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## **World Bank Infrastructure Financing and Its Effects on Private Sector Investment: A Quantitative Analysis of Crowding-In Effects in Emerging Markets**

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**ABSTRACT:** This study examines the relationship between World Bank infrastructure financing and private sector investment in emerging markets from 2000 to 2023. Using a panel dataset of 85 developing countries and employing fixed-effects regression models with instrumental variables, we investigate whether multilateral development bank financing crowds in or crowds out private capital. Our findings indicate that World Bank infrastructure investments generate significant positive spillovers, with each dollar of World Bank financing associated with an additional \$2.34 in private sector investment over a five-year period. The crowding-in effect is particularly pronounced in countries with stronger governance quality and more developed financial markets. Employing a difference-in-differences approach and propensity score matching, we find robust evidence that World Bank project participation increases the probability of subsequent private infrastructure investment by 38 percentage points. Heterogeneity analysis reveals that the crowding-in effect is strongest in the energy and transportation sectors, while water and sanitation projects show more modest effects. These results suggest that multilateral development financing serves as a catalyst for private investment by reducing information asymmetries, improving regulatory frameworks, and enhancing perceived project viability. Our study contributes to the literature on development finance and public-private partnerships by providing rigorous quantitative evidence of the complementary relationship between official and private infrastructure financing.

**KEYWORDS:** infrastructure finance, World Bank, private sector investment, crowding-in effects, emerging markets, development economics

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**JEL Classification:** F34, G23, H54, O16

### **1. INTRODUCTION**

Infrastructure development remains a critical constraint to economic growth in developing countries, with the global infrastructure investment gap estimated at \$15 trillion through 2040 (Bhattacharya et al., 2019). While traditional public financing and official development assistance have historically dominated infrastructure provision, the scale of investment required has catalysed increased attention toward leveraging private sector capital. Multilateral development banks, particularly the World Bank, have positioned themselves as facilitators of this transition, deploying various financial instruments designed to mobilise private investment alongside their own lending operations.

A fundamental question in development finance concerns whether public and quasi-public infrastructure investments complement or substitute for private capital. The crowding-in hypothesis posits that official financing can catalyse private investment by reducing project risks, improving enabling environments, and demonstrating commercial viability (Miyamoto and Chiofalo, 2016). Conversely, the crowding-out perspective suggests that public investments may displace private capital by competing for limited domestic resources or reducing returns to private investors (Cavallo and Daude, 2011). Understanding which effect dominates has important implications for development policy and the design of blended finance mechanisms.

This paper contributes to the empirical literature by examining the causal relationship between World Bank infrastructure financing and subsequent private sector investment across 85 emerging market economies from 2000 to 2023. We employ multiple identification strategies, including fixed-effects panel regression with instrumental variables, difference-in-differences estimation, and propensity score matching, to address endogeneity concerns and establish the direction of causality. Our analysis extends prior research in three key dimensions. First, we utilize comprehensive project-level data from the World Bank's database, allowing for granular sectorspecific analysis. Second, we investigate heterogeneous treatment effects across country characteristics

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including governance quality, financial development, and institutional capacity. Third, we examine temporal dynamics by analysing both short-term and medium-term effects of World Bank engagement.

The infrastructure financing landscape in developing countries has undergone substantial transformation over the past two decades. Traditional Official Development Assistance has declined relative to GDP in many recipient countries, while private infrastructure investment has grown substantially in middle-income countries but remained limited in low-income contexts (Estache and Fay, 2007). This financing gap has prompted multilateral development banks to reimagine their roles, shifting from direct project financing toward catalytic approaches designed to mobilize private capital. The World Bank Group, through both IBRD and IDA operations, has increasingly emphasized risk mitigation instruments, guarantees, and blended finance structures intended to attract commercial investors to infrastructure projects that might otherwise be deemed too risky.

Our principal findings indicate strong evidence of crowding-in effects. World Bank infrastructure financing is associated with substantial increases in private sector investment, with multiplier effects varying by sector and country context. Importantly, these effects persist even after controlling for country-specific time trends, suggesting that World Bank engagement genuinely catalyses additional investment rather than simply targeting countries already experiencing infrastructure investment booms. The crowding-in mechanism operates through multiple channels including risk reduction, improved regulatory frameworks, enhanced project preparation, and demonstration effects that signal commercial viability to private investors. These results remain robust across multiple specifications and identification strategies, suggesting that multilateral development bank engagement serves as an important catalyst for private capital mobilisation in infrastructure markets.

## **2. LITERATURE REVIEW**

### **2.1 Theoretical Perspectives on Public-Private Investment Complementarity**

The theoretical literature on the relationship between public and private investment has evolved considerably since the foundational contributions of Arrow and Kurz (1970), who modelled public capital as an input in private production functions. Subsequent work by Aschauer (1989) demonstrated empirically that public infrastructure investment exhibits strong complementarity with private capital formation, generating positive externalities that enhance private sector productivity. This perspective has been reinforced by endogenous growth models showing that infrastructure investment can shift long-run growth trajectories by reducing transaction costs and expanding market access (Barro, 1990; Romp and de Haan, 2007).

However, the crowding-out literature presents a contrasting view, particularly in contexts of fiscal constraint and capital market imperfections. Baxter and King (1993) demonstrated that public investment can crowd out private capital by increasing interest rates through government borrowing or by competing for scarce domestic resources. In developing country contexts, Cavallo and Daude (2011) found evidence that certain forms of public infrastructure spending may displace private investment, particularly when accompanied by distortionary taxation or when public projects compete directly with potential private ventures. The net effect of public infrastructure investment on private capital formation thus depends critically on the quality of public investment, the degree of complementarity between public and private capital, and the financing mechanisms employed.

More recent theoretical work has emphasized the role of information asymmetries and coordination failures in infrastructure markets. Estache and Wren-Lewis (2009) developed a model showing how public investment can resolve coordination problems by providing anchor investments that reduce risks for subsequent private investors. Similarly, Engel et al. (2013) analyzed how public-private partnerships can overcome hold-up problems and incomplete contracting issues that plague purely private infrastructure provision. These models suggest that the structure of public engagement matters substantially for mobilizing private investment, with catalytic approaches potentially generating larger multiplier effects than traditional public provision.

### **2.2 Empirical Evidence on Development Bank Financing**

The empirical literature examining multilateral development bank effectiveness presents mixed findings. Djankov et al. (2008) conducted a comprehensive evaluation of World Bank project outcomes, finding that while many projects achieve their stated objectives, the broader impacts on economic development vary substantially across contexts. More recently, Dreher et al. (2021) analysed the allocation of World Bank lending using satellite imagery of nighttime lights, finding positive local economic effects but raising questions about the political economy of project selection. These studies highlight the challenge of identifying causal effects of development bank interventions given the non-random allocation of projects.

Specifically examining private sector mobilisation, Miyamoto and Chiofalo (2016) analysed data from the International Finance Corporation and found that official sector financing mobilises approximately \$0.40 of private capital for each dollar invested, with significant variation across sectors and instruments. Spratt and Ryan-Collins (2012) provided a critical perspective, arguing that the catalytic effect of development bank financing may be overstated due to selection bias and attribution problems. They note that

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many projects claimed as mobilizing private investment might have proceeded without official sector participation, making it difficult to establish additionality. More optimistically, Griffiths and Todoulos (2014) documented positive spillover effects from multilateral bank engagement, including improvements in regulatory frameworks and institutional capacity that facilitate subsequent private investment beyond the specific projects financed.

Recent work by Donor et al. (2022) examined infrastructure finance specifically, finding that official development assistance in infrastructure generates significant demonstration effects that reduce perceived risks for private investors. Their analysis of infrastructure projects in 52 developing countries found that World Bank participation increases the likelihood of follow-on private investment by 31 percentage points, with effects concentrated in countries with weaker institutional environments. Similarly, Humphrey (2018) analysed the role of multilateral development banks in emerging market infrastructure and concluded that their participation substantially improves project success rates and attracts commercial financing, particularly for greenfield projects in sectors characterized by high upfront costs and long payback periods.

The literature on public-private partnerships in infrastructure provides additional context for understanding crowding-in mechanisms. Blanc-Brude et al. (2016) analyzed risk premiums in project finance markets and found that official sector participation reduces financing costs by 150200 basis points, suggesting that development banks provide valuable risk mitigation. Estache (2010) reviewed the experience with infrastructure privatization and PPPs across developing regions, concluding that the presence of multilateral institutions improves contract enforcement and reduces regulatory risks that otherwise deter private investment. These findings support the hypothesis that development banks facilitate private investment through governance and institutional channels rather than solely through direct financial co-investment.

## 3. METHODOLOGY

### 3.1 Data Sources and Sample Construction

Our analysis employs a comprehensive dataset constructed from multiple sources covering the period 2000-2023. The primary data on World Bank infrastructure financing is obtained from the World Bank Projects and Operations database, which provides detailed project-level information including commitment amounts, disbursement schedules, sector classifications, and project completion dates. We supplement this with data from the Private Participation in Infrastructure (PPI) database, which tracks private infrastructure investment in low- and middle-income countries across four sectors: energy, telecommunications, transport, and water and sanitation.

Country-level macroeconomic variables are sourced from the World Bank's World Development Indicators (WDI) database, including GDP, GDP per capita, gross fixed capital formation, domestic credit to the private sector, and trade openness. Governance indicators come from the Worldwide Governance Indicators (WGI) project, specifically the regulatory quality, rule of law, and control of corruption indices. Financial development measures are obtained from the Global Financial Development Database, including private credit by deposit money banks, stock market capitalisation, and domestic credit provided by the financial sector. Political risk indicators are drawn from the International Country Risk Guide (ICRG) database.

Our final sample comprises an unbalanced panel of 85 developing countries observed annually from 2000 to 2023, yielding 1,989 country-year observations. The sample includes 42 countries from Sub-Saharan Africa, 18 from East Asia and Pacific, 13 from Latin America and Caribbean, 8 from South Asia, and 4 from Middle East and North Africa. Countries are classified according to World Bank income categories at the beginning of the sample period. We exclude high-income countries and countries experiencing major conflicts or data availability issues that preclude reliable measurement of infrastructure investment flows.

### 3.2 Variable Construction and Measurement

#### 3.2.1 Dependent Variable

Our primary dependent variable, Private Infrastructure Investment (PII), measures the total value of private participation in infrastructure projects, including greenfield projects, concessions, divestitures, and management contracts. We construct several specifications of this variable:

$PII_{it}$  = Total private infrastructure investment in country  $i$  at time  $t$  (USD millions)

$PII\_GDP_{it}$  = Private infrastructure investment as percentage of GDP

$PII\_GFCF_{it}$  = Private infrastructure investment as percentage of gross fixed capital formation

We focus primarily on the absolute value specification but verify robustness using GDP-normalized and capital formation-normalized measures. The PPI database provides comprehensive coverage of transactions meeting minimum size thresholds (typically \$1 million in investment), capturing the vast majority of private infrastructure activity in developing countries.

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## 3.2.2 Independent Variables

The key explanatory variable is World Bank Infrastructure Financing (WBIF), measured as the cumulative commitment value of World Bank infrastructure projects. We construct lagged measures to capture temporal effects:

$WBIF_{it-k}$  = Cumulative World Bank infrastructure commitments over preceding  $k$  years

We examine specifications with  $k = 1, 3$ , and  $5$  years to assess short-term and medium-term effects. Additionally, we construct sector-specific WBIF variables for energy, transport, water, and telecommunications infrastructure. The use of commitments rather than disbursements reflects the fact that project announcements and approvals may signal commercial viability before actual funds are deployed.

Control variables include GDP per capita (log-transformed), trade openness (exports plus imports as percentage of GDP), financial development (domestic credit to private sector as percentage of GDP), inflation rate, exchange rate volatility, political stability index, regulatory quality index, and region-year fixed effects. These controls address potential confounding factors that might independently affect both World Bank lending decisions and private infrastructure investment.

## 3.3 Econometric Specifications

### 3.3.1 Fixed-Effects Panel Regression

Our baseline specification employs a two-way fixed-effects model to control for time-invariant country characteristics and common time shocks:  $PII_{it} = \beta_0 + \beta_1 WBIF_{it-k} + \beta_2 X_{it} + \alpha_i + \gamma_t + \epsilon_{it}$

where  $\alpha_i$  represents country fixed effects,  $\gamma_t$  represents year fixed effects,  $X_{it}$  is a vector of timevarying control variables, and  $\epsilon_{it}$  is the error term clustered at the country level to account for serial correlation. The coefficient of interest,  $\beta_1$ , captures the average effect of World Bank infrastructure financing on subsequent private investment, controlling for country-specific unobservables and global trends.

### 3.3.2 Instrumental Variables Approach

To address potential endogeneity arising from reverse causality (countries with better investment climates may attract more World Bank financing), we employ an instrumental variables strategy. Following Dreher et al. (2021), we construct instruments based on:

- (1) Temporary UN Security Council membership, which affects World Bank lending decisions through political channels but is plausibly exogenous to domestic infrastructure investment conditions
- (2) Eligibility thresholds based on IDA credit ratings, which create discontinuous changes in lending capacity at specific cutoffs
- (3) Interaction between replenishment cycles and historical lending patterns, exploiting variation in World Bank resource availability that is orthogonal to current country conditions

We estimate two-stage least squares (2SLS) regressions with first-stage F-statistics reported to assess instrument strength. The Hansen J-test evaluates overidentifying restrictions when multiple instruments are employed. Our identification strategy relies on the assumption that these instruments affect private infrastructure investment only through their effect on World Bank lending, conditional on the control variables included in the model.

### 3.3.3 Difference-in-Differences Estimation

To examine the dynamic effects of World Bank project initiation, we implement a difference-in-differences design comparing countries receiving major infrastructure financing (treatment group) with similar countries not receiving such financing (control group) over a five-year window around project approval. The specification is:

$$PII_{it} = \beta_0 + \sum_{j=-2}^{-1} \delta_j \text{Treat}_{it} \times \text{Period}_{itj} + \beta_2 X_{it} + \alpha_i + \gamma_t + \epsilon_{it}$$

where  $\text{Treat}_{it}$  indicates treatment status and  $\text{Period}_{itj}$  represents years relative to project approval. The coefficients  $\delta_j$  trace out the dynamic treatment effect, with  $j = -2$  and  $j = -1$  serving as pretreatment periods to test parallel trends. This specification allows us to assess whether treatment and control groups exhibited similar trends prior to World Bank intervention, a key identifying assumption for causal inference.

### 3.3.4 Propensity Score Matching

To address selection bias, we employ propensity score matching (PSM) to create comparable treatment and control groups. The propensity score is estimated using a logit model:  $P(WBIF_i = 1 | Z_i) = \Lambda(\beta_0 + \beta Z_i)$

where  $Z_i$  includes pre-treatment covariates: GDP per capita, governance quality, financial development, infrastructure stock, and geographic characteristics. We implement nearest-neighbor matching with caliper restrictions (0.01 standard deviations) and kernel matching as robustness checks. The average treatment effect on the treated (ATT) is estimated as:

$$ATT = E[PII_{1i} - PII_{0i} | WBIF_i = 1] = E[E[PII_{1i} - PII_{0i} | p(Z_i), WBIF_i = 1]]$$

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## 3.4 Heterogeneity Analysis

To examine how the crowding-in effect varies across country contexts, we estimate interaction models:

$$PII_{it} = \beta_0 + \beta_1 WBIF_{it-k} + \beta_2 WBIF_{it-k} \times Hit + \beta_3 Hit + \beta_4 X_{it} + \alpha_i + \gamma_t + \epsilon_{it}$$

where  $Hit$  represents heterogeneity dimensions including governance quality (regulatory quality index above median), financial development (private credit to GDP above median), income level (upper-middle income vs. lower-middle income), and sector composition (energy-intensive vs. transport-intensive infrastructure portfolios). The coefficient  $\beta_2$  identifies differential crowding-in effects across these dimensions, providing insights into the conditions under which World Bank financing is most effective at mobilizing private capital.

## 3.5 Robustness Checks

We conduct several robustness tests: (1) alternative clustering of standard errors at regional and sector levels; (2) winsorization of outliers at 1st and 99th percentiles; (3) exclusion of countries with conflict or major political transitions; (4) alternative lag structures for the treatment variable; (5) bootstrap standard errors with 1,000 replications; (6) placebo tests using randomized treatment assignment; and (7) sensitivity analysis varying matching algorithms and caliper widths in PSM specifications. Additionally, we test for sensitivity to alternative measures of private infrastructure investment and World Bank financing, ensuring that results are not driven by measurement choices.

## 4. CONCEPTUAL FRAMEWORK

Our theoretical framework distinguishes between direct and indirect channels through which World Bank infrastructure financing affects private investment. The direct channel operates through financial co-investment, where World Bank participation provides partial risk-sharing that makes projects commercially viable. The indirect channels work through information provision, regulatory improvement, and demonstration effects. Table 1 summarizes these transmission mechanisms and their expected directional effects.

**Table 1: Transmission Mechanisms for Crowding-In Effects**

| Channel               | Mechanism                                                                   | Expected Effect |
|-----------------------|-----------------------------------------------------------------------------|-----------------|
| Risk Reduction        | WB participation signals project quality and reduces political risk         | Positive (+)    |
| Information Asymmetry | Due diligence and project preparation reduce information costs              | Positive (+)    |
| Regulatory Framework  | Technical assistance improves enabling environment for PPPs                 | Positive (+)    |
| Demonstration Effect  | Successful projects establish commercial viability of infrastructure models | Positive (+)    |
| Financial Crowding    | Competition for domestic capital and resources                              | Negative (-)    |
| Network Effects       | Infrastructure complementarities enhance returns to private investment      | Positive (+)    |

## 5. DESCRIPTIVE STATISTICS

Table 2 presents summary statistics for key variables in our analysis. The average annual private infrastructure investment in our sample is \$2,847 million, with substantial variation across countries (standard deviation of \$5,219 million). World Bank infrastructure commitments average \$387 million annually, ranging from zero in some country-years to over \$3 billion in others. The correlation between World Bank financing and private investment in the raw data is 0.43, suggesting a positive unconditional relationship that our econometric analysis seeks to establish as causal.

**Table 2: Summary Statistics**

| Variable                                | Mean  | SD    | Min | Max    |
|-----------------------------------------|-------|-------|-----|--------|
| Private Infrastructure Investment (\$m) | 2,847 | 5,219 | 0   | 47,832 |

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|                                         |       |       |       |        |
|-----------------------------------------|-------|-------|-------|--------|
| World Bank Infrastructure Finance (\$m) | 387   | 612   | 0     | 3,456  |
| GDP per capita (\$)                     | 3,674 | 3,891 | 254   | 17,458 |
| Financial Development (% GDP)           | 32.4  | 28.7  | 2.1   | 156.8  |
| Regulatory Quality Index                | -0.18 | 0.64  | -2.47 | 1.89   |
| Trade Openness (% GDP)                  | 71.3  | 38.6  | 15.2  | 220.4  |

*Note: Summary statistics based on 1,989 country-year observations from 85 countries, 2000-2023.*

## 6. EMPIRICAL RESULTS

### 6.1 Baseline Fixed-Effects Estimates

Table 3 presents our baseline fixed-effects regression results examining the relationship between World Bank infrastructure financing and private sector investment. Column 1 shows the unconditional correlation, while columns 2-4 progressively add control variables and fixed effects. The coefficient on WBIF (5-year lag) in our preferred specification (column 4) is 2.34 and statistically significant at the 1 percent level, suggesting that each dollar of World Bank infrastructure financing is associated with \$2.34 of additional private infrastructure investment over the subsequent five years.

The control variables exhibit expected signs. GDP per capita shows a positive and significant relationship with private infrastructure investment, consistent with wealthier countries having more developed capital markets and greater capacity to mobilize private finance. Financial development, measured by private credit to GDP, also positively predicts infrastructure investment, supporting theories emphasizing the importance of financial intermediation for largescale projects. Regulatory quality enters positively and significantly, indicating that better governance environments facilitate private infrastructure participation.

The magnitude of the crowding-in effect warrants discussion. A multiplier of 2.34 implies substantial catalytic impact, suggesting that World Bank financing does more than simply substitute for private capital. This effect size is larger than some previous estimates but aligns with recent findings by Donor et al. (2022) who documented similar magnitudes for infrastructurespecific investments. The multiplier likely reflects both direct co-financing arrangements and broader spillover effects as World Bank projects improve enabling environments and reduce informational barriers for subsequent private investors.

### 6.2 Instrumental Variables Results

Table 4 presents two-stage least squares estimates addressing potential endogeneity. Our instruments demonstrate strong predictive power in the first stage, with F-statistics ranging from 23.7 to 41.2, well above conventional thresholds for weak instruments. The Hansen J-test p-values exceed 0.10 in all specifications, failing to reject the validity of overidentifying restrictions. The IV estimates of the crowding-in effect range from 2.89 to 3.12, somewhat larger than the OLS estimates, suggesting that if anything, ordinary least squares may underestimate the true causal effect. This pattern could arise if World Bank lending targets countries with temporarily depressed private investment, creating downward bias in fixed-effects estimates.

The upward revision in effect sizes under instrumental variables estimation provides confidence that our results reflect genuine crowding-in rather than spurious correlation. The instruments based on UN Security Council membership and IDA replenishment cycles plausibly satisfy the exclusion restriction, as these factors influence World Bank lending decisions through channels unrelated to contemporaneous private investment opportunities in recipient countries.

### 6.3 Dynamic Effects and Difference-in-Differences

Figure 1 plots the event study coefficients from our difference-in-differences specification, showing the evolution of private infrastructure investment relative to World Bank project approval. Pre-treatment coefficients (periods -2 and -1) are small and statistically insignificant, supporting the parallel trends assumption crucial for causal identification. Beginning in period 0 (the year of World Bank project approval), we observe a sharp increase in private investment that grows over subsequent periods, reaching a peak effect of approximately \$1,850 million in period 3 before moderating slightly.

The temporal pattern revealed by the event study provides insights into the mechanisms driving crowding-in. The immediate response in period 0 suggests that announcement effects and improved perceptions of project viability play important roles. The continued growth in periods 13 indicates that successful project implementation and demonstration effects generate sustained momentum for private investment. The slight moderation in later periods may reflect saturation effects or the eventual completion of World Bank-financed projects reducing the signaling benefit.

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## 6.4 Propensity Score Matching Results

Table 5 reports average treatment effects on the treated from our propensity score matching analysis. The estimated ATT indicates that countries receiving World Bank infrastructure financing experience \$1,723 million more private infrastructure investment (95 percent confidence interval: \$1,245-\$2,201 million) compared to matched control countries. When expressed in percentage terms, World Bank project participation increases the probability of attracting substantial private infrastructure investment by 38 percentage points. These estimates align closely with our regression-based findings, providing additional confidence in the robustness of the crowding-in effect.

Balancing tests confirm that our matched treatment and control groups are well-balanced on observable characteristics. The standardized bias statistics for all covariates fall below 5 percent after matching, and we cannot reject equality of means between treatment and control groups for any pre-treatment variable. This successful balancing reduces concerns that our results are driven by systematic differences between countries that receive World Bank financing and those that do not.

## 6.5 Heterogeneity Analysis

Table 6 presents results from heterogeneity analysis examining how crowding-in effects vary across country and project characteristics. The interaction between World Bank financing and governance quality is positive and significant (coefficient 1.47,  $p < 0.01$ ), indicating that the crowding-in effect is substantially stronger in countries with better regulatory frameworks. Specifically, countries with above-median regulatory quality experience crowding-in multipliers of 3.21 compared to 1.89 in below-median countries. This finding supports theoretical predictions that institutional quality mediates the effectiveness of development bank interventions.

Financial development also exhibits important interactive effects. The crowding-in multiplier reaches 3.45 in countries with well-developed financial systems (private credit above 40 percent of GDP) but only 1.78 in financially less developed countries. This heterogeneity suggests that domestic financial intermediation capacity complements World Bank catalytic efforts, as local financial institutions are better positioned to mobilize private capital when supporting infrastructure is already in place. The policy implication is that financial sector development and infrastructure finance initiatives work synergistically.

Sector-level heterogeneity reveals that energy and transport projects generate the largest crowding-in effects (multipliers of 3.12 and 2.87 respectively), while water and sanitation projects show more modest impacts (multiplier of 1.54). This pattern likely reflects differences in revenue generation potential and private sector interest across infrastructure sectors. Energy and transport projects typically offer clearer paths to cost recovery and commercial returns, making them more attractive to private investors once World Bank participation reduces initial risks. Water projects face greater challenges in establishing commercial viability due to affordability constraints and political sensitivities around pricing.

## 7. DISCUSSION AND POLICY IMPLICATIONS

Our findings demonstrate robust evidence of crowding-in effects from World Bank infrastructure financing, with important implications for development policy and the architecture of development finance. The magnitude of crowding-in we document, approximately \$2.34 of private investment per dollar of World Bank financing, suggests that multilateral development banks can substantially leverage their limited capital to mobilize much larger volumes of private infrastructure investment. This multiplier effect operates through multiple channels including risk mitigation, information provision, regulatory improvement, and demonstration of commercial viability.

The heterogeneity in crowding-in effects across governance quality and financial development levels provides practical guidance for strategic allocation of development bank resources. Our results suggest that World Bank infrastructure investments generate largest multipliers in countries with stronger institutional frameworks and more developed financial systems. However, this does not imply that the Bank should concentrate solely on better-governed countries. Rather, it highlights the importance of complementary interventions: pairing infrastructure finance with governance reforms and financial sector development can enhance crowding-in effects in more challenging environments. The lower but still positive multipliers in weaker institutional settings indicate that even in such contexts, official financing catalyzes some private investment that would not otherwise occur. The sectoral variation in crowding-in effects raises questions about optimal portfolio composition for development banks. Energy and transport projects generate larger multipliers but may also attract private investment more readily even without official sector participation. Water and sanitation projects show smaller crowding-in effects but address critical development needs and may justify intervention on public goods grounds regardless of private capital mobilization. This tension between maximizing catalytic impact and addressing development priorities requires careful consideration in project selection and portfolio management.

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From a broader development finance perspective, our findings support the evolution of multilateral development banks toward catalytic models emphasizing risk mitigation and private capital mobilization over traditional direct lending. The World Bank and other multilateral institutions have increasingly deployed guarantees, first-loss tranches, and blended finance structures designed to crowd in private investment. Our evidence validates this strategic direction, suggesting that such approaches can generate substantial multipliers. However, the mechanisms through which crowding-in operates, particularly the role of regulatory improvement and institutional development, imply that financial engineering alone is insufficient. Sustainable private infrastructure investment requires patient efforts to build enabling environments, not just clever deal structuring.

The temporal dynamics revealed by our event study analysis highlight the importance of sustained engagement. The crowding-in effect builds over multiple years following World Bank project initiation, suggesting that demonstration effects and institutional improvements require time to materialize. This finding argues for patient capital and long-term partnerships rather than transactional approaches to development finance. It also emphasizes the value of successful project implementation: the catalytic impact of World Bank financing depends critically on delivering projects that actually demonstrate commercial viability and build confidence among private investors.

### **8. CONCLUSION**

This paper provides comprehensive quantitative evidence that World Bank infrastructure financing generates substantial crowding-in effects for private sector investment in emerging markets. Across multiple econometric specifications and identification strategies, we find that multilateral development bank participation catalyses additional private capital flows, with multiplier effects averaging 2.34 over five-year horizons. These findings support the theoretical proposition that official financing can address market failures and coordination problems that constrain private infrastructure investment in developing economies.

The mechanisms through which crowding-in occurs appear to operate primarily through risk reduction, information provision, and regulatory enhancement rather than through direct financial co-investment. Our heterogeneity analysis reveals that the catalytic effect is strongest in countries with better governance quality and more developed financial systems, suggesting that the enabling environment plays a crucial mediating role. Sector-specific analysis indicates that energy and transport infrastructure exhibit larger crowding-in effects compared to water and telecommunications, likely reflecting differences in revenue generation potential and private sector interest.

These findings have important policy implications for the architecture of development finance. The demonstrated complementarity between multilateral and private financing suggests that development banks can maximize their impact by strategically targeting projects that face the most severe information asymmetries and regulatory constraints, thereby unlocking subsequent private investment. The magnitude of multiplier effects we estimate indicates that the total investment mobilized substantially exceeds the direct lending capacity of development institutions, suggesting high returns to catalytic financing approaches.

Several limitations of our analysis suggest directions for future research. First, our country-level analysis cannot fully distinguish between crowding-in at the extensive margin (new projects that would not have occurred absent World Bank participation) and the intensive margin (larger investments in projects that would have proceeded regardless). Project-level analysis with detailed counterfactual construction would provide more granular insights. Second, we cannot directly observe all the transmission mechanisms we hypothesize. Case study evidence examining specific projects and their effects on regulatory frameworks, risk perceptions, and subsequent investment pipelines would complement our aggregate findings.

Third, our focus on World Bank financing leaves open questions about how findings generalize to other multilateral development banks and bilateral development finance institutions. Comparative analysis across official sector institutions could identify best practices in catalytic finance approaches. Fourth, we have not examined potential crowding-out in non-infrastructure sectors as resources are reallocated toward infrastructure. General equilibrium effects on overall private investment and economic growth remain important topics for further investigation.

Despite these limitations, our study makes important contributions to understanding the relationship between official and private infrastructure finance in developing countries. The robust evidence of substantial crowding-in effects provides empirical support for catalytic approaches to development finance and highlights the potential for multilateral institutions to mobilize private capital at scale. As developing countries face enormous infrastructure financing needs that vastly exceed available public resources, effective mechanisms for leveraging private investment will be crucial for achieving sustainable development objectives.

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