Ambrogio Lorenzetti; The Effects of Good Government on the City Life; Fresco; Palazzo Pubblico, Siena (Italy)
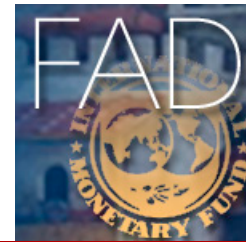
Efficiency-Adjusted Public Capital and Growth

IMF-WB Conference on "Fiscal Policy, Equity, and Long-Term Growth in Developing Countries"

Sanjeev Gupta

April 21, 2013

1

Outline of Presentation

➢ **Motivation**

➢ **Literature overview**

➢ **Constructing public capital stocks**

➢ **Stylized facts**

➢ **Empirical model and estimation strategy**

➢ **Estimation results**

➢ **Policy implications**

1. Motivation

- ➤ **A long legacy of failed public projects in many countries**
- ➤ **At the same time, these countries need to invest more to ease the infrastructure gap**

- ➤ **In this paper we:**
  - correct public capital for efficiency of public investment
  - reexamine public capital–growth relationship in LICs and MICs
  - identify stages of public investment management process with highest impact on productivity of public capital
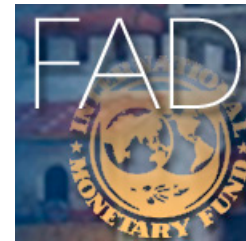
2. Literature Overview

➢ **Is public capital productive?**

- ▪ Some early studies mainly for individual countries estimated negligible or zero impact of public capital on growth (Holtz-Eakin and Schwartz, 1995; Bonaglia et al., 2004)

- ▪ A recent paper using results from previous papers (meta-analysis) estimated an average output elasticity of public capital to be around 0.15 (Bom and Litghart, 2010)

- ▪ But substantial heterogeneity across countries depending on the assumptions
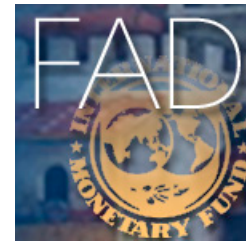
2. Literature Overview

Several issues remain unaddressed:

➢ Existing studies focus primarily on advanced economies

➢ Limited estimates of public capital stock and its productivity for developing countries

➢ The assumption that all public investment spending translates fully into productive public capital may not hold for developing countries

➢ Finally, limited understanding of links between aggregate productivity of public capital and public investment processes

3. Constructing Public Capital Stocks

➢ Public and private capital stocks are constructed using standard perpetual inventory methodology(K'_{it})

$$K_{it} = K_{it-1} - d_{it} * K_{it-1} + I_{it-1}$$

where: I_{it-1}= public or private investment at time t-1

d_{it} = depreciation rate (varies across time and income groups)

➢ Public capital stocks are adjusted (K'_{it}) to reflect public sector inefficiencies.

$$K'_{it} = K'_{it-1} - d_{it} * K'_{it-1} + \boldsymbol{q_i} * I_{it-1}$$

$$q_i = \frac{1}{4} \left(q_i^{appraisal} + q_i^{selection} + q_i^{implementation} + q_i^{evaluation} \right)$$

where: $\boldsymbol{q_i}$ = normalized [0, 1] as calculated by Dabla-Noris et al (2011)

3. The Public Investment Management Index (PIMI)

$$PIMI: q_i = \frac{1}{4}\sum_{j=1}^{4} S_{ij}$$

Strategic Guidance and Project Appraisal $S_1 = Appraisal = \frac{1}{4}\sum_{j=1}^{4} s_{1i}$

- S_{11}: Strategic guidance and availability of sector strategies
- S_{12}: Transparency of appraisal standards
- S_{31}: Observed conduct of ex ante appraisals
- S_{41}: Independent review of appraisals

Project Selection $S_2 = Selection = \frac{1}{5}\sum_{j=1}^{5} s_{2i}$

- S_{21}: Existence of MT framework and its integration into budget
- S_{22}: Inclusion in budget of donor funded projects
- S_{23}: Integration of current and capital spending in budget
- S_{24}: Nature of scrutiny and funding supplied by legislature
- S_{25}: Public access to key fiscal information

3. The Public Investment Management Index (PIMI)

$$PIMI: q_i = \frac{1}{4}\sum_{j=1}^{4} S_{ij}$$

Project Implementation

$$S_3 = Implementation = \frac{1}{5}\sum_{j=1}^{5} s_{3l}$$

- S_{31}: Degree of open competition for award of contracts
- S_{32}: Complaints mechanisms relating to procurement
- S_{33}: Funding flows during budget execution
- S_{34}: Quality of internal controls
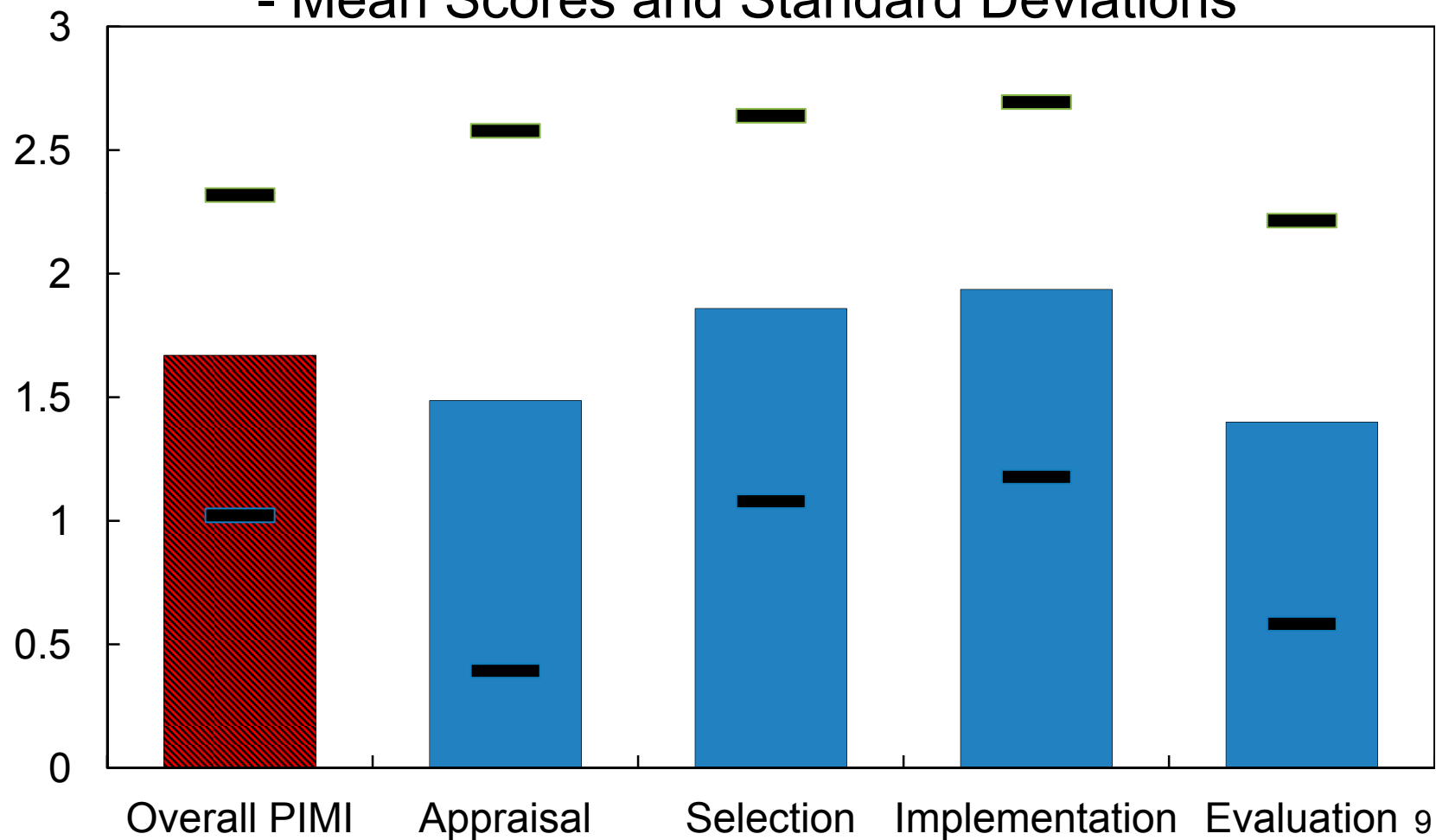- S_{35}: Effectiveness of internal audit

Project Evaluation and Audit

$$S_4 = Evaluation = \frac{1}{3}\sum_{j=1}^{3} s_{4l}$$

- S_{41}: Ex-post evaluations
- S_{42}: Timely External audits and scrutiny by the legislature
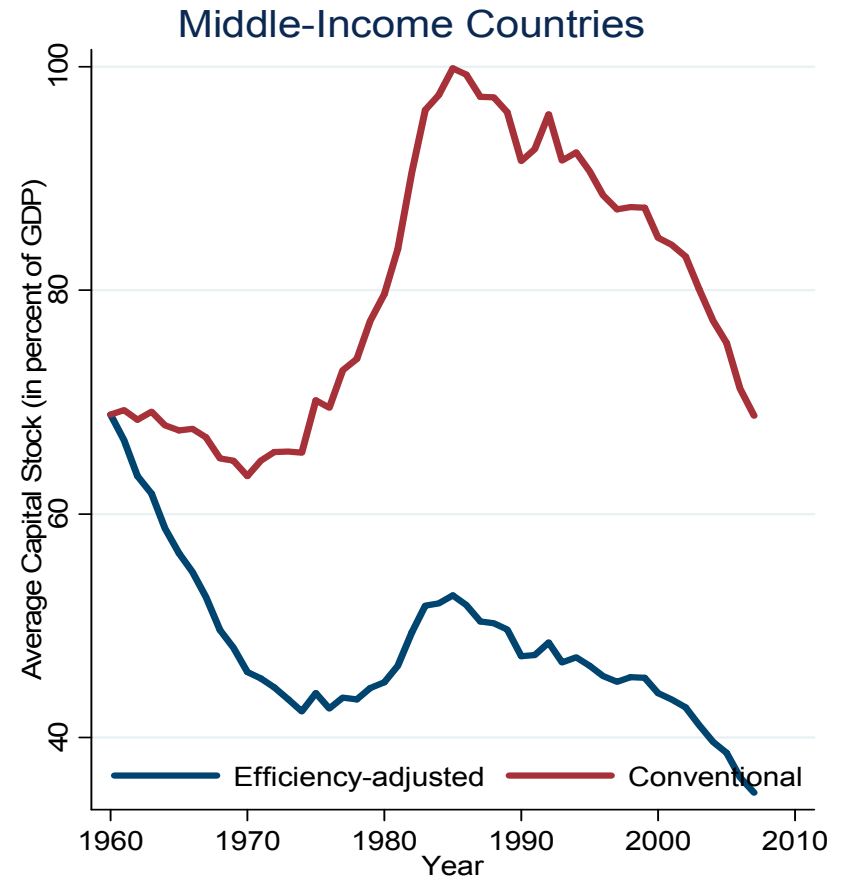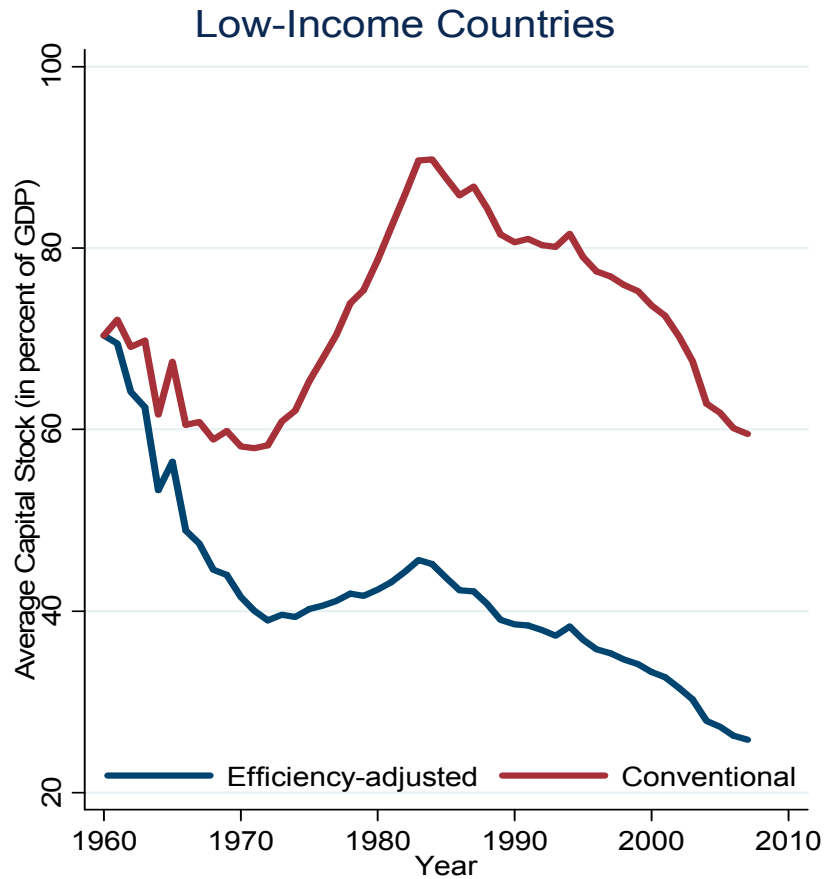- S_{43}: Maintenance of asset registers, and/or asset values

3. PIMI Scores and Range

Public Investment Management Index (PIMI)
- Mean Scores and Standard Deviations

4. Stylized Facts
Average Public Capital Stocks
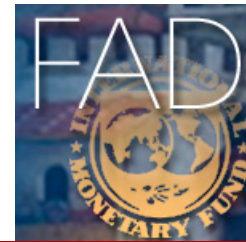
5. Empirical Model and Estimation Strategy

The aggregate production function:

$$Y = AS^\alpha K^\beta G^\gamma \quad (1)$$

$$y_{it} = a_0 + \alpha s_{it} + \beta k_{it} + \gamma g_{it} + \lambda_t + \eta_i + v_{it} \quad (2)$$

where:

- y = log GDP
- k = log private capital
- g = log public capital
- s = log human capital adjusted labor
- λ_t = set of time dummies
- η_i = set of unobserved time-invariant country-specific effects
- v_{it} = possibly autoregressive error term ($v_{it} = \rho v_{it} + \varepsilon_{it}$)

5. Empirical Model and Estimation Strategy

➢ Our baseline sample consists of 52 countries for which PIMI-adjusted capital stocks are available: unadjusted capital stocks are also generated for 122 countries

➢ To study the impact of investment stages we construct additional set of capital stocks by eliminating each PIMI component one by one

➢ Data is organized in 5-year intervals that allows to use Barro and Lee data on human capital and to estimate long-term income shares

➢ Coefficients estimated with dynamic system GMM that captures the reverse causality from income to public capital and is suitable for persistent data

6. Estimation Results– Baseline Regressions

|	Dynamic System-GMM - No PIMI			Dynamic System GMM - PIMI		
	ALL	MIC	LIC	ALL	MIC	LIC
	(1)	(2)	(3)	(4)	(5)	(6)
Estimated Factor Shares						
Skilled Labor	0.390**	0.265*	0.583***	0.336*	0.249*	0.637***
	(0.18)	(0.14)	(0.22)	(0.19)	(0.15)	(0.23)
Private Capital	0.231**	0.286***	0.231**	0.297***	0.314***	0.300***
	(0.09)	(0.10)	(0.09)	(0.09)	(0.10)	(0.09)
Public Capital	0.233***	0.167**	0.253***	…	…	…
	(0.07)	(0.08)	(0.09)			
PIMI-adjusted Public Capital	…	…	…	0.154*	0.162**	0.143*
				(0.08)	(0.07)	(0.09)
Implied Marginal Productivities						
Private Capital	0.40	0.26	0.55	0.51	0.28	0.71
Public Capital	0.52	0.30	0.65	…	…	…
PIMI-adjusted Public Capital	…	…	…	0.69	0.51	0.80
Hansen J-test	[1.00]	[1.00]	[1.00]	[1.00]	[1.00]	[1.00]
AR(2) test	[0.71]	[0.51]	[0.77]	[0.60]	[0.50]	[0.86]
Common factors	[0.13]	[0.04]	[0.64]	[0.14]	[0.09]	[0.75]
Observations	414	186	228	414	186	228
Countries	52	24	28	52	24	28

Dependent variable is the log-difference of real GDP in international dollars. Standard errors in parentheses: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.
All is the entire sample of 52 countries, **MIC** consists of 24 middle-income countries and **LIC** consists of 28 low-income countries.

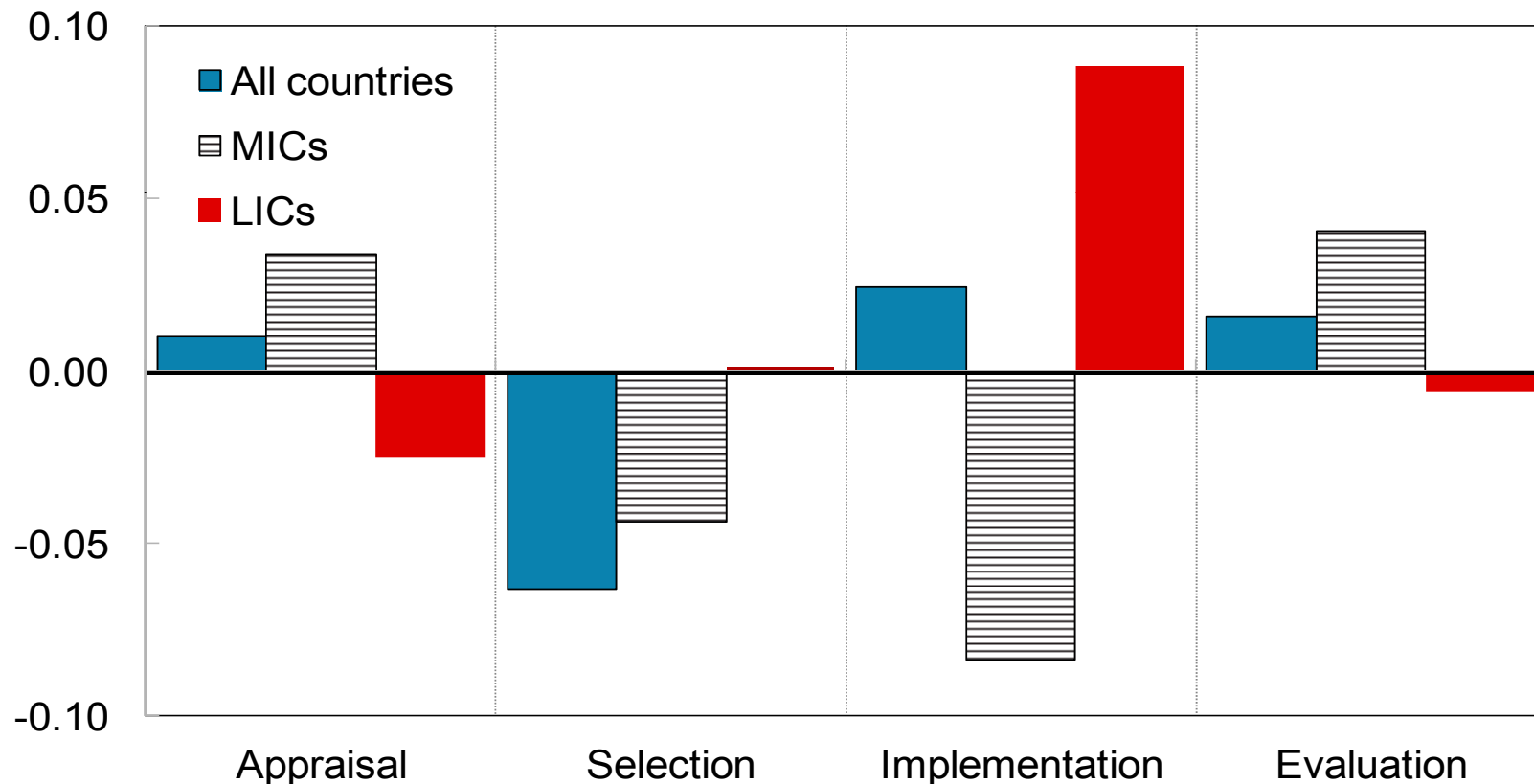# 6. Estimation Results–-the Effect of PIMI Adjustment

Increase in Measured Productivity of Capital with Efficiency Adjustment of Public Investment
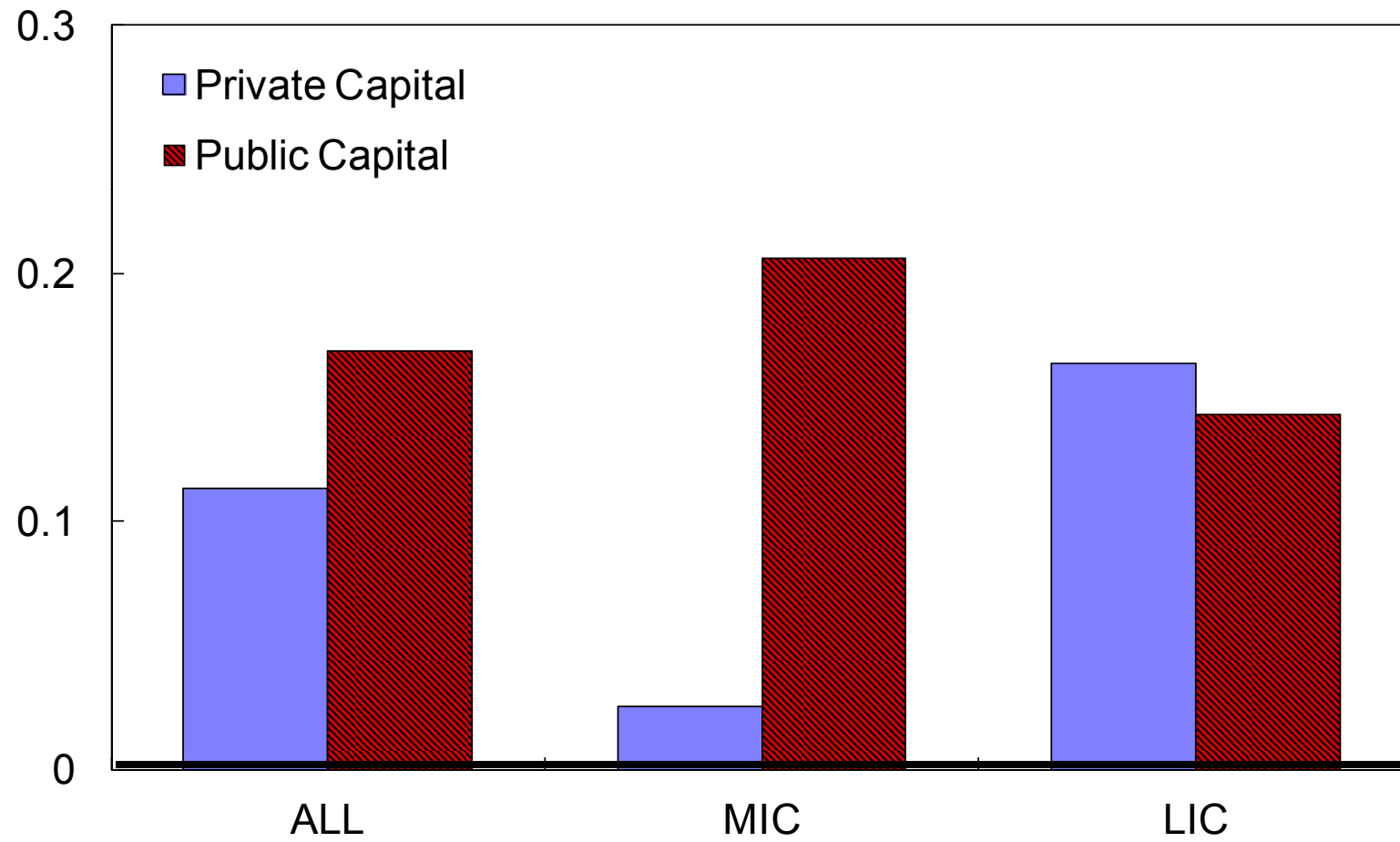
6. Estimation Results and Policy Implications – Public Investment Stages

Deviation in Measured Productivity of Capital from the aggregate PIMI-adjusted baseline *

* Shows the extent to which margianl productivity of a particular investment management stage differs from the aggregate marginal productivity. Point-estimates of factor shares are used to compute marginal productivities of investment stages. For LICs excluding implementation and selection stages leads to insignificant estimates of factor shares, implying that these stages are the most productive.
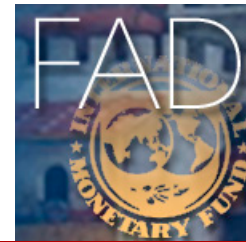
7. Policy Implications

➢ Using conventional measures can lead to an overestimation of public capital stock—effective public capital might be up to one-half of the estimated stock

➢ Our estimates confirm the productive role of public capital

➢ The marginal productivity of both private and public capital increases once public capital is adjusted for efficiency

➢ Project implementation (e.g., competitive bidding and internal audit) and selection are the most important components of the overall investment process in LICs
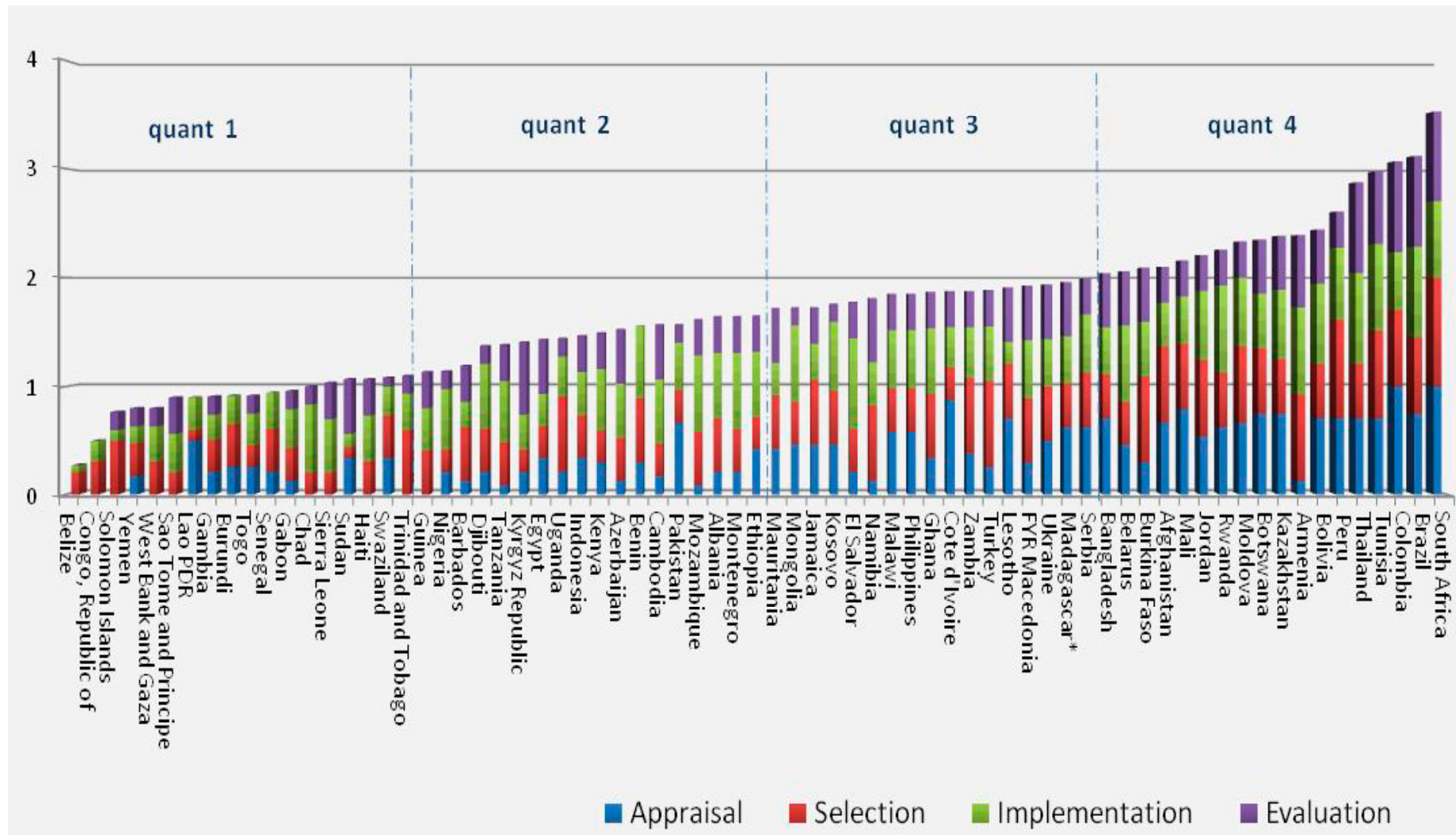
7. Policy Implications

- ➢ For MICs, the relevant investment components are appraisal and evaluation

- ➢ Finally, scaling up of public investment must be accompanied by targeted improvements in specific stages of investment process to enhance productivity of public capital

Thank you!

6. Estimation Results and Policy Implications – Public Investment Stages

	Dynamic System-GMM: MIC				Dynamic System-GMM: LIC			
Omitted category:	Appraisal	Selection	Implementation	Evaluation	Appraisal	Selection	Implementation	Evaluation
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Estimated Factor Shares								
Skilled Labor	0.260*	0.234[*]	0.242*	0.265*	0.649***	0.637***	0.647***	0.620***
	(0.15)	(0.15)	(0.14)	(0.16)	(0.23)	(0.23)	(0.23)	(0.22)
Private Capital	0.320***	0.329***	0.296***	0.314***	0.294***	0.302***	0.312***	0.303***
	(0.10)	(0.09)	(0.09)	(0.10)	(0.10)	(0.10)	(0.09)	(0.09)
PIMI-adjusted Public Capital	0.155**	0.166***	0.183***	0.155**	0.149[*]	0.133	0.122	0.152*
	(0.07)	(0.06)	(0.06)	(0.07)	(0.10)	(0.09)	(0.09)	(0.08)
Implied Marginal Productivities								
Private Capital	0.290	0.298	0.268	0.284	0.696	0.715	0.739	0.718
PIMI-adjusted Public Capital	0.474	0.551	0.591	0.467	0.822	0.798	0.709	0.803
Hansen J-test	[1.00]	[1.00]	[1.00]	[1.00]	[1.00]	[1.00]	[1.00]	[1.00]
AR(2) test	[0.50]	[0.50]	[0.51]	[0.49]	[0.84]	[0.88]	[0.88]	[0.85]
Common factors	[0.08]	[0.13]	[0.09]	[0.07]	[0.55]	[0.83]	[0.88]	[0.78]
Observations	186	186	186	186	228	228	228	228
Countries	24	24	24	24	28	28	28	28

Note: Dependent variable is the log-difference of real GDP in international dollars. Standard errors in parentheses: [*] p<0.15, * p<0.1, ** p<0.05, *** p<0.01.

All is our entire sample of 52 countries, **MIC** is the subsample of 24 middle-income countries, and **LIC** is the subsample of 28 low-income countries

4. Stylized Facts
Scale of Overestimation

Overestimation of Public Capital Stock
An indication of the Magnitude
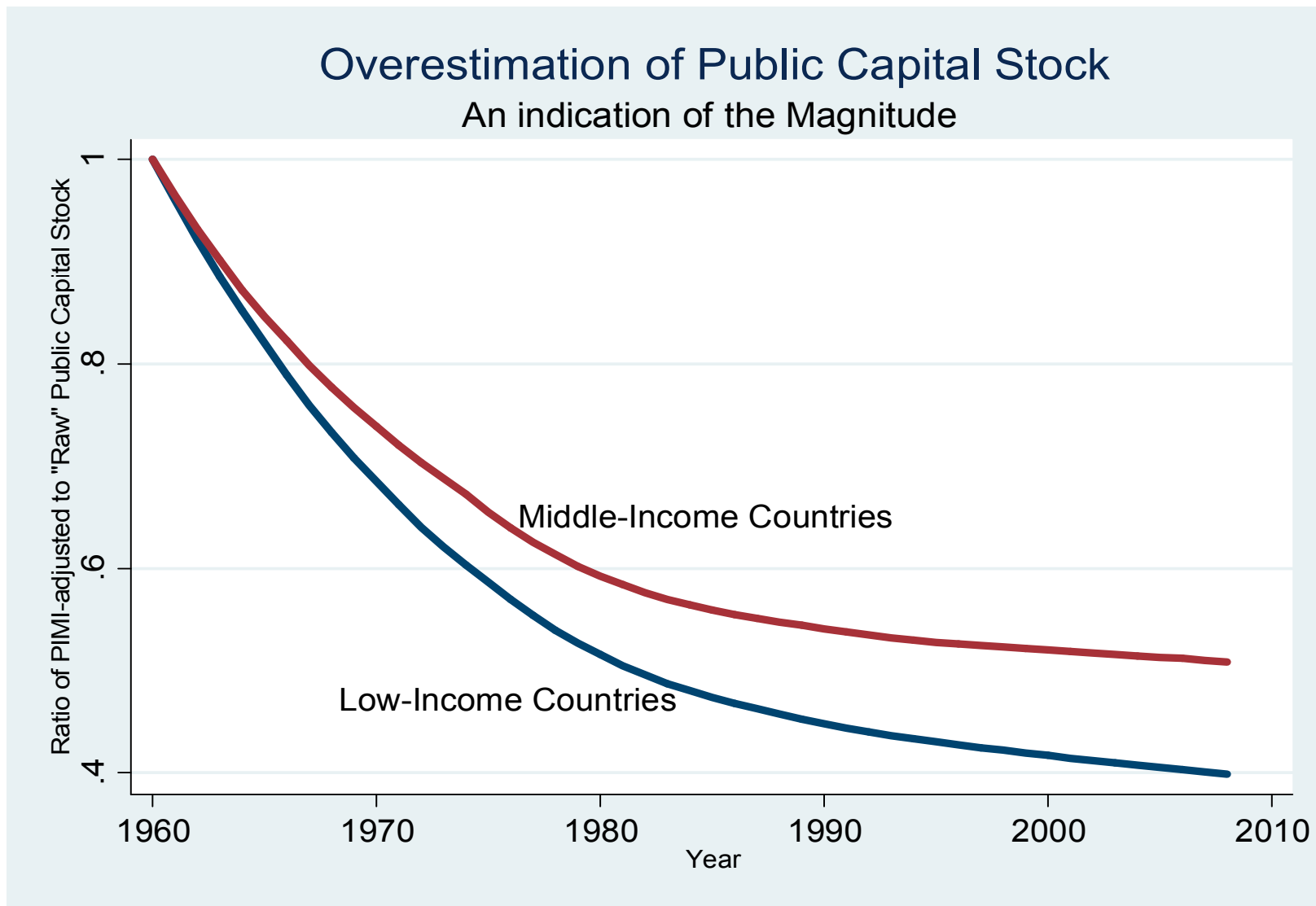
6. Estimation Results and Policy Implications – Robustness Tests

➢ **CES:**
  ▪ Cobb-Douglas functional form cannot be rejected

➢ **CRS:**
  ▪ Imposing CRS to all factors increases coefficient estimates (especially on labor) but does not render the baseline invalid

➢ **Separating H and L:**
  ▪ The factor share on PIMI-adjusted public capital is robust at 0.14.
  ▪ The results support adjusting the raw labor for human capital

➢ **Full sample:**
  ▪ In the full sample with 122 countries the income share of non-adjusted public capital at 0.167 is significant and close to the existing studies

➢ **Time-varying PIMI:**
  ▪ Applying the time-series variation of ICRG Investment Profile to PIMI yields 0.174 as the income share of public capital

➢ **Depreciation rates:**
  ▪ Alternative depreciation rates as discussed in Kamps (2006) and Arslanalp et al (2010)