RESEARCH REPORT

CROWDING OUT PRIVATE INVESTMENT IN BOLIVIA

Evidence for the 1988–2010 Period

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Abstract: This article analyzes whether public investment has crowded out private investment in Bolivia during the 1988–2010 period. The evidence demonstrates that this is generally the case, as public investment has been shown to consistently run counterclockwise to private investment. Interestingly, the quality of the institutional setting and the openness of the economy to trade with other nations do not seem to matter to the relation between public investment and private investment. The findings suggest, however, that increases in domestic credit to the private sector lessen the crowding-out effect, which calls attention to the importance of a stable and healthy financial system as a way to encourage private investment.

This article analyzes whether public investment has crowded out private investment in Bolivia since 1988.[1] The findings suggest that this is generally the case, as public investment consistently has been shown, with a variety of econometric specifications and estimation methods, to run in the opposite direction to private investment.[2] The findings also suggest that channeling domestic credit to

I am grateful to three anonymous *LARR* reviewers for helpful comments and suggestions. I am solely responsible for any errors that remain.

1. *Public investment* in this work refers to capital investment made by the decentralized governments of the nine departments that constitute Bolivia.

2. A caveat is in place regarding the crowding-out effect tested in this work. If there is significant slack in an economy, public investment does not necessarily crowd out private investment, as the elasticity of private investment with respect to its public counterpart would be close to zero. The period analyzed here, however (1988–2010), is one of continuous positive growth after tumultuous hyperinfla-

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the private sector lessens the crowding-out effect, which highlights the importance of building and maintaining a healthy financial system in the country.

The impact of public investment on private investment has been studied at length in various contexts. However, a specific study of this kind focusing on Bolivia has not been done, to my knowledge, which is unfortunate because of the historically conflictive relationship that has existed between government and private economic interests in this country. For the period of this research, 1988 to 2010, Bolivia has swirled from a fragile recovery after the hyperinflation of the mid-1980s to a period of deregulation that favored private investment over any and all types of public investment (throughout the 1990s), to the current situation, in which despite previous experiences with an overbearing state—which may have been the principal reason for the hyperinflation of the 1980s—the country has returned to an affinity to greater public intervention. This is reflected in greater levels of public investment and comes at the expense of private investment. The issue of whether public investment is subject to distortions, rent-seeking behavior, and inefficiency, or whether it is rather a response to market failures that have been endemic to the country since its establishment, is a topic that is alive and well in Bolivia, hence the timeliness of this study.

In addition to variables ascertaining the weight of public and private investment, other qualitative indicators are also included in the analysis. Of these, institutional control variables that capture level of corruption, suitability of the investment environment, and efficiency of the financial system are used and are found to be largely insignificant in affecting private investment. Financial development, however—measured by the amount of credit directed to the private sector—is found to positively and significantly affect private investment, and it does seem to lessen the crowding-out effect. Although no distinction is made between different types of public investment, as done, for instance, in Devarajan, Swaroop, and Zou (1996) and Khan and Reinhart (1990), the findings support the generally believed assumption that often times government meddling hampers private intervention.

The issue of the relationship between public and private investment has been a focus of attention in the literature for several decades now, and it is still the subject of considerable controversy. In the next section I explore this controversy by reviewing some of the most important findings on the subject. I then present the empirical methodology, and in the following section introduce the data and its sources. Results of the empirical exercise and robustness checks to demonstrate the consistency of the findings are then presented, followed by a conclusion.

LITERATURE REVIEW

Research on the relationship between public and private investment has usually focused on whether these investments have a different impact on economic

tion (during the mid-1980s); hence crowding out of private investment is a distinct possibility (i.e., the elasticity of substitution is less than 0).

growth. Although there is no clear-cut reason as to why the institutional source of investment should matter, if there are inefficiencies or distortions associated with the process of public investment, then the differences between public and private investment are indeed an issue. Khan and Kumar (1997) analyze the extent to which public and private investment may have a complementary or substitutive relationship. They argue that complementarities may arise in the case of public investment in infrastructure but find that if public projects are of dubious quality, they may have a negative impact on private investment and on growth. In the same line, Robinson and Torvik (2005) illustrate a particular type of public investment that fits the description of an inefficient public work. So-called white elephants are public works that are politically attractive but have negative social surplus. The authors' point is that white elephants, while very popular with the electorate, are likely to have inefficient redistribution results.[3] Other authors have also found similar results, both for a cross section and for individual countries. Cavallo and Daude (2008) found a strong and robust crowding-out effect for a panel of 116 developing countries, across regions and over time. Looney (1992), analyzing the effect of public investment in infrastructure in Saudi Arabia, found that public intervention does not appear to have played a strong role in stimulating private-sector investment. Forte and Magazzino (2011), analyzing the impact of public expenditures and growth, found that countries with high gross domestic product in the European Union have overcome the level of government size compatible with GDP growth rate maximization. Cumming and MacIntosh (2006), on a slightly different kind of investment scenario, demonstrate that in a particular tax-driven Canadian public venture capital, it showed higher agency costs and lower profitability than private venture capital funds.

Despite the evidence pointing to the negative relationship between private and public investment, several more recent studies have shown that improving infrastructure has a positive impact on output, particularly in developing countries. Notable examples include Canning (1999), which used panel data for a large number of countries; Demetriades and Mamuneas's (2000) analysis of a set of Organization of Economic Cooperation and Development (OECD) countries; Fernald (1999), which concentrates on US industry; Crafts's (2009) analysis of the UK case; Di Giacinto, Micucci, and Montanaro (2010), which finds evidence of "crowding in"[4] in Italy; Calderón and Servén (2003), focussing on Latin America; Magazzino and Valeri (2012), which finds Granger causation between public capital and factor productivity in the transport sector in Italy; and Cumming (2013), which finds that in Europe, government venture capital funds have not crowded out private

3. Evo Morales, president of Bolivia since 2006, has announced his intention to spend more than $300 million on a Chinese satellite ("Bolivian President Evo Morales Seeks ITU Support to Launch Satellite," International Telecommunications Union Press Release, September 9, 2009, at http://www.itu.int/newsroom/press_releases/2009/23.html). Although no one in the country seems to know what the capabilities of the satellite will be, his proposal is very popular, and construction of the satellite has begun. Time will tell whether this is a white elephant.

4. In line with the analysis of Khan and Kumar (1997), public investment crowds in private investment when a complementary linkage is believed to exist between them. The crowding-out effect occurs when public investment substitutes for, or displaces, private investment.

venture capital investment. In addition, where a positive relationship between public expenditures and growth has been found, as in Bayraktar and Moreno-Dodson (2010), it has tended to happen in countries capable of using public funds for productive purposes and where the economic policy environment is conducive to entrepreneurship.

Though this is not the first article that attempts to test the linkages between public and private investment,[5] it is the first that concentrates on the Bolivian experience in the past two decades. Several studies have concentrated on topics related to the one analyzed here, but they either have limited or noncontemporaneous data sets, as evident in Coronado and Aguayo's (2002) work—or they focus only marginally on the relationship between public and private investment. For instance, Lora (2007) found some evidence of complementarity between public and private investment for a set of seven Latin American countries, including Bolivia, but the main focus of the article is to assess the influence of public indebtedness on public investment in infrastructure. Likewise, Ramirez (2000) found evidence that private and public investment are complementary in a set of Latin American countries for the period 1980–1995, and Agosin and Machado (2005), in a model of three developing regions and for the period 1970–1996, found some evidence in Bolivia of foreign direct investment (FDI) crowding out domestic investment.

This article not only adds to that existing body of work but also amplifies the scope of research by including other variables that have not been included or have been included only marginally. In addition to variables that measure the impact of financial development and trade openness, others that capture level of corruption, suitability of the investment environment, and efficiency of the financial system are also introduced to account for the institutional arrangements of the country. Although other authors have explored the issue of the reliability of institutions as a proxy for a suitable business environment,[6] none has addressed the issue explicitly for the Bolivian case. Bojanic (2012) studied the impact of financial development and trade on the Bolivian economy and found unidirectional Granger causality from indicators of financial development and trade to economic growth. Similarly, Costantini and colleagues (2010) showed that developing countries, including Bolivia, that managed to suppress domestic real interest rates without generating inflation enjoyed higher levels of investment than those that would have been obtained under more liberal conditions, and Pargal (2003) assessed the importance of the regulatory framework in the nine largest economies in Latin America as a determinant of private-sector investment in public services. He

5. A sample of representative studies of the relationship between public and private investment includes Aschauer (1989), Blejer and Khan (1984), Coutinho and Gallo (1991), Fisher and Turnovsky (1998), Everhart and Sumlinski (2001), and Erden and Holcombe (2005).

6. See, for instance, Mauro (1998), Keefer and Knack (2002), De la Croix and Delavallade (2009), and Rajkumar and Swaroop (2008), which explore from different angles the issue of good governance and conclude that high public investment ratios are more likely to be observed in countries with weak institutions, which illustrates that larger rent-seeking activities are often found in nations with less credible institutions.

found that the most significant institutional determinant of private investment is the passage of legislation liberalizing the investment regime.

EMPIRICAL METHODOLOGY

To evaluate the impact of public investment on private investment, autoregressive moving average (ARMA) specifications were utilized to account for serial correlation. To reinforce this exercise, instrumental variables (IV) estimates are also reported, as it is likely that some of the explanatory variables are correlated with the disturbance term.[7]

A common finding in time regressions is that residuals are correlated with their own lagged values. This serial correlation violates the standard assumption that disturbances are not correlated with other disturbances. A consequence of this violation is that ordinary-least-squares (OLS) estimates are no longer efficient but are biased and inconsistent, and standard errors are generally understated.

To test for serial correlation, the Ljung–Box Q statistic and the Breusch-Godfrey Lagrange multiplier test can be utilized to verify whether high-order serial correlation is present.[8] For all the specifications utilized in this work, these tests were performed and serial correlation was found to exist, hence the decision to utilize an ARMA model to account for higher-order serial correlation. The autoregressive term (AR) corresponds to the use of a lagged value of the residual in the forecasting equation for the unconditional residual, and the moving average term (MA) corresponds to the lagged values of the forecast error to improve the current forecast. Because quarterly data is utilized throughout, fourth-order serial correlation is expected, and the correct specification is an ARMA(4,1).

The baseline specification is given by the following:

$$\left(\frac{I^P}{GDP}\right)_{i,t} = c + \delta GDP_{i,t} + \sigma\left(\frac{I^P}{GDP}\right)_{i,t-1} + \alpha\left(\frac{I^G}{GDP}\right)_{i,t} + \beta X_{i,t} + \mu_{i,t} \quad (1)$$

where I^P and I^G represent private and public investment, respectively; GDP stands for gross domestic product, X is a vector of control variables, c is the intercept, and $\mu_{i,t}$ is the error term of the form

$$\mu_{i,t} = \rho_1\mu_{t-1} + \rho_2\mu_{t-2} + \rho_3\mu_{t-3} + \rho_4\mu_{t-4} + \varepsilon_t + \theta_i\varepsilon_{t-1} \quad (2)$$

to account for a SAR(4) and MA(1) process. The quarterly seasonality is captured in the parameter ρ.

The inclusion of control variables (institutional, financial development, and trade openness variables) in (1) means that the net effect of an increase in public

7. Previous research by Erden and Holcombe (2005) and Ramirez (2000) has influenced the work presented here. However, the specifications and statistical techniques utilized here are to my knowledge the first of their kind for Bolivia.

8. The Durbin-Watson test was not utilized as an indicator of serial correlation since it is not valid when there are lagged dependent variables on the right side of the regression equation. Furthermore, it is only valid to test for first-order serial correlation.

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investment on the private investment ratio depends on the estimated coefficient and on the level of the indices for the control variables. Specifically, the net effect of a change in the public investment ratio is given by the following equation:

$$\Delta\left(\frac{I^P}{GDP}\right)_{i,t} = (\alpha + \beta X_{i,t})\Delta\,(I^G/GDP)_{i,t} \tag{3}$$

where Δ represents the change in the respective variable. Equation (3) states that any change in the public investment ratio affects private investment directly via α, and indirectly through the interaction effect with the control variable $X_{i,t}$.

In addition to the ARMA specification, instrumental variables are also utilized to account for the possibility that the right-hand variables in (1) are correlated with $\mu_{i,t}$. Since this is a distinct possibility given the utilization of a lagged dependent variable, reinforcing the ARMA exercise with IV estimates seems appropriate.[9] The basic idea behind instrumental variables is to find a set of variables—the *instruments*—that are correlated with the explanatory variables and not correlated with the disturbances. These instruments are utilized to eliminate the correlation between right-hand variables and the disturbances. Two-stage least squares (TSLS), a special case of IV regression, was utilized, as it allows for the variables from the original specifications to be replaced by the fitted values from the first-stage estimation, which finds the portions of the endogenous and exogenous variables attributed to the instruments. As the instruments must be correlated with the explanatory variables but uncorrelated with $\mu_{i,t}$, in this work the chosen instruments are lagged values of the explanatory variables along with the intercept and the time trend. The selection of lagged values assures meeting the exclusion restriction required in IV models, hence sampling distributions are normal, and point estimates, hypothesis tests, and confidence intervals are all reliable.

DATA

Because of differences in periodicity of the variables utilized here (i.e., figures for trade, credit to the private sector, interest rates, corruption, and investment profile are available on a monthly basis where as those for GDP, private investment, and public investment[10] are produced on a quarterly basis), the empirical analysis uses three-quarter, forward-moving averages, at current prices, of private investment, public investment, GDP, credit to the private sector, the sum of exports and imports, the nominal lending interest rate on dollar-denominated

9. Other justifications for the use of instrumental variables are that some valid explanatory variables may have been omitted from the specification, and the explanatory variables are subject to measurement error. It is possible that many other variables that have an impact on private investment in Bolivia have been omitted, and it is also possible that the institutional, financial development, and trade openness variables used in this work are less than adequate. The utilization of IV makes sense either way.

10. During the early years of the period analyzed here (late 1980s to mid-1990s), official figures for public and private investment were made available only on a quarterly basis. Although this situation has improved somewhat—now figures for public and private investment are available on a monthly basis—figures are subject to recurring modifications until they are deemed official. Figures for GDP, in contrast, are made available on a yearly and quarterly basis.

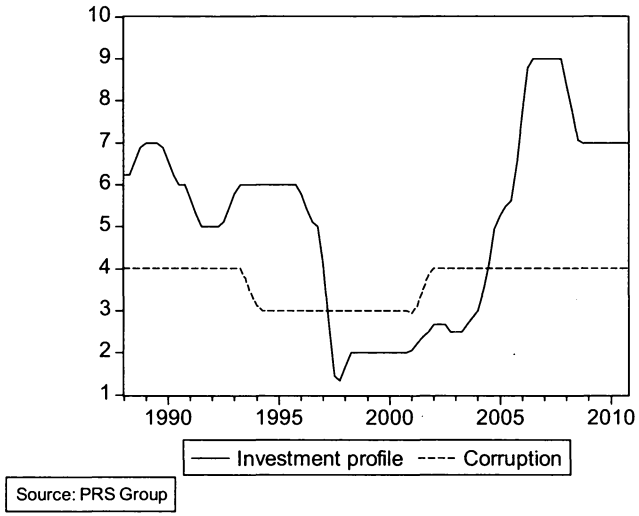

Figure 1 Corruption and Investment Profile Indices

credits with a maturity of 181–360 days, and indices for the investment profile and the corruption level for the period 1Q1988–4Q2010. All data have been obtained from the statistical bulletins and annual reports of the Central Bank of Bolivia,[11] Bojanic (2013b),[12] and the Political Risk Services Group.[13] The explanatory variables GDP, corruption, interest rate, and investment profile have been transformed to the logarithmic form to achieve stationarity in variance. The scales of the corruption and investment profile indices have also been inverted; hence, in contrast to their original character, higher numbers for these indices represent higher levels of corruption and a riskier investment environment, respectively.[14]

Figure 1 illustrates the evolution of the corruption and investment profile indices during the 1988–2010 period. Figure 1 makes clear that while corruption levels have not varied substantially during the period analyzed—corruption did decrease slightly during the mid-1990s, only to rebound to its previous level during the 2000s—the suitability of the investment environment in the country changed substantially. It improved dramatically during the mid-1990s but took a turn for the worse during the latter part of that decade and into the 2000s, when the riskiness of the investment environment increased to record levels.

Table 1 reports unit root tests for all variables utilized in this work with the

11. Banco Central de Bolivia, http://www.bcb.gob.bo/?q=pub_boletin-estadistico.

12. Kendall Hunt Publishing Company, http://www.kendallhunt.com/store-product.aspx?id=57530.

13. The PRS Group, http://www.prsgroup.com/CountryData.aspx.

14. Refer to The PRS Group (www.prsgroup.com/ICRG_Methodology.aspx) for details on the methodology utilized in the construction of the corruption and investment profile indices, which PRS reports on a monthly basis.

Table 1 Unit root and stationarity tests

	ADF		*DF-GLS*		*KPSS*	
	Level	First difference	Level	First difference	Level	First difference
Private investment as a share of GDP	−2.3762	−7.6338**	−1.1430	−3.2761**	0.1947	0.1441
Public investment as a share of GDP	−2.7711*	−5.1152**	−2.2512	−3.8683**	0.1632	0.0562
Credit to the private sector as a share of GDP	−1.9819	−7.4559**	−1.3312	−3.5956**	0.3441	0.1349
Total trade as a share of GDP	−1.7323	−5.4746**	−0.7363	−4.3156**	0.1190	0.0905
GDP (in logs)	−0.2993	−5.9694**	2.2613	−3.3195**	0.1171	0.1247*
Corruption (in logs)	−1.2521	−4.0760**	−1.1172	−5.9808**	0.3272	0.1919
Interest rate (in logs)	−0.3958	−5.0592**	1.3317	−4.1368**	0.1171	0.0527
investment profile (in logs)	−1.2970	−4.5969**	−1.1999	−6.0968**	0.2459	0.2073

*$p < .10$; **$p < .05$.

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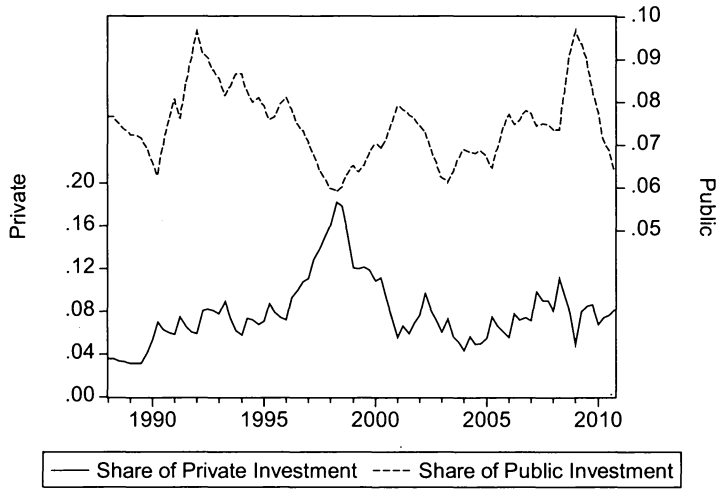

Figure 2 Share of Private and Public Investment on GDP, 1988–2010

augmented Dickey-Fuller test (ADF test), the Dickey-Fuller GLS (ERS) test, and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test.[15] According to the three tests, all variables are either integrated of order one, *I*(1), and/or stationary (KPSS test). The appendix presents summary statistics of the variables.

RESULTS

Since the objective of this work is to analyze how public investment affects private investment, a visual image of the evolution of these variables is pertinent. Figure 2 illustrates how these variables, as a share of GDP, have evolved since 1988.[16]

As can be observed, private investment rose systematically during most of the 1990s, reached a peak in 1998,[17] and then began an uneven descent, which continues until the end of the period analyzed. Public investment, in contrast, decreased continuously during the 1990s but began ascending in the next decade. In 2009 it reached its highest level, almost 10 percent of GDP, and the trend for the foreseeable future seems to point upward,[18] despite a late plunge in the latter quarters of

15. For a detailed analysis of the implications of this test, see Dickey and Fuller (1979, 1981). For an analysis of this improved Dickey-Fuller test, see Elliot, Rothenberg, and Stock (1996). See Kwiatkowski and colleagues (1992) for details on this alternative test for stationarity.

16. Figure 2 shows the evolution of three-quarter, forward-moving averages—at current prices—of both private investment and public investment as a share of GDP.

17. During the 1990s Bolivia privatized key public companies in areas as varied as telecommunications, hydrocarbons, electricity, mining, air transport, and water and sewerage systems, hence the growing importance of private investment, particularly foreign direct investment, during those years.

18. In an interview with Alejandro Parellada on October 27, 2008 (translated by Richard Fidler) and published in *LINKS International Journal of Socialist Renewal*, Bolivia's vice president Alvaro García

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2010.[19] What is clear is that the negative relationship between private and public investment is not cyclical but reflects a trend that seems to have gotten stronger since approximately the year 2000. Estimates for the elasticity of substitution[20] between public and private investment—reported in tables 3–6—are consistently negative, denoting that crowding out of private investment seems to have taken place during the period 1988–2010.[21] To reinforce the patterns observed in figure 2, table 2 presents pairwise correlations for all variables.

Unsurprisingly, the correlation between private and public investment is –0.351, which illustrates the diverging paths of the variables. Private investment also shows the expected correlations with the rest of the variables—positive with national income (as measured by GDP) and ratios of financial development and trade openness, and negative with the institutional indicators. The main objective of this article is to probe these correlations, particularly the causal link between private and public investment.

Table 3 reports ARMA estimates for seven different specifications. In all cases, the dependent variable is the ratio of private investment to GDP.[22] Table 3 presents the results for the baseline specification, which includes GDP, the lagged dependent variable, and the ratio of public investment to GDP. Specifications (2), (3), (4), (5), and (6) add to the baseline model the variables related to financial development (credit to the private sector as a share of GDP), trade openness (sum of exports and imports as a share of GDP), and institutional control variables (corruption, nominal interest rate, and investment profile), respectively. The final specification on column 7 includes all variables.

Linera stated the government's goal to increase public expenditures to at least half of total capital expenditures (http://www.links.org.au/node/751).

19. It is important to point out that data on the exact structure of public investments at the departmental or regional level is not easy to come by. However, estimates reported in Bojanic (2013a) point out that, as a share of total government expenditures and for the period 1988–2010, average public expenditures in infrastructure, education, health, and defense were 8.96 percent, 1.57 percent, 1.14 percent, and 8.48 percent, respectively. For the 2000s, the average share of these sectors changed to 8.71 percent, 2.06 percent, 1.33 percent, and 4.10 percent, respectively, with the education sector gaining the most (30 percent gain) at the expense of the defense sector, which experienced a plunge of more than 50 percent.

20. Equation (1) was estimated utilizing natural logarithms in order to estimate the elasticity of substitution (ε_s) between public and private investment. The coefficient of $\left(\frac{I^G}{GDP}\right)_{i,t}$ is ε_s and measures, percentage-wise, how a change in public investment (as a share of GDP) affects private investment. Crowding out is observed if $\varepsilon_s < 0$.

21. Although the role and importance of financial market participants is not directly addressed here, it is important to point out that public and private investment play out in a Bolivian economy with an established stock exchange (Bolsa Boliviana de Valores SA), several private and public funds, and financial institutions specialized in a variety of industries. According to the Bolivian Stock Exchange (www.bbv.com.bo/diagrama-del-mercado-de-valores), as of 2013 there are more than one hundred different types of players in the market, seventeen of which are private equity funds; the rest are divided into public equity, central government, municipal, and industry-specific funds.

22. Several different types of specifications were tested, utilizing both shares and levels. The results reported here utilize shares for most variables; in all cases GDP (in logs) is also included as a control variable to account for the economic cycles of the country. A quadratic trend has been included in all specifications because both public and private investments as a share of GDP have shown a nonlinear evolution over the period analyzed. Although there were other possibilities (i.e., linear, cubic, or exponential trends), best results were obtained with a quadratic trend.

Table 2 Pairwise correlation

	Private investment as a share of GDP	Public investment as a share of GDP	Credit to private sector as a share of GDP	Total trade as a share of GDP	GDP (in logs)	Corruption (in logs)	Interest Rate (in logs)	Investment profile (in logs)
Private investment as a share of GDP	1							
Public investment as a share of GDP	−0.351	1						
Credit to private sector as a share of GDP	0.191	0.264	1					
Total trade as a share of GDP	0.045	0.075	−0.348	1				
GDP (in logs)	0.258	−0.101	−0.538	0.867	1			
Corruption (in logs)	−0.577	0.192	−0.079	0.359	0.106	1		
Interest rate (in logs)	−0.006	0.083	0.497	−0.863	−0.928	−0.372	1	
Investment profile (in logs)	−0.517	0.495	0.197	0.430	0.008	0.536	−0.147	1

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Table 3 ARMA estimates (least squares): Effect of public investment, control variables on private investment. Dependent variable: Private investment/GDP.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	−0.4869	−0.8783	−0.3347	−0.9353	−0.4874	−0.4950	−0.8720
	(−0.67)	(−1.39)	(−0.45)	(−1.26)	(−0.66)	(−0.68)	(−1.29)
Gross domestic product (GDP)	0.0243	0.0408	0.0166	0.0417	0.0243	0.0247	0.0368
	(0.77)	(1.49)	(0.52)	(1.31)	(0.76)	(0.78)	(1.26)
$(\text{Private investment/GDP})_{t-1}$	0.7088**	0.6521**	0.7205**	0.6858**	0.7089**	0.6994**	0.6301**
	(8.80)	(9.29)	(9.10)	(8.73)	(8.65)	(8.46)	(8.63)
Public investment/GDP	−0.4179**	−0.3444**	−0.3601	−0.4129**	−0.4173**	−0.4040**	−0.3386
	(−2.26)	(−2.12)	(−1.90)	(−2.29)	(−2.10)	(−2.17)	(−1.87)
Credit to private sector/GDP		0.1622**					0.1480**
		(4.52)					(3.84)
Total trade/GDP			0.0508				0.0488
			(1.32)				(1.32)
Corruption				0.0456**			0.0293
				(2.14)			(1.46)
Interest rate					−0.0001		0.0149
					(−0.01)		(1.07)
Investment profile						−0.0035	−0.0060
						(−0.64)	(−1.14)
SAR(4)	0.8635**	0.8337**	0.8778**	0.8738**	0.8635**	0.8690**	0.8630**
	(10.75)	(10.49)	(10.68)	(11.70)	(10.66)	(10.93)	(10.68)
MA(1)	0.5993**	0.5330**	0.6076**	0.5996**	0.5992**	0.6041**	0.5574**
	(4.71)	(4.38)	(4.82)	(4.88)	(4.66)	(4.75)	(4.51)
Time trend (quadratic)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ε_s	−0.47	−0.39	−0.40	−0.47	−0.51	−0.48	−0.43
Adj. R^2	0.91	0.93	0.91	0.91	0.91	0.91	0.93
ARCH LM test	F-stat=1.84	F-stat=0.01	F-stat=1.80	F-stat=1.32	F-stat=1.83	F-stat=1.83	F-stat=0.01
	(p=0.18)	(p=0.94)	(p=0.18)	(p=0.25)	(p=0.18)	(p=0.18)	(p=0.91)
Inverted AR roots	.96	.96	.97	.97	.96	.97	.96
Inverted MA roots	−.60	−.53	−.61	−.60	−.60	−.60	−.56
No. of observations	87	87	87	87	87	87	87

Note: Parentheses show t-statistics. ε_s = elasticity of substitution between public and private investment.
**$p < .05$.

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The baseline specification reported in column 1 of table 3 shows a negative and significant impact of public investment on private investment. In the short run, a one-percentage-point increase in the ratio of public investment to GDP decreases the private investment-to-GDP ratio by 0.42 percentage points. The implied long-run effect shows crowding out, with a 145 percent reduction of private investment in response to an increase in public investment.[23] The lagged dependent variable is positive and significant, a result that is unsurprising, as it reflects the irreversibility of the investment made in the preceding period. The national income indicator (GDP) has the expected positive sign but is not statistically significant. This result is replicated in all specifications, as GDP consistently shows a positive but insignificant effect on the dependent variable.

In column 2 the financial development indicator is added to the baseline specification. Unsurprisingly, it is positive and significant, demonstrating the incontrovertible effect of this variable on private investment. Public investment remains negative and significant, illustrating the seeming persistence of the crowding-out effect. Interestingly, the addition of the trade openness indicator (positive but statistically insignificant) shown in column 3 seems to lessen the crowding-out effect as public investment as a share of GDP is no longer significant, although it is difficult to draw any definite conclusions as the sign of this variable remains negative and similar in magnitude to the findings in all other specifications. Columns 4–6 add to the baseline specification the institutional control variables. In most cases,[24] the variables are insignificant, the size of their coefficients is close to zero, and the crowding-out effect of public over private investment does not disappear. The results seem to imply that the institutional quality of the country does not matter for the impact that public investment has on private investment.[25]

When all variables are included in the model (column 7), the coefficient of public investment as a share of GDP remains negative and of similar magnitude than in previous specifications, but it is no longer statistically significant. The financial development indicator is positive and significant, and the trade openness and institutional control variables remain insignificant. The ARMA results seem to denote that crowding out of private investment by public investment tends to remain despite the institutional quality, the level of financial innovation, and the level of trade openness of the country.[26]

Instrumental variable estimates are shown in table 4. The dependent variable is also the ratio of private investment to GDP; the seven specifications reflected in

23. The long-run effect is approximated by the ratio between the coefficient of $\left(\frac{I^G}{GDP}\right)_{,t}$ and (1) less the coefficient of $\left(\frac{I^P}{GDP}\right)_{,t-1}$), or $\alpha/(1-\sigma)$. Although several specifications were tried, the best fit was found when private investment as a share of GDP with one lag was utilized as the explanatory variable, which is why specifications reported here only utilize this variable to analyze its effect on the dependent variable.

24. In specification (4), corruption is statistically significant, and the size of its coefficient is 0.0456.

25. The statistical insignificance and the negligible size of the coefficients of the institutional variables may be the result of their lack of statistical power, as they tend to show little time-series variation in the sample analyzed.

26. The ARCH LM test statistic is also reported for all specifications. As the estimates and corresponding probabilities attest, autoregressive conditional heteroskedasticity (ARCH) in the residuals—a common problem in time-series analysis—is not present in any of the regressions.

columns 1–7 are the same ones obtained with ARMA models. As is evident, the IV estimates are similar to the ARMA estimates, with one important exception. Crowding out of private investment seems to significantly decline when the financial innovation indicator is included in the specification, as the magnitude of the coefficient of public investment to GDP is reduced by 33 percent and 26 percent, respectively, when compared to equivalent ARMA specifications (columns 2 and 7). In addition to the diminished magnitude of this variable, it also becomes statistically insignificant, evidencing that perhaps the way to reduce the negative effect of public investment on private investment is by increasing the amount of (private) financing of the private sector, which calls attention to the importance of a healthy and vibrant financial system in the country. As with the ARMA findings, other factors—such as trade openness and institutional indicators—do not seem to matter on the crowding-out effect of private investment by its public counterpart.

Robustness checks are presented in table 5, which reports summarized results with three alternative estimation methods, namely ARMA, instrumental variables, and generalized method of moments (GMM).[27] In the three cases, the reported estimates correspond to specifications that include all variables. With different estimation methods, the basic pattern of behavior of all variables is generally the same. The crowding-out effect seems to be reduced when the financial development variable is present—at least with ARMA and IV regressions—although it remains present when the GMM method is employed. The level of income as well as trade openness and institutional factors also show a similar pattern of behavior regardless of the method employed, lends support to the reliability of the findings reported in this work.

A final check on the robustness of the findings of this work is presented in table 6. In table 6 dummy variables for the privatization period (1Q1992–4Q1998) and for the presidency of Evo Morales (1Q2006–4Q2010) are included in the baseline specifications with institutional indicators (i.e., corruption and investment profile indices).[28] As can be observed, the inclusion of these dummy variables does not change in any significant manner the baseline estimates, as the crowding-out effect remains, and its magnitude is almost unaltered in all cases. Additionally, the last column of table 6 shows the baseline specification when all variables are measured relative to population rather than GDP.[29] As the estimates attest, the crowding-out effect remains, it is of similar magnitude, and it is statistically significant, highlighting that the results of this work are robust even when benchmarked by population.[30]

27. As was the case with the IV models, the GMM specification utilizes lagged values of the explanatory variables as instruments, hence ensuring that the exclusion restriction required of this method is met.

28. In Bolivia the transfer of key sectors in the economy to the private sector also occurred through a variant of traditional privatizations. Capitalization of certain public enterprises took place when instead of collecting financial resources for the transfer of a company, government demanded that those financial resources be reinvested into the very companies being sold. Although the end result was the same, the political connotations of both methods were very different within the country. In this work privatization and capitalization refer to the same thing.

29. This alternative method was taken from Cumming (2013).

30. All specifications utilized in this work were carried out benchmarking the main variables by population. In all cases, the estimates were almost identical to the case when variables are measured in terms of GDP.

Table 4 IV estimates (TSLS): Effect of public investment, control variables on private investment. Dependent variable: Private investment/GDP

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	−0.8656	−1.2547**	−0.8443	−1.2255	−0.9507	−0.7937	−1.0971**
	(−1.31)	(−2.67)	(−1.36)	(−1.76)	(−1.28)	(−1.23)	(−2.78)
Gross domestic product (GDP)	0.0418	0.0571**	0.0395	0.0550	0.0471	0.0384	0.0468**
	(1.42)	(2.73)	(1.42)	(1.80)	(1.43)	(1.34)	(2.75)
$(\text{Private investment/GDP})_{t-1}$	0.5340**	0.6292**	0.6000**	0.5769**	0.4850**	0.5799**	0.6507**
	(3.83)	(7.38)	(4.60)	(4.91)	(3.36)	(4.23)	(8.90)
Public investment/GDP	−0.4613**	−0.2311	−0.3541	−0.3712	−0.5880**	−0.4533**	−0.2506
	(−2.35)	(−1.50)	(−1.71)	(−1.98)	(−2.75)	(−2.31)	(−1.55)
Credit to private sector/GDP		0.2151**					0.2046**
		(4.68)					(4.83)
Total trade/GDP			0.0536				0.0304
			(1.40)				(0.95)
Corruption				0.0419			0.0131
				(1.88)			(0.86)
Interest rate					−0.0079		0.0202
					(−0.48)		(1.59)
Investment profile						−0.0004	−0.0058
						(−0.08)	(−1.33)
SAR(4)	0.6717**	0.6002**	0.6525**	0.7139**	0.7094**	0.6629**	0.5775**
	(6.27)	(6.43)	(5.92)	(7.27)	(6.77)	(6.14)	(5.58)
MA(2)	0.4492**	0.0518	0.3913	0.4363**	0.5151**	0.4144	−0.1472
	(2.10)	(0.37)	(1.95)	(2.40)	(2.34)	(1.98)	(−1.09)
Time trend (quadratic)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ε_s	−0.56	−0.26	−0.33	−0.51	−0.69	−0.60	−0.27
Adj. R^2	0.86	0.90	0.87	0.87	0.86	0.87	0.90
ARCH LM test	F-stat=1.76	F-stat=2.55	F-stat=1.74	F-stat=1.90	F-stat=1.78	F-stat=1.77	F-stat=2.52
	(p=0.08)	(p=0.08)	(p=0.08)	(p=0.06)	(p=0.08)	(p=0.08)	(p=0.12)
Inverted AR roots	.91	.88	.90	.92	.92	.90	.87
No. of observations	87	87	87	87	87	87	87
Instruments	5	6	6	6	6	6	10

Note: Parentheses show t-statistics. ε_s = elasticity of substitution between public and private investment.
**$p < .05$

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Table 5 Robustness of alternative estimation methods. Dependent variable: Private investment/GDP.

	ARMA (OLS)	IV (TSLS)	GMM
Intercept	−0.8720	−1.0971**	−1.7309**
	(−1.29)	(−2.78)	(−2.94)
Gross domestic product (GDP)	0.0368	0.0468**	0.0701**
	(1.26)	(2.75)	(2.98)
$(\text{Private investment/GDP})_{t-1}$	0.6301**	0.6507**	0.2539
	(8.63)	(8.90)	(1.73)
Public investment/GDP	−0.3386	−0.2506	−0.8096**
	(−1.87)	(−1.55)	(−3.80)
Credit to private sector/GDP	0.1480**	0.2046**	0.3982**
	(3.84)	(4.83)	(5.33)
Total trade/GDP	0.0488	0.0304	0.0017
	(1.32)	(0.95)	(0.03)
Corruption	0.0293	0.0131	0.0150
	(1.46)	(0.86)	(0.54)
Interest rate	0.0149	0.0202	0.0855**
	(1.07)	(1.59)	(3.79)
Investment profile	−0.0060	−0.0058	−0.0152**
	(−1.14)	(−1.33)	(−2.16)
Time trend (quadratic)	Yes	Yes	Yes
ε_s	−0.43	−0.27	−0.33
Adj. R^2	0.93	0.90	0.87
Inverted AR roots	.97	.87	—
Inverted MA roots	−.58	.36	—
No. of observations	87	87	90
Instruments	—	10	10

Note: Parentheses show t-statistics. ε_s = elasticity of substitution between public and private investment.
**$p < .05$.

CONCLUSIONS

The findings presented here represent the first formal analysis on the linkages between public and private investment in Bolivia since 1988. The results indicate that public investment crowds out private investment despite the influence of trade openness or the institutional quality of the Bolivian economy. However, crowding out of private investment seems to decrease with greater financing of the private sector, highlighting the importance of a stable and healthy financial system.

While the results indicate that overall public investment seems to crowd out private investment, they are not implying that all forms of public investment render the same effect. I am well aware that certain types of government intervention are likely to increase private investment, particularly in developing countries like Bolivia. The results obtained here, however, show that in many cases government actions distort the business environment and displace private investment. In countries like Bolivia, with a deficient institutional quality, the activities of the

Table 6 OLS estimates: Effect of public investment, Evo, privatization, corruption, and investment environment on private investment. Dependent variables: Private investment/GDP, private investment/population.

	Baseline corruption	Evo	Privatization	Baseline investment profile	Evo	Privatization	Population benchmark
Gross domestic product (GDP)	0.0417	0.0368	0.0341	0.0247	0.0187	0.0171	0.1994**
	(1.31)	(1.13)	(1.11)	(0.78)	(0.57)	(0.56)	(3.17)
$(\text{Private investment/GDP})_{t-1}$	0.6858**	0.6818**	0.6519**	0.6994**	0.6911**	0.6603**	0.6190**
	(8.73)	(8.60)	(8.52)	(8.46)	(8.25)	(8.23)	(7.42)
Public investment/GDP	−0.4129**	−0.4466**	−0.4784**	−0.4040**	−0.4436**	−0.4704**	−0.4127**
	(−2.29)	(−2.39)	(−2.72)	(−2.17)	(−2.30)	(−.2.59)	(−2.40)
Corruption	0.0456**	0.0456**	0.0434**				
	(2.14)	(2.13)	(2.12)				
Investment profile				−0.0035	−0.0046	−0.0042	
				(−0.64)	(−0.82)	(−0.80)	
Dummy		0.0049	0.0106**		0.0062	0.0112**	
		(0.70)	(2.33)		(0.86)	(2.38)	
Time trend (quadratic)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ε_s	−0.47	−0.51	−0.49	−0.48	−0.52	−0.50	−0.46
Adj. R^2	0.91	0.91	0.92	0.91	0.91	0.91	0.95
No. of observations	87	87	87	87	87	87	87

Note: Parentheses show t-statistics. ε_s = elasticity of substitution between public and private investment. Estimates are not reported for intercept, autoregressive and moving average regressors, inverted roots, and ARCH LM tests. The rightmost column reflects a specification by which dependent and explanatory variables are measured with respect to population rather than GDP.

**$p < .05$.

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public sector are likely to have a significant impact on the decisions of private entrepreneurs, and as the results of this work demonstrate, the impacts can be considerable.

An important lesson emerges from the findings reported here: crowding out of private investment seems to decrease with greater financial development, as reflected in the amount of (private) credit channeled to the private sector. The policy implication of this is straightforward and sets in place the importance of maintaining a healthy, competitive financial system as the most direct way to positively influence private investment in the country. It also calls into question current attempts by the Morales administration to set interest-rate ceilings for different types of loans, as well as other restrictive measures that may look good on paper—such as forcing financial institutions to set a fixed percentage of their utilities for social projects—but which may ultimately threaten the stability of the country's financial system.

Appendix: Summary statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Private investment as a share of GDP	92	0.079	0.031	0.031	0.181
Public investment as a share of GDP	92	0.075	0.009	0.059	0.097
Credit to the private sector as a share of GDP	92	0.019	0.010	−0.001	0.041
Total trade as a share of GDP	92	0.393	0.119	0.207	0.669
GDP (in logs)	92	23.165	0.701	21.847	24.410
Corruption (in logs)	92	1.289	0.134	1.080	1.386
Interest rate (in logs)	92	2.531	0.388	1.702	3.103
Investment profile (in logs)	92	1.516	0.526	0.288	2.197

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