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Public Investment Quality and its Implications for Sovereign Risk and Debt Sustainability

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Public Investment Quality and its Implications for Sovereign Risk and Debt Sustainability

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Abstract

This paper introduces a novel index to measure public investment quality, utilizing the World Bank's investment project performance data from 120 countries over the period 2000-2021. After detailing the construction of the index, the paper examines how public investment quality influences the relationship between the level of public investment and sovereign risk. We find that high levels of public investment are linked to lower sovereign risk in countries with high investment quality, and conversely, to higher sovereign risk in countries with low investment quality. This relationship is especially pronounced in sub-investment grade countries. We corroborate these results by showing that when public investment quality is high, scaling up public investment enhances fiscal sustainability by reducing the debt-to-GDP ratio in the long run: high-quality public investment is self-financing. However, the opposite is true when public investment quality is low, where increased public investment results in a deterioration of fiscal fundamentals.

JEL classification: E22; G24; H54; H63.

Keywords: Public investment; Public investment quality; Sovereign risk; Debt sustainability.

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1. Introduction

Not all public capital is equally productive. Allocating one dollar to public investment does not always result in an equivalent increase in productive public assets. In the worse cases, public investment may yield "white elephant" projects that lack positive growth effects and, through their distortions, may even exert a negative impact on growth. Thus, the capacity of public investment to drive economic growth depends on the efficiency and effectiveness of its implementation: the "quality" of public investment. (Cavallo and Daude 2011; Gupta et al. 2014; Izquierdo et al. 2018; Leduc and Wilson 2012; Leeper et al. 2010).

Ensuring high quality public investment is particularly important for emerging market and developing economies (EMDEs) which have significant infrastructure gaps and limited fiscal space. In such a situation, an increase in the level of high-quality public investment can improve fiscal fundamentals (and thus reduce sovereign risk) even if it leads to a temporary increase in the government deficit and debt. However, scaling up low quality public investment can have the opposite effects and lead to a deterioration of fiscal fundamentals through two channels: (i) the increase in government expenditure associated with public investment and the costs of maintaining the resulting public infrastructure, and (ii) the inefficient allocation of resources and suboptimal growth outcomes stemming from low-quality investment projects.[2]

This paper introduces a novel index to assess public investment quality and tests how this index affects the relationship between public investment levels and each of sovereign risk and fiscal fundamentals.

Corruption and weak governance leading to inefficient investment project management, political consideration in project appraisal, budget management and procurement challenges are among the major known impediments for effective public investment (Rajaram et al. 2014). These issues are also addressed in public investment management assessment frameworks developed by the World Bank and the IMF, encompassing essential features of an effective public investment management system that spans all stages of an investment project from initial project appraisal to implementation and ex-post evaluation (Kim et al 2020; IMF 2022). However, public investment quality is a multi-dimensional phenomenon that encompasses a variety of microeconomic and governance characteristics, some of which are difficult to measure and capture in a single aggregate index which is internally consistent and comparable across time and countries. Building such a measure is one of the objectives of this paper.

To date, aside from proxy indicators that are used to indirectly infer public investment quality—for instance, institutional development measures—there have been only a few attempts to develop a measure that explicitly focuses on public investment quality or efficiency. To the best of our knowledge, the only index that specifically focuses on public investment quality is Public

[2] Berg et al. (2019) define low efficiency of public investment as a low ratio between the actual increment of public capital and the amount spent. They show that there are conditions under which increases in public investment in inefficient countries do not necessarily have a lower impact on growth than in efficient countries. However, even when the conditions studied by Berg et al. (2019) apply, inefficient public investment is more likely to have worse fiscal consequences with respect to efficient public investment. Annex B provides a detailed literature review of the measures employed to date.

Investment Management Index (PIMI) developed by Dabla-Norris et al. (2012).[3] While PIMI is useful for cross-country comparisons and has been extensively used in the literature, its construction required a herculean effort in terms of data collection and relied on qualitative information partly based on "in-country discussion with country officials, review of published and unpublished material, and discussions with relevant stakeholders." (Dabla Norris et al. 2012, p. 244). Thus, the PIMI index is hard to replicate and costly to update.

Consequently, the index is only available for a subset of countries (71 economies) and has not been updated since the original data collection period in 2007-2010. Another potential drawback of the PIMI is its emphasis on public investment procedures rather than outcomes. It is thus a *de jure* index of public investment quality rather than a *de facto* index.

In this paper we address these issues by developing a novel index of public investment quality (PIQ) that measures *de facto* aggregate country-level efficiency of public investment. The index is based on publicly available World Bank data on investment project performance evaluations. Rather than being based on public investment procedures, our index focuses on outcomes as it is based on impartial evaluations of specific investment projects conducted by experts in a consistent appraisal framework. As PIQ is constructed using publicly available data, it can be easily replicated and updated.

Our index covers 120 EMDEs over 2000-2021. It shows significant variation in public investment quality across EMDEs, with lower values of the index in commodity-exporting and low-income countries (LICs). We also find that the gap in public investment quality between low-income and higher-income countries, as well as between commodity-exporting and commodity-importing EMDEs, has widened over time.

We use the PIQ index to test whether public investment quality affects the relationship between public investment and sovereign risk. We conjecture that when the quality of public investment is high, an increase of public investment will increase future growth and fiscal revenues and thus reduce sovereign risk. We expect the opposite for countries with low public investment quality. In this case, scaling up of public investment should be associated with worse fiscal fundamentals and higher sovereign risk. The data support these hypotheses and show that the mediating effect of the PIQ index on the link between public investment and sovereign risk is especially important for sub-investment grade countries. We also show that increasing public investment leads to higher debt ratios in low-investment-quality countries and to lower debt ratios in high-investment-quality countries. These results support the idea that public investment can "fund itself" but only when public investment is efficient.

[3] PIMI is a composite index that focuses on the efficiency of public investment management based on 17 indicators evaluating the stages of the public investment management cycle: (i) strategic guidance and project appraisal; (ii) project selection; (iii) project management and implementation; (iv) and project evaluation and audit. Besides this index, there have also been a few attempts to develop a measure of public expenditure efficiency using a combination of proxy variables, a data envelopment analysis, or other methods (IMF 2015; IMF 2021; Afonso et al. 2022; Herrera and Ouedraogo 2018).

In testing for the links between public investing quality and sovereign risk, we contribute to the large literature on the drivers of sovereign spreads and ratings.[4] Two papers that are closely related to ours are Afonso et al. (2022) and Combes et al. (2012). Afonso et al. (2022) find that greater public spending efficiency is associated with better sovereign ratings in a sample of 35 OECD countries. Combes et al. (2012) study a panel of 30 EMDEs and find that spending composition matters with higher current public spending being associated with higher spreads and higher public investment leading to lower spreads. Unlike us, these authors do not explore the role of public investment quality.

Our findings have important policy implications for EMDEs, particularly for countries grappling with elevated sovereign spreads, constrained fiscal capacity, and intermittent access to international capital markets. Specifically, our results highlight the pivotal role of public investment quality in ensuring debt sustainability through the sovereign risk channel. They show that scaling up public investment in countries characterized by inadequate public investment management processes can jeopardize macroeconomic stability. These findings are of utmost importance for LICs, which often trail behind other developing economies in terms of public investment quality, all while facing severe fiscal space constraints and infrastructure gaps.

The interplay of these interlinked challenges, many rooted in deep-seated structural issues, presents significant hurdles for policymakers in LICs seeking to utilize public investment as a catalyst for growth. This underscores the urgent need for intensified efforts to enhance technical and financial assistance to these nations from the global community. A comprehensive approach is required, involving meticulous assessment and ongoing monitoring of public investment projects throughout their lifecycle, drawing from established frameworks such as those outlined by the World Bank and IMF for public investment management. This should be complemented by strengthened frameworks for managing public expenditure and ensuring debt sustainability to mitigate the inherent risks of debt distress.[5] Additionally, concerted action is needed among creditors and development partners to offer concessional development assistance, aligning efforts to provide support on favorable terms. Such a multipronged strategy is essential to empower LICs to overcome the challenges hindering their effective use of public investment as a tool for fostering growth.

The rest of the paper is structured as follows. Section 2 describes the construction of the public investment quality index and its properties. Section 3 analyzes the implications of public investment quality for sovereign risk and debt sustainability. Section 4 reviews policy implications and concludes.

[4] This literature has focused on the role of GDP growth, income per capita, inflation, public and external debt, default history, fiscal and external balances, foreign reserves, government effectiveness, debt composition, and trade (see, among others, Cantor and Packer 1996; Afonso 2003; Afonso, Gomes, and Rother 2011; Mora, 2006; Salvatore et al. 2013; Eichengreen et al. 2003, 2022; Aizenman et al. 2016; and Jeanneret 2018).

[5] In this context, see also a discussion in IEG (2021) on the assessment of the public financial and debt management support for IDA-eligible countries.

2 Public investment quality index: estimation and properties

2.1. Data and methodology

Project Performance Ratings Database. We build our public investment quality (PIQ) index using publicly available data from the World Bank Project Performance Ratings Database. These ratings are based on the evaluation of World Bank projects carried out impartially by the World Bank's Independent Evaluation Group (IEG).[6] The database reports the results of project assessments aimed at evaluating the relevance of project objectives and design, project outcomes relative to stated objectives, and the efficiency of resource use in achieving the project's objectives. The ratings are based on data from IEG's Implementation Completion Report Reviews—these are desk reviews of World Bank's Implementation Completion and Results Reports (ICR) of lending projects—and Project Performance Assessment Reports (PPARs) which are independent field-based project evaluations based on site visits and interviews with stakeholders. The World Bank Project Performance Ratings Database covers 5,900 projects in 150 countries over the period 2000-2022.[7]

Recap of the IEG project evaluation methodology. At the end of every project funded by the World Bank, the evaluation team prepares evaluation reports and ratings. During the IEG evaluation process, the team conducts an independent, desk-based critical review of the evidence, results, and ratings of the completed project. Using evidence from the ICR and an interview with the last task team leader, IEG establishes its own ratings of the project based on the World Bank evaluation criteria. These ratings employ a harmonized methodology and a set of standardized scales, ensuring full comparability across countries and over time. The IEG methodology provides a granular metric based on six potential scores, ranging from "Highly unsatisfactory" to "Highly satisfactory." Before being publicly disclosed on the portal, project review reports, along with evaluation ratings, undergo thorough reviews and approvals from designated review coordinators, managers, and World Bank global practices.[8]

Construction of the PIQ index. For the purposes of our analysis, we convert the qualitative project outcome ratings into numerical scores that range between 1 and 6: 1 = "Highly unsatisfactory", 2 = "Unsatisfactory", 3 = "Moderately unsatisfactory", 4 = "Moderately satisfactory", 5 = "Satisfactory", and 6 = "Highly satisfactory". As we focus on public investment, we only use the data on projects in the Investment Project Financing (IPF) category.[9] These investment projects finance activities that create the physical and social infrastructure needed for sustainable economic development over medium- to long-term horizons (5-10 years).[10] We augment the IEG project

[6] IEG is an independent unit within the World Bank Group responsible for assessing its programs and activities. All the data used to build the index are available on the website of the Independent Evaluation Group – World Bank Project Performance Ratings: http://ieg.worldbankgroup.org/ratings.

[7] As of August 2022. For the estimations we use the period 2000-2021.

[8] Additional details on the methodology of project evaluations with guidelines for each evaluation step are reported in IEG (2017) and are available at the dedicated web portal: https://ieg.worldbankgroup.org/methodology.

[9] We thus do not incorporate other project categories, including Program-for-Results Financing, Development Policy Financing.

[10] Most of these projects focus on infrastructure, human development, agriculture, and public administration. One should note, however, that, while IPF investment projects are generally associated with physical and social

evaluations dataset with additional project characteristics from the World Bank's Projects and Operations portal data. The resulting dataset includes 4,671 projects covering 146 countries over 2000-2021.

Previous work that used World Bank project data to examine the determinants of project outcomes, includes Ashton et al. (2021), Bulman et al. (2017), Chauvet et al. (2010), Denizer et al. (2013), and Dreher et al. (2013). We build on their work to quantify cross-country heterogeneity in project outcomes while controlling for project-level characteristics. Our aim in this exercise is not to estimate the drivers of project outcomes. Instead, we control for project-specific, sector-specific, and World Bank intervention-induced factors to obtain a residual term which captures country-level factors determinants of project outcome. Formally, we start by estimating the following model:

$$PS_{i,s,c,t} = \boldsymbol{X_{i,s,c,t}}\boldsymbol{\Gamma} + \mu_s + \tau_t + [\beta y_{c,t} + \delta g_{c,t}] + \varepsilon_{i,s,c,t} \qquad (2.1)$$

where $PS_{i,s,c,t}$ is the numeric project outcome score (ranging from 1 to 6) for project i in sector s, country c, and year t; $\boldsymbol{X_{i,c,s,t}}$ is a matrix of project-specific characteristics; $y_{c,t}$ is real per capita GDP, $g_{c,t}$ is real GDP growth in country c, year t (we include these variables to control for the level of economic development and the business cycle effects—the results are robust to estimating the model without $y_{c,t}$ and $g_{c,t}$), μ_s and τ_t are sector and year fixed effects, and $\varepsilon_{i,s,c,t}$ is the error term.

The matrix of project-specific characteristics includes *Project length, Project volume*, *Agreement type, Quality at entry*, and *Quality of supervision.*[11] *Project length* measures the actual duration of the project and ranges between 1 and 20 years, with an average value of 7.6 years. *Project volume* is a categorical variable aimed at measuring the total cost of each project. It includes five categories ranging from less than 10 million USD to over 100 million USD (in the regression, we include a dummy for each of these five categories).

Quality at entry and *Quality of supervision* control for the influence of project-specific monitoring and supervision by the World Bank. The first variable is a numeric six-point indicator ranging from 1 = "Highly unsatisfactory" to 6 = "Highly satisfactory" that reflects the World Bank staff's assessment of the likelihood that the operation would achieve planned development outcomes and align with the Bank's fiduciary responsibilities. The second variable is also a six-point score and reflects the extent to which World Bank staff proactively identified and addressed threats to achieving development outcomes and fulfilling the Bank's fiduciary role. Thus, *Quality at entry*

infrastructure, de facto many of them also envision a mix of spending both on gross fixed capital formation and current expenditures such as technical assistance, reforms, etc. (not necessarily directly related to fixed investment). Therefore, as one of the robustness exercises, we also examine the index based only on IPF projects of the Infrastructure WB Practice Group. However, this significantly limits the project sample (956 projects). Since the version of the index based only on this infrastructure category and our baseline PIQ index that is based on all IPF projects are highly correlated, we proceed with the more robust baseline PIQ index.

[11] We also conduct robustness checks where we also control for project manager (task team leader) effects by including dummy variables or, alternatively, continuous variables measuring work experience and educational attainment of project managers.

and *Quality of supervision* jointly convey the evaluated quality of project implementation and monitoring by the World Bank. Importantly, both of these variables capture the services provided by the World Bank to ensure quality at entry of the project and effective implementation through appropriate supervision rather than the public investment management of the implementing country's authorities. Given that the objective of the PIQ index is to quantify country-specific public investment management quality, we control for these World Bank inputs.

Agreement type reflects the type of legal instrument (signed agreement) associated with the project. It includes the following categories: CARB (Carbon Initiative), GEF (Global Environment Fund), IBRD (International Bank for Reconstruction and Development lending), IDA (International Development Association lending), MONT (Montreal Protocol), RETF (Recipient Executed Trust Fund), and SPF (Special Fund). Most projects in the dataset (86 percent) are IBRD and IDA lending projects. The sector fixed effects control for twelve sectors defined using data from the World Bank Operations Portal and based on the dominant sector of operation in each project.[12]

We use Equation 2.1 to build three versions of the public investment quality index: a time-invariant measure (PIQ-F) and two time-variant measures (PIQ-D and PIQ-Q). To build the first measure, we start by estimating Equation 2.1 using all available data. We then recover the regression's residuals and build the index by computing country averages of the residuals. As mentioned, the idea of the index is to obtain a measure of average country-specific project quality which is orthogonal to project characteristics and World Bank inputs. This procedure is similar to estimating the model with country fixed effects and then using the country fixed effects (which measure country-specific unobserved heterogeneity) as our index of public investment quality. We prefer to use OLS and then average the residuals because this approach is simpler from a computational point of view and reduces potential multicollinearity problems. In any case, fixed effects estimations yield results which are similar to those of the pooled OLS estimates described above (compare columns 1 and 2 of Table 2.1).

Given that our dependent variable is ordinal we also experiment with ordered logit and ordered probit regressions (see columns 5-7 of Table 2.1) and then use the fixed effects or country-level averages of residuals to measure investment quality. Again, the results are similar. However, the non-linear nature of these models and the incidental parameter problem inhibit direct interpretation of the residuals and country fixed effects. Given that our results are robust to different approaches, we use OLS as baseline.

We find that project performance is positively correlated with GDP growth and income per capita (even though income per capita is rarely statistically significant), that larger projects tend to perform better, and so do projects with higher quality at entry and better quality of supervision (see Table 2.1).

To build our baseline time-varying measure of public investment quality (PIQ-D), we estimate Equation 2.1 for rolling 10-year windows over 2000-2021, and then measure average investment

[12] The sectors are: Agriculture; Education; Energy and extractives; Financial sector; Health; Information and Communication Technologies; Industry, trade and services; Public administration; Social protection; Transportation; Water; Other.

quality for the period under consideration using the same procedure described above. For instance, we estimate the model over 2000-2009 to build the index for 2009, use data for 2001-2010 to build the index for 2010, and so on.[13] Note thus that the 2009 index should be interpreted as reflecting average investment quality over the period 2000-2009 and the 2010 index should be interpreted as measuring average investment quality over 2001-2010. There is thus an overlap between the values for 2009 and 2010, and the index behaves like a moving average.

There are two reasons why we use this approach. First, all institutional variables tend to move slowly, and investors interested in assessing sovereign risk will focus on recent past performance. In this sense, the moving average index that we use in our analysis is an appropriate measure of how investors are likely to assess investment quality in each country. Second, year-by-year estimates are unstable because our database only includes an average of 4.5 completed projects for each country-year (the average drops to 3.6 if we exclude China and India) and there are country-years with just one project or no projects at all. In fact, in building our PIQ-D index we only consider country-periods which have at least eight projects.[14]

Our results are robust to using an alternative time-variant measure built by following the steps described above but by using 5-year windows (PIQ-Q). Given that the PIQ-Q index is based on a relatively small number of projects (on average, less than 20 for each 5-year period-country), we only use it to test whether our results are robust to using non-overlapping estimation periods.

In a battery of robustness checks, we also experiment with a measure of investment quality that controls for project manager characteristics. We do this by using two approaches: (i) by including a TTL dummy variables and (ii) by controlling for TTL characteristics, including years of experience and educational attainment.[15] While controlling for TTL characteristics leads to a substantial loss of observations, we find that the baseline PIQ index is highly correlated with the version built using regressions with TTL fixed effects or characteristics (see Annex Table A1 for estimation results and Annex Figure A1 for the correlation between the two indexes).

One possible caveat with our index is that it focuses on World Bank-financed investment projects. There are two potential issues here.

First, it is likely that World Bank monitoring improves the performance of public investment. However, this should not be an issue because we build our index by holding constant World Bank inputs and focus on a residual element which is associated with country-specific project performance. As long as the influence of World Bank monitoring is uncorrelated with country-specific variables which affect public investment performance, our index remains a valid measure of country-specific public investment quality.

[13] Note that we only retain country-years with at least 8 observations of project outcomes in a given period for robustness.

[14] This seems the optimal threshold given the tradeoff between the number of country-years for which the index can be estimated, and the stability of the index based on a sensitivity analysis with alternative thresholds.

[15] Project data on TTLs are obtained from the WB Operations Portal and from Limodio (2021) and Bulman et al. (2015). In all cases, we remove identifying information and numerically code TTL names.

Second, World Bank investment projects may potentially have higher quality in comparison with national investment projects. However, as the same approach is applied to all countries in the sample, our measures are internally consistent and comparable over time and across countries, unless there is a systematic bias in the evaluation of investment projects in some countries relative to others.

2.3. Characteristics of the public investment quality index

Using the procedure described in the previous section we obtain PIQ-F scores for 120 countries (PIQ-F is a cross-sectional index spanning 2000-2021), PIQ-D scores for an unbalanced panel covering up to 107 countries over 2010-2021 (for a total of 898 observations), and PIQ-Q scores for an unbalanced panel of up to 91 countries over 2004-2021 (for a total of 894 observations). The three indexes have similar distributions and are highly correlated with each other (Table 2.2 and Annex Figure A2).

PIQ-F is positively correlated with a set of standard measures of institutional quality and infrastructure development, as well as with the PIMI index (Figure 2.2). The index is significantly correlated with institutional quality measures that reflect regulatory quality and public sector management. The correlation with PIMI is also positive but weaker. This could be attributed to a time mismatch (PIMI primarily relies on data from the 2007-2010 period) and to the fact that, unlike PIQ, PIMI does not control for income per capita and GDP growth.[16]

Figure 2.3 shows the evolution of the correlation between PIQ-D and different measures of institutional quality and public investment management. The solid line shows the slope coefficient of 10-year rolling-window regressions of PIQ-D on different institutional quality and public investment management measures, and the dashed line indicates the corresponding 90-percent confidence intervals. We find that PIQ-D is positively and statistically significantly correlated with PIMI up to 2013. After that the correlation goes to zero and becomes insignificant, which supports the conjecture that PIMI may not be an accurate measure of the quality of public investment management in more recent years. By contrast, PIQ-D index remains positively and significantly correlated with the time-variant measures of institutional quality.

We find that LICs have low investment quality and lag other EMDEs (Figure 2.4).[17] This is consistent with what has been found for other indicators of public sector efficiency (IMF 2015; Dabla-Norris et al. 2012). There is also a large gap between commodity-exporting EMDEs and other EMDEs. In line with the "paradox of plenty," we find that commodity exporters have low PIQ scores.[18] There is also evidence that the gap between rich and poor EMDEs, as well as that between commodity exporters and commodity importers has widened over time (Figure 2.5). Comparing across regions, we find that countries in Sub-Saharan Africa (SSA) and in the Middle

[16] The correlation between PIQ and PIMI is much higher when the number of control variables in the computation of PIQ is minimized and the period spans only the years over which the underlying PIMI data were collected.
[17] This is even though the PIQ indexes are derived while controlling for real per capita GDP. PIQ values obtained without controlling for GDP per capita show even larger differences across income groups.
[18] This is also consistent with the findings in Dabla-Norris et al. (2012).

East and North Africa (MNA) lag other EMDEs. However, there is also significant heterogeneity within country groups. Therefore, the regional averages should be interpreted with caution.

Table 2.1. Drivers of investment project performance

	(1) POLS 2000-21	(2) FE 2000-21	(3) POLS 2000-09	(4) POLS 2012-21	(5) OProbit 2000-21	(6) OProbit FE 2000-21	(7) OLogit 2000-21
Real GDP growth	0.008**	0.004	0.011*	0.003	0.013**	0.005	0.023**
	(0.003)	(0.004)	(0.006)	(0.003)	(0.006)	(0.006)	(0.010)
Real GDP per capita, log	0.025	0.108	0.037	0.024	0.049*	0.207*	0.075
	(0.019)	(0.073)	(0.028)	(0.024)	(0.030)	(0.118)	(0.052)
Project length	0.011*	0.013**	0.006	0.011	0.010	0.013	0.012
	(0.007)	(0.006)	(0.011)	(0.008)	(0.010)	(0.010)	(0.018)
Project vol. 10-25 mn	0.116***	0.130***	0.133**	0.092*	0.175***	0.199***	0.238***
	(0.034)	(0.038)	(0.053)	(0.051)	(0.053)	(0.058)	(0.092)
Project vol. 25-50 mn	0.150***	0.178***	0.194***	0.097	0.234***	0.279***	0.327***
	(0.042)	(0.046)	(0.062)	(0.062)	(0.065)	(0.071)	(0.113)
Project vol. 50-100 mn	0.187***	0.229***	0.257***	0.150**	0.290***	0.358***	0.462***
	(0.039)	(0.045)	(0.060)	(0.061)	(0.060)	(0.069)	(0.106)
Project vol. > 100 mn	0.183***	0.224***	0.208***	0.155**	0.303***	0.365***	0.431***
	(0.050)	(0.058)	(0.060)	(0.065)	(0.079)	(0.093)	(0.140)
Quality at entry	0.374***	0.372***	0.344***	0.450***	0.579***	0.596***	1.076***
	(0.015)	(0.016)	(0.020)	(0.021)	(0.027)	(0.028)	(0.047)
Quality of supervision	0.437***	0.422***	0.394***	0.503***	0.634***	0.637***	1.181***
	(0.014)	(0.014)	(0.020)	(0.022)	(0.027)	(0.027)	(0.052)
Sector FE	yes	yes	yes	yes	yes	yes	yes
Agreement type FE	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes
Country FE	no	yes	no	no	no	yes	no
Observations	4,440	4,440	2,119	1,901	4,440	4,440	4,440
Adj. R-squared	0.560	0.573	0.522	0.620	0.280	0.302	0.290

Source: Authors' estimates.

Note: POLS indicates estimation results using pooled OLS specification (baseline model). FE indicates a specification with country fixed effects (column 2). Specifications for 2000-09 and 2012-21 are reported in columns 3 and 4. OProbit and OLogit indicate ordered probit and ordered logit models. OProbit FE indicates ordered probit with country fixed effects. Standard errors clustered at the country level are in parentheses. *, **, *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively.

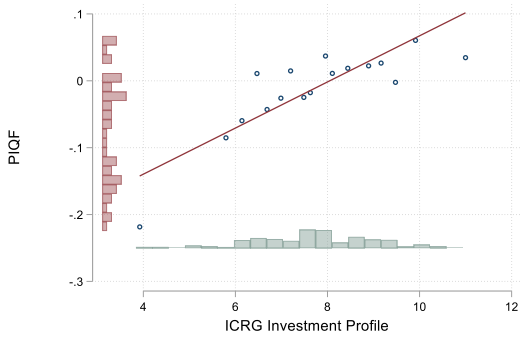
Table 2.2. Summary statistics for the PIQ indexes

Index	Observations	Mean	Std. dev.	Min	Max	Num. of countries	Time span	Projects per country-period, mean
PIQ-F (static)	120	0.003	0.195	-0.600	0.549	120	2000-2021	71
PIQ-D (dynamic)	898	0.003	0.179	-0.651	0.634	107	2009-2021	32-35
PIQ-Q (dynamic)	894	0.004	0.213	-0.847	0.729	91	2004-2021	16-20

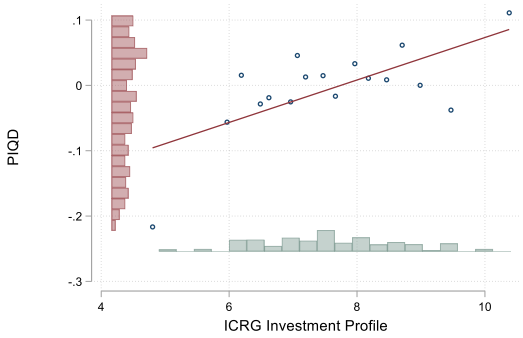
Source: Authors' estimates.

Figure 2.2. Correlation between PIQ and institutional measures

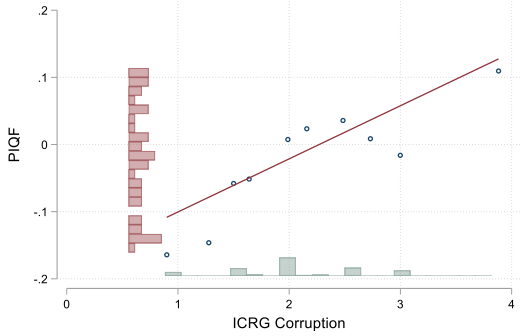
A. PIQ-F vs ICRG Investment Profile Index



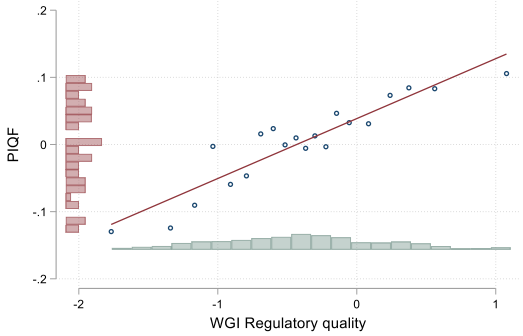
B. PIQ-D vs ICRG Investment Profile Index



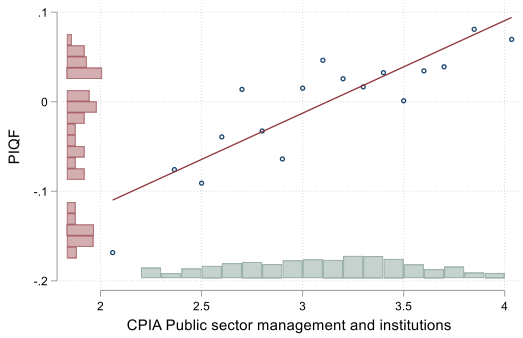
C. PIQ-F vs ICRG Corruption Index



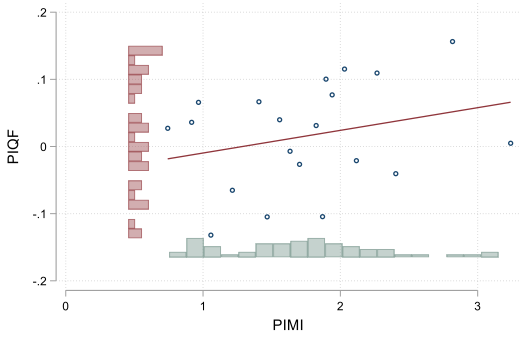
D. PIQ-F vs WGI Regulatory Quality



E. PIQ-F vs CPIA Public Sector Management and Institutions

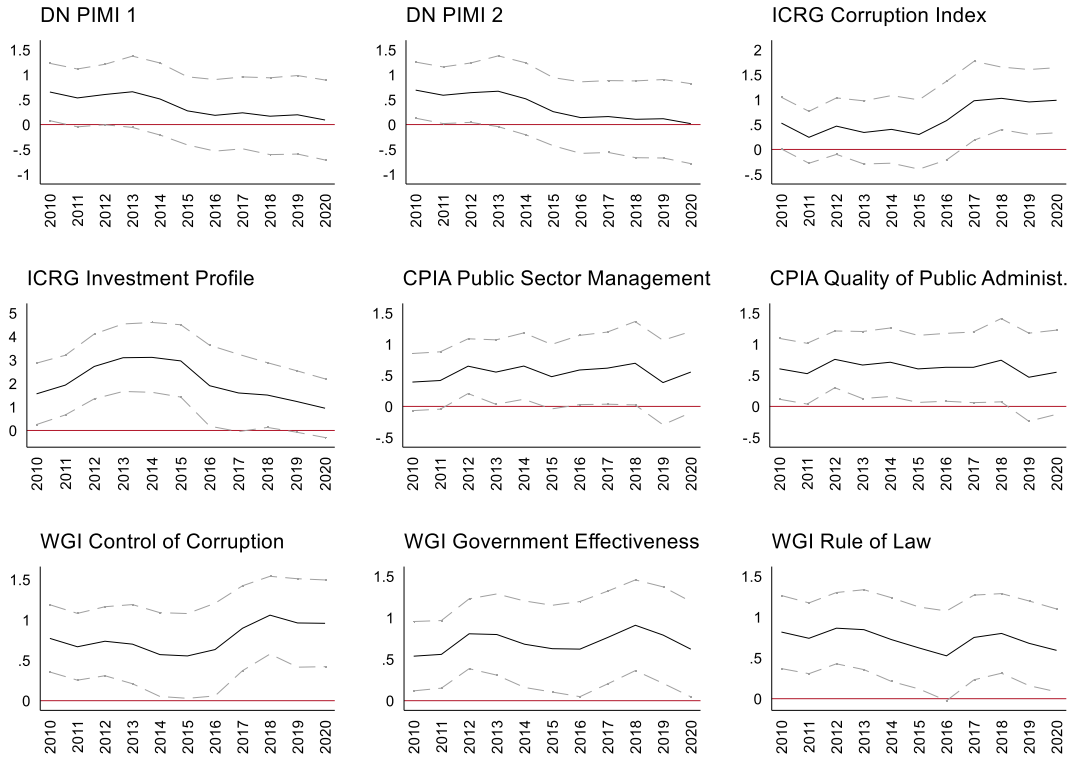


F. PIQ-F vs Dabla-Norris PIMI index



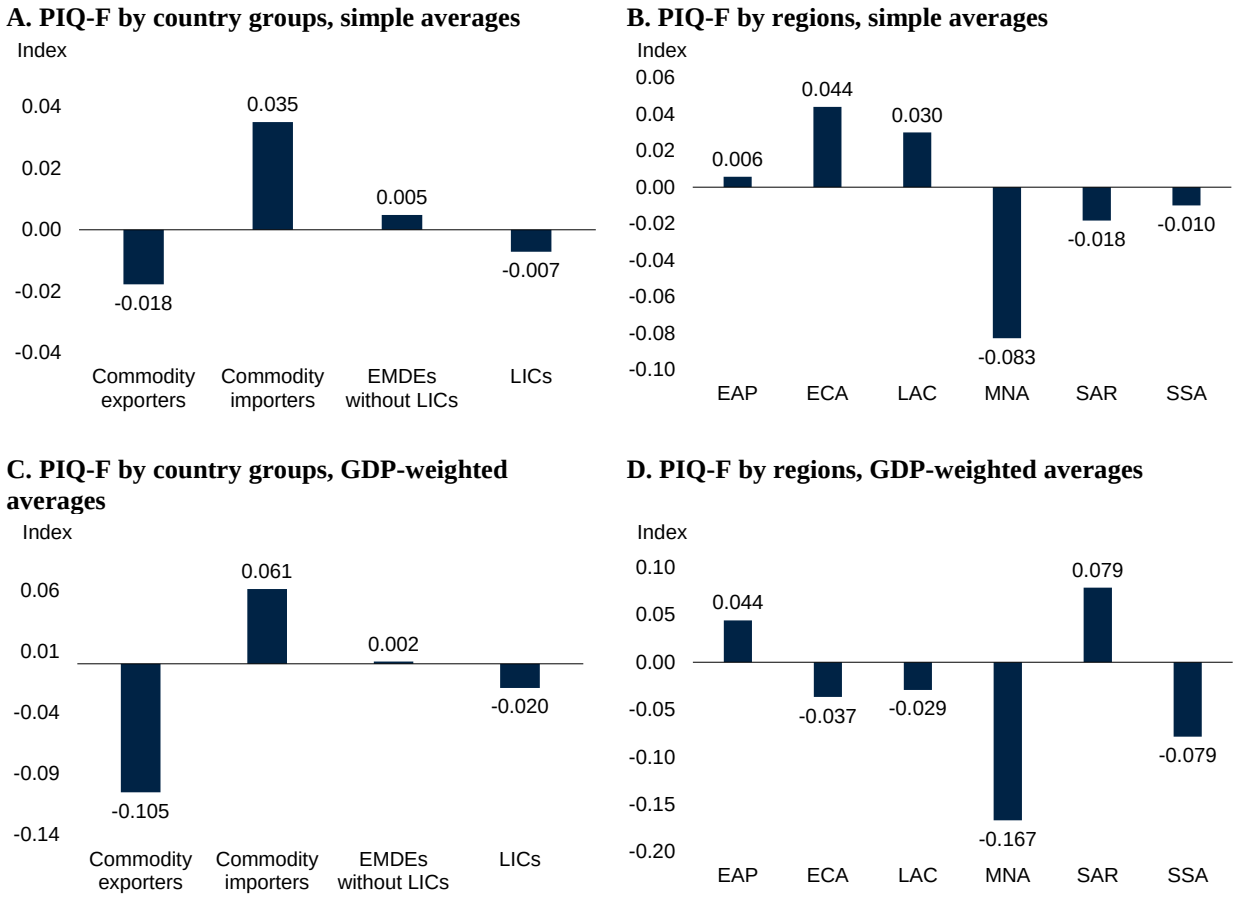
Sources: Authors' estimates; Dabla-Norris et al. (2012); International Country Risk Guide (ICRG); World Bank's Worldwide Governance Indicators (WGI) and Country Policy and Institutional Assessment (CPIA).
Note: The figure shows binned scatterplots with fitted linear regression lines for the 2000-21. A. Sample includes 87 countries. B. Sample includes 78 countries. C. Sample includes 87 countries. D. Sample includes 120 countries. E. Sample includes 76 countries. F. Sample includes 62 countries.

Figure 2.3. Dynamic association of PIQ-D with PIMI and proxy variables



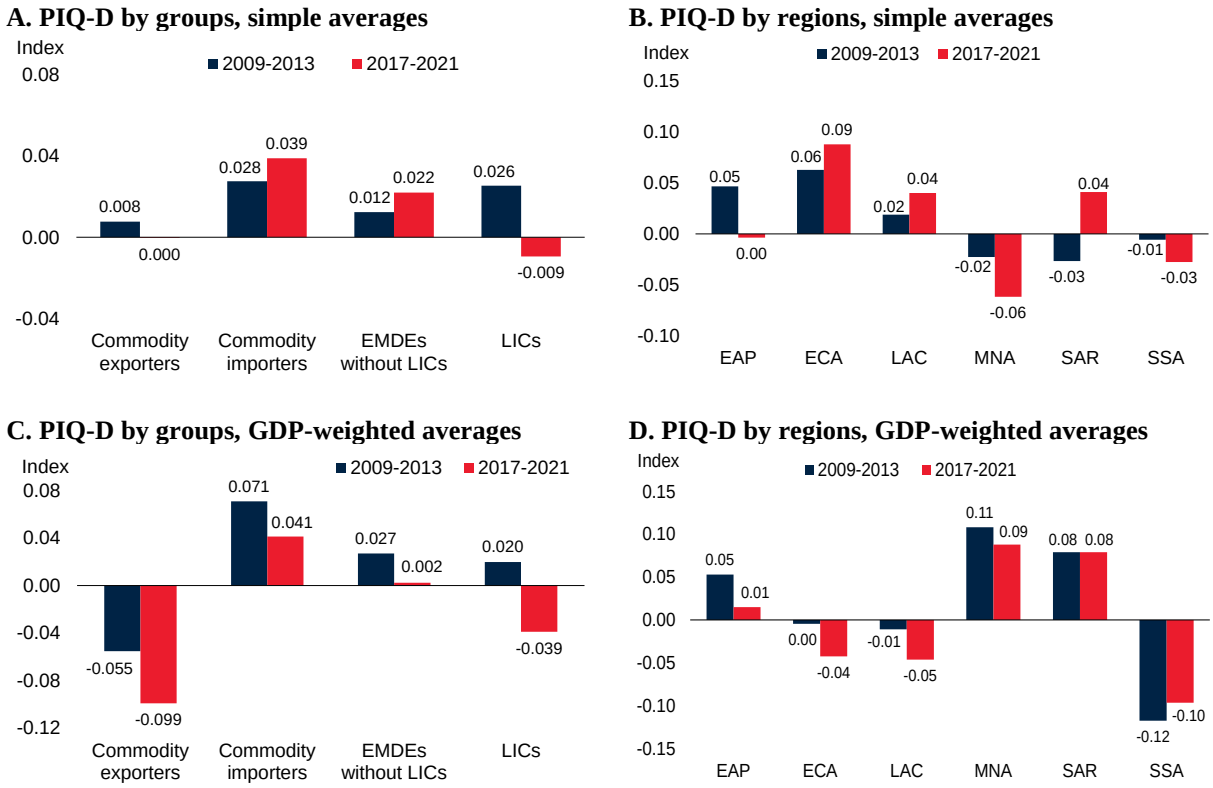
Sources: Authors' estimates; Dabla-Norris et al. (2012); International Country Risk Guide (ICRG); World Bank's Worldwide Governance Indicators (WGI) and Country Policy and Institutional Assessment (CPIA).
Note: Coefficients from 10-year rolling regressions of PIQ-D on the covariates. Dashed lines indicate 90-percent confidence bands.

Figure 2.4. PIQ-F index by EMDE groups and regions



Source: Authors' estimates.
Note: EAP = East Asia and Pacific; EMDEs = emerging market and developing economies; LAC = Latin America and the Caribbean; LICs = low-income countries; MNA = Middle East and North Africa; SAR = South Asia; SSA = Sub-Saharan Africa. Higher index values indicate better public investment quality. PIQ-F index ranges from -0.6 to 0.5. A.C. The sample includes 118 EMDEs: 24 LICs, 73 commodity-exporting EMDEs, and 45 commodity-importing EMDEs. B.D. The sample includes 118 EMDEs, including 8 SAR, 41 SSA, 23 ECA, 11 MNA, 22 LAC, 13 EAP countries. C.D. GDP-weighted averages are based on 2000-21 real GDP.

Figure 2.5. PIQ-D index by EMDE groups and regions



Source: Authors' estimates.
Note: EAP = East Asia and Pacific; EMDEs = emerging market and developing economies; LAC = Latin America and the Caribbean; LICs = low-income countries; MNA = Middle East and North Africa; SAR = South Asia; SSA = Sub-Saharan Africa. Strongly balanced panel of 83 EMDEs. Higher index values indicate better public investment quality. PIQ-D index ranges from -0.7 to 0.6. A.C. The sample includes 51 commodity-exporting EMDEs, 32 commodity-importing EMDEs, and 19 LICs. B.D. The sample includes 8 EAP, 18 ECA, 15 LAC, 7 MNA, 7 SAR, and 28 SSA countries. C.D. GDP-weighted averages are based on real GDP averages over the respective periods.

3. Implications of public investment quality for sovereign risk and debt sustainability

The objective of this section is to test the fiscal implication of public investment quality.

3.1. Conceptual framework

One can envision several transmission channels through which public investment quality may impact public debt sustainability and sovereign risk dynamics in the context of the conventional $(r - g)$ framework. Consider the standard debt dynamic equation:

$$\left[\frac{B}{Y}\right]_t = \frac{(1+r)}{(1+g)}\left[\frac{B}{Y}\right]_{t-1} - pb_t$$

where B and Y are public debt and GDP levels, respectively; r and g are the real interest rate and real output growth rate; and pb is the primary balance as a share of GDP.

Public investment boosts both short-run aggregate demand, and high-quality public investment also boosts long-run aggregate supply via improvements in productivity. Large public investment multipliers for countries with greater public investment efficiency are documented by Adarov (2024), Daude (2011), Furceri and Li (2017), Gupta et al. (2014), Izquierdo et al. (2018), Leduc and Wilson (2012), and Leeper et al. (2010).

There can also be important fiscal transmission channels because scaling up of high-quality public investment may decrease sovereign risk (and the other way around for low quality public investment). Thus, better public investment quality may improve debt sustainability by boosting g and reducing r. There can also be a positive impact on the primary balance because high-quality public investment is likely to yield infrastructure that is less costly to maintain, and vice versa.[19]

3.2. Data and sample

We use the PIQ index to gauge whether public investment quality affects the relationship between public investment and sovereign risk in EMDE countries.[20] We conduct this exercise by using two measures of sovereign risk: sovereign ratings and 5-year CDS spreads.[21]

Sovereign ratings reflect an independent assessment by a credit rating agency of the creditworthiness of a country—the level of credit risk associated with investing in its debt. We focus on the three main rating agencies—Standard and Poor's, Moody's, and Fitch—and source the rating data from Bloomberg.

The three rating agencies that we consider do not express their rating opinions with numerical scores. Ratings are instead communicated with alpha-numeric scores that range between AAA (the highest rating) and D/SD (meaning that a country is in default) for Standard & Poor's and Fitch and between Aaa and C for Moody's. For our empirical analysis, we convert the ratings into a

[19] On the maintenance costs of public capital stock see Kalaitzidakis and Kaylvitis (2005) and Kalyvitis and Vella (2015).
[20] Most of the countries in the PIQ dataset are EMDEs. The only countries classified as advanced economies are Latvia and Lithuania. We do not include these two countries in the analysis of sovereign risk.
[21] For robustness, we also check the results with EMBI spreads.

numerical scale that ranges from 1 to 21, with 1 corresponding to the highest rating ("Aaa" for Moody's and "AAA" for S&P and Fitch) and 21 to the lowest rating. A higher value of the numerical index is thus associated with a worse rating.

An important threshold is that separating investment grade ("BBB-" or higher for Fitch and S&P, and "Baa3" or higher for Moody's) and sub-investment grade countries. In our numerical scale, investment grade countries have a rating of 10 and below. As not all agencies rate all countries, we maximize the number of observations by averaging the ratings of the three agencies for each country-year and only use one or two agencies for countries that are not rated by all three agencies.[22] Table 3.1 reports the correspondence between the alpha-numeric ratings, their numerical counterparts, and our combined numeric sovereign rating.

The data on 5-year CDS spreads are sourced from the World Bank's Fiscal Space database (Kose et al. 2017). Higher spreads convey higher premium demanded by investors, i.e., higher sovereign risk. Out two sovereign risk measures are highly correlated: the correlation between sovereign ratings and the CDS spreads is 0.7 and is statistically significant at the 1-percent level.

Other variables are sourced from various publicly accessible databases. Data on the share of government debt in foreign currency in total government debt is from the World Bank's Fiscal Space database. Data on public investment are from the IMF Investment and Capital Stock Dataset. The measures of institutional development are from the International Country Risk Guide (ICRG), World Bank's Worldwide Governance Indicators (WGI), Country Policy and Institutional Assessment (CPIA), and World Economic Forum (WEF). Most macroeconomic data (general government debt-to-GDP ratio, exchange rate, inflation, foreign reserves as a share of GDP, real GDP growth, per capita GDP, net real ODA received, age dependency ratio, net FDI inflows, foreign trade-to-GDP ratio, current account balance, and total natural resource rents as a share of GDP) are from the World Bank's World Development Indicators (WDI). Data on financial crises are from Laeven and Valencia (2020). Capital account openness data are sourced from the most recent update of Chinn and Ito (2006). Summary statistics for the variables used in the estimations are reported in Annex Table A2.

On average, EMDEs exhibit higher sovereign risk compared to advanced economies. However, there is significant heterogeneity within both country groups (Figure 3.1). Sovereign risk in low-income countries is significantly higher than in middle-income and high-income countries. Among EMDEs, except for the majority of high-income ones, sovereign ratings generally fall within the speculative rating range (10-21 on our combined scale). If we exclude the Middle East and North Africa (MNA), all EMDE regions have average sovereign ratings above 10, indicating elevated risk (Figure 3.2). In recent years, sovereign risk has increased in all EMDE groups.[23]

[22] This averaging procedure does not generate any source of bias because the correlation between the ratings of the three agencies is well above 90 percent.

[23] We measure sovereign risk with yearly average. Note that we follow Combes et al. (2021) and use the log of CDS spreads. Taking logs helps in downplaying the role of outliers in the heavily skewed distribution of spreads and in addressing heteroscedasticity issues in the CDS spreads data.

3.3. Estimation results

Sovereign risk reflects the perception by market participants or rating agencies of the ability of a government to fully meet its debt obligations. As these perceptions are influenced by a variety of socio-economic factors, we estimate how public investment quality affects the relationship between public investment and sovereign risk while controlling for a large number of variables that have been found to be associated with sovereign risk.

As mentioned, we expect that higher levels of public investment will increase sovereign risk in countries with low investment quality and reduce sovereign risk in countries with high investment quality. To test this hypothesis, we estimate the following model:

$$SR_{c,t} = \alpha + PINV_{c,t}\left(\beta + \gamma PIQ_{c,t}\right) + \delta PIQ_{c,t} + \boldsymbol{X_{c,t-1}\Theta} + \tau_t + \rho_c + \varepsilon_{c,t} \qquad (3.1)$$

where $SR_{c,t}$ is sovereign risk in country c, year t, $PINV_{c,t}$ is public investment over GDP in country c year t, $PIQ_{c,t}$ is the public investment quality index for country c year t (either the static index PIQ-F or the dynamic index PIQ-D), $\boldsymbol{X_{c,t-1}}$ is a matrix of country-year controls (all lagged to attenuate simultaneity), τ_t are year fixed effects, and ρ_c are either region or country fixed effects.[24] As mentioned, we use two measures of sovereign risk: sovereign ratings and the log of 5-year CDS spreads.

In the set-up of Equation 3.1, our main parameter of interest is γ. This interactive term measures how the relationship between public investment varies with public investment quality. Given that our dependent variable is increasing in sovereign risk, we expect to find a negative value of γ, indicating that public investment is positively associated with sovereign risk when the quality of public investment is low and negatively associated with sovereign risk when the quality of public investment is high. Note that PIQ's average value is close to zero. Hence, in the set up of Equation 3.1, the parameter β shows the correlation between public investment and sovereign risk for the country with an average level of investment quality. We also center the public investment variable by subtracting its sample mean (0.07). Thus, the parameter δ indicates the correlation between

[24] The list of control variables includes: general government gross debt (percent of GDP), total reserves (percent of GDP), log of exchange rate (LCU per USD, period average), CPI inflation, real GDP growth, real GDP per capita (constant 2015 USD, log), current account balance (percent of GDP), Laeven-Valencia financial crisis dummy variables (systemic banking crisis, currency crisis, debt crisis, and debt restructuring), private credit as a share of GDP, natural resource rents (percent of GDP), log of real net ODA received, Chinn-Ito financial openness index, foreign trade (percent of GDP), net FDI inflows (percent of GDP). As the sample for which we have CDS data is smaller than the sample for which we have credit ratings data, we try to preserve observations by reducing the number of controls in baseline parsimonious specifications and show that the results are robust to using the full set of controls. We also check that collinearity is not an issue (the correlation matrix is reported in Table A5). The reverse causality from sovereign risk to public investment is also not a concern: the correlation between sovereign risk measures and public investment ratio is low, and regressions of public investment ratio on sovereign risk, controlling for other variables in the specification, also does not yield a statistically significant effect of sovereign risk on public investment.

sovereign risk and public investment quality for the country-year with an average level of public investment.

We start with a parsimonious specification which only includes year fixed effects and a subset of controls which allow us to estimate the model for a large sample of country-years. Columns 1 and 2 of Table 3.1 use PIQ-F and show that higher levels of public investment are associated with lower sovereign risk for countries with average public investment quality (however, the coefficient is only statistically significant in the CDS spreads regression of column 1) and that higher investment quality is associated with lower sovereign risk. More interesting for our purposes is the interactive coefficient which supports our hypothesis that public investment has a large negative effect on sovereign risk in countries with higher values of the PIQ index.

The top two panels of Figure 3.3 plot the relationship between sovereign risk and public investment at different values of the PIQ index. They show that an increase in public investment is associated with higher sovereign risk in countries with low values of the PIQ index, and with a lower sovereign risk in countries with high values of the PIQ index. The point estimates indicate that a one-standard-deviation increase in public investment as a share of GDP is associated with a 3 notches downgrade in the sovereign rating and a 3.4 percent increase in CDS spreads for countries with the lowest possible value of the PIQ index. Conversely, a one-standard-deviation increase in public investment as a share of GDP is associated with an upgrade by almost 4 notches and a reduction in CDS spreads by 5.2 percent for countries with the highest value of the PIQ index.

Another way to describe how PIQ affects the relationship between public investment and sovereign risk is through a heatmap that shows sovereign risk predictive margins for all possible combinations of public investment and PIQ (see Figure 3.4 which is based on the first two columns of Table 3.1). Consider, for instance, the left panel of Figure 3.4 and move vertically starting from a point with low PIQ (-0.4). The figure shows that, for low levels of public investment, sovereign risk is at its average value, and as public investment increases sovereign risk also increases. If we are instead at average levels of PIQ (say 0.0), the increase in public investment has no effect on sovereign risk. Finally, for countries with high values of PIQ (say, 0.04), sovereign risk decreases as public investment increases.

We could also consider horizontal movements in the figure. We find that when public investment is low, PIQ does not matter for sovereign risk. However, when public investment is greater than 10 percent of GDP, sovereign risk decreases with investment quality. Finally, if we move along the main diagonal of the figure (a joint increase of public investment and investment quality) we observe a decrease in sovereign risk. The same happens if we move along the opposite diagonal (a decrease in public investment and an increase in investment quality). Summing up, scaling up of public investment with low public investment quality increases sovereign risk and leads to near-default when public investment levels reach 20 percent of GDP.[25] By contrast, public investment increases for high-PIQ countries lead to a reduction in sovereign risk. For low levels of public investment and for PIQ levels around the sample mean the sensitivity of sovereign risk to changes in either of the variables is negligible.

[25] Taking into account the global mean of 0.07 as the public investment variable is centered in the model.

In columns 3-4 of Table 3.1, we use the dynamic version of the public investment quality index (PIQ-D), in columns 5-8 we use a richer set of controls, and in columns 9-10 we estimate the model without the interaction between public investment and investment quality. The bottom three panels of Figure 3.3 show that our baseline results are robust to using the dynamic version of the index and to augmenting the model with a richer set of controls. When we estimate Equation 3.1 without the interaction term (columns 9-10), we find that both main effects (β and δ in Equation 3.1) are negative and statistically significant when we measure sovereign risk with CDS spreads. However, only public investment quality is statistically significant in the specification with sovereign rating.

Next, we estimate models similar to those reported in Table 3.1 controlling for both year and either region or country fixed effects.[26] The results for the models with region fixed effects are almost identical to those that only include year fixed effects (compare columns 1-2 and 5-6 of Table 3.2 with the corresponding columns in Table 3.1; see also Figure 3.5).[27] The results for models that include country fixed effects are qualitatively similar (columns 3-4 and 7 of Table 3.2). However, the interaction coefficient is not always statistically significant at conventional levels (this is especially the case when we measure sovereign risk with credit ratings). This is not unexpected given the limited within-country variation of investment quality. It is however worth noting that, even with country fixed effects, the relationship between sovereign risk and public investment is negative and statistically significant for high values of the PIQ index (see panels 3 and 6 of Figure 3.5).

Investment grade vs non-investment grade countries

As sovereign risk tends to react more to investors' sentiment in countries with weak fundamentals (Al-Amine and Willems 2023), we expect that the effect of public investment quality on the relationship between public investment and sovereign risk should be particularly important for countries with precarious creditworthiness.

To explore this possibility, we estimate our baseline CDS spread model by splitting our full sample into investment grade country-years (230 observations in the regressions that use PIQ-F and 95 observations in the regressions that include PIQ-D) and non-investment grade country-years (278 observations in the regressions that use PIQ-F and 128 observations in the regressions that include PIQ-D).

We find that the interaction between public investment and the PIQ index is negative and statistically significant in the non-investment grade sample for both versions of the PIQ index (columns 1B and 2B of Table 3.3). For the investment grade subsample, we find that higher public investment is associated with lower spreads (the coefficient, however, is not always statistically significant) but that investment quality does not matter for the relationship between public investment and CDS spreads (columns 1A and 2A of Table 3.3).

[26] We use the following regions: East Asia and Pacific (EAP), Europe and Central Asia (ECA), Latin America and the Caribbean (LAC), Middle East and North Africa (MNA), South Asia (SAR), and Sub-Saharan Africa (SSA).

[27] Note that these models can only be estimated using the dynamic index PIQ-D as PIQ-F is collinear with country fixed effects. Debt restructuring dummy variable drops out for CDS spread regressions with fixed effects.

Figure 3.6 illustrates the importance of investment quality for sub-investment grade countries and the lack of such an effect for investment grade countries. A comparisons of panels 2B of Figure 3.6 with panel 3 of Figure 3.5 shows that the estimates for the non-investment grade subsample are more precisely estimates and have a steeper slope, implying a stronger effect of investment quality in the sub-investment grade subsample than in the full sample of Table 3.2.

Robustness checks.

We check whether our results are robust to using alternative estimation frameworks and measures of investment quality.

As a first step, we re-estimate our baseline model using the Mundlak-Chamberlain correlated random effects. This model yields estimates consistent with the fixed effects model while allowing for time-invariant covariates, which, inter alia, enables us to examine the direct impact of the PIQ-F index. Columns 1 and 2 of Annex Table A3 and associated marginal effects in Figure A3 show that PIQ-F has a negative and statistically significant impact on sovereign risk, although the non-linear effect is not as strong in the case of sovereign ratings.

Next, we show that our baseline results are robust to dropping outliers (columns 3-4 of Table A3 and associated panels of Figure A3). Outliers here are defined as observations with values exceeding two standard deviations from the mean for public investment-to-GDP ratio, the PIQ index, and the sovereign risk measure used in the model.

We also show that the results are robust to using the Emerging Markets Bond Index (EMBI) spread as an alternative measure of sovereign risk (columns 5-6 of Table A3), as well as to using ordered logit and ordered probit with year fixed effects as an alternative estimator for the sovereign rating variable (columns 7-8 of Table A3).

Finally, we re-estimate our baseline models using the index computed over a 5-year estimation window (PIQ-Q). One advantage of the PIQ-Q index is that it allows us to use a panel with non-overlapping periods (we can only do this for sovereign rating because the spreads data do not have sufficient time-variation). While PIQ-Q is based on a smaller number of projects, it produces results that are fully in line with our baseline (see Columns 1-4 of Table A4 and panels 1-4 of Figure A4). Columns 5 and 6 of Table A4 and the corresponding panels of Figure A4 show that our results are robust (in fact, they become stronger) when we use non-overlapping periods.

3.4. Implications for public debt sustainability

As a final empirical exercise, we test whether public investment quality affects the relationship between public investment and the evolution of the public debt-to-GDP ratio. Specifically, we compute impulse responses through a local projections model estimated separately for high- and low-PIQ countries. Formally, we estimate the following model:

$$\left[D_{c,t+k} - D_{c,t-1}\right] = \beta_k DPINV_{c,t} + \boldsymbol{X_{c,t}\Omega} + \tau_t + \rho_c + \varepsilon_{c,t} \qquad (3.2)$$

where $[D_{c,t+k} - D_{c,t-1}]$ is the difference in public debt as a percentage of GDP between year $t+k$ and year *t-1* (with k = *0-10)* for country c; $DPINV_{c,t}$ is the change in public investment as a percentage of GDP in country c, year t, $\boldsymbol{X_{c,t}}$ is a matrix of country-year control variables, including real GDP growth, inflation, sovereign rating, the primary balance as a percentage of GDP, and the change in the ratio of general government final consumption to GDP; τ_t are year fixed effects, and ρ_c are country fixed effects.

In order to have a clear separation between low- and high-investment quality countries, we estimate Equation 3.2 by only including countries with a value of PIQ-F which is either one-standard deviation above the sample mean (this is the high-investment quality sub-sample with the value of PIQ-F greater than 0.2) or one-standard deviation below the sample mean (this is the low-investment quality sub-sample with the value of PIQ-F smaller than -0.2).[28]

The top panels of Figure 3.7 report the results and show that in high-investment-quality countries an increase in public investment leads to a reduction in debt ratios, but the effect is not statistically significant (top left panel). This result indicates that in countries with high investment quality, public investment "funds itself." This effect arises as a result of a decrease in sovereign risk and lower cost of borrowing that we describe in the previous section, and the positive impact on economic growth via both demand and supply channels as the public spending multiplier is greater for countries with higher spending efficiency (Abiad et al. 2016; Adarov 2024; Furceri and Li 2017).

In low-investment-quality countries, instead, higher levels of public investment are associated with higher debt ratios, with the effect becoming more statistically significant over time (especially after 7 years). Besides the adverse effects of low-quality public investment on borrowing costs described above, this result may reflect the continuously increasing fiscal burden of upkeeping less productive or lower-quality public assets.

One challenge related to the estimation of Equation 3.2 is endogeneity. For instance, the expected future path of public debt may influence public investment decisions. Alternatively, there might be an unobserved variable that jointly determines public investment and the evolution of the debt-to-GDP ratio. Although it is not obvious how these endogeneity concerns could bias the different responses in high- and low-investment quality countries documented in the top panels of Figure 3.7, we take endogeneity seriously and instrument public investment in the local projections model with a shock identified in an ancillary VAR model.[29]

We proceed as follows. As a first step, we estimate a panel VAR model that includes public investment-to-GDP, real GDP growth, inflation, the current account balance, and country and time fixed effects.[30] We then recover the model's shocks using the identification approach first

[28] These threshold levels also correspond to the values of PIQ-F beyond which one can see the non-linear effects on sovereign risk manifesting themselves strongly (see, for instance, Figure 3.4).

[29] In this regard, we resort to local projections with external instruments (LP-IV) approach. See Stock and Watson (2018) for the general treatment of LP-IV and Barnichon et al. (2022) for a recent application to the analysis of public spending multipliers.

[30] The time fixed effects are included by subtracting panel means to implicitly control for common shocks.

suggested by Blanchard and Perotti (2002) and use this shock as instrument for the local projection estimates.[31]

The bottom panels of Figure 3.7 show the results obtained by estimating the local projections model (Equation 3.2) with instrumented public investment. These results corroborate our previous finding that scaling up of public investment leads to an increase of fiscal space in countries with high-quality public investment and reduces fiscal space in countries with low-quality public investment. The only difference with respect to the original local projections model is that we now find that the reduction in the debt-to-GDP ratio in high-quality public investment countries is statistically significant at various horizons, while the debt-to-GDP ratio in low-quality public investment countries is not always statistically significant. The results are in line with expectations and limited evidence available from the literature, which also finds that debt-to-GDP ratio in countries with high investment efficiency tends to decline more than in countries with low efficiency (see, for instance, estimates using the local projections framework in Abiad et al. 2016, or the modeling results in IMF 2014).[32]

As a final robustness check, we also experiment by instrumenting public investment with the residual of a regression of the change in public investment-to-GDP ratio on real GDP growth and output growth forecasts at horizons of up to 5 years. Controlling for forecasts alleviates possible fiscal foresight effects brought about by the fact that public investment innovations may incorporate information on anticipated future macroeconomic conditions. The results of this robustness check are also in line with the baseline results: public investment shocks improve debt sustainability for high PIQ quality countries, with more pronounced effects at the horizon of up to 5 years, and worsen debt sustainability for low PIQ countries with the effect gradually increasing over time both in terms of the magnitude and statistical significance (see Annex Figure A5).

[31] Blanchard-Perotti (2002) approach identifies government spending shocks by assuming that government spending is predetermined and does not respond contemporaneously to the macroeconomic stance. This is implemented by ordering government spending first in a PVAR model identified with a Cholesky decomposition. Born and Müller (2012) show that this approach can also be applied to annual-frequency data. As this approach is vulnerable to possible anticipation effects, we also use an alternative instrument that controls for growth forecasts.

[32] In particular, in IMF (2014) model-based simulations for advanced economies, EMDEs and low-income countries suggest that public investment may lead to higher debt-to-GDP ratios on account of lower efficiency of investment. In Abiad et al. (2016), public investment reduces debt-to-GDP ratio in countries with high public investment efficiency, they tend to increase the debt-to-GDP ratio in countries with low public investment efficiency.

Table 3.1. Sovereign risk ratings

Moody's	Moody's numeric	S&P	S&P numeric	Fitch	Fitch numeric	Rating description	Combined numeric sovereign rating	Investment grade
Aaa	1	AAA	1	AAA	1	Prime	1	yes
Aa1	2	AA+	2	AA+	2	High grade	2	yes
Aa2	3	AA	3	AA	3	High grade	3	yes
Aa3	4	AA−	4	AA−	4	High grade	4	yes
A1	5	A+	5	A+	5	Upper medium grade	5	yes
A2	6	A	6	A	6	Upper medium grade	6	yes
A3	7	A−	7	A−	7	Upper medium grade	7	yes
Baa1	8	BBB+	8	BBB+	8	Lower medium grade	8	yes
Baa2	9	BBB	9	BBB	9	Lower medium grade	9	yes
Baa3	10	BBB−	10	BBB−	10	Lower medium grade	10	yes
Ba1	11	BB+	11	BB+	11	Non-investment grade	11	no
Ba2	12	BB	12	BB	12	Non-investment grade	12	no
Ba3	13	BB−	13	BB−	13	Speculative	13	no
B1	14	B+	14	B+	14	Highly speculative	14	no
B2	15	B	15	B	15	Highly speculative	15	no
B3	16	B−	16	B−	16	Highly speculative	16	no
Caa1	17	CCC+	17	CCC+	17	Substantial risks	17	no
Caa2	18	CCC	18	CCC	18	Substantial risks	18	no
Caa3	19	CCC−	19	CCC−	19	Substantial risks	19	no
Ca	20	CC	20	CC	20	Extremely speculative	20	no
		C	21	C	21	Default imminent	21	no
C	21	RD	22	RD	22	In default	21	no
		SD	23	D	23	In default	21	no
		D	24			In default	21	no

Source: Authors' elaboration based on the information from Moody's, S&P, and Fitch.

Table 3.1. Implications of public investment quality for sovereign risk, baseline results

	1 CDS spread	2 Sov. rating	3 CDS spread	4 Sov. rating	5 CDS spread	6 Sov. rating	7 CDS spread	8 Sov. rating	9 CDS spread	10 Sov. rating
Public investment (share of GDP)	-3.502**	-9.094	-0.298	-15.747**	-3.230**	-1.516	-2.172	-1.646	-4.074**	-10.230
	(1.312)	(5.837)	(2.076)	(7.795)	(1.488)	(4.073)	(2.319)	(4.228)	(1.860)	(7.366)
PIQ-F	-2.243***	-4.873***			-2.135**	-4.089***	-2.223**	-3.806***	-1.325**	-3.150**
	(0.458)	(1.342)			(0.887)	(1.142)	(0.960)	(1.306)	(0.604)	(1.281)
PIQ-F × Public investment (share of GDP)	-41.380***	-101.536***			-35.411***	-61.697**	-44.724**	-65.726**		
	(6.477)	(36.239)			(9.612)	(28.476)	(18.226)	(28.139)		
PIQ-D			-1.628**	-1.896**						
			(0.770)	(0.875)						
PIQ-D × Public investment (share of GDP)			-34.653*	-56.456***						
			(18.180)	(19.565)						
General government gross debt, percent of GDP	0.009***	0.030***	0.009***	0.027**	0.009***	0.035***	0.013***	0.032***	0.010***	0.029***
	(0.002)	(0.009)	(0.003)	(0.012)	(0.003)	(0.008)	(0.004)	(0.007)	(0.002)	(0.008)
Total reserves (percent of GDP)	-0.004	-0.018	-0.002	-0.006	-0.003	-0.001	-0.008	-0.003	-0.006	-0.024
	(0.004)	(0.015)	(0.005)	(0.016)	(0.005)	(0.014)	(0.006)	(0.015)	(0.004)	(0.017)
Exchange rate (LCU per USD), log	-0.035	0.016	-0.027	-0.072	-0.029	0.039	-0.019	0.034	-0.029	-0.003
	(0.023)	(0.084)	(0.030)	(0.091)	(0.022)	(0.075)	(0.027)	(0.073)	(0.026)	(0.085)
Inflation, consumer prices (percent)	0.042***	0.082***	0.062***	0.041	0.040**	0.047**	0.062***	0.047**	0.040***	0.078***
	(0.013)	(0.018)	(0.017)	(0.036)	(0.018)	(0.018)	(0.021)	(0.020)	(0.014)	(0.019)
Real GDP growth (percent)	-0.029*	-0.051	-0.039**	-0.131***	-0.017	-0.037	-0.019	-0.029	-0.029*	-0.056
	(0.015)	(0.035)	(0.016)	(0.045)	(0.018)	(0.035)	(0.024)	(0.036)	(0.015)	(0.037)
Real GDP per capita, log	-0.661***	-2.173***	-0.409*	-2.438***	-0.583**	-1.605***	-0.544**	-1.479***	-0.597***	-2.047***
	(0.191)	(0.305)	(0.220)	(0.340)	(0.247)	(0.373)	(0.220)	(0.401)	(0.193)	(0.317)
Current account balance (percent of GDP)	-0.007	-0.062**	-0.029**	-0.084**	-0.019	-0.059***	-0.030*	-0.058**	-0.001	-0.057**
	(0.010)	(0.024)	(0.013)	(0.036)	(0.015)	(0.017)	(0.017)	(0.024)	(0.011)	(0.024)
Systemic banking crisis DV	1.004***	0.606	1.072*	1.123	1.582***	1.574*	1.359***	1.511*	0.923***	0.476
	(0.317)	(0.671)	(0.563)	(0.817)	(0.334)	(0.804)	(0.398)	(0.764)	(0.291)	(0.630)
Currency crisis DV	0.269	0.292	0.158	-0.074	0.187	0.126	0.080	0.347	0.150	0.043
	(0.193)	(0.407)	(0.259)	(0.366)	(0.179)	(0.409)	(0.224)	(0.411)	(0.174)	(0.451)
Debt crisis DV	1.090	3.395**	1.640	3.478	1.573	3.278***	0.587	2.065**	1.041	3.715**
	(0.785)	(1.305)	(1.055)	(2.105)	(1.056)	(0.987)	(1.283)	(0.946)	(0.776)	(1.441)
Debt restructuring DV	1.016***	2.079*		1.468	0.899**	1.621**	0.807**	1.674**	0.950***	2.183*
	(0.340)	(1.075)		(2.346)	(0.343)	(0.802)	(0.383)	(0.681)	(0.343)	(1.219)
Domestic credit to private sector, percent of GDP					-0.004	-0.037***	-0.003	-0.044***		
					(0.002)	(0.009)	(0.004)	(0.007)		
Total natural resources rents (percent of GDP)					0.001	-0.009	0.010	-0.010		
					(0.010)	(0.020)	(0.018)	(0.022)		
Real net ODA received, log					-0.056	-0.361*	-0.054	-0.118		
					(0.069)	(0.204)	(0.073)	(0.202)		
Chinn-Ito KA index							-0.001	0.022		
							(0.070)	(0.115)		
Trade (percent of GDP)							0.003	0.020***		
							(0.004)	(0.006)		
FDI, net inflows (percent of GDP)							-0.007	-0.051**		
							(0.026)	(0.024)		
Constant	10.485***	28.481***	8.357***	31.289***	11.152***	32.576***	10.244***	25.868***	9.971***	27.689***
	(1.745)	(2.503)	(2.019)	(2.766)	(3.237)	(6.029)	(2.908)	(6.642)	(1.744)	(2.539)
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	508	1,072	225	490	373	925	331	861	508	1,072
Adj. R-sq	0.556	0.538	0.590	0.572	0.567	0.607	0.587	0.660	0.530	0.515

Source: Authors' estimations.
Note: *, **, *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively. Country-level clustered standard errors are in parentheses.

Table 3.2. Estimation results with region and country fixed effects

	1 CDS spread	2 CDS spread	3 CDS spread	4 CDS spread	5 Sov. rating	6 Sov. rating	7 Sov. rating
Public investment (share of GDP)	-0.747	-0.919	-3.471	-4.501	-5.628	-13.788**	-15.551***
	(1.743)	(2.127)	(3.283)	(3.563)	(4.825)	(5.812)	(5.240)
PIQ-F	-1.833***	-1.976***			-3.623**		
	(0.434)	(0.596)			(1.388)		
PIQ-F × Public investment (share of GDP)	-21.312**	-23.865**			-72.451**		
	(9.708)	(11.412)			(36.133)		
PIQ-D			-0.540	-0.980		-2.169**	-0.693
			(0.745)	(0.719)		(0.875)	(0.765)
PIQ-D × Public investment (share of GDP)			-29.189	-43.299*		-47.036**	-8.420
			(21.517)	(22.455)		(22.001)	(18.148)
General government gross debt, percent of GDP	0.010***	0.014**	0.010	0.017	0.045***	0.049***	0.049***
	(0.004)	(0.006)	(0.011)	(0.012)	(0.008)	(0.010)	(0.010)
Total reserves (percent of GDP)	0.002	-0.001	-0.019*	-0.012	-0.018	-0.017	-0.039*
	(0.004)	(0.004)	(0.009)	(0.010)	(0.014)	(0.015)	(0.020)
Exchange rate (LCU per USD), log	-0.008	0.017	1.164*	1.300***	0.101	0.045	1.382***
	(0.024)	(0.035)	(0.570)	(0.457)	(0.095)	(0.098)	(0.513)
Inflation, consumer prices (percent)	0.040***	0.036***	0.010	0.002	0.082***	0.057	-0.014
	(0.012)	(0.013)	(0.011)	(0.013)	(0.018)	(0.038)	(0.017)
Real GDP growth (percent)	-0.021	0.010	-0.019	-0.009	-0.007	-0.021	-0.004
	(0.013)	(0.016)	(0.011)	(0.010)	(0.025)	(0.036)	(0.017)
Real GDP per capita, log	-0.960***	-1.026***	-1.568**	-1.206	-2.807***	-3.035***	-4.537***
	(0.242)	(0.291)	(0.706)	(0.862)	(0.310)	(0.407)	(1.053)
Current account balance (percent of GDP)	0.001	0.006	-0.032***	-0.029***	-0.033*	-0.044	-0.006
	(0.008)	(0.016)	(0.009)	(0.008)	(0.018)	(0.027)	(0.013)
Systemic banking crisis DV	0.903***	1.110***	1.404***	1.447**	0.260	0.355	0.478
	(0.242)	(0.217)	(0.374)	(0.616)	(0.604)	(0.837)	(0.361)
Currency crisis DV	0.247	0.149	-0.234	-0.130	0.451	-0.027	0.154
	(0.191)	(0.135)	(0.153)	(0.174)	(0.389)	(0.377)	(0.178)
Debt crisis DV	0.888	0.906	1.664**	1.787*	2.524*	2.935	1.096***
	(0.731)	(0.756)	(0.727)	(0.874)	(1.428)	(2.236)	(0.381)
Debt restructuring DV	0.884***	0.839***			1.614	0.855	-0.579
	(0.263)	(0.214)			(1.060)	(2.946)	(0.597)
Domestic credit to private sector, percent of GDP		-0.001		-0.000			
		(0.003)		(0.007)			
Total natural resources rents (percent of GDP)		-0.005		0.025			
		(0.010)		(0.017)			
Real net ODA received, log		-0.096		0.031			
		(0.076)		(0.059)			
Constant	12.888***	15.173***	14.749**	9.349	32.664***	34.616***	42.851***
	(2.062)	(3.440)	(6.378)	(7.777)	(2.585)	(3.245)	(8.664)
Region FE	yes	yes	no	no	yes	yes	no
Country FE	no	no	yes	yes	no	no	yes
Year FE	yes	yes	yes	yes	yes	yes	yes
Observations	508	373	224	173	1,072	490	486
Adj. R-sq	0.600	0.628	0.854	0.869	0.598	0.634	0.942

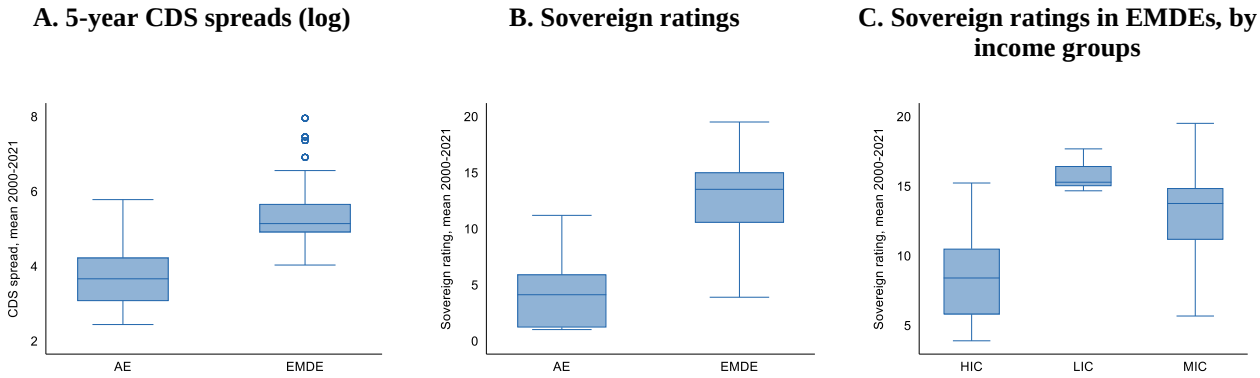
Source: Authors' estimations.
Note: *, **, *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively. Country-level clustered standard errors are in parentheses.

Table 3.3. Estimation results with investment-grade and non-investment grade samples

Dep. var. = CDS spread, log	1A	1B	2A	2B
	Investment grade	Non-investment grade	Investment grade	Non-investment grade
Public investment (share of GDP)	-1.470	-1.116	-5.233*	-8.919**
	(1.660)	(2.103)	(2.750)	(3.537)
PIQ-F	-0.647	-2.875***		
	(0.534)	(0.963)		
PIQ-F × Public investment (share of GDP)	-4.150	-35.450***		
	(18.991)	(10.700)		
PIQ-D			0.144	-0.930
			(0.508)	(0.650)
PIQ-D × Public investment (share of GDP)			9.463	-57.489**
			(15.494)	(25.532)
General government gross debt, percent of GDP	-0.000	0.008**	0.005	0.005
	(0.003)	(0.003)	(0.009)	(0.011)
Total reserves (percent of GDP)	-0.002	-0.013	-0.005	-0.015
	(0.005)	(0.008)	(0.009)	(0.010)
Exchange rate (LCU per USD), log	-0.026	-0.020	0.019	1.322**
	(0.026)	(0.028)	(0.361)	(0.616)
Inflation, consumer prices (percent)	0.067***	0.025**	-0.011	0.012
	(0.023)	(0.012)	(0.014)	(0.012)
Real GDP growth (percent)	-0.042*	-0.031**	-0.031*	-0.006
	(0.023)	(0.011)	(0.014)	(0.011)
Real GDP per capita, log	-0.109	-0.375	-0.973	-2.791**
	(0.142)	(0.230)	(0.733)	(1.261)
Current account balance (percent of GDP)	0.008	-0.036*	-0.028*	-0.029***
	(0.008)	(0.018)	(0.015)	(0.009)
Systemic banking crisis DV	0.236	1.896***	0.785***	2.674***
	(0.211)	(0.529)	(0.221)	(0.485)
Currency crisis DV	0.136	0.128	-0.255**	-0.354
	(0.149)	(0.248)	(0.104)	(0.305)
Debt crisis DV		2.176**		1.547**
		(0.939)		(0.714)
Debt restructuring DV		0.915***		-
		(0.230)		
Year FE	yes	yes	yes	yes
Country FE	no	no	yes	yes
Observations	230	278	95	128
Adj. R-sq.	0.708	0.449	0.865	0.846

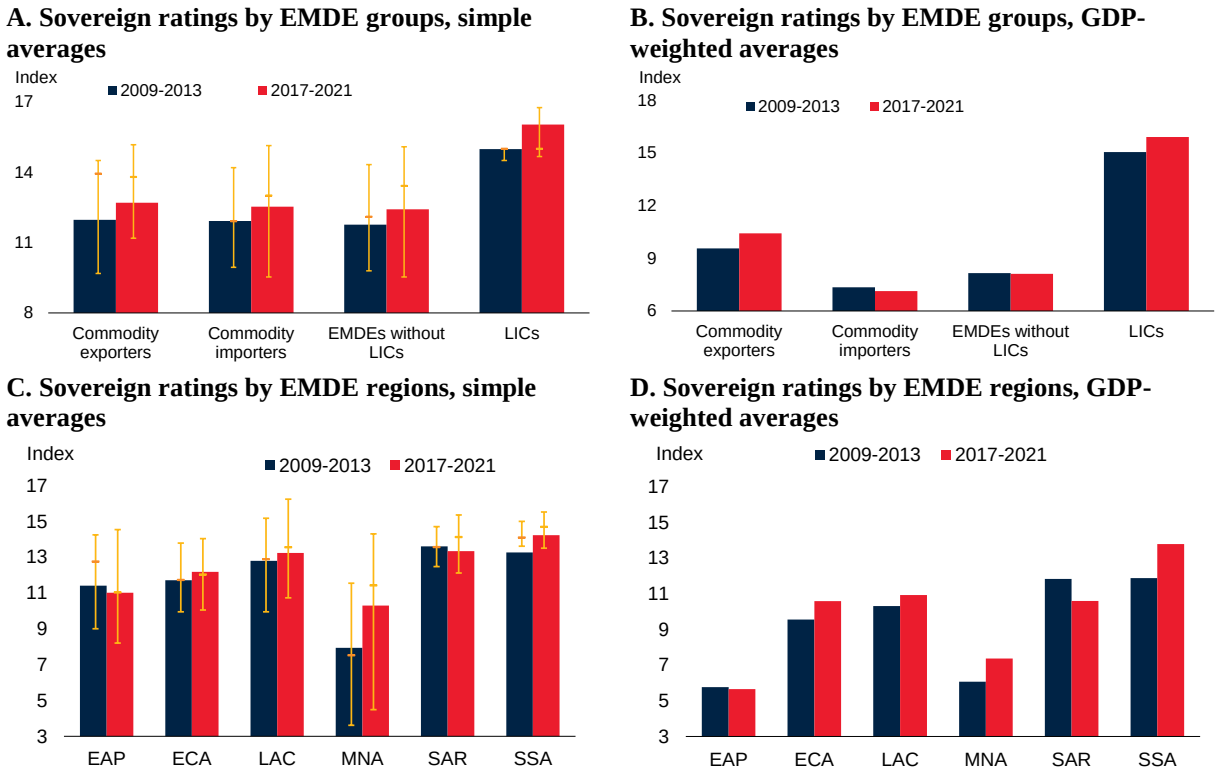
Source: Authors' estimations.
*Note: *, **, **** indicate statistical significance at the 10, 5, and 1 percent levels, respectively. Country-level clustered standard errors are in parentheses.

Figure 3.1. Sovereign risk by country groups, 2000-21 averages



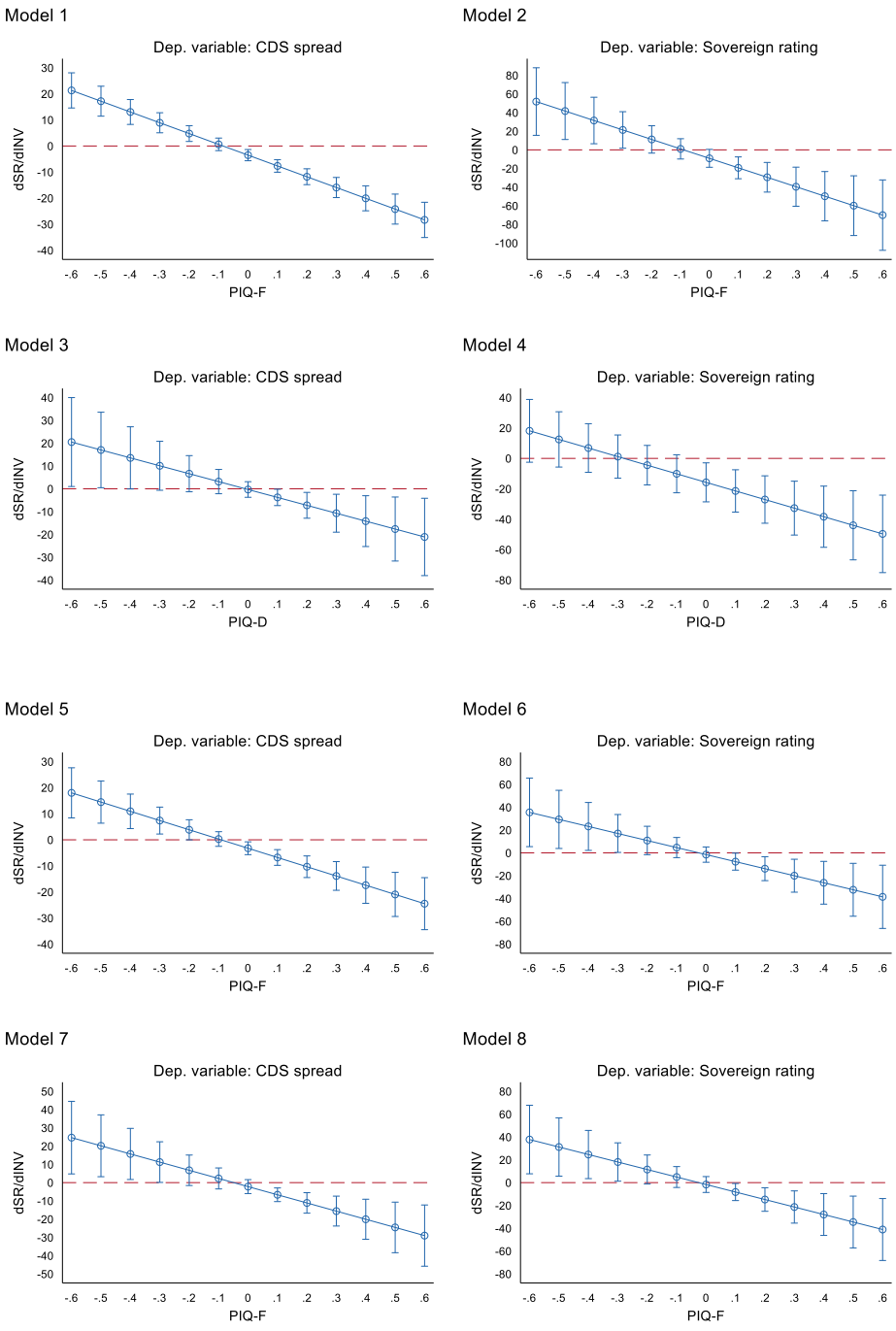
Sources: Bloomberg; Kose et al. (2017).
Note: The figure shows boxplot charts for 2000-21 averages of sovereign risk variables. AE = advanced economies; EMDE = emerging market and developing economies; HIC = high-income EMDEs; LIC = low-income EMDEs; MIC = middle-income EMDEs.

Figure 3.2. Sovereign ratings by EMDE regions and groups



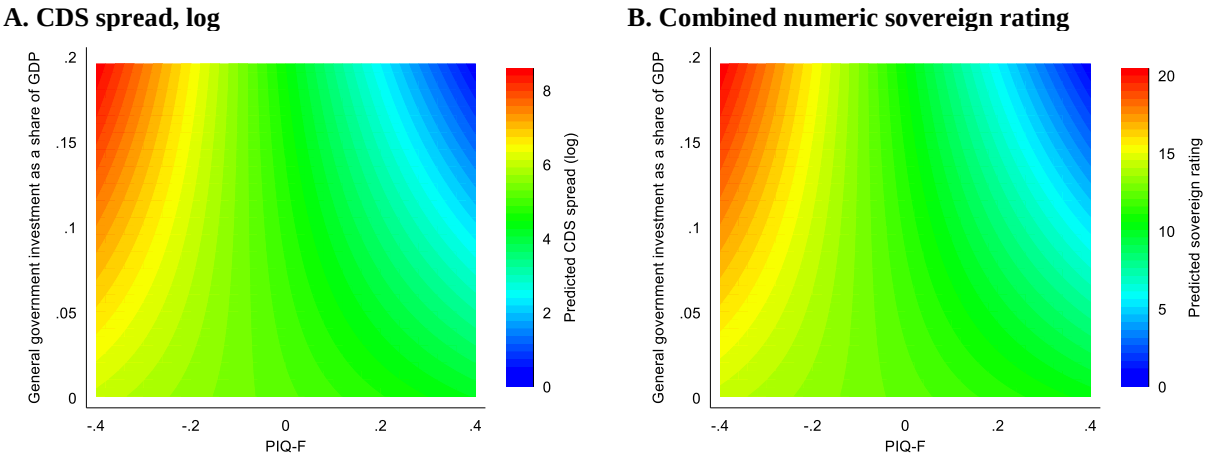
Sources: Bloomberg; Kose et al. (2017).
Note: EAP = East Asia and Pacific; EMDEs = emerging market and developing economies; LAC = Latin America and the Caribbean; LICs = low-income countries; MNA = Middle East and North Africa; SAR = South Asia; SSA = Sub-Saharan Africa. The figure shows combined numeric sovereign ratings ranging from 1 = lowest risk to 21 = highest risk. The sample includes 88 EMDEs (strongly balanced panel), of which 5 are LICs, 49 are commodity-exporting EMDEs, and 39 are commodity-importing EMDEs. The sample includes 10 EAP, 19 ECA, 24 LAC, 11 MNA, 4 SAR, and 20 SSA EMDEs. A.C. Simple averages. Orange whiskers show medians and interquartile ranges. B.D. GDP-weighted averages based on real GDP averaged over the respective periods.

Figure 3.3. Marginal effects of public investment on sovereign risk conditional on public investment quality



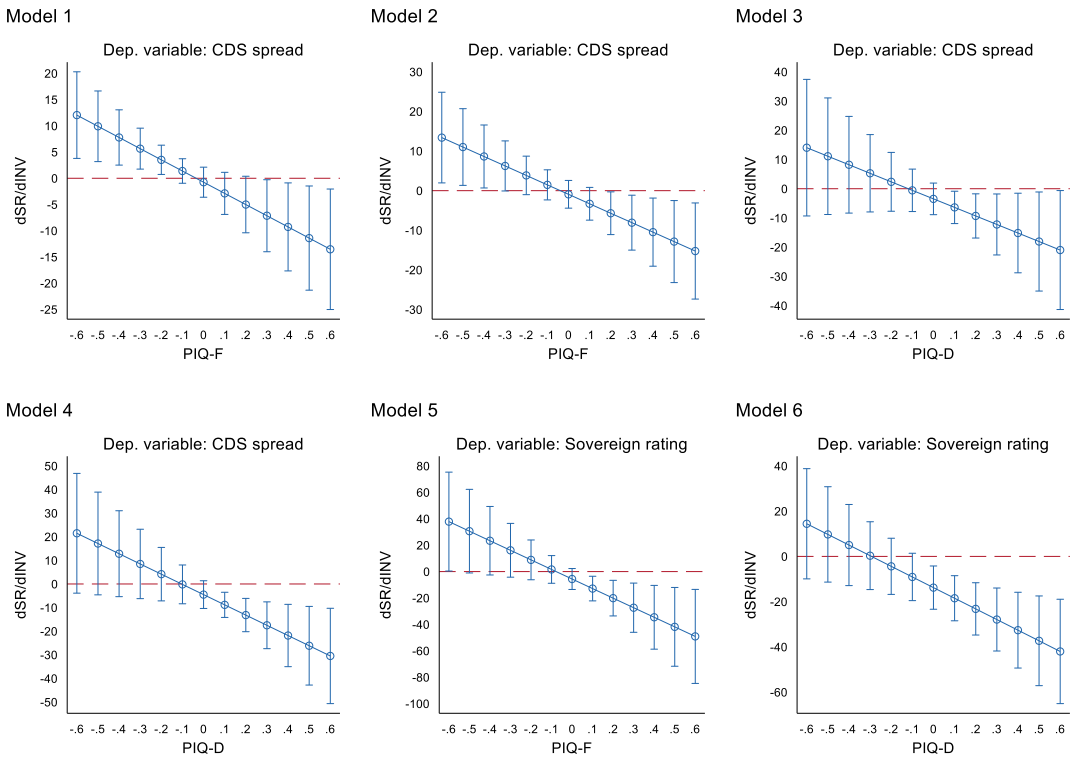
Source: Authors' estimates.
Note: The figure shows the marginal effects of public investment on sovereign risk at different levels of the PIQ indexes. Models 1-8 indicate the specification number in Table 3.1. The vertical axis indicates the marginal effect of public investment on sovereign risk. Vertical bars indicate 90-percent confidence bands.

Figure 3.4. Predictive margins for sovereign risk



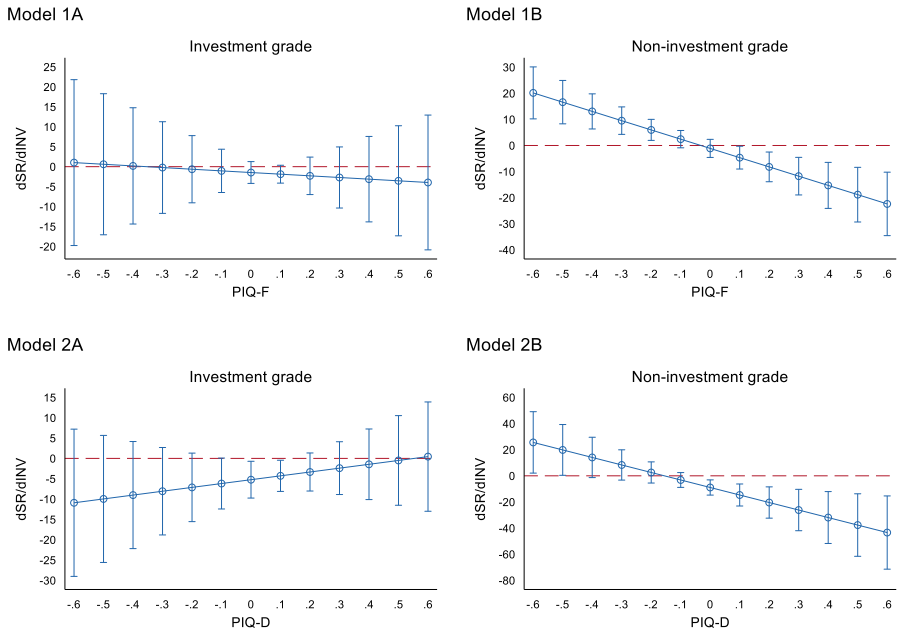
Source: Authors' estimates.
Notes: Predictive margins for CDS spreads (log) in Panel A and combined numeric sovereign ratings in Panel B at different levels of PIQ-F and public investment as a share of GDP, based on models 1 and 2. The color scale reflects model-predicted sovereign risk levels ranging from blue (low risk) to red (high risk).

Figure 3.5. Marginal effects for estimations with region and country fixed effects



Source: Authors' estimates.
Note: The figure shows the marginal effects of public investment on sovereign risk at different levels of the PIQ indexes. The vertical axis indicates the marginal effect of public investment on sovereign risk. Vertical bars indicate 90-percent confidence bands.

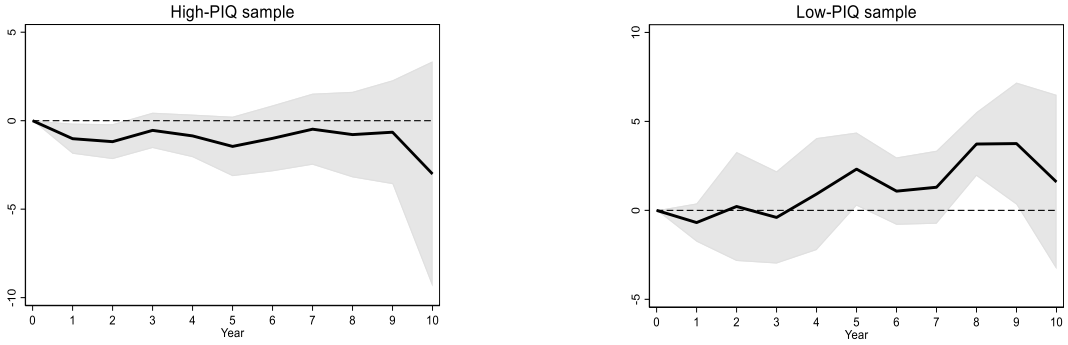
Figure 3.6. Marginal effects for investment grade vs sub-investment grade rating samples



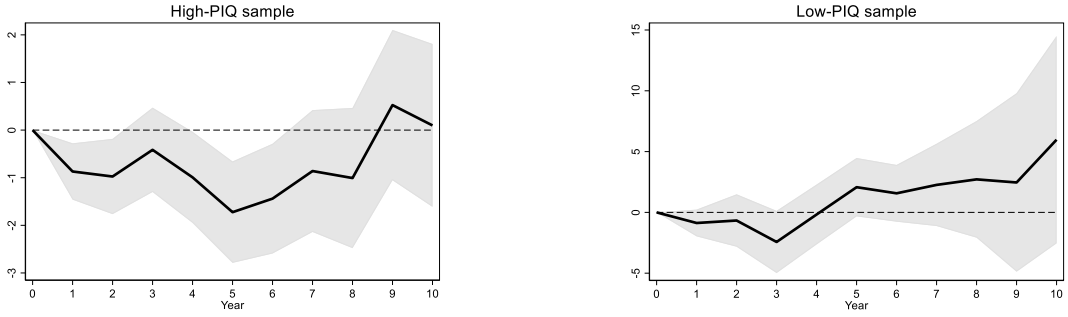
Source: Authors' estimates.
Note: The figure shows the marginal effects of public investment on sovereign risk at different levels of the PIQ indexes. The vertical axis indicates the marginal effect of public investment on sovereign risk. Vertical bars indicate 90-percent confidence bands.

Figure 3.7. Implications of public investment quality for public debt dynamics

Panel A. Impulse variable: public investment-to-GDP ratio; Response variable: public debt-to-GDP ratio



Panel B. Impulse variable: instrumented public investment-to-GDP ratio; Response variable: public debt-to-GDP ratio



Source: Authors' estimates.
Note: Impulse-response functions associated with the local projection model estimated for high-PIQ and low-PIQ samples, indicating cumulative responses to a public investment shock at t = 1 over the horizon of ten years. Impulse variable: public investment shock. Response variable: change in public debt as a percent of GDP at horizons up to 10 years following the shock. The shaded area indicates 90-percent confidence bands.

4. Conclusion and policy implications

The paper builds a new *de facto* index of public investment quality based on World Bank's data on investment project evaluations for the period 2000-21. The index allows to assess public investment quality for a large number of EMDEs and to track the evolution of public investment quality over time. We show that low-income countries and commodity-exporting EMDEs have much lower public investment quality in comparison with other EMDEs and that this gap has widened over time. This is especially alarming in light of the importance of public investment quality for growth-inducing effects of public investment.

The paper also shows that public investment quality has important implications for sovereign risk. Specifically, we show that scaling up of public investment leads to lower sovereign risk for countries with high public investment quality and increases sovereign risk for countries with low public investment quality. The results indicate that this effect is particularly important for countries with low levels of creditworthiness. We also show that in countries with high public investment quality, scaling up of public investment pays for itself. Debt-to-GDP ratios do not increase after a positive public investment shock. The opposite is true for low-public-investment-quality countries, where scaling up of public investment leads to an increase in public debt in the following years.

The results of this paper help inform policy debates by providing empirical evidence on the macroeconomic implications of public investment and its quality. Many EMDEs face debt sustainability issues, particularly in the aftermath of the COVID-19 pandemic and the associated global economic recession. We show that the quality of public investment has non-trivial consequences for the cost of capital and debt sustainability. In this regard, scaling up of public investment when public spending is not efficient may be detrimental to macroeconomic stability.

These issues are especially critical for LICs that face significant infrastructure gaps but have limited capacity to address them given high sovereign spreads, limited fiscal space, intermittent access to the international capital market. For these countries it is vital to step up technical and financial support from the global community with a multipronged strategy integrating public investment management framework—including careful assessment of investment projects at all stages of development and implementation (Adarov 2024; Kim et al. 2020; IMF 2022)—with improved public expenditure and debt sustainability frameworks. Given the massive scale of the reform effort needed for effective operationalization of these frameworks, this requires also coordinated efforts among creditors and development partners to provide development assistance on concessional terms.

Annex A. Additional results and robustness checks

Table A1. Regression results controlling for TTL effects

	(1) Baseline	(2) TTL DV	(3) TTL Char
Real GDP growth	0.008**	0.010*	0.006
	(0.003)	(0.006)	(0.008)
Real GDP per capita, log	0.025	0.009	0.017
	(0.019)	(0.034)	(0.045)
Project length	0.011*	0.005	0.022
	(0.007)	(0.011)	(0.019)
Project volume 10-25 mn	0.116***	0.181***	0.115
	(0.034)	(0.064)	(0.122)
Project volume 25-50 mn	0.150***	0.192**	0.146
	(0.042)	(0.087)	(0.149)
Project volume 50-100 mn	0.187***	0.203**	0.142
	(0.039)	(0.093)	(0.169)
Project volume > 100 mn	0.183***	0.173*	0.149
	(0.050)	(0.095)	(0.134)
Quality at entry	0.374***	0.357***	0.388***
	(0.015)	(0.025)	(0.038)
Quality of supervision	0.437***	0.417***	0.389***
	(0.014)	(0.029)	(0.039)
TTL experience			0.002
			(0.006)
TTL education			-0.065
			(0.060)
TTL FE	no	yes	no
Sector FE	yes	yes	yes
Agreement type FE	yes	yes	yes
Year FE	yes	yes	yes
Observations	4,440	4,439	521
Adj. R-squared	0.560	0.596	0.551

Source: Authors' estimates.
Note: The table reports estimation results for the full-sample pooled OLS baseline specification in column 1, the baseline specification with TTL fixed effects (column 2) and TTL work experience and educational attainment variables (column 3). Standard errors clustered at the country level are in parentheses. *, **, *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively.

Table A2. Summary statistics

	Obs.	Mean	St. dev.	Min	Max
5-year sovereign CDS spreads, basis points, log	639	5.294	1.129	2.654	11.06
Combined sovereign rating, 1=high, 21=low	1,635	12.11	3.645	3	21
General government investment as a share of GDP	2,623	0.067	0.045	0.000	0.457
PIQ-F	120	0.003	0.194	-0.600	0.549
PIQ-D	793	0.005	0.181	-0.651	0.633
General government gross debt, percent of GDP	2,918	52.48	45.89	0.002	600.1
Real GDP growth (percent)	3,022	4.071	5.350	-50.34	86.83
Real GDP per capita, log	3,018	8.028	1.145	5.555	11.08
Total natural resources rents (percent of GDP)	3,022	9.062	12.52	0	87.58
Current account balance (percent of GDP)	2,699	-3.337	16.44	-70.43	311.8
Foreign direct investment, net inflows (percent of GDP)	2,984	4.446	6.557	-40.08	103.3
Inflation, consumer prices (percent)	2,783	7.190	19.31	-18.11	513.9
Trade (percent of GDP)	2,674	80.69	37.19	1.219	348.0
Domestic credit to private sector (percent of GDP)	2,854	35.35	29.08	0.198	205.5
Exchange rate (LCU per US$, period average), log	2,994	3.344	2.747	-3.113	22.63
Net ODA received (constant 2018 US$), log	2,729	19.33	1.537	11.00	23.99
Systemic banking crisis dummy variable	3,060	0.005	0.068	0	1
Currency crisis dummy variable	3,060	0.017	0.129	0	1
Debt crisis dummy variable	3,060	0.007	0.081	0	1
Debt restructuring dummy variable	3,060	0.007	0.083	0	1
Total reserves (percent of GDP)	2,683	19.74	18.09	0.031	229.5
Chinn-Ito Capital account openness index	2,767	-0.090	1.471	-1.924	2.322

Source: Authors' calculations.

Table A3. Robustness checks for sovereign risk regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Model	*M-C CRE*	*M-C CRE*	*POLS Outlier check*	*POLS Outlier check*	*POLS*	*POLS*	*Ordered logit*	*Ordered probit*
Dependent variable:	CDS spread	Sov. Rating	CDS spread	Sov. rating	EMBI spread	EMBI spread	Sov. rating	Sov. rating
Public investment (share of GDP)	-5.833	-6.133**	-3.053**	-9.755	-1.045	1.659	-8.065	-4.496*
	(4.071)	(3.027)	(1.494)	(6.969)	(1.118)	(1.273)	(5.285)	(2.697)
PIQ-F	-2.096***	-2.851**	-1.918***	-4.570***	-1.230**		-3.894***	-2.397***
	(0.393)	(1.375)	(0.343)	(1.566)	(0.559)		(1.244)	(0.632)
PIQ-F × Public investment (share of GDP)	-41.523***	-14.239	-41.983***	-102.677***	-26.720**		-83.873**	-48.997***
	(8.232)	(15.740)	(7.200)	(38.585)	(10.271)		(37.017)	(17.149)
General government gross debt, percent of GDP	0.014	0.034***	0.009***	0.027***	0.005***	0.005***	0.026***	0.014***
	(0.009)	(0.008)	(0.002)	(0.008)	(0.002)	(0.002)	(0.008)	(0.004)
Total reserves (percent of GDP)	-0.001	-0.030*	-0.002	-0.012	-0.006	-0.006*	-0.014	-0.008
	(0.008)	(0.018)	(0.004)	(0.015)	(0.005)	(0.004)	(0.015)	(0.008)
Exchange rate (LCU per USD)	0.836	1.042**	-0.023	0.017	-0.010	0.002	0.029	0.010
	(0.647)	(0.439)	(0.020)	(0.085)	(0.021)	(0.015)	(0.069)	(0.041)
Inflation, consumer prices (percent)	0.010	0.030**	0.034***	0.090***	0.023***	0.032***	0.086***	0.042***
	(0.007)	(0.013)	(0.009)	(0.017)	(0.004)	(0.011)	(0.017)	(0.010)
Real GDP growth (percent)	-0.027*	-0.007	-0.025*	-0.047	-0.022*	-0.033***	-0.050	-0.032*
	(0.016)	(0.013)	(0.013)	(0.036)	(0.011)	(0.012)	(0.036)	(0.017)
Real GDP per capita, log	-0.241	-4.202***	-0.528***	-2.232***	-0.323***	-0.226**	-1.907***	-1.060***
	(0.583)	(0.862)	(0.132)	(0.299)	(0.096)	(0.092)	(0.300)	(0.163)
Current account balance (percent of GDP)	-0.007	0.021*	-0.005	-0.056***	-0.005	-0.030***	-0.053**	-0.030***
	(0.010)	(0.013)	(0.009)	(0.021)	(0.011)	(0.009)	(0.022)	(0.011)
Systemic banking crisis DV	0.998***	0.126	0.594***	0.488	0.567**	0.443**	0.545	0.302
	(0.374)	(0.439)	(0.174)	(0.594)	(0.225)	(0.209)	(0.627)	(0.311)
Currency crisis DV	0.060	0.492**	0.153	0.272	0.210**	0.101	0.003	0.104
	(0.217)	(0.203)	(0.168)	(0.405)	(0.096)	(0.103)	(0.345)	(0.209)
Debt crisis DV	1.187	0.732	-	1.015	0.131	0.424	3.000**	1.690***
	(0.842)	(0.721)	-	(0.903)	(0.584)	(0.556)	(1.215)	(0.455)
Debt restructuring DV	1.040***	0.745	1.043***	2.840***	0.287	-0.678	2.548***	1.137**
	(0.288)	(0.532)	(0.281)	(0.783)	(0.329)	(0.658)	(0.936)	(0.519)
PIQ-D						-1.248***		
						(0.333)		
PIQ-D × Public investment (share of GDP)						-20.604**		
						(9.005)		
$\bar{\boldsymbol{X}}$: matrix of panel-level means of time-varying explanatory variables	yes	yes	no	no	no	no	no	no
Year FE	yes	yes	yes	yes	yes	yes	yes	yes
Observations	508	1,072	463	1,024	602	283	1,072	1,072
Adj. R-sq (col.1-4, 6-7), pseudo R-sq (col. 5-6)	0.678	0.550	0.531	0.530	0.500	0.530	0.169	0.162

Source: Authors' estimates.

Note: Columns 1-2 (M-C CRE): Mundlak-Chamberlain correlated random effects model. Columns 3-4 (POLS Outlier check): POLS dropping outlier countries. Columns 5-6: POLS with EMBI spread as the dependent variable. Columns 7-8: ordered logit and ordered probit models. Standard errors clustered at the country level are in parentheses. *, **, *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively.

Table A4. Estimation results with PIQ-Q index

	1 CDS spread	2 Sov. rating	3 Sov. rating	4 Sov. rating	5 Sov. rating	6 Sov. rating
Public investment (share of GDP)	-0.909	-15.057**	-8.229**	-15.062**	-10.981	-16.114**
	(1.617)	(6.787)	(3.983)	(7.040)	(9.992)	(7.091)
PIQ-Q	-1.415**	-2.381**	-1.054**	-1.375**	-3.470**	-2.493***
	(0.524)	(0.977)	(0.410)	(0.542)	(1.501)	(0.874)
PIQ-Q × Public investment (share of GDP)	-44.632***	-73.038***	-38.209***	-35.645*	-90.763**	-79.142***
	(10.552)	(22.381)	(13.593)	(19.918)	(40.973)	(25.296)
General government gross debt, percent of GDP	0.008*	0.010	0.035***		0.006	0.013
	(0.004)	(0.012)	(0.009)		(0.014)	(0.012)
Total reserves (percent of GDP)	-0.010	-0.030	-0.054*		0.024	0.004
	(0.011)	(0.028)	(0.029)		(0.023)	(0.014)
Exchange rate (LCU per USD, period average), log	-0.030	-0.103	1.689***		-0.065	-0.105
	(0.032)	(0.089)	(0.437)		(0.091)	(0.087)
Inflation, consumer prices (percent)	0.065***	0.063*	0.018		0.148***	0.097**
	(0.021)	(0.034)	(0.016)		(0.053)	(0.039)
Real GDP growth (percent)	-0.038*	-0.107**	-0.032***		-0.151*	-0.025
	(0.019)	(0.041)	(0.011)		(0.084)	(0.085)
Real GDP per capita, log	-0.478**	-2.305***	-3.866***		-2.152***	-2.182***
	(0.182)	(0.313)	(1.026)		(0.321)	(0.303)
Current account balance (percent of GDP)	0.009	-0.070**	-0.002		-0.119***	-0.079**
	(0.011)	(0.032)	(0.016)		(0.038)	(0.039)
Systemic banking crisis DV	1.751*	2.089***	0.627		0.611	0.591
	(0.970)	(0.656)	(0.384)		(0.439)	(0.729)
Currency crisis DV	0.209	-0.193	0.041		0.418	-0.355
	(0.307)	(0.362)	(0.193)		(0.548)	(0.442)
Debt crisis DV	-0.197	1.889	-0.119		1.504***	1.390**
	(1.179)	(1.270)	(0.552)		(0.555)	(0.567)
Debt restructuring DV	1.561***	2.397	-0.635		-0.131	2.061***
	(0.232)	(1.490)	(0.617)		(0.845)	(0.607)
Constant	8.923***	31.116***	36.723***	12.784***	28.276***	28.834***
	(1.782)	(2.616)	(8.987)	(0.081)	(2.934)	(2.852)
Year FE	yes	yes	yes	yes	no	no
5-year period FE	no	no	no	no	yes	yes
Country FE	no	no	yes	yes	no	no
Observations	249	539	537	599	130	171
Adj. R-sq	0.596	0.591	0.922	0.859	0.603	0.581

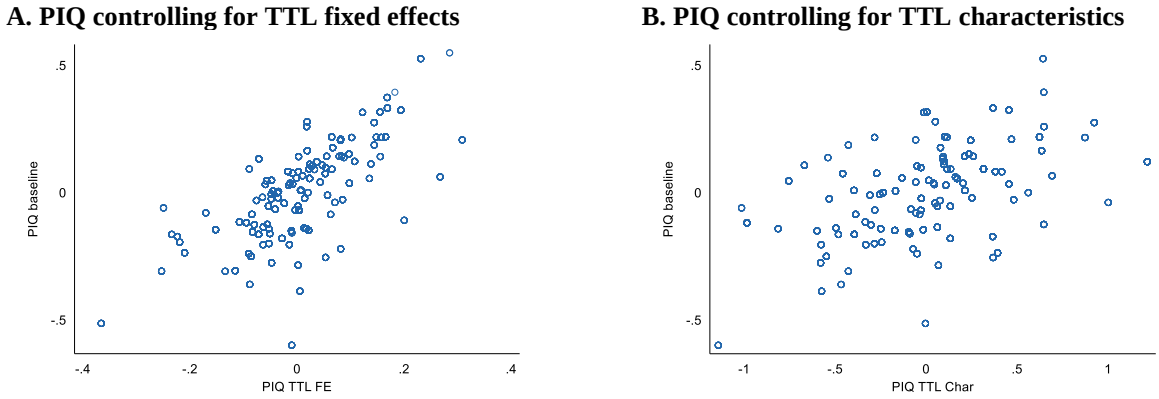
Source: Authors' estimates.
Note: Columns 1-4 report estimations with annual-frequency data. Columns 5-6 report results with non-overlapping 5-year averages (the following periods: 2002-06; 2007-11; 2012-16; 2014-21). Column 5 shows results with control variables lagged by one period, column 6 shows results with control variables not lagged. *, **, *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively. Country-level clustered standard errors are in parentheses.

Table A5. Pairwise correlations matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) PIQ-Q	1.00											
(2) PIQ-D	0.76	1.00										
(3) CDS spread	-0.28	-0.22	1.00									
(4) Sovereign rating	-0.20	-0.10	0.73	1.00								
(5) Public investment, share of GDP	0.07	0.07	-0.03	-0.21	1.00							
(6) Public debt, share of GDP	0.05	0.00	0.35	0.39	0.01	1.00						
(7) Total reserves, share of GDP	0.01	-0.11	0.02	-0.17	0.08	-0.09	1.00					
(8) Exchange rate	-0.07	-0.08	0.06	0.25	-0.07	0.03	-0.06	1.00				
(9) Inflation	-0.06	-0.03	0.42	0.23	-0.03	0.13	-0.06	0.02	1.00			
(10) Real GDP growth	0.06	0.04	-0.33	-0.06	0.12	-0.11	-0.09	0.07	-0.06	1.00		
(11) Real GDP per capita	0.10	0.01	-0.27	-0.55	-0.04	-0.16	0.10	-0.47	-0.11	-0.09	1.00	
(12) Current account, share of GDP	-0.02	0.06	-0.08	-0.37	-0.07	-0.23	0.11	-0.10	0.00	0.08	0.11	1.00

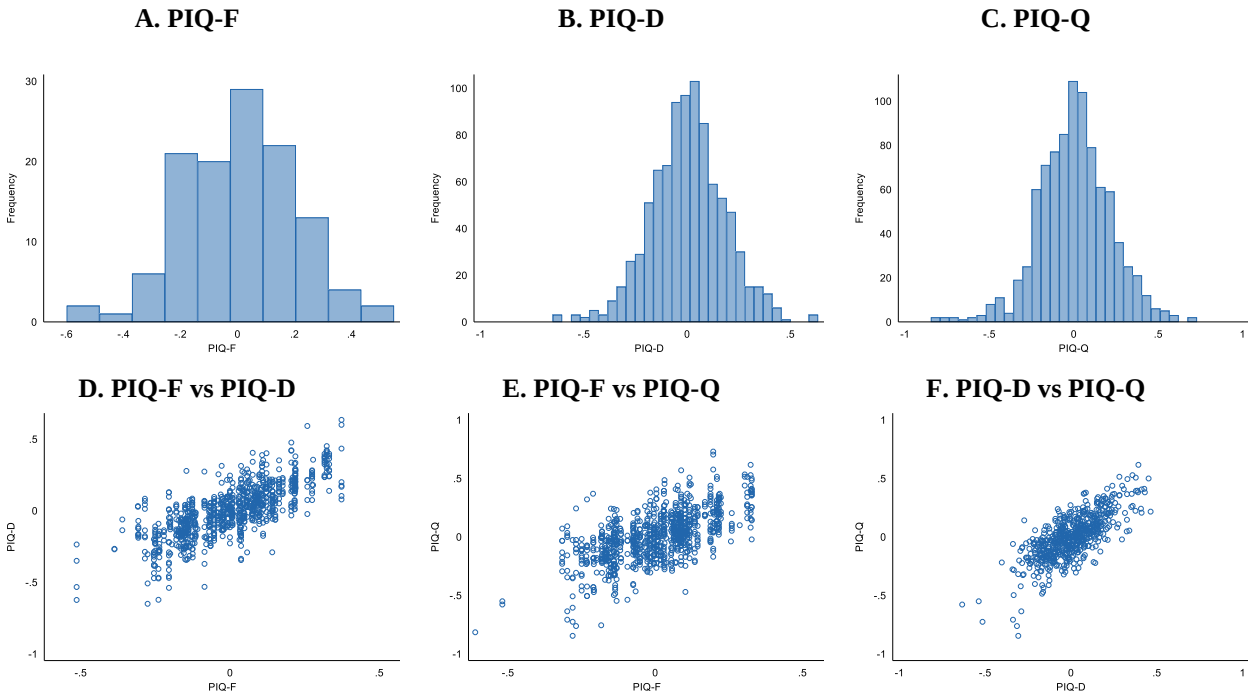
Source: Authors' calculations.

Figure A1. Baseline PIQ index and index versions controlling for TTL effects



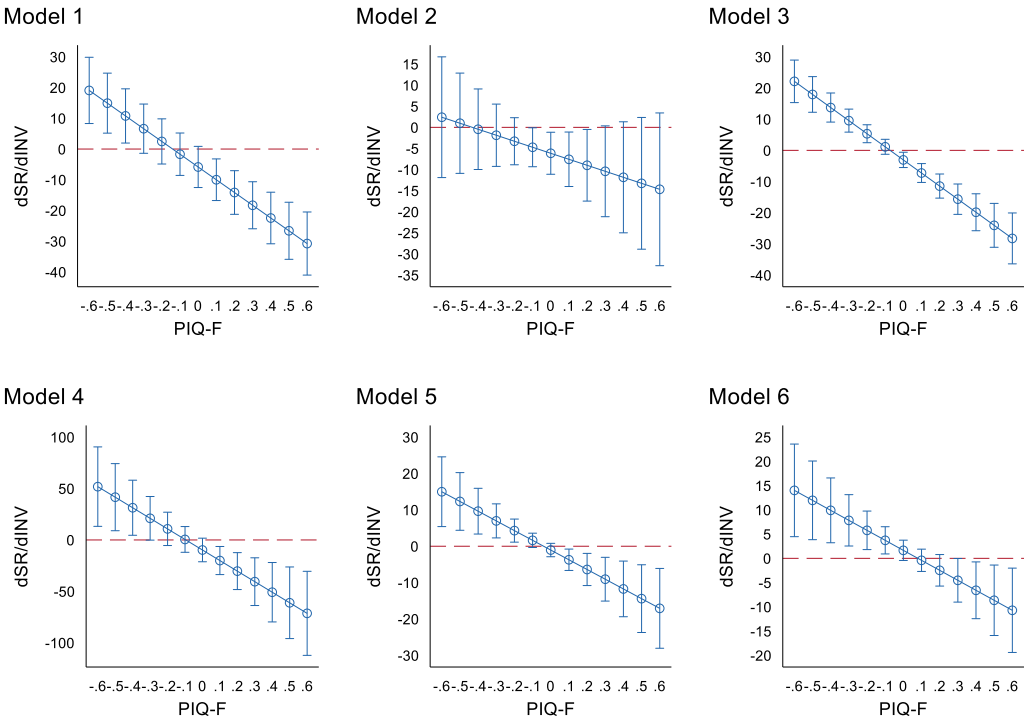
Source: Authors' estimates.
Note: "PIQ baseline" denotes the PIQ-F index, "PIQ TTL FE" and "PIQ TTL Char" are PIQ index versions based on specifications controlling for TTL fixed effects and TTL work experience and educational attainment variables, respectively, associated with columns 2 and 3 of Annex Table A1.

Figure A2. Frequency distribution of the PIQ indexes



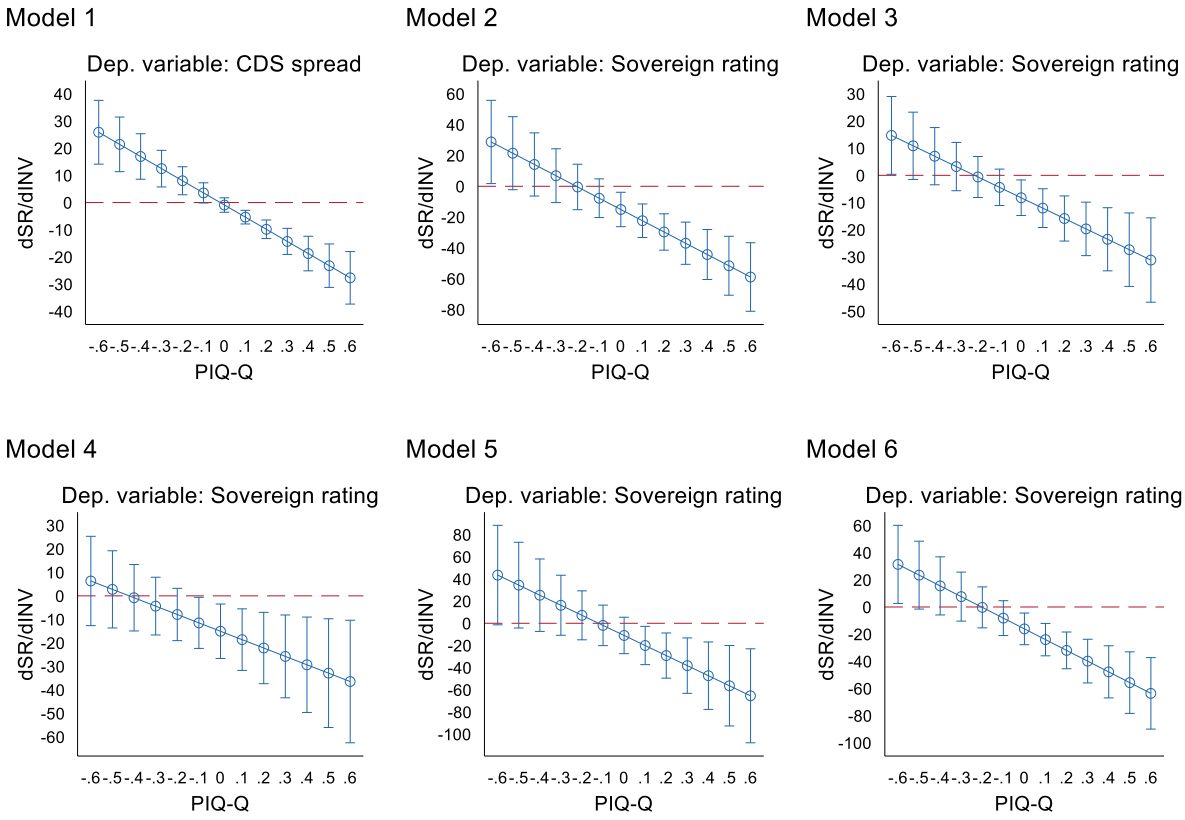
Source: Authors' estimates.
Note: The figure shows the frequency distribution and scatterplots of the PIQ-F, PIQ-D, and PIQ-Q indexes for the panel data.

Figure A3. Marginal effects for additional robustness checks



Source: Authors' estimates.
Note: The figure shows the marginal effects of public investment on sovereign risk at different levels of the PIQ-F index, associated with the estimation results reported in Annex Table A3, columns 1-6, respectively. The vertical axis indicates the marginal effect of public investment on sovereign risk. Vertical bars indicate 90-percent confidence bands.

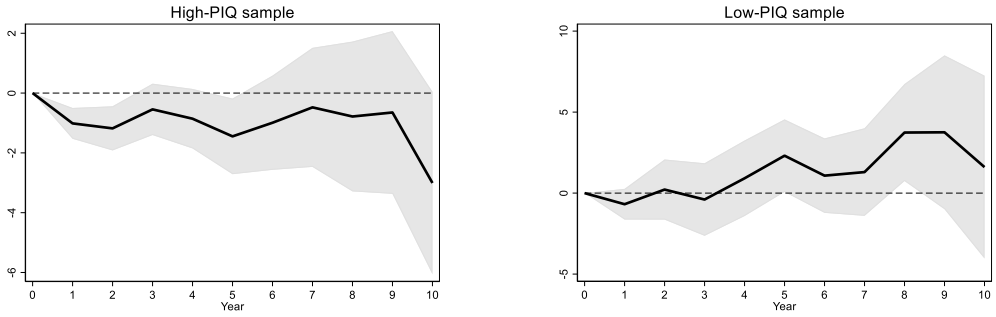
Figure A4. Marginal effects for estimations with PIQ-Q



Source: Authors' estimates.
Note: The figure shows the marginal effects of public investment on sovereign risk at different levels of the PIQ-Q index, associated with the estimation results reported in Annex Table A4, columns 1-6, respectively. The vertical axis indicates the marginal effect of public investment on sovereign risk. Vertical bars indicate 90-percent confidence bands.

Figure A5. Implications of public investment quality for public debt dynamics: additional results

Impulse: instrumented public investment-to-GDP (version 2); Response: public debt-to-GDP



Source: Authors' estimates.
Note: Impulse-response functions associated with the local projection model estimated for high-PIQ and low-PIQ samples, indicating cumulative responses to a public investment shock at t=1 over the horizon of ten years. Impulse variable: instrumented public investment-to-GDP change. Response variable: change in public debt as a percent of GDP at horizons up to 10 years following the shock. The shaded area indicates 90-percent confidence bands.

Annex B. Literature on measuring public investment quality and the effects of public investment quality

This annex reviews two strands of the literature on public investment quality that focus on how to measure public investment quality and on the economic effects of public investment quality.

Measuring of public investment quality

A seminal paper in the literature aimed at measuring public investment quality is Dabla Norris et al. (2012). This paper introduces a multi-dimensional index—the Public Investment Management Index, PIMI—aimed at assessing the effectiveness of public investment management processes across 71 emerging market and developing economies. PIMI measures the efficiency of these processes by aggregating 17 indicators across four critical stages: (i) Strategic Guidance and Project Appraisal; (ii) Project Selection and Budgeting; (iii) Project Implementation; and (iv) Project Evaluation and Audit.[33]

PIMI's primary objective is to spotlight institutional features that serve to minimize risks and ensure the proficient management of public investment. Dabla Norris et al. (2012) show that there are wide variations in the efficiency and effectiveness public investment management across middle- and low-income countries.

An inherent limitation of the PIMI pertains to its reliance on qualitative data, rendering replication and updates challenging. Furthermore, its dependence on secondary data sources and proxies restricts its ability to comprehensively evaluate crucial institutions pertinent to public investment (IMF 2015).[34] To address these issues, IMF (2015) builds a novel Public Investment Efficiency Index (PIE-X) and a Public Investment Management Assessment (PIMA) tool.

Public investment efficiency relates to the correlation between the value of public capital stock and the quantified coverage and quality of infrastructure assets. The IMF Public Investment Efficiency Index PIE-X is the vertical distance from an efficiency frontier delineated by countries

[33] Assessment of the first stage is based on four indicators: Nature of strategic guidance and availability of sector strategies; (ii) Transparency of appraisal standards; (iii) Observed conduct of ex ante appraisals; (iv) Independent review of appraisals conducted. Assessment of the second stage is based on five indicators: (i) Existence of medium-term planning framework and its integration to the budget; (ii) Inclusion in budget (or similar) for donor funded projects; (iii) Integration of recurrent and investment expenditures in budget; (iv) Nature of scrutiny and funding supplied by legislature, including its committees; and (v) Public access to key fiscal information. Assessment of the third stage is based on five indicators: (i) Degree of open competition for award of contracts; (ii) Nature of any complaints mechanism relating to procurement; (iii) Funding flows during budget execution; (iv) Existence and effectiveness of internal controls, such as commitment controls; and (v) Effectiveness of system of internal audit. Assessment of the fourth stage is based on two indicators: (i) Degree to which ex-post evaluations are conducted and (ii) Degree to which external audits are produced on a timely basis and scrutinized by the legislature.

[34] Canela and Moreno-Brid (2022) build a "New PIMI" for sixteen Latin American countries and suggest that their methodology is better suited at evaluating the quality of public investment management than that used in the original PIMI.

with the highest levels of infrastructure coverage and quality (output) concerning their public capital stock (input). Countries positioned at the forefront of infrastructure coverage and quality, relative to their public capital stock and income per capita, serve as benchmarks for efficiency and receive a PIE-X score of 1. Other countries receive PIE-X scores ranging between 0 and 1, contingent upon their vertical distance from the frontier in comparison to peer best performers. The efficiency frontier is defined using three metrics: (i) A physical indicator that uses data on the volume of economic and social infrastructure; (ii) A survey-based indicator drawn from a World Economic Forum survey that measures business leaders' perceptions of infrastructure service quality; (iii) A hybrid indicator that gives equal weight to the physical and survey-based metrics.

The index, which is computed for more than 100 countries and includes both advanced economies and EMDEs, shows that there is a positive relationship between the efficiency of public investment and income per capita. IMF (2015) also finds that that the slope of the efficiency frontier declines as the public capital stock increases, indicating diminishing marginal returns to additional investment.

A limitation of the of PIE-X is that the physical indicator is based on volume and fails to comprehensively capture quality, while the survey-based indicator is inherently subjective. The IMF's Public Investment Management Assessment (PIMA) evaluates the decision-making process of public investment across three key stages: (i) planning; (ii) allocation; and (iii) implementation. Each stage is assessed using five indicators. For planning, the focus is on indicators that recognize the importance of robust institutional frameworks in ensuring the fiscal sustainability of public investment and institutions that facilitate coordination across sectors, governmental levels, and between public and private entities.[35] For allocation, the indicators translate the idea that optimal allocation of capital spending requires a comprehensive, unified, and medium-term perspective on capital budgeting. This involves employing objective criteria and competitive procedures to appraise and select investment projects, ensuring they are directed towards the most productive sectors.[36] For implementation, indicators capture the necessity of executing public investment projects in a timely and cost-effective manner. This calls for institutions that ensure projects are

[35] Thus, PIMA assesses whether countries have: (i) Fiscal principles or rules which ensure that overall levels of public investment are adequate, predictable, and sustainable; (ii) National and sectoral plans which ensure public investment decisions are based on clear and realistic priorities, cost estimates, and objectives for each sector; (iii) Central-local coordination arrangements that integrate public investment plans across levels of government, provide certainty about funding from the central government, and ensure sustainable levels of subnational borrowing; (iv) Management of public-private partnerships, which ensure effective evaluation, selection, and monitoring of PPP projects and liabilities; and (v) Regulation of infrastructure companies, which promotes open and competitive markets for the provision of infrastructure services, objective pricing of infrastructure outputs, and effective oversight of infrastructure company investment plans (IMF 2015, pp. 20-21).

[36] Thus, PIMA assesses whether countries have: (i) Multi-year budgeting that provides transparency and predictability regarding levels of investment by ministry, program, and project over the medium term; (ii) Budget comprehensiveness that ensures that all public investment, regardless of the funding channel, is authorized by the legislature and disclosed in the budget documentation; (iii) Budget unity that ensures that decisions about individual projects take account of both their immediate capital and future operating and maintenance costs; (iv) Project appraisal that ensures that project proposals are subject to published appraisal using standard methodology and taking account of potential risks; and (iv) Project selection that ensures that projects are systematically vetted, selected based on transparent criteria, and included in a pipeline of approved projects (IMF 2015, p. 21).

adequately funded, transparently monitored, and efficiently managed, thereby improving overall project effectiveness.[37]

Countries are assigned a PIMA score on a scale of 0 to 10 on the basis of how many of the key features are in place. Compared to PIMI, PIMA provides a more comprehensive evaluation, incorporating factors such as macro-fiscal frameworks, integration of investment planning in medium-term budgeting, coordination of public investment across government levels, and private sector involvement in infrastructure provision. Additionally, the PIMA framework is particularly more suitable for high-income countries.

IMF (2015) estimates that enhancing public investment management institutions can narrow the public investment efficiency gap by approximately two-thirds. It also shows that institutional strength tends to vary across the investment cycle, with planning exhibiting the lowest strength and implementation the highest. However, there is considerable cross-country heterogeneity. Advanced Economies have relatively robust management of Public-Private Partnerships (PPPs), regulation of infrastructure firms, and comprehensive budgeting. In contrast, EMDEs exhibit weaknesses in funding availability, project implementation management, and public asset monitoring.

IMF (2015) acknowledges the limitations in coverage and scope of both the PIE-X indicator and the PIMA. While these metrics offer valuable insights into certain aspects of the public investment process, they may not encompass the entirety of factors that influence the effectiveness and outcomes of public investments. Consequently, relying solely on these indicators may not provide a complete and nuanced understanding of the complex dynamics at play in public investment decision-making and implementation.

Kapsoli et al. (2023) extend the efficiency frontier framework introduced by the IMF (2015), acknowledging inherent limitations associated with estimated efficiency scores stemming from potential variability in data availability and methodological choices. Their study systematically explores analytical considerations in the selection and utilization of inputs and outputs for public investment efficiency analysis, with a specific focus on core physical infrastructure. Expanding upon the methodology proposed by the IMF, they refine efficiency estimates and introduce additional estimates employing alternative methodologies and models. Encouragingly, their findings suggest that efficiency rankings remain largely robust across different estimation methods. Nevertheless, they highlight the significance of disaggregated, granular information for

[37] Thus, PIMA assesses whether countries have: (i) Protection of investment that ensures project appropriations are sufficient to cover total project costs and cannot be diverted at the discretion of the executive; (ii) Availability of funding that allows for the planning and commitment of investment projects based on reliable forecasts and timely cash flows from the treasury; (iii) Transparency of budget execution that ensures that major investment projects are tendered in a competitive and transparent process, monitored during project implementation, and independently audited; (iv) Project management that identifies an accountable project manager working in accordance with approved implementation plans, and provides standardized procedures and guidelines for project adjustments; and (v) Monitoring of public assets that ensures assets are properly recorded and reported and that their depreciation is recognized in financial statements. (IMF 2015, pp. 21-22).

a more comprehensive assessment. Through a case study of Latin America, they illustrate how aggregated approaches may lead to inflated efficiency scores.

The effects of public investment quality

Much of the theoretical and empirical literature supports the idea that public investment raises output through both demand and supply effects (see Aschauer 1989; Straub 2007; and Chakraborty and Dabla-Norris 2009). The impact of improvements in the efficiency of public investment on growth has received less attention. Theoretical work by Chakraborty and Dabla-Norris (2009) and Shen et al. (2018) suggests that public investment efficiency amplifies the positive growth effects of public investment. Gupta et al. (2014), IMF (2014, 2015), and Morozumi and Veiga (2018), provide empirical support for this hypothesis. Grigoli (2014) and Grigoli and Kapsoli (2018) show that public investment efficiency has also a positive effect on the accumulation of human capital (health and education). One striking result of Grigoli and Kapsoli (2018) is that, for any given level of expanding, low-income economies in sub-Saharan Africa could increase life expectancy by about five years by improving the quality of public investment in human capital.

A contrarian view is provided by Berg et al. (2019) who note that countries with low levels of efficiency are likely to have particularly scarce public capital and, therefore, a higher marginal productivity of public capital than high-efficiency countries. As a result, the higher marginal productivity may offset any losses from lower levels of efficiency, such that the growth impact of higher investment spending is likely to be roughly invariant to the level of efficiency. However, these theoretical results do not mean that efficiency is unimportant as they emphasize that increases in efficiency can have an important impact on growth. They are thus consistent with the idea that improving efficiency within any given country has a positive impact on growth. The estimates of IMF (2015) indicate that in the countries with the highest level of public investment efficiency, public investment has twice the growth impact compared with least efficient countries.

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