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Public private partnerships and water and sanitation infrastructure development in Zimbabwe: what determines financing?

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Abstract

Background Zimbabwe envisions being an upper-middle-income economy by the year 2030. The vision 2030 has infrastructure development as a stand-out pillar upon which it is founded. The vision envisages well-developed, modern, efficient and resilient infrastructure as paramount to Zimbabwe's economic recovery. The policy plan seeks to increase infrastructure investments in energy, transport, information technology, tourism, housing, and water and sanitation. However, a still hesitant private sector exists with regard to investment in water and sanitation infrastructure even in developed countries. Thus, the study seeks to analyse determinants of financing water and sanitation public private partnerships in Zimbabwe given that there is no consensus between researchers on how determinant factors impact PPP investments.

Methods The study applied Tobit regression methodology on data collected for the 25 years ending 2021 to investigate determinants of financing water sanitation PPPs in Zimbabwe. Tobit regression method is preferred given the censored nature of the investment values of water and sanitation public private partnerships that reached financial closure in Zimbabwe.

Results In Zimbabwe, financial market development is a key financing determinant of water and sanitation public private partnerships. Both the capital and bank market development influences infrastructure financing in Zimbabwe's water and sanitation sector. Moreover, foreign direct investment negatively and significantly relates with water and sanitation public private partnership investments.

Conclusion Attracting private investment into Zimbabwe's water and sanitation sector requires that policy design targets capital and bank market development. Reforms can be achieved through putting in place sound frameworks that facilitate effective financial intermediation systems, enhance market liquidity and lower cost of capital.

Keywords Public–Private Partnerships, Water and sanitation, Infrastructure finance, Zimbabwe

JEL Classification H53, H54, O16, R42, E22

Introduction

Decades of under-investment in critical infrastructure has affected countries around the world, with the need for quality and resilient infrastructure coming during a period of severe economic underperformance (Woetzel, Garemo, Mischke, Kamra and Palter 2017; Strickland 2016). If the trend is allowed to continue, estimations are that insufficient infrastructure investment will ultimately result in the erosion of future growth potential and

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productivity. The global economy, over the decade ending 2030, needs to channel at least US\$90 trillion into infrastructure if future demographic and economic developments are to be sustained (Panayiotou and Medda 2016). Annually, this translates into expenditure of between US\$5 trillion and US\$6 trillion towards the construction of new urban settlements, transport networks, energy systems, telecommunications systems and water and sanitation networks. This level of capital requirement implies that the current levels of expenditure allocations towards infrastructure, estimated to be between US\$2 trillion and US\$3 trillion, be doubled (Panayiotou and Medda 2016). When efforts to ameliorate the adverse consequences of climate change are factored in, the projected annual investment expenditure should be much higher.

Zimbabwe envisions being an upper-middle-income economy by the year 2030. The vision 2030 has infrastructure development as a stand-out pillar upon which it is founded (Government of Zimbabwe 2018). The vision envisages well-developed, modern, efficient and resilient infrastructure as paramount to Zimbabwe's economic recovery. The policy plan seeks to increase infrastructure investments in energy, transport, information technology, tourism, housing, and water and sanitation, in alignment with and pursuit of the UN's SDGs (Government of Zimbabwe 2018). A list of infrastructure projects that the Government of Zimbabwe seek to execute in the short term is detailed in the Zimbabwe Transitional Stabilisation Programme (ZTSP) (Ministry of Finance and Economic Development 2019). The implementation of ZTSP require a total of US\$ 9 billion worth of investment. How this huge amount of investment can be mobilised, at a time when Zimbabwe is confronted with adverse conditions of floundering tax receipts and drying international lines of credit is a tall order that businesses, the public, and policy makers have to confront (Nyandoro 2019).

Given this context, it has become necessary to explore alternative sources of infrastructure financing, largely private since the traditional model of state financing has proved insufficient (Strickland 2016). Inevitably, the argument regarding why the private sector should be involved in what otherwise is traditionally public infrastructure space metamorphoses into how the private sector should be involved in the segment of the economy. Public private partnerships (PPP) provides a financing alternative for infrastructure development. Although a number of international development organisations differ in their conceptualisation of what constitutes a PPP and what does not (Jomo, Chowdhury, Sharma and Platz 2016), according to the Zimbabwe Investment Development Agency [ZIDA] (2019), a PPP is an agreement between a contracting authority and a counter party under which the counter party receives benefits for executing the

contracting authority's functions. The definitions of PPPs thus encompass a wide range of agreements that include, but are not limited to, concession contracts, management and lease contracts. This study thus seeks to analyse the key determinants of water and sanitation PPPs financing in Zimbabwe. Panayiotou (2017) noted that a still hesitant private sector exists with regard to investment in infrastructure even in developed countries largely because of information asymmetry. The study is thus instrumental in bringing to the fore perspectives on water and sanitation PPP financing in Zimbabwe with the goal of attracting capital resources into the sector. The African Development Bank [AfDB] (2019) noted that PPP financing policy and strategy have to be tailor-made to a particular country and to a particular sector. Studies that adopt this recommended view are scant in Zimbabwe, especially for the water and sanitation sector, a gap that this study seeks to contribute towards.

The rest of the paper is organised as follows: 1.1 section describes the water and sanitation infrastructure sector in Zimbabwe, elaborates of PPPs for infrastructure development in Zimbabwe, discusses the sources of PPP financing, "Literature review" section reviews the literature, "Methodology" section outlines the methodology, "Tobit regression results and discussion of findings" section discusses the empirical findings and "Conclusion" section concludes the paper.

Literature review

Despite gaining political independence four decades ago, a period that is long enough for strategic socio-economic policies to have been implemented, the state of water and sanitation provision in Zimbabwe is poor (Nhapi 2015). Zimbabwe's urban water supply and sanitation sector at one time had the highest access rates in Africa. Over the first two decades from Zimbabwe's independence in 1980, water coverage increased from 32 to 56% with sanitation access rate mimicking the same trend, increasing to 55% from 28% (African Ministers Council on Water [AMCOW] 2015). By the late 1990s, urban water services had attained impressive access coverage rates of over 90% (AMCOW 2015). Unfortunately, this is no longer the case, as there has been a steep deterioration in service provision the extent of which is alarming for a country that is not under a military conflict of any type. Deferred maintenance and lack of funding for system rehabilitation and expansion has made service intermittent and created a constant threat to public health (Cole et al. 2021).

New investment into the water and sanitation sector has been difficult to come by leading to a sustained decline in operations. Sewage systems are constantly experiencing large-scale blockages and the scarcity of chemicals has led to raw sewage being disposed into

urban water supply bodies such as Lake Chivero and Darwin-dale dam which are prime water sources for Harare and Norton, respectively (Tendaupenyu and Magadza 2017). Water treatment plants are dysfunctional. A large constituent of these pieces of machinery have outlived their economic life (Nhongo et al. 2018). The failure of the state-owned Zimbabwe Electricity Supply Authority (ZESA) to generate and distribute reliable electricity has further compounded the water and sanitation challenges in Zimbabwe (Homerai et al. 2019). Water and sewage systems run on electricity without which they cannot be operated. The dilapidated state of water and sanitation in Zimbabwe is adversely impacting operation of water dependent business enterprises, much the same way the general populace is being affected by unreliable water supplies (Khumalo, Dube, and Madzivire 2020).

Elsewhere, more structured deals have become synonymous with infrastructure financing (Pinto 2017). Hybrid structures that are better compatible with development projects are being used and PPPs provides one such example. Private capital is used to develop, operate and manage water and sanitation infrastructure, which traditionally is operated by public bodies on a not-for-profit basis (Esty 2004; Yoshino and Stillman 2018). The private partner usually assumes the construction and operating risks of the project given that private sector companies have superior construction management skills set. On the other hand, Mosa (2022) avers that public investment across sectors has to be evaluated based on their potential socio-economic contributions, economic growth, and/or economy-wide benefits. The PPP infrastructure financing model is thus viewed as an extension of the French “concession” to public services delivery under which a government agency that owns public services entities decides to engage private sector companies for construction and operation of the assets along with transferring of the obligation for ongoing maintenance over a period of time (World Bank 2014).

The PPP Knowledge Lab (2021), reports that since 1994, only seven mega-PPP deals have reached financial closure in Zimbabwe. Of these, three are in the road transportation sector, one is in the railways sector and three are in the energy sector. Despite the socio-economic importance of the water and sanitation sector and the infrastructure deficiency this sector has in Zimbabwe, according to the PPP Knowledge Lab (2021), no mega water and sanitation PPP deal has successfully been completed. Table 1 shows that transport sector has the lion’s share of major PPP investments in Zimbabwe, 63.6% whilst energy has 33.3%. Essentially there is bias in the distribution of PPP investments in Zimbabwe (Africa Capacity Building Foundation [ACBF] 2016). This

Table 1 Mega PPP that reached financial closure in Zimbabwe. Source: World Bank PPI database (2021)

Project name	Sector	Year	US\$ Million
Limpopo Toll Bridge	Transport	1994	18
African Power	Energy	1998	600
Beitbridge—Bulawayo Railway	Transport	1998	85
Ngezi platinum highway	Transport	2001	17
Newlands bypass	Transport	2007	12
Beitbridge Border Post	Transport	2011	97
Chisumbanje ethanol project	Energy	2013	600
Plumtree Bulawayo Project	Transport	2014	206
Kupinga small hydropower	Energy	2017	6
Uhuru Energy Solar Plant	Energy	2017	60
Beitbridge modernisation	Transport	2021	300
Total Investment value			2001,00

confirm that Zimbabwe still lags behind in terms of successful financing of water and sanitation PPPs.

Water and sanitation PPPs are financed from diverse sources. In Africa, International Development Institutions (IDI) and private sector capital are important sources of finance. The Kigali Bulk Water supply plant is an example of PPP financed from multiple sources. A blended finance structure spearheaded by the Emerging Africa Infrastructure Fund (EAIF) was used. Jointly the AfDB, the EAIF syndicated an 18 year tenure, USD40 million loan (International Finance Co-operation [IFC] 2020). The IFC and the Technical Assistance Facility (TAF) along with other sponsors, further provided additional finance for the USD61 million water plant (World Bank 2020).

Some other water and sanitation PPPs have been financed purely from private sources. Gisclon, McCauley and McNall (2002) states that the financing of the R74 million Durban Waste Water treatment plant was entirely from private sources. Loanable funds were secured from the Development bank of South Africa and the Rand Merchant Bank. Active commercial banks on the water and sanitation PPPs loan market in Africa include the Standard Bank South Africa. More than 70% of the US\$126 million Befesa desalination PPP project was financed by the Standard Bank Group, with the balance coming from the Spanish and Japanese project partners (Water Technology 2013). A USD\$180 million investment guarantee from the Multilateral Investment Guarantee Agency (MIGA) enhanced the risk profile of the project (MIGA 2021). Multilateral support is imperative in de-risking water and sanitation PPP projects.

Other notable financial institutions providing loans for financing PPP projects include the European Investment Bank (EIB), International Development Association

(IDA) as well as the International Bank for Reconstruction and Development (IBRD). For instance, Goreangab Water Plant in Namibia, constructed at an estimated cost of US\$15 million was financed through a loan from the EIB and similarly, water and sanitation PPPs in Mozambique, Zambia and Senegal accessed financing from IDA loans. The World Bank PPPI data base further highlight that the main sources of revenue for water and sanitation PPPs in developing Africa are user fees, direct wholesaling to the market, purchase agreements and disbursements from the government.

Academics have shown that financing of water and sanitation PPPs is dependent on a multi-faceted set of determinants, some of which are economic in nature. Jensen and Blanc-Brude (2006) revealed that a one standard deviation change in GDP per capita leads to 138.8% increase in PPP investments whilst government indebtedness exhibited a significant impact on water PPP investments. Indebted governments owing to financial pressure are compelled to seek investment respite through accommodating private players. The Zimbabwean government has difficulties attracting international lines of credit due to indebtedness a reason that explains a shift towards pro-private investment policies in water and sanitation. Similarly, the IMF (2006), using count and censored regression analysis provided empirical evidence of the fact that the size of the market, market purchasing power, inflation and import cover impact PPP investments. The similarity of research findings between IMF (2006) and Jansen and Blanc-Brude (2006) can be explained by the observation that the focus of analysis for both studies is the developing world and the sample period investigated is the same. However insightful the results are, these cannot be superimposed on Zimbabwe given the structural changes the country has gone through over the years hence the need for current studies that can be more useful to investors and policymakers. On the other hand, arguing that developing countries have greater need for fresh capital injection in infrastructure and a stable macro-economic environment is a pre-condition for attracting investment, Sharma (2011) tested the influence of macro-economic stability on innovative financing of infrastructure. A negative relationship between inflation and PPP investment was established. The finding is consistent with economic theory that emphasises the corrosive effect of inflation on investment returns. Population and the ratio of international reserves to imports both showed evidence of positively varying with investment in PPPs. Long import cover reduces the likelihood of currency instability. The study however assumed that macro-economic factors symmetrically affect infrastructure sectors in developing countries. This current study will narrow the analysis to water and sanitation sector in

a low income country, Zimbabwe. Rao (2018), for a set of Asian economies averred that macroeconomic variables and bank balance sheet variables such as non-performing loans influence commercial banks' decisions to finance PPPs. In such a case, unlocking the full potential of bank financing of public private partnerships can be attributed to reducing macroeconomic risk factors and having adequately capitalised banks.

Other than economic factors, the governance environment determines the sustainable financing of water and sanitation PPPs. More specifically, the rule of law, control of corruption, regulatory quality, government effectiveness, voice and accountability and political stability collectively or individually influence PPP financing. Nonetheless, in some cases researchers have reported contrasting findings on the relationship between elements of the governance environment and water and sanitation PPP financing. For instance, in sharp contrast to Jensen and Blanc-Brude (2005), Banerjee et al. (2006) reported that more corrupt economies attract infrastructure investments for a unit increase in the corruption index. In as much as international infrastructure companies may indeed choose to circumvent corruption, Banerjee et al. (2006) noted that it is impossible at times given that first mover and location advantages may precisely be in those corrupt countries. Similarly, and rather strikingly, Fleta-Asin and Munoz (2021), reported that increase in political instability results in more infrastructure investments. This is contrary to earlier studies that emphasised the centrality of political stability in attracting private sector investments in public infrastructure (Taguchi and Sinouchi 2019). A possible explanation for the inverse relationship between political stability and PPP investments is through the mechanism of citizen demand for service delivery communicated through street protest and political uprising. Governments will thus, involuntarily be compelled to respond to such calls by investing more into infrastructure and investing private participation in the process.

PPP investments require financial market access to borrow upfront. The level of financial market development thus becomes an important factor determining the successful physical and financial completion of a PPP project. Ba, Gasmi and Nomba (2010) provided evidence to the effect that the level of financial market development determines the volume of private investments in energy markets in developing countries. However, relative to the bank market, the capital market is the main driver of private investments in the PPP infrastructure market suggesting therefore that policy should be targeted at developing capital markets. Extending the analysis to water PPP in Zimbabwe and comparing the findings will greatly add to the discourse on PPP financing policies in

Africa and developing countries at large. Contrastingly, Ba et al. (2017) found that bank market development is the main driver of investment volumes in developing countries. In fact, a one-point increase in investment in domestic banks' liquid liabilities as a proportion of GDP will result in a 1.1% increase in private investment in PPP infrastructure projects. The coefficient measuring the impact of stock market development though positively related to PPP investment, is not significant. This finding suggests that international flows into infrastructure markets are being intermediated through the banking sector rather than the stock markets due to the embryonic state of capital markets in developing countries. By implication, countries with a banking sector that permits unrestricted mobility of capital and healthy lending capacity to the private sector encourage private investors in infrastructure PPPs in developing countries.

Despite detailed studies on PPPs having been carried out in other countries, PPP research in Zimbabwe is very limited. A literature survey from google scholar among other research repositories identifies only 13 articles published in peer-reviewed journals since the year 2012. The years 2015, 2017, 2020 and 2021 have two published articles each whilst the years 2012, 2013, 2018 and 2019 had a single publication each. This validates the observation by Sai et al. (2015) that PPP research in developing jurisdictions such as Zimbabwe is limited when a comparison is made with the United States of America, the United Kingdom, Australia and China. Cui et al. (2018) report that between 1990 and 2000, 165 PPP publications were on China. Over the same time frame, the United Kingdom (UK) PPP market contributed 108 studies. The UK is the pioneering country of the PPP concept hence the wider attention the market receives from scholars and practitioners. Some other notable nations found to be with a high number of studies by Cui et al. (2018) include the USA with 84 articles, Australia with 80 articles, and India with 40 articles. The limited PPP studies on Zimbabwe have focused on different themes. Some studies are centered on the scope of PPP implementation in Zimbabwe (Dube and Chigumira 2012; Zinyama and Nhema 2015). Sai et al. (2015) researched the constraints to PPP implementation in Zimbabwe, whilst the risk factors impacting PPP development projects in Zimbabwe were examined by Chakuchichi (2017). An evaluation of the effectiveness of PPPs in solving infrastructure challenges in Masvingo urban area was conducted by Chitungo (2017).

However, despite the critical importance of the sources of finance to the successful execution of a PPP strategy, limited attention has been given to this subject in Zimbabwe. Tshehla and Mukudu (2020) attempted to cover this research gap by investigating project financing for

infrastructure development in Zimbabwe. The study identified banks, insurance companies and pension funds as rich sources of liquid resources for infrastructure financing. Nonetheless, the finding of the study is based on a very small sample (12 respondents) and moreover constraints to project financing is assumed to have a symmetric impact on infrastructure sectors given that the study adopted a broad view of infrastructure. Risk and return profiles in infrastructure investments vary significantly with sectors and sub-sectors (Bitsch et al. 2010). It is imperative for academic studies to capture these variations. The current study will investigate determinants of PPP financing, with specific reference to the water and sanitation sector in Zimbabwe.

Methodology

Data, variables and sample

This study used secondary data for empirical analysis. Previous studies in PPP infrastructure investments used secondary data to answer research questions (Jensen and Blanc-Brude 2006; Sharma 2011; Panayides, Parola and Lam 2015). The World Bank's Private Participation in Infrastructure (PPI) database is used to gather data on water and sanitation PPPs. Data on investment values of water and sanitation PPPs that reached financial closure is extracted from the data base. Whilst the PPI database provided a good coverage of mega PPP projects, according to Jansen et al. (2006), it does not provide comprehensive coverage of small projects and those involving domestic investors. For that reason, local data banks: the Reserve Bank of Zimbabwe (RBZ) data bank and the Zimbabwe Central Statistics office (CSO) will complement the World Bank databases. Data is collected for a 25 year period spanning 1996–2021. The time frame is justified in view of the realisation that it is only in the late 1990s that the pioneering PPP reached financial close in Zimbabwe. Being a single country study, the sample period thus has 25 data points, which we deem to be adequate for the purposes of this research. Secondly, and in line with Sharma (2011), Ba et al. (2017), Pan et al. (2020) the dependent variable (PPPUSD) is also defined as the investment value of PPPs that reached financial closure in a particular year.

The explanatory variables and the respective previous studies in which they were used are summarised in Table 2. The subsequent section explains the derivation of the composite governance index as well as specifying the empirical model.

Governance quality index

In line with Nxumalo and Makoni (2021), we applied the principal component analysis (PCA) technique to generate a composite governance index. Conducting principal

Table 2 Explanatory variables. Source: Authors' own compilation

Variable	Indicator	Data source	References
GDPP	GDP per capita	World Bank WDI database	Jensen and Blanc-Brude (2006) IMF (2006) (Rao 2020)
IRIMP	International reserves to imports ratio	World Bank WDI database	IMF (2006) Sharma (2011) Kumar (2019)
INF	Consumer price index	World Bank WDI database, Reserve Bank of Zimbabwe	IMF (2006) Sharma (2011) Rao (2020) Kumar (2019)
FDI	Net FDI to GDP (%)	World Bank WDI database	Marozva and Makoni (2018); Chikaza and Simatele (2021)
SMC	Stock market capitalisation to GDP (%)	World Bank WDI database	Ba et al. (2010); Ba et al. (2017)
DBC	Domestic bank credit to GDP (%)	World Bank WDI database	Ba et al. (2010); Ba et al. (2017)
BCD	Bank credit to bank deposits (%)	Reserve Bank of Zimbabwe	Pan et al. (2020)
NPL	Non-performing loans to bank assets (%)	Reserve Bank of Zimbabwe	Telang and Prakash (2015); Kamau (2016); Rao (2020)
CC	Control of corruption percentile rank	World Bank WGI database	Jensen and Blanc-Brude (2005); Benerjee, Oetzel and Ranganathan (2006); Moszoro et al., (2015); Nxumalo (2020)
RQ	Regulatory quality percentile rank	World Bank WGI database	Benerjee, Oetzel and Ranganathan (2006); Moszoro et al. (2015); Taguchi and Sinouchi (2019); Nxumalo (2020)
RL	Rule of law percentile rank	World Bank WGI database	Jensen and Blanc-Brude (2005); Benerjee, Oetzel and Ranganathan (2006); Moszoro et al. (2015); Nxumalo (2020)
VA	Voice and accountability percentile rank	World Bank WGI database	Benerjee, Oetzel and Ranganathan (2006); Taguchi and Sinouchi (2019); Fleta-Asin and Munoz (2021); Nxumalo (2020)
PS	Political stability percentile rank	World Bank WGI database	Jensen and Blanc-Brude (2005); Benerjee, Oetzel and Ranganathan (2006); Moszoro et al. (2015); Nxumalo (2020)
GE	Government effectiveness percentile rank	World Bank WGI database	Jensen and Blanc-Brude (2005); Benerjee, Oetzel and Ranganathan (2006); Taguchi and Sinouch (2019); Nxumalo (2020)

component analysis entails the estimation of the eigenvalues of the correlation matrix of the original governance data set. Generally, components associated with the largest eigenvalues accounts for the greatest part of the variation between the variables and thus embodies and summarises the critical information about the original data set (Nxumalo and Makoni 2021). The use of a composite index is justified given that the WGI's variables are confirmed in the existing scholarly literature as being highly correlated. Further, and as averred under the empirical review section, there is no consensus among researchers on the most pertinent governance variable that influences water and sanitation PPP financing; hence the application of a constructed composite index becomes necessary to avoid spurious regression outcomes for this study.

Table 3 presents the eigenvalues of the correlation matrix of the governance variables: control of corruption (CC), regulatory quality (RQ), rule of law (RL), voice and accountability (VA) political stability (PS) and government effectiveness (GE). The maximum variation of the original dataset is explained by the first component (83.67%) and the eigenvalue of 5,02,037.

The respective eigenvector loadings from the PCA are presented in Table 4. It is evident from the table that the first component (PC1) has positive coefficients across the six dimensions of measuring the quality of governance. This implies that the six measures of governance played

Table 3 Principal components analysis-eigenvalues. Source: Authors' own compilation

Principal component	Eigenvalue	Proportion (of Variance)	Cumulative (Variance proportion)
1	5.02037	0.8367	0.8367
2	0.74742	0.1246	0.9613
3	0.14065	0.0234	0.9847
4	0.04465	0.0074	0.9922
5	0.03582	0.0060	0.9982
6	0.01107	0.0018	1.0000

a positive role of explaining the overall quality of governance in Zimbabwe. Thus, it can be deduced that PC1 embodies the most important information with regard to the governance environment in the original data set (Ait-Sahalia and Xiu 2019).

Having applied the PCA, a data reduction technique to model the variance structure of a set of governance variables and subsequently generate a composite governance index (GIX), the next section specifies the empirical models and discuss the estimation technique.

Model specification

The aim of the study is to establish the financing determinants of water and sanitation PPP infrastructure projects

Table 4 Eigenvector loadings

Variable	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6
CC	0.4367	-0.1252	0.2781	0.4583	-0.4453	-0.5549
RQ	0.4379	-0.1618	0.0490	-0.2177	-0.5428	0.6615
RL	0.4376	-0.0919	-0.1895	-0.7439	0.1224	-0.4425
VA	0.4256	-0.0213	-0.7539	0.4202	0.2476	0.1103
PS	0.2465	0.9633	0.0936	-0.0220	-0.0326	0.0316
GE	0.4291	-0.1460	0.5542	0.1101	0.6555	0.2134

control of corruption (CC), regulatory quality (RQ), rule of law (RL), voice and accountability (VA) political stability (PS) and government effectiveness (GE)

in Zimbabwe. In order to achieve the objective, the Tobit regression framework is applied given that the dependent variable, the dollar value of investments in water and sanitation PPP projects (PPPUSD) is a continuous and non-negative variable (IME, 2006; Pan et al. 2020, Fleta-Asin et al. 2021). Furthermore, the Tobit regression model accounts for censoring in the dependent variable which can potentially create biases if Ordinary Least Squares (OLS) was to be used. The Tobit model uses maximum likelihood estimation (MLE) to estimate the parameters. PPPUSD is considered to be left censored, being described by a clustering pattern around zero. Zimbabwe is an infant PPP market and as such, over the sample period, some years have recorded zero PPPs that reach financial closure. Being guided by the review of empirical studies and theory, the regression model is specified as:

$$\begin{aligned} \Delta \log PPPUSD_t = & \alpha_0 + \alpha_1 \Delta \log GDPP_{t-1} + \alpha_2 \Delta IRIMP_{t-1} \\ & + \alpha_3 \Delta \log INF_{t-1} + \alpha_4 \Delta \log FDI_t \\ & + \alpha_5 \Delta SMC_t + \alpha_6 \Delta DBC_t + \alpha_7 \Delta BCD_t \\ & + \alpha_8 \Delta NPL_t + \alpha_9 \Delta GIX_t + \varepsilon_t \end{aligned} \tag{1}$$

where $\Delta \log PPPUSD_t$ is the first difference of the logarithm of PPP investment value in USD; $\Delta \log GDPP_{t-1}$: is the first difference of the logarithm of the one period lag of GDP per capita; $\Delta IRIMP_{t-1}$ is the difference of the one period lag of the ratio of international reserves to imports ratio; $\Delta \log INF_{t-1}$ is the first difference of the logarithm of the one period lag of the level of inflation. One period lag of the macroeconomic variables are used in the model to rule out endogeneity and to manage adjustment lags (Ba et al. 2017). The acronym $\Delta \log FDI_t$ is the first difference of the logarithm of the inflow of foreign direct investment; ΔSMC_t is the first difference of the stock market capitalisation to GDP ratio; ΔDBC_t is the first difference of the domestic bank credit to the private sector; ΔBCD_t is the first difference of the bank credit to bank deposits ratio; ΔNPL_t is the first difference of non-performing loans; ΔGIX_t is the first difference of the PCA constructed governance index, and ε_{it} : is the error term.

The Augmented-Dickey-Fuller test, one of the most widely used in economic and finance research is used for unit root testing (Shrestha and Bhatta, 2018). Multicollinearity is controlled through retaining explanatory variables with a variance inflation factor [VIF] that is less than 10 (Chikaza and Simatele 2021). The VIF test results are presented in appendix 1 and the average VIF is 2.9 implying therefore that multicollinearity is adequately managed in the analysis. The robust standard errors are used in the estimation to control for heteroskedasticity (Brooks 2008). The findings of the study are presented in the subsequent section.

Tobit regression results and discussion of findings

The regression results are presented in Table 5. Economic growth, proxied by GDP per capita, is not a significant determinant of water and sanitation PPP financing. This finding is inconsistent with previous studies that reported a positive and significant influence of GDP per capita on PPP infrastructure investments (Jensen and Blanc-Brude 2006; Sharma 2011; Pan et al. 2020). The ratio of international reserves to imports (IRIMP) is also insignificant. Nakatani (2017) established that this variable, although an important determinant of PPP infrastructure investments, countries with low import cover are susceptible to currency crashes. The import cover has been largely very low in Zimbabwe, due to the absence of international reserves in the country (Kavila and Roux 2016).

Despite the volatile inflation dynamics over the sample period and the erosive effect inflation has on investment returns, the impact of inflation on PPP financing in Zimbabwe is insignificant (Tshehla and Mukudu 2020; Maune et al. 2020). Earlier, Chan, Lam, Wen, Ameyaw, Shou, Qing, Wang, and Ke (2015), asserted that stable rate of inflation explains the closure of more PPPs in the water sector in China. We further determined that FDI negatively and significantly relates to PPP financing at the 1% level of significance. This negative relationship between FDI and water infrastructure finance in Zimbabwe implies that private sector involvement is valued subject to dwindling international capital flows. Only

Table 5 Regression results

Regression variables	Model estimates	Marginal effects at mean
$\Delta \log \text{GDPP}$	-1.512949 (3.280401)	-0.7663977 (1.607257)
ΔIRIMP	-0.2571028 (0.298214)	-0.1302377 (0.1617209)
ΔLogIFN	-0.1472769 (0.2316438)	-0.0746044 (0.1187306)
$\Delta \log \text{FDI}$	-0.7182303*** (0.2380025)	-0.3638259*** (0.1291991)
ΔSMC	0.0137709*** (0.0040614)	0.0069758*** (0.0022856)
ΔDBC	-0.0357665** (0.0124036)	-0.0181178** (0.0073303)
ΔBCD	0.0483468*** (0.0122759)	0.0244905*** (0.0071298)
ΔNPL	-0.1511356*** (0.0377787)	-0.0765591*** (0.0180268)
ΔGIX	-1.160472 (0.85648)	-0.5878471 (0.4258632)
Con	-0.0277334 (0.2101808)	
Number of obs	25	
$F(8, 17)$	16,05	
Prob > F	0.0000	
Pseudo R2	0.2722	
Log pseudolikelihood	-31.208599	

***, ** and * represents 1%, 5% and 10% level of significance respectively

when there is pressure on public finance, does the Government of Zimbabwe seek to attract private investors to finance water and sanitation infrastructure (Maposa and Munanga 2021).

The ratio of stock market capitalisation to gross domestic product is significant at 1% and depicts a positive relationship with water infrastructure financing. This finding aligns with Ba et al. (2010), who previously found that in developing countries, the capital market is the main driver of PPP investments. Infrastructure projects are characteristically long term in nature and for that reason they rely on efficient and effective capital markets for long-term financing. The Zimbabwe Stock Exchange (ZSE) has a long functional history having been established in 1896 and strategies have been adopted to enhance the financing potential of the market (Nyangara, Ndlovu and Tyavambiza 2016). With regard to bank market development, the ratio of bank credit to bank deposits (BCD) positively and significantly influences water and sanitation PPP financing. This evidence is consistent with Kamu (2016) and Rao (2018) who, in their respective studies, concluded that banks with a solid capital base

are capable of lending towards project finance. However, bank lending is dependent on key credit factors. Divergent to priory expectations, the ratio of domestic bank credit to private sector as percentage of gross domestic product (DBC) are insignificant. Bank loans are a key source of debt finance during early contraction phase in PPP deals (Ba et al. 2017; Rao 2020). Non-performing loans (NPL) have a significant and negative bearing on financing of water and sanitation PPPs. The proposition that non-performing assets curtails financial institutions lending potential, whilst high asset quality enhances the propensity to lend towards project finance deals is supported by this finding (Rao 2018). The level of NPL in Zimbabwe's banking sector has been improving since 2015 (RBZ 2020). Contrary to Benerjee, Oetzel and Ranganathan (2006), Taguchi and Sinouchi (2019), Fleta-Asin and Munoz (2021) who emphasised the role of governance in PPP finance, this study concludes that the state of governance does not determine PPP financing in Zimbabwe. This may possibly be due to the fact that water and sanitation PPPs are sponsored by Chinese investors, who have little regard for governance affairs of host countries.

The findings from this study underscore that macro-economic policy interventions necessary to stimulate capital inflows into water and sanitation PPPs, should evolve around bank market and capital market development, in line with Marozva and Makoni (2018). A clear spillover benefit that the Government of Zimbabwe can expect from promoting financial sector development is that of attracting further private investment that is generally lacking in the water and sanitation infrastructure sector. Reforms can be achieved through putting in place sound investment and institutional frameworks that facilitate effective financial intermediation systems, while also safeguarding investor interests through sound institutional quality. Financial policy reforms can target crowding in pension funds, mutual funds and insurance companies which are a rich repository of loanable funds for bankable projects, as these financial institutions' funds are available and suitable for long term projects and returns on investments.

Conclusion

This study investigated the determinants of financing of water and sanitation PPP infrastructure projects in Zimbabwe using the Tobit regression analysis, using data for a 25 year period from 1996 ending in 2021. This study significantly extends previous work on PPP research in other countries, by extending the variables applied to PPP studies in Zimbabwe, which predominantly used qualitative techniques. This study is contextualised to Zimbabwe, a developing African country with limited PPP projects, data and studies published on it. The Zimbabwe

economy has also been bedevilled by rampant corruption, runaway inflation exceeding 400% per annum, and a general lack of interest from international investors due to the hostile economic and political environment. This study thus aimed to highlight the importance of removing barriers and overcoming these hurdles for the better good of the country as a whole. In addition, the study was undertaken following the realisation that researchers have reported mixed results on the impact of economic, governance and capital market development variables on PPP investments. Our study confirmed that a robust inverse relationship between PPP financing and foreign direct investment exists, implying that, subject to international inflow constraints, the Government engages the private sector for infrastructure development. Furthermore, we found that financial market development variables: stock market capitalisation to GDP ratio, the ratio of bank credit to private sector, bank credit to bank deposit ratio, and the level of non-performing loans all drive the financing of water and sanitation PPPs in the country. The PCA constructed governance index exhibited a negative and insignificant relationship with PPP finance. In as much as the analysis is a vital contribution towards the scant literature on the factors that are important with regard to attracting capital for water and sanitation PPP infrastructure financing in Zimbabwe, this study is constrained by data limitations. As a development finance concept, PPPs are a recent phenomenon that have been operationalised since the late 1990s, hence the sample period was limited to only 25 years. Moreover, this study applied a mono-method, which although considered adequate for the purpose of achieving the research objective, it has potential to create analytical biases. Thus, future studies can combine the analysis techniques and compare the results, to determine whether different findings are reached based on the methodology applied. In addition, this work can be extended to water sectors in other developing countries and a cross-sectional comparison of the findings can be undertaken to assess factors giving rise to successful fund raising and closure of PPPs. More work can also be done to unpack the institutional quality factors embodied in the World Bank indices such as government effectiveness and the rule of law, which form the basis of nation branding, and thus influence a country's ability to attract increased foreign capital flows.

Control of corruption *CC*, regulatory quality *RQ*, rule of law *RL*, voice and accountability *VA* political stability *PS* and government effectiveness *GE*.

Appendix

See Table 6.

Table 6 Multicollinearity analysis

Variable	VIF	1/VIF
SMC	4.86	0.205629
FDI	3.61	0.276951
DBC	3.22	0.310108
NPL	3.19	0.313640
BCD	3.11	0.321777
GDPP	3.01	0.332011
GIX	2.17	0.460557
IRIMP	1.88	0.532185
IFN	1.43	0.701414
Mean VIF	2.94	

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Author contributions

This paper was derived from the first author's PhD study, while the co-author served as the student's supervisor for the PhD. Therefore, the contribution of both authors was a joint effort and premised on the entire scholarly journey, including conceptualisation, writing, analysis, reviewing and editing. Both authors read and approved the final manuscript.

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Availability of data and materials

All secondary data used in this study is publicly available from the various websites, and databases, as indicated in the references. The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was conducted as part of a Ph.D. program, with institutional ethical approval received from the University of South Africa (UNISA), bearing the reference: 2022_CRERC_009 (SD).

Consent for publication

All authors read the manuscript and agreed to its publication.

Competing interests

The authors declare that they have no competing financial or non-financial interests directly related to the work submitted for publication.

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