	1.000			
GOV4	0.843***	0.763***	0.562***	1.000		
GOV5	0.502***	0.439***	0.437***	0.545***	1.000	
GOV6	0.769***	0.717***	0.501***	0.650***	0.106**	1.000

Note: ***, ** and *denote significance at 1 percent, 5 percent and 10 percent respectively