



# World Economic Outlook International Monetary Fund

## Is it Time for an Infrastructure Push? The Macroeconomic Effects of Public Investment

*Abdul Abiad (team lead), Aseel Almansour, Davide Furceri, Carlos Mulas-Granados, and Petia Topalova  
with contributions from the Economic Modeling and Development Macroeconomic Division , and  
with support from Angela Espiritu, Sinem Kilic Celik, and Olivia Ma*



# Outline of Presentation

- Motivation and Summary of Main Findings
- The Economic of Infrastructure
- Public and Infrastructure Capital and Investment: Where Do We Stand?
- The Macroeconomic Effects of Public Investment
- Policy Implications

# Motivation and Main Findings

# Motivation- Why look at public investment now?

- In AEs, there is still a lot of slack, compounded by worries over secular stagnation
- In many EMDEs, infrastructure bottlenecks are contributing to slower growth
- Across all economies, there are concerns about long-run potential, with insufficient public/infrastructure investment being one of the reasons for concern
- Given the current environment of low borrowing costs, might this be a good time to increase public investment?



# Summary of main findings: the time is right for an infrastructure push

- The stock of public capital, a proxy for infrastructure, has declined significantly as a share of output over the past three decades across the world
  - In emerging market and developing economies, gaps in the quantity of infrastructure per capita are glaring
  - In some advanced economies the quality of the existing infrastructure stock is deteriorating
- Higher public infrastructure investment boosts output in the short and long term
- The effects are stronger during periods of economic slack and monetary accommodation, and when investment efficiency is high
- Debt-financed public investment tends to have large output effects without increasing the debt-to-GDP ratio

# **The Economic of Infrastructure**



# Characteristics of infrastructure investment

- Infrastructure investments are often large, capital-intensive projects that tend to be “natural monopolies
- Tend to have significant up-front costs, but the benefits or returns accrue over very long periods of time, often many decades
- Have the potential to generate positive externalities, so that the social return to a project can exceed the private returns it can generate for the operator
- In deciding which infrastructure projects to undertake, governments must carefully weigh broader social returns against funding costs and fiscal consequences

# The macroeconomic effect of infrastructure investment: a conceptual framework

- Infrastructure investments increases output in the short-term by boosting aggregate demand
  - the size of the effect depends on the state of the economy
- Infrastructure investments increases output in the long-term by boosting aggregate supply
  - the size of the effect depends on the efficiency of investment
- If short-term multipliers, public investment efficiency, and the elasticity of output to public capital are sufficiently high, an increase in public investment can be “self-financing” in that it leads to a reduction in the debt-to-GDP ratio

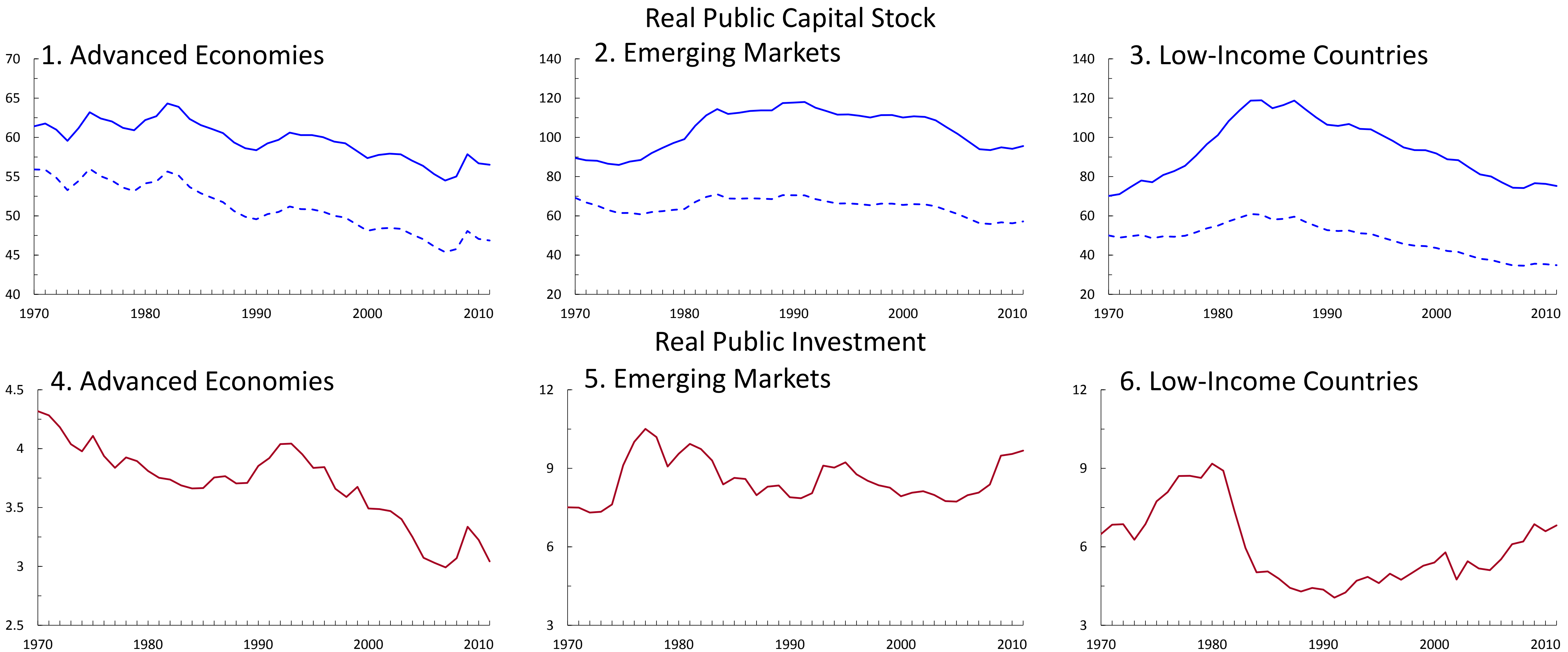


# **Public and Infrastructure Capital and Investment: Where Do We Stand?**



# The stock of public capital has declined as share of output across all income groups

**Figure 1. Evolution of Public Capital Stock and Public Investment (percent of GDP; PPP-weighted)**



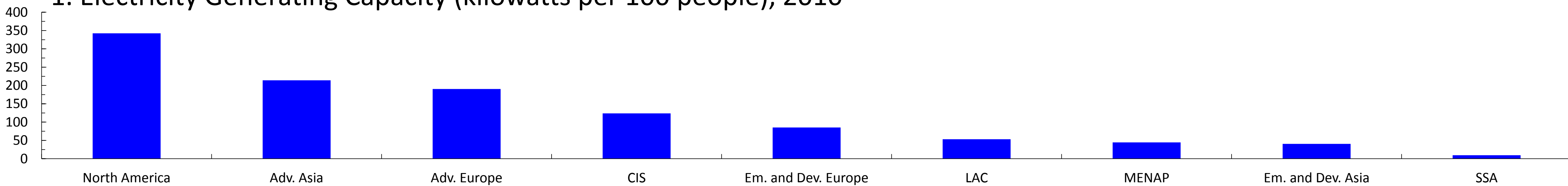
Note: Dashed lines represent efficiency adjusted real public capital stock as percent of GDP, PPP-weighted.



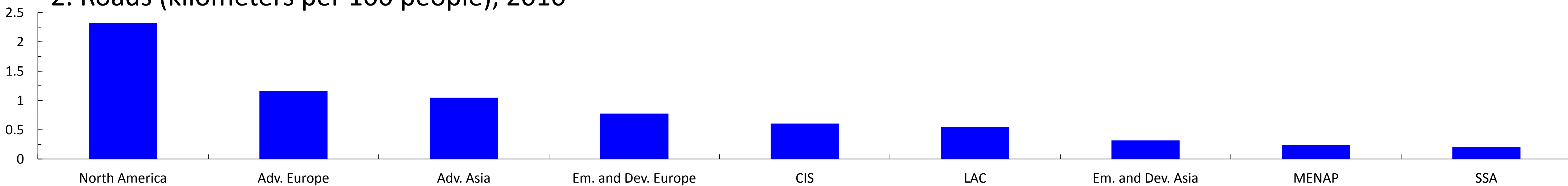
# In EMDEs infrastructure gaps are glaring

**Figure 2. Physical Measures of Infrastructure** (percent of GDP; PPP-weighted)

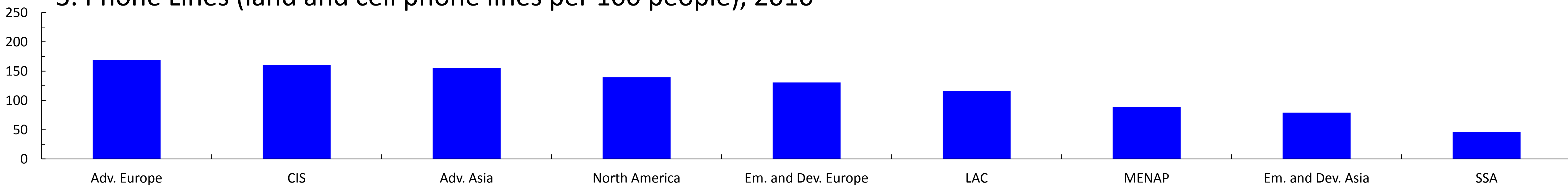
## 1. Electricity Generating Capacity (kilowatts per 100 people), 2010



## 2. Roads (kilometers per 100 people), 2010



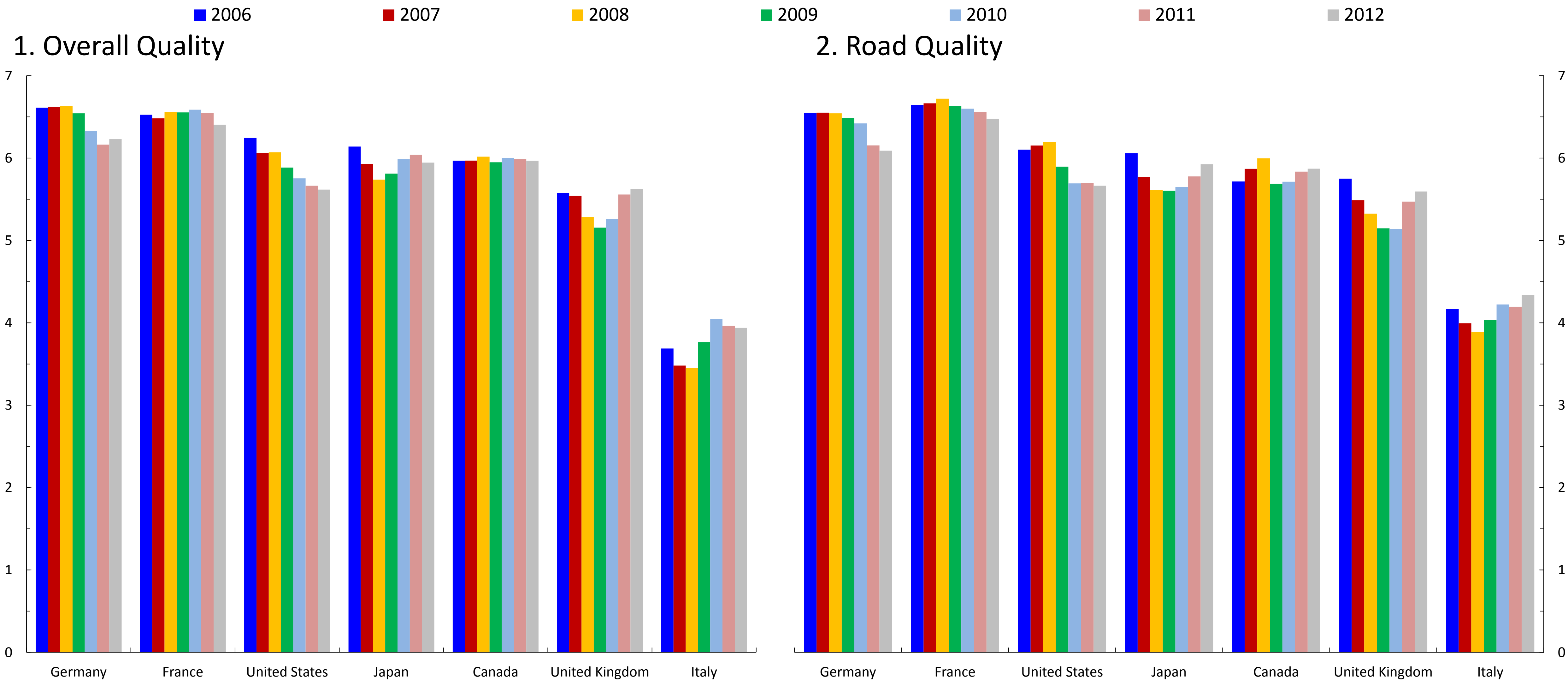
## 3. Phone Lines (land and cell phone lines per 100 people), 2010





# In some AEs the quality of infrastructure is deteriorating

**Figure 3. Quality of Infrastructure in G7 Economies** *(Scale, 1–7; higher score indicates better infrastructure)*





# **Macroeconomic Effects of Public Investment in AEs: Empirical Evidence**



# Empirical strategy

## Baseline

$$y_{i,t+k} - y_{i,t} = \alpha_i^k + \gamma_t^k + \beta^k FE_{i,t} + \varepsilon_{i,t}^k,$$

FE is fiscal shock, identified as the forecast error of public investment as share of GDP (Auerbach and Gorodnichenko 2012, 2013)

## Non-linear effects

$$y_{i,t+k} - y_{i,t} = \alpha_i^k + \gamma_t^k + \beta_1^k G(z_t) FE_{i,t} + \beta_2^k (1 - G(z_t)) FE_{i,t} + \varepsilon_{i,t}^k,$$

with

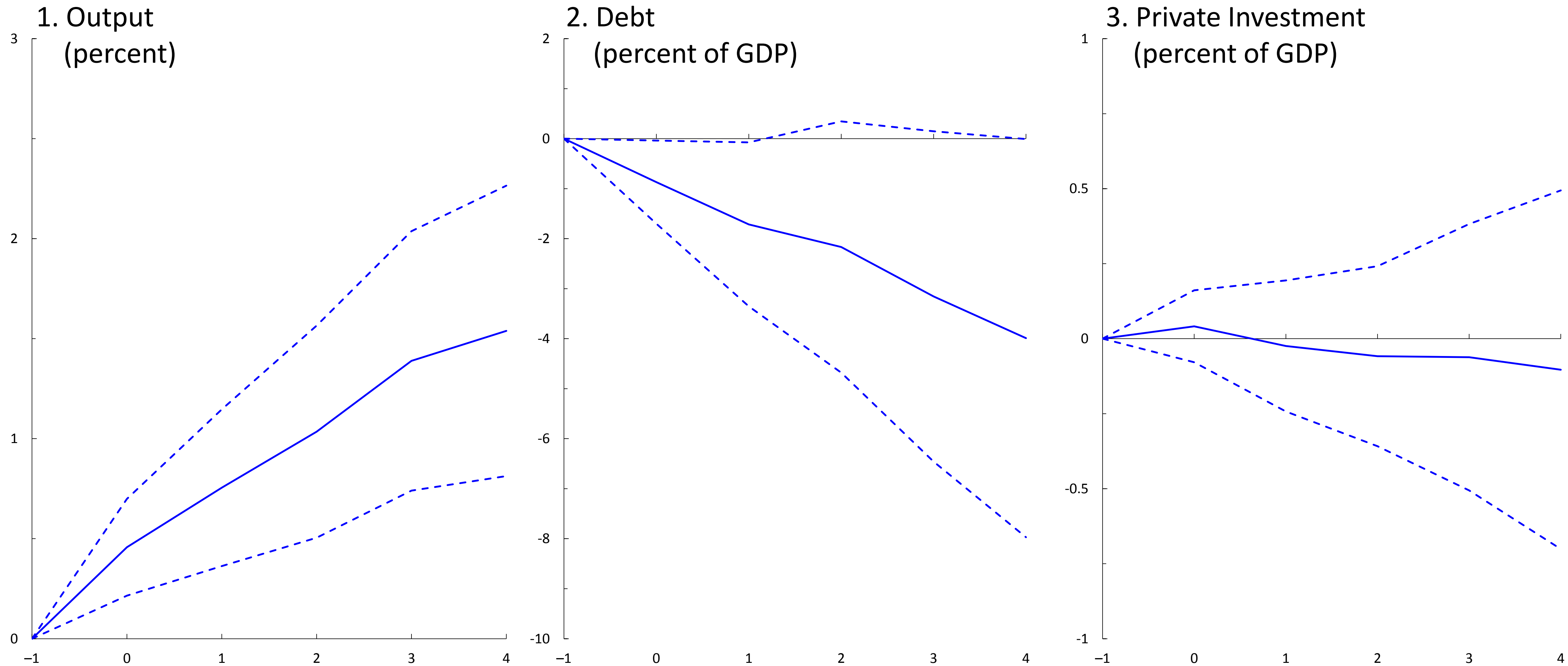
$$G(z_{it}) = \frac{\exp(\gamma z_{it})}{1 + \exp(\gamma z_{it})}, \quad \gamma > 0$$

z is an indicator of the state of the economy (or degree of public investment efficiency)



# Baseline results

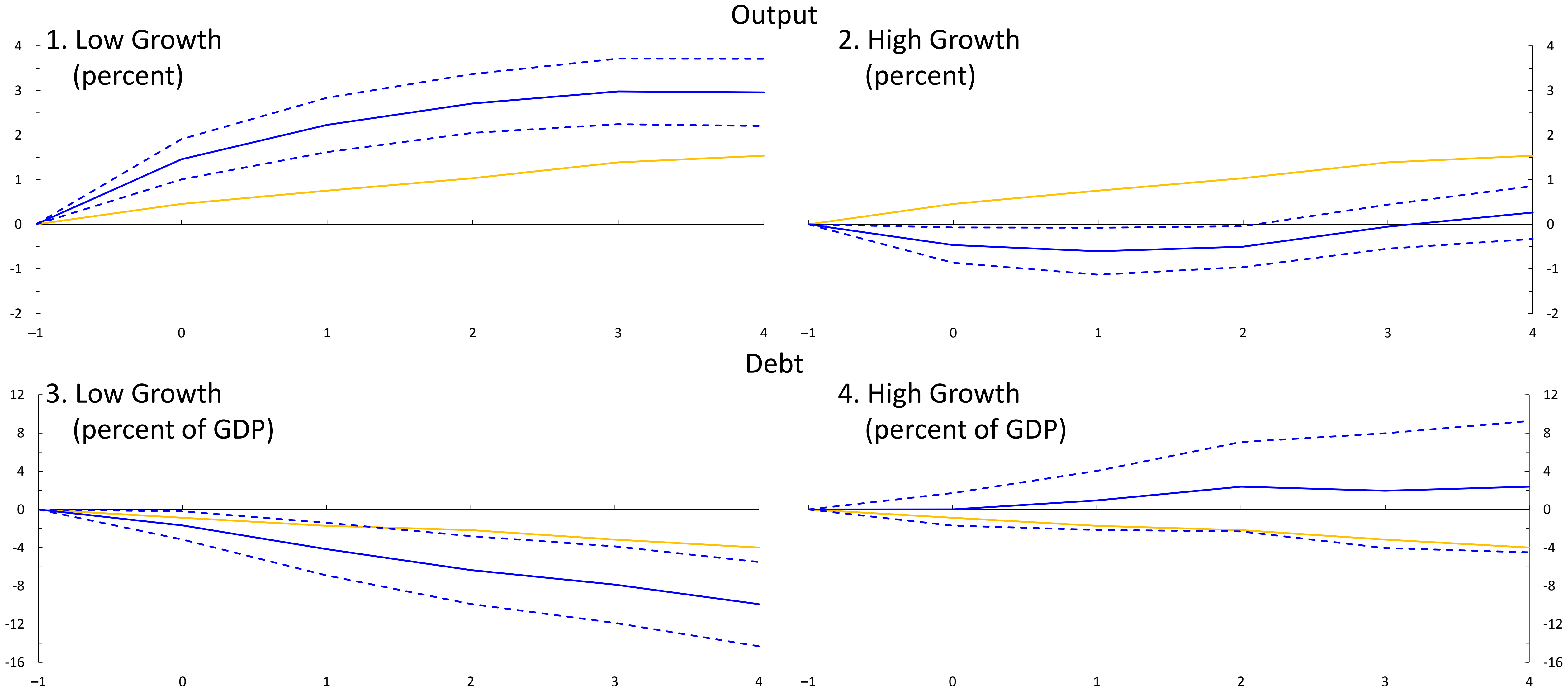
Figure 4. Effect of Public Investment in Advanced Economies (*Years on x-axis*)





# Larger effects during periods of economic slack...

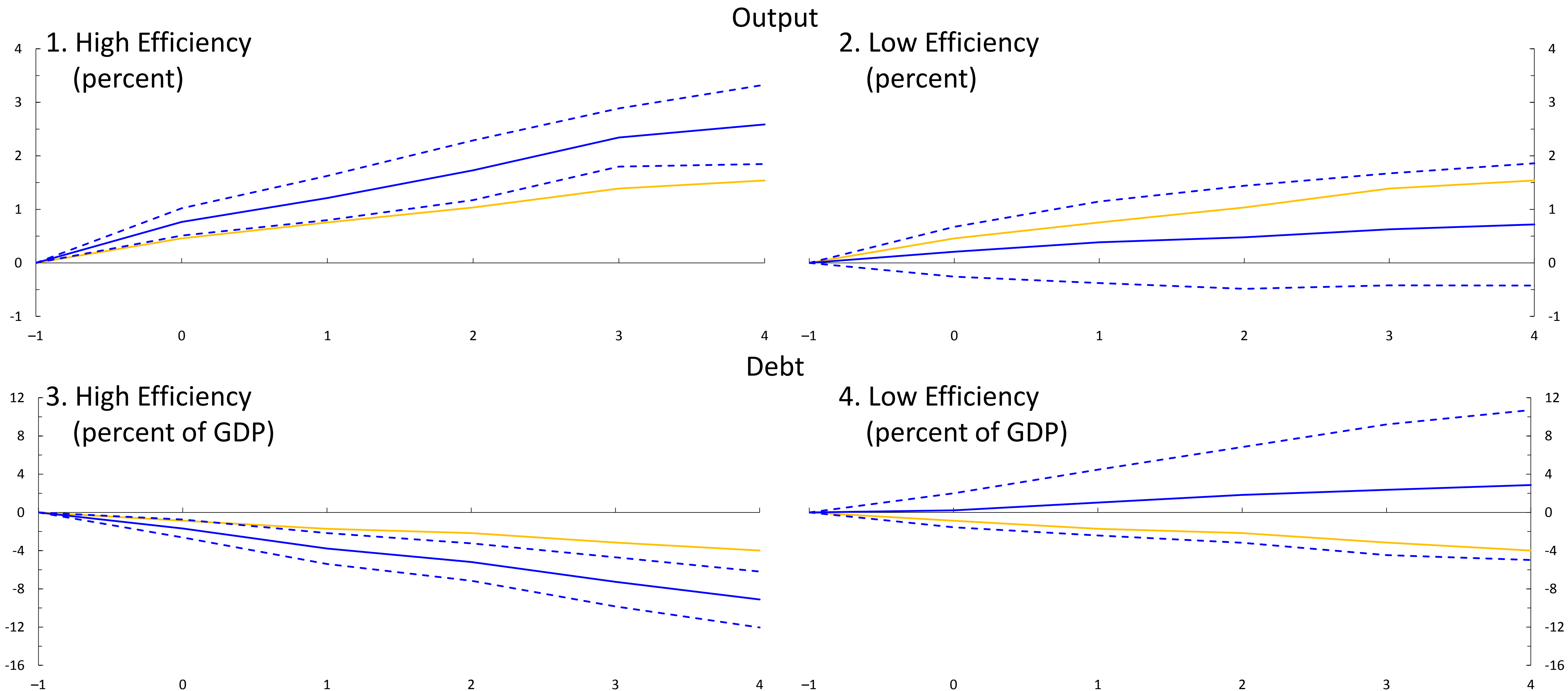
Figure 5. Effect of Public Investment in Advanced Economies: Role of Economic Conditions (*Years on x-axis*)





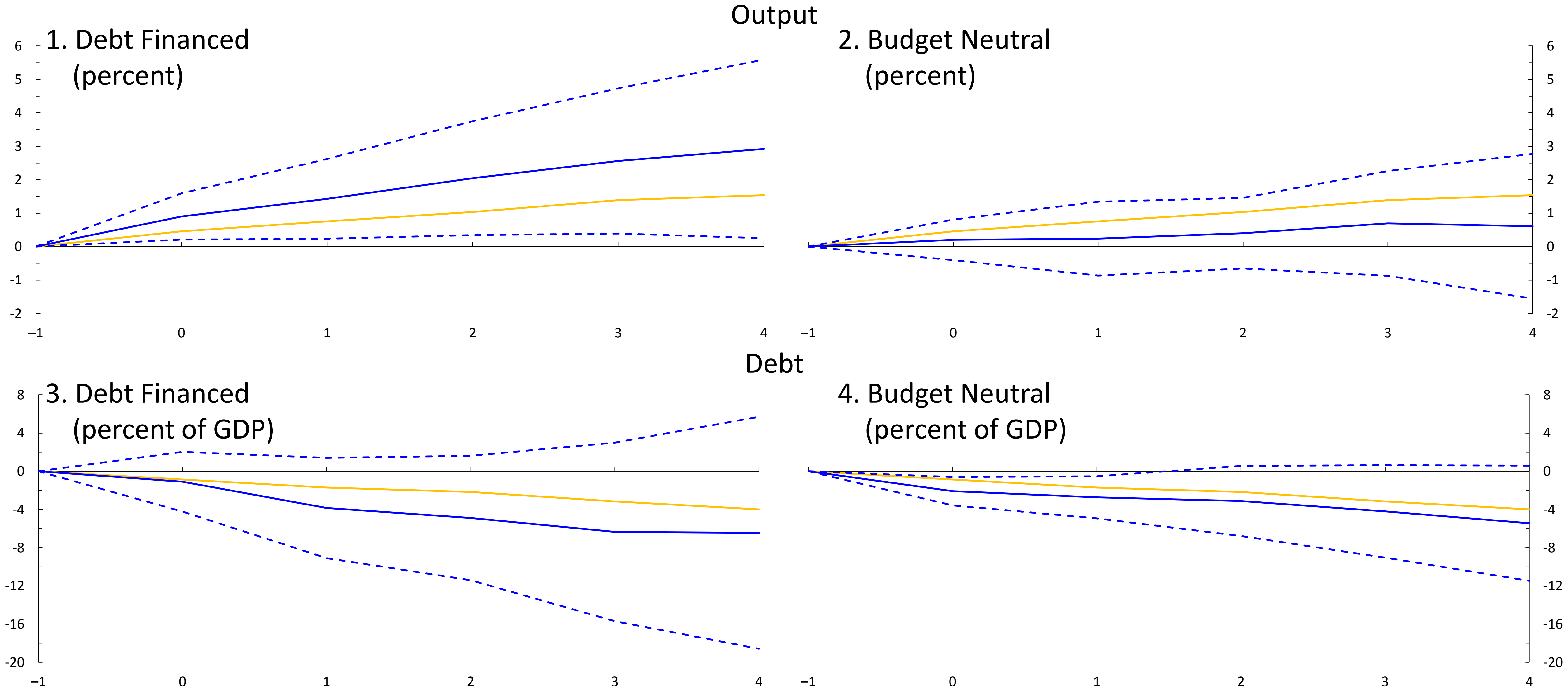
# ...and in countries with greater efficiency...

**Figure 6. Effect of Public Investment in Advanced Economies: Role of Efficiency** (*Years on x-axis*)



# ...and when is debt financed

**Figure 7. Effect of Public Investment in Advanced Economies: Role of Mode of Financing** (*Years on x-axis*)





# **Macroeconomic Effects of Public Investment in EMs and LICs: Empirical Evidence**

# Empirical strategy

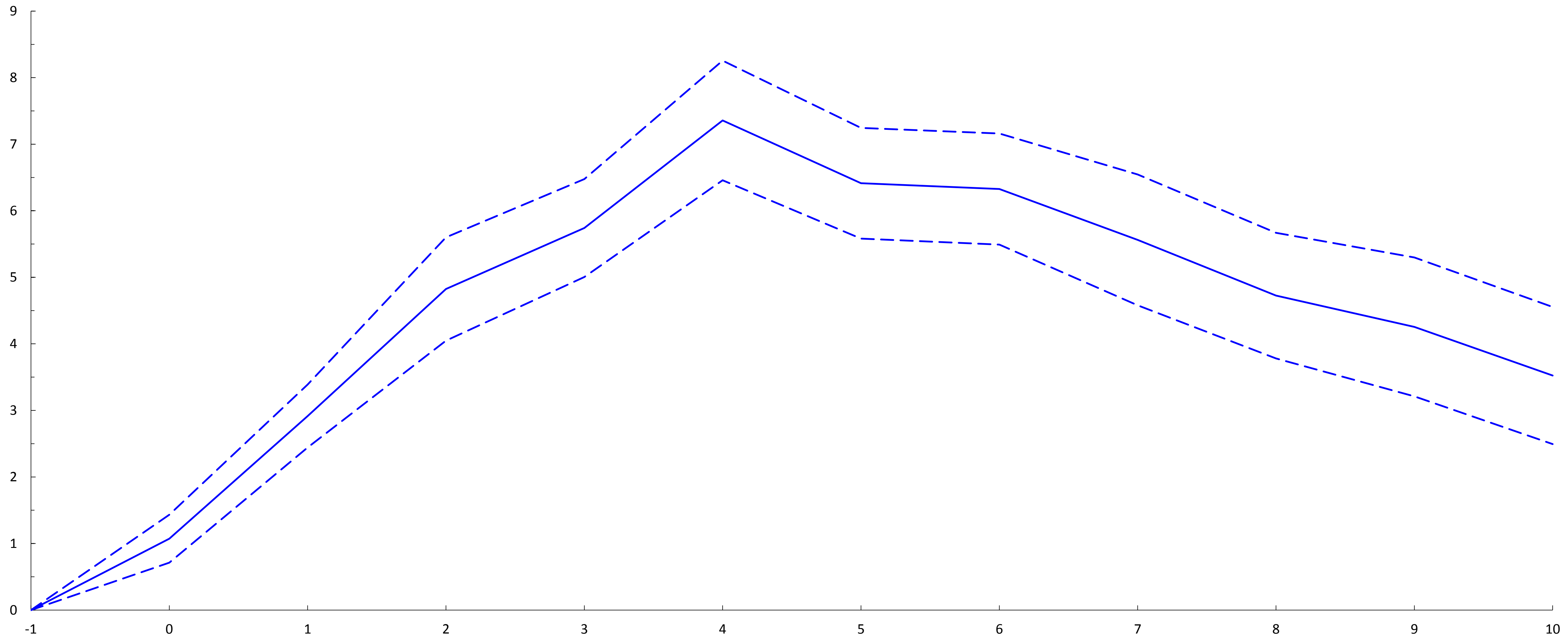
## Three complementary approaches

1. Describe the evolution of key macroeconomic variables surrounding public investment booms (Warner, 2014)
2. Identify exogenous shocks to public investment as residuals from an estimated spending rule (Corsetti, Meier and Muller, 2012)
3. Instrument public investment with the predetermined component of disbursement on loans from official creditors to developing countries (Eden and Kraay, 2014)



# Public investment booms identified as large increases in government investment spending

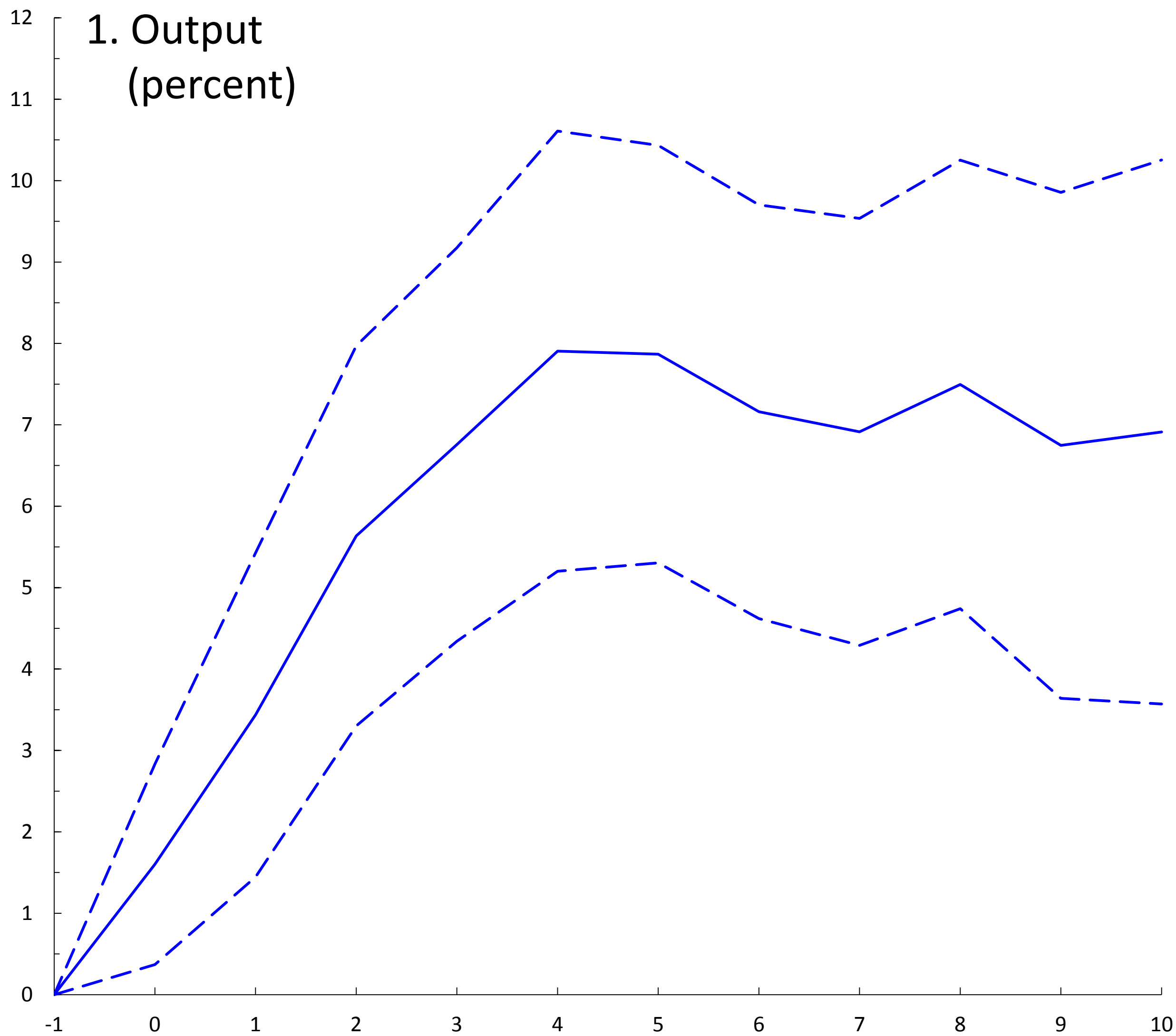
Figure 8. Public Investment (percent of GDP)



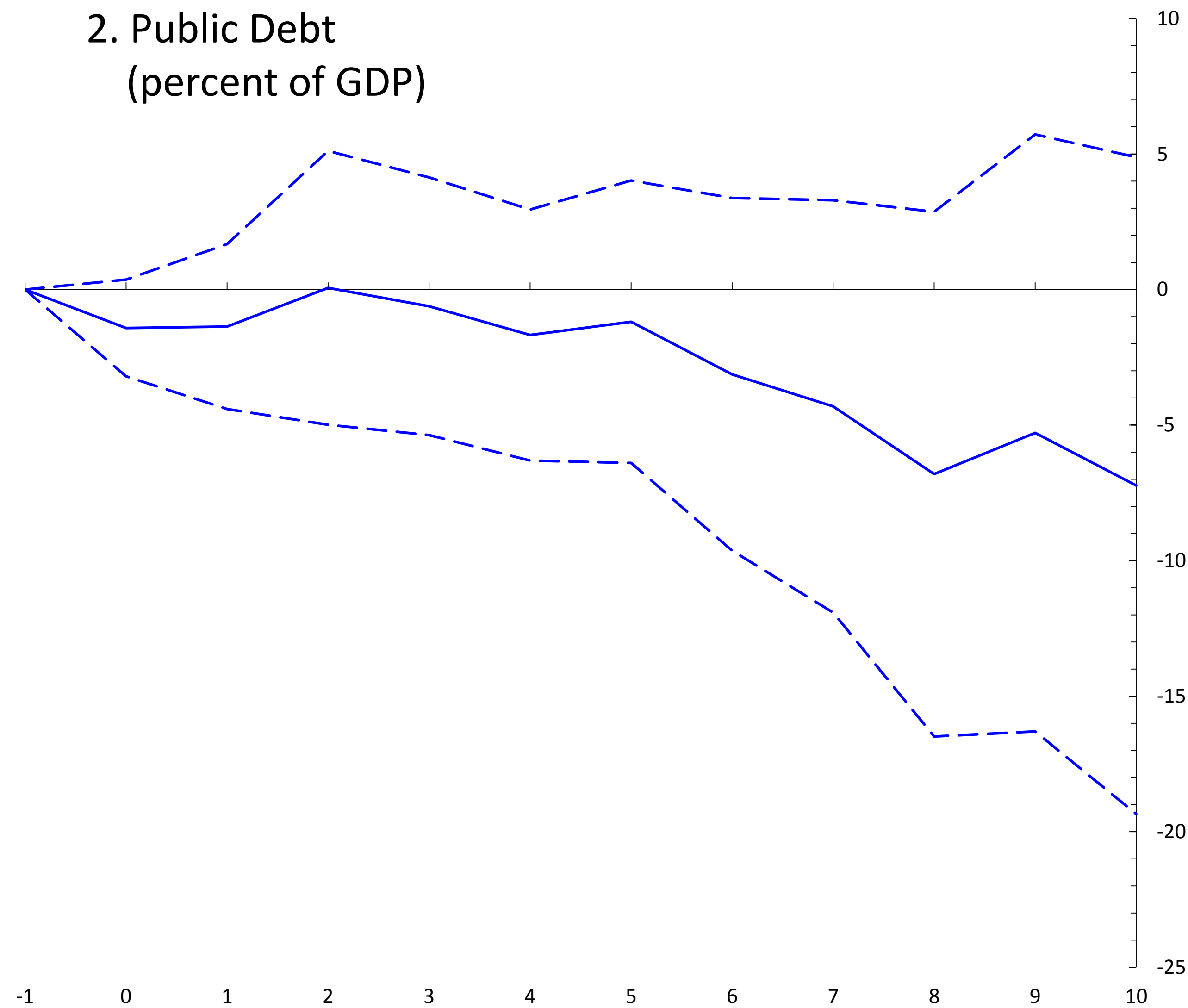
... and are accompanied by a sustained rise in the level of output, while debt levels remain unchanged

**Figure 9. Output and Public Debt in the Aftermath of Public Investment Booms** (*Years on x-axis*)

1. Output  
(percent)



2. Public Debt  
(percent of GDP)

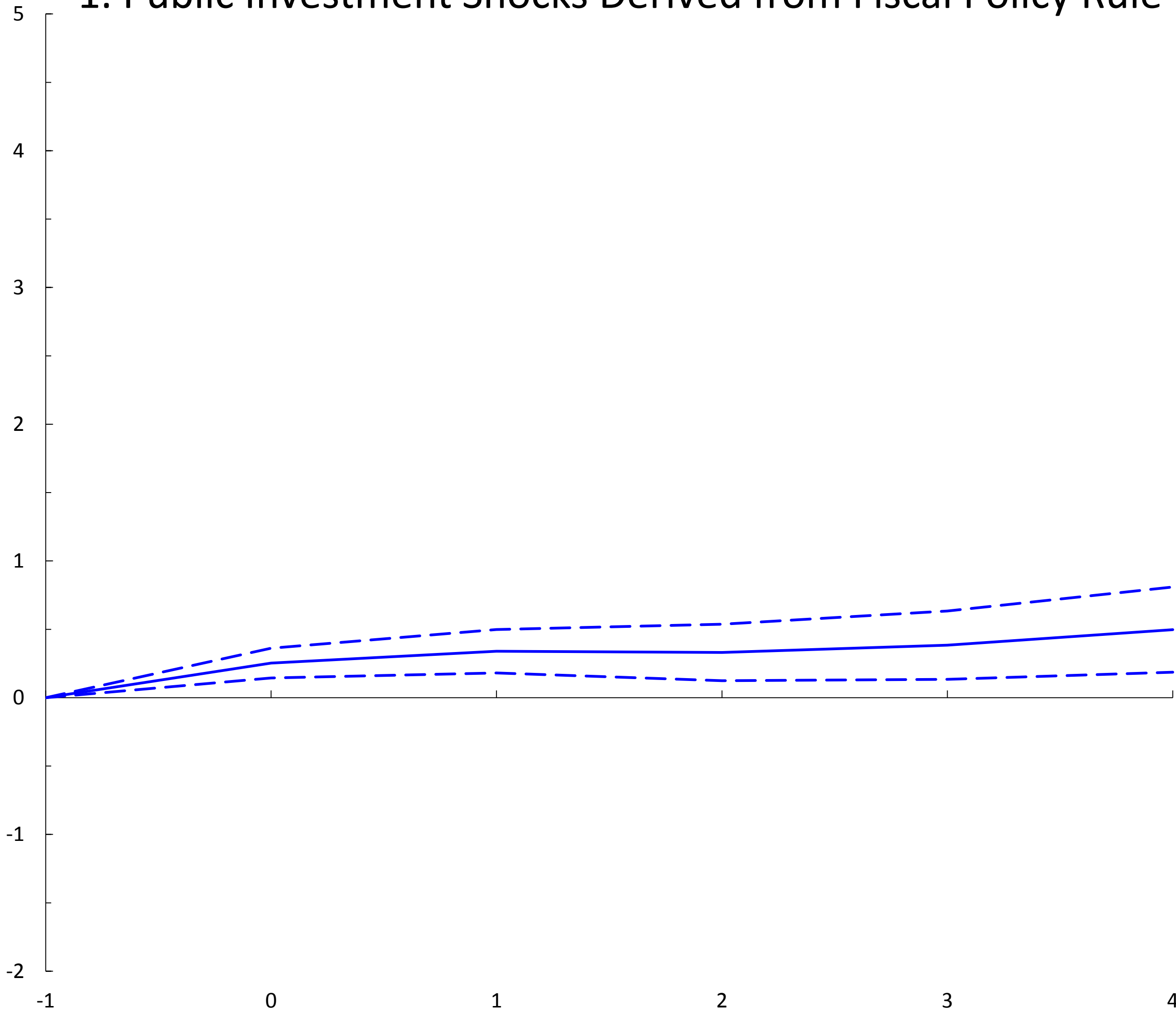




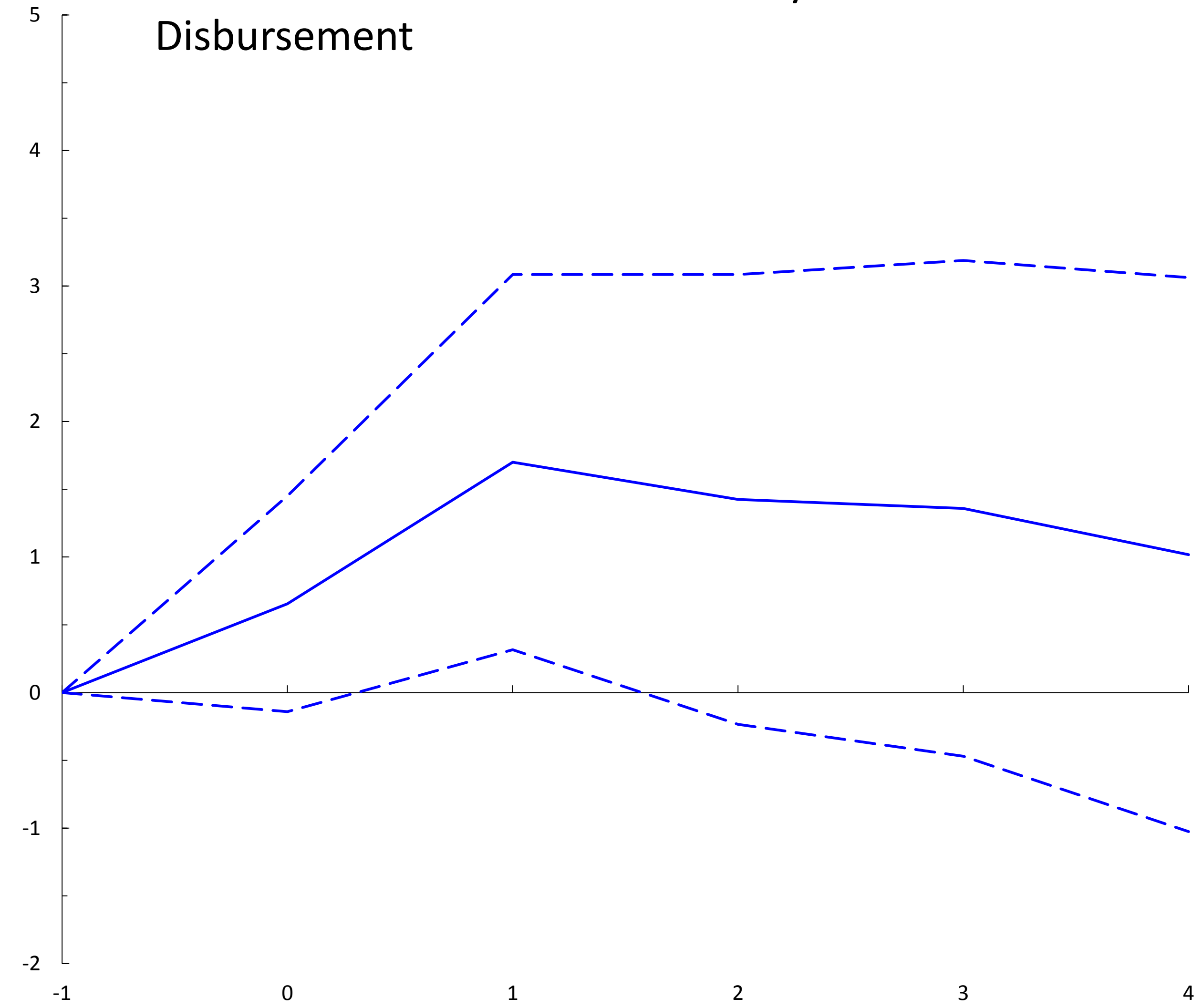
# Public investment has a positive, long lasting effect on output in EMs and LICs.

**Figure 9. Effect of Public Investment on Output in Emerging Market and Developing Economies** (*Percent; years on x-axis*)

1. Public Investment Shocks Derived from Fiscal Policy Rule



2. Public Investment Instrumented by Official Loan Disbursement





# Summary of empirical findings on macroeconomic effects of public investment

Public investment has a positive and long lasting effect on the level of output.

No evidence of rising levels of public debt or crowding out private investment.

Macroeconomic response is shaped by:

- **Degree of economic slack:** positive output effects are more pronounced when public investment is undertaken during periods of economic slack.
- **Efficiency of public investment:** countries with greater efficiency of public investment get a bigger bang for their buck.
- **How public investment is financed:** Public investment has larger output effects when it is financed by issuing debt rather than by raising taxes or cutting other spending.



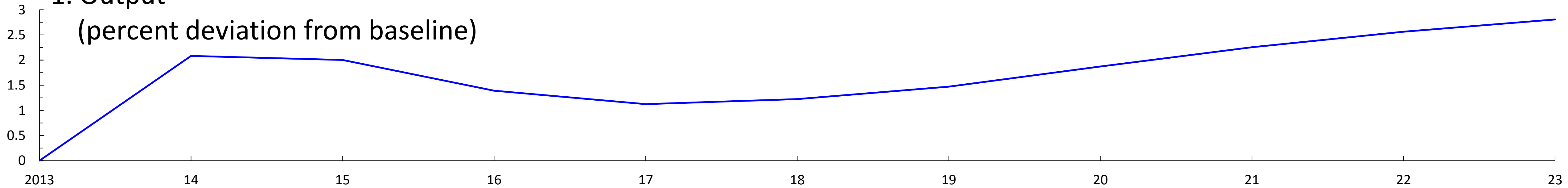
# **Macroeconomic Effects of Public Investment: Model Simulations**

# Current scenario for AEs

**Figure 10. Model Simulations: Effect of Public Investment in Advanced Economies in the Current Scenario**

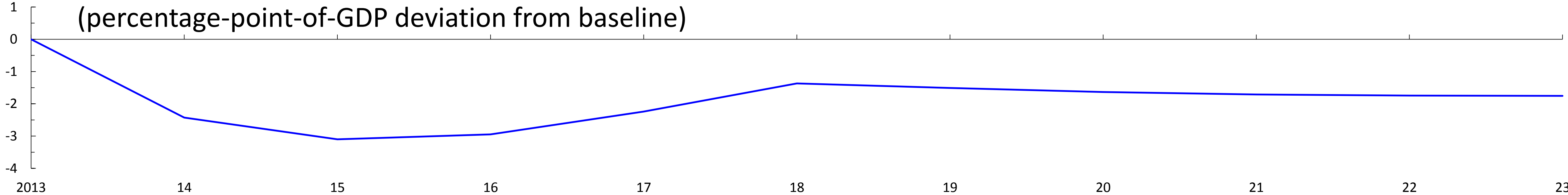
## 1. Output

(percent deviation from baseline)



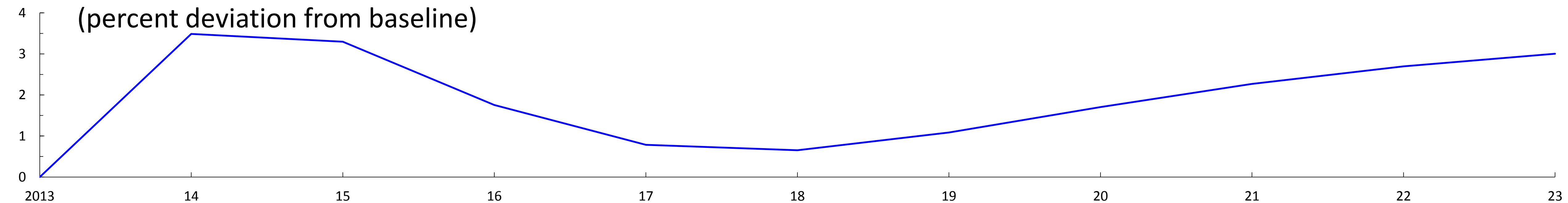
## 2. Debt

(percentage-point-of-GDP deviation from baseline)



## 3. Private Investment

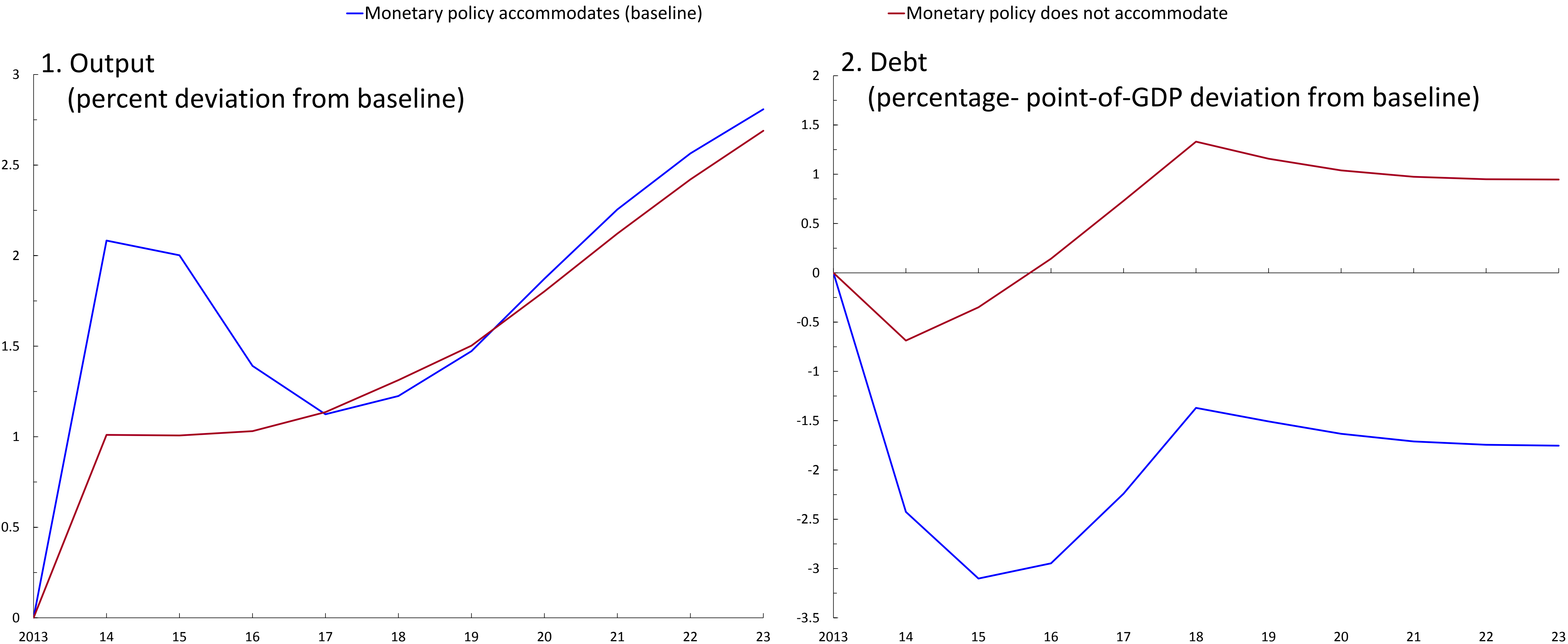
(percent deviation from baseline)





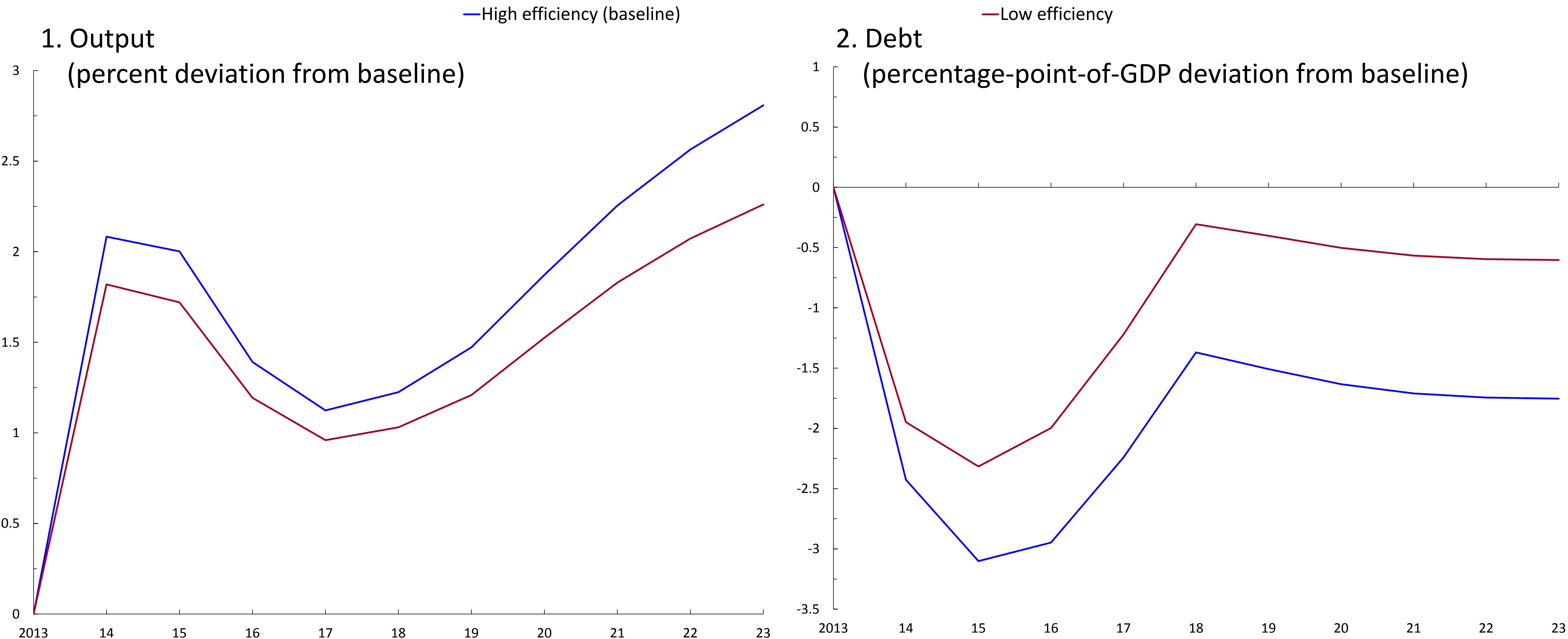
# The role of monetary policy accommodation

**Figure 11. Model Simulations: Effect of Public Investment in Advanced Economies—Role of Monetary Policy**



# The Role of Efficiency

**Figure 12. Model Simulations: Effect of Public Investment in Advanced Economies—Role of Efficiency**





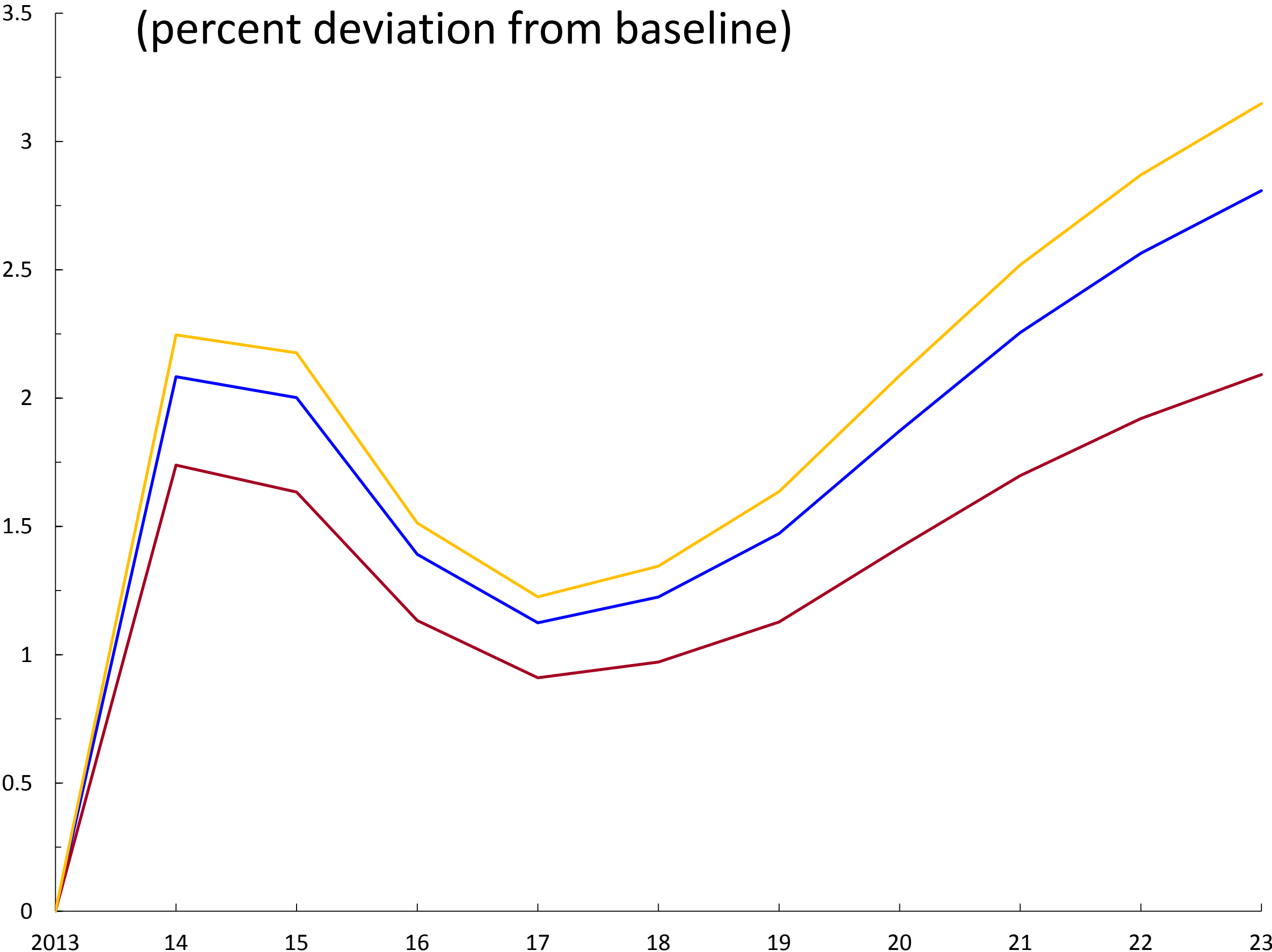
# Return on Public Capital

Figure 13. Model Simulations: Effect of Public Investment in Advanced Economies—Role of Return on Public Capital

Base line      Low return      High return

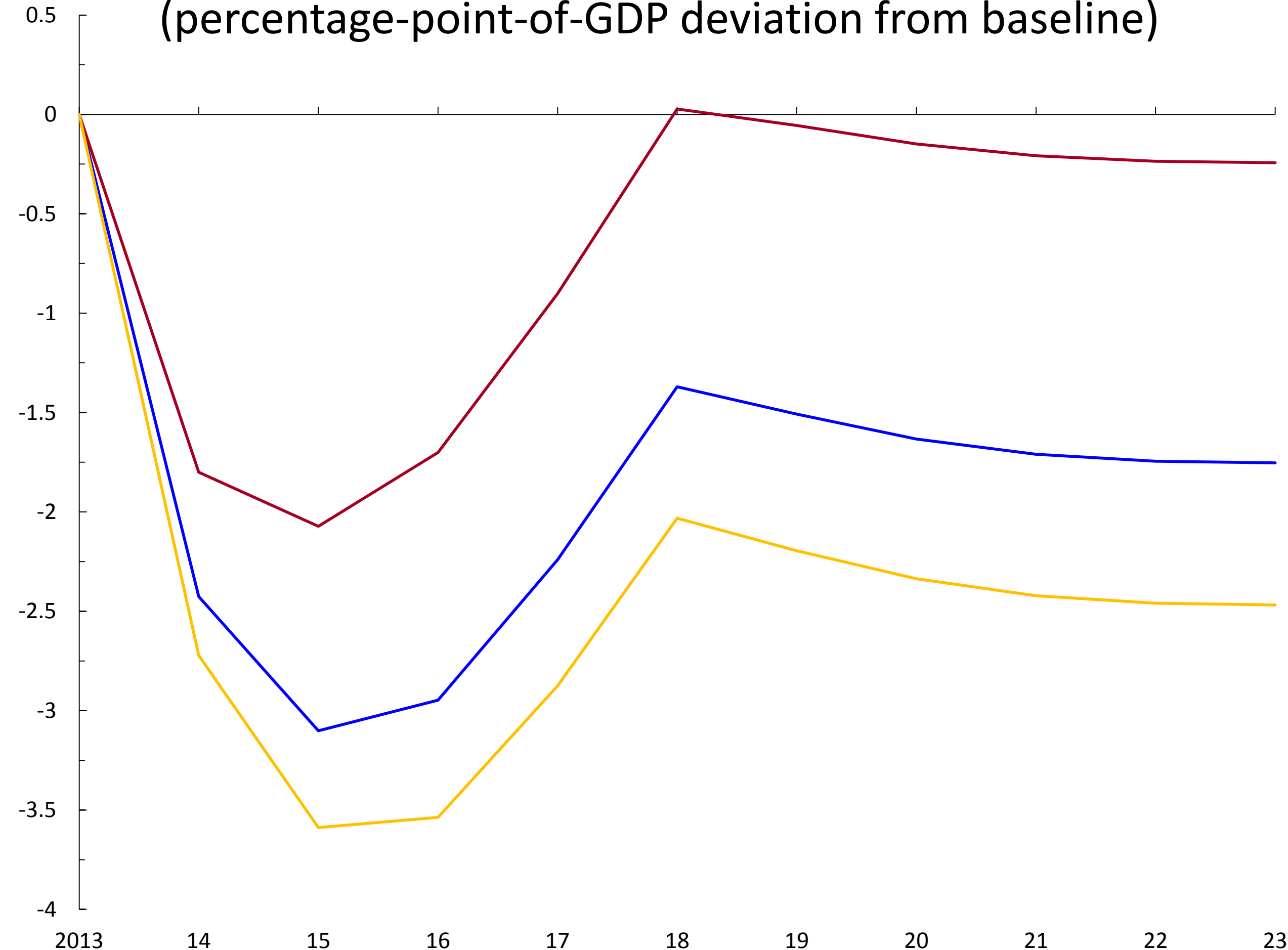
## 1. Output

(percent deviation from baseline)



## 2. Debt

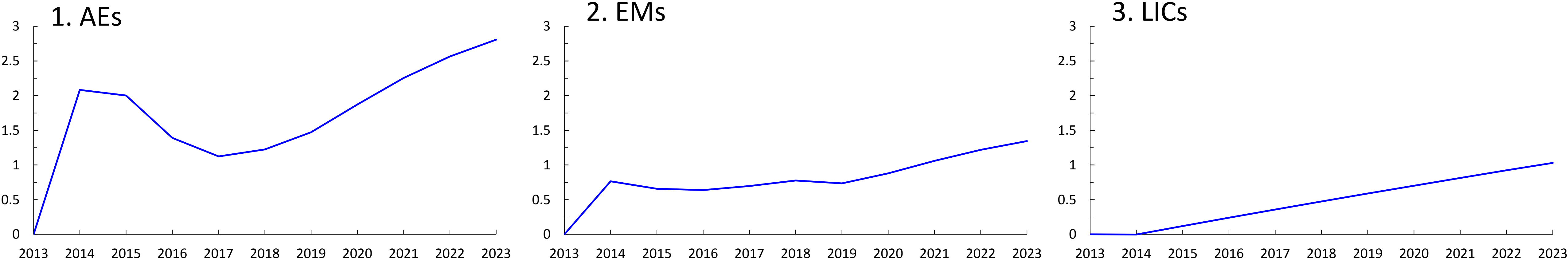
(percentage-point-of-GDP deviation from baseline)



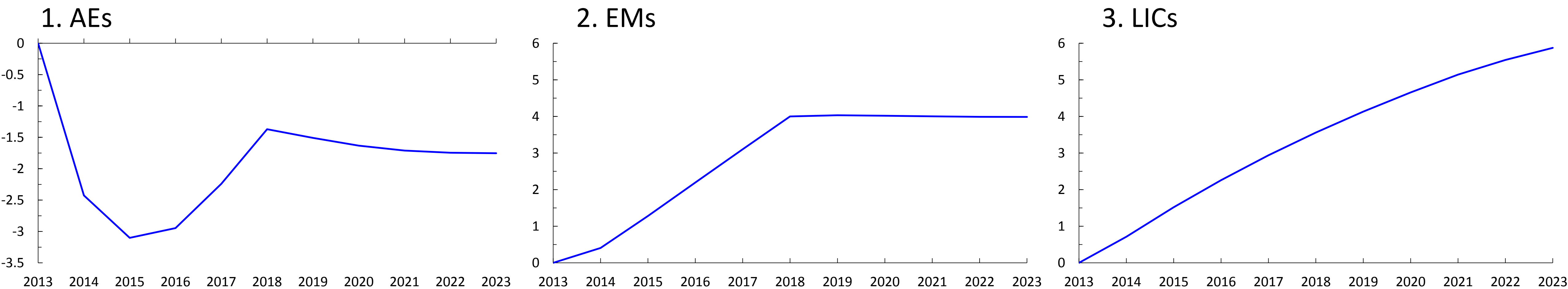
# The effect of public investment shocks in AEs, EMs and LICs

**Figure 14. Effect of Public Investment Shocks**

Output (percent deviation from baseline)



Debt (percentage-point-of-GDP deviation from baseline)





# Summary of simulation findings on macroeconomic effects of public investment

## **AEs**

- Public Investment has a positive and long lasting effect on the level of output
- Evidence of a decrease in the level of public debt and crowding in of private investment
- Larger macroeconomic responses in periods of economic slack [mp accommodates] and for greater efficiency of public investment

## **EMs and LICs**

- Public Investment has a positive and long lasting effect on the level of output, but lower effects compared to AEs
- Lower efficiency of public investment leads to a trade-off between higher output and debt

# Policy Implications



# The time is right for an infrastructure push

- For economies with clearly identified infrastructure needs and efficient public investment processes and where there is economic slack and monetary accommodation, there is a strong case for increasing public infrastructure spending.
- For these economies, the positive effects on output of increasing public infrastructure investment actually lead to a decline in public-debt-to-GDP ratios.
- Increasing the efficiency of public investment is critical to reap its full benefits. Thus, the key priority for economies with relatively low efficiency of public investment should be to raise the quality of infrastructure investment through better project appraisal, selection, and execution.





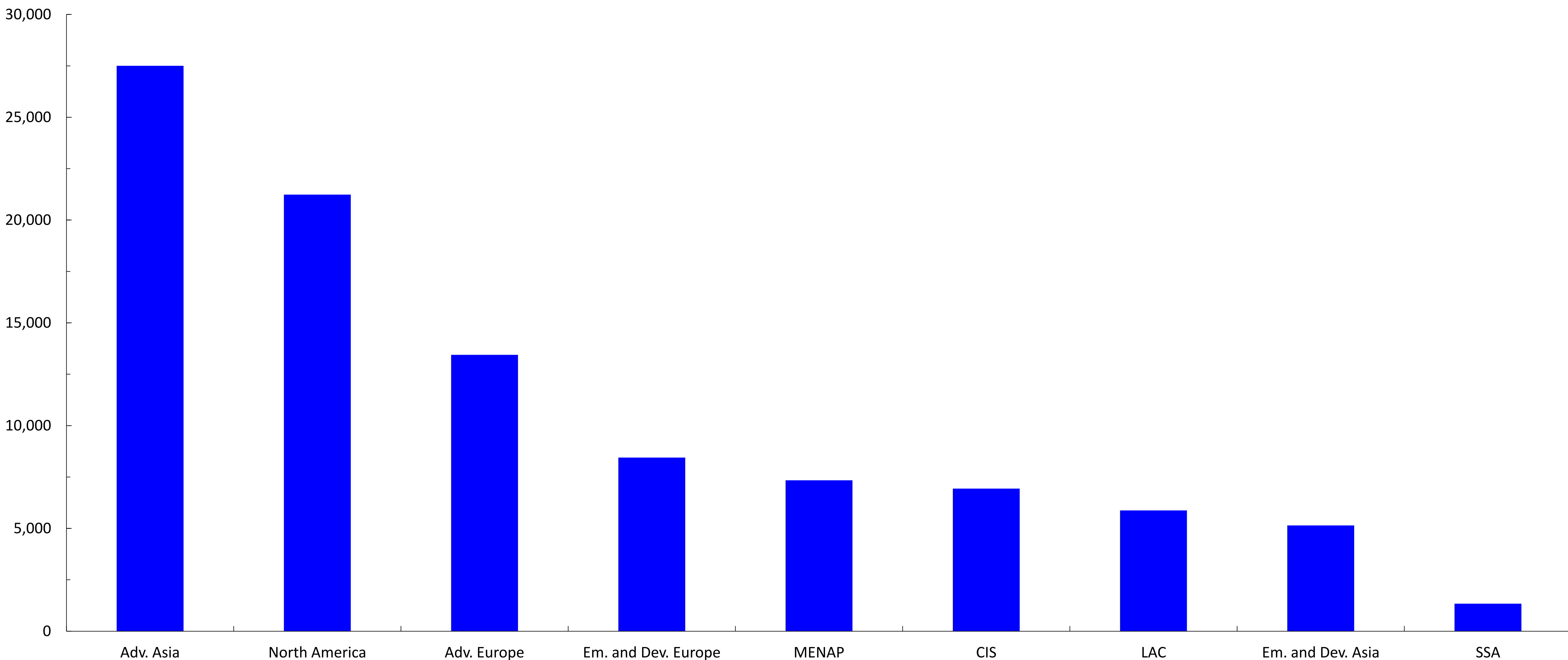
# World Economic Outlook International Monetary Fund

Thank you



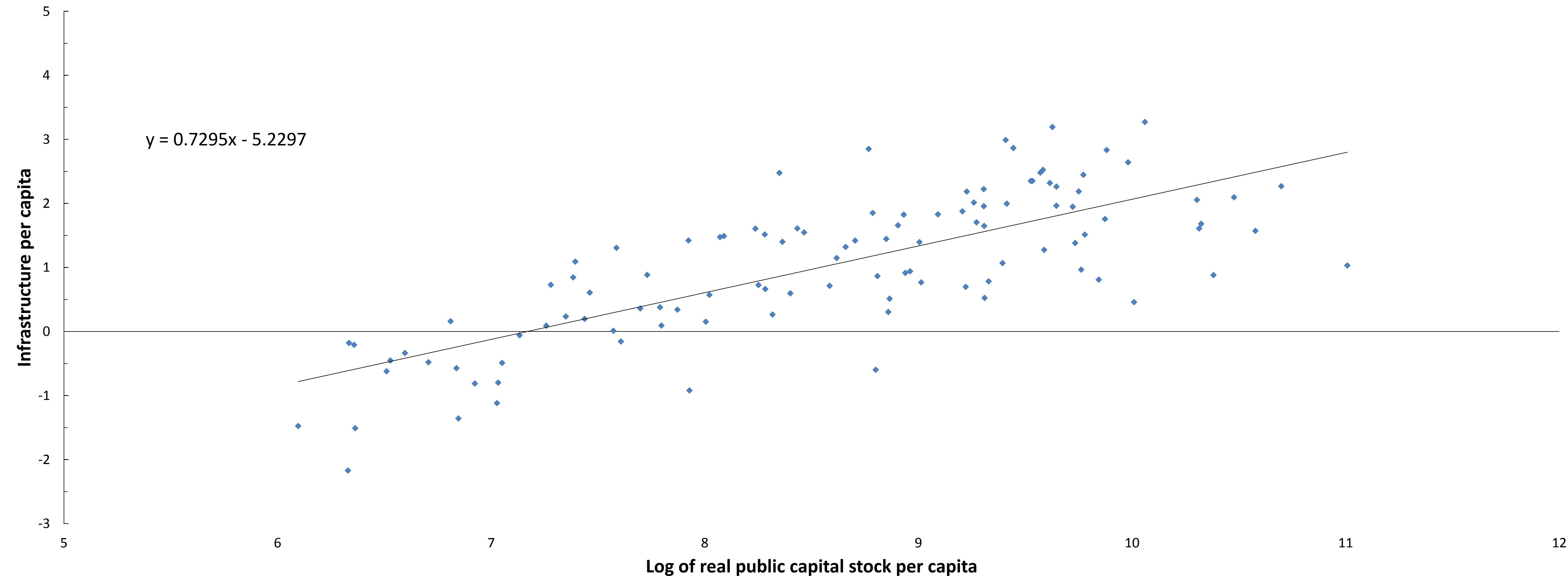
# The stock of public capital per capita is still much higher in AEs than in EMDEs...

**Figure 15. Real Per Capita Public Capital Stock, 2010** (*2005 PPP dollars per person*)



# There is a strong correlation between public capital and physical measures of infrastructure across countries.

**Figure 16. Infrastructure and Real Public Capital Stock per capita** (*average, 2005–11*)





# The macroeconomic effect of infrastructure investment: a Conceptual framework

- Infrastructure investments increases output in the short-term by boosting aggregate demand, and the debt-to-(potential) GDP ratio by:  $\Delta d = (1 - \mu\tau)\Delta i$
- Infrastructure investments increases output in the long-term by boosting aggregate supply, which will generate future tax dividends:  $\tau\Delta Y = \tau\epsilon y_o \Delta i$
- If short-term multipliers, public investment efficiency, and the elasticity of output to public capital are sufficiently high such that:  $(r - g)(1 - \mu\tau) - \tau\epsilon y_o \leq 0$

then an increase in public investment can be “self-financing” in that it leads to a reduction in the debt-to-GDP ratio

# Macroeconomic Effects of Public Investment Shocks in AEs



# AEs results- robustness checks

**Table 1. Effect of Public Investment on Output in Advanced Economies: Robustness**

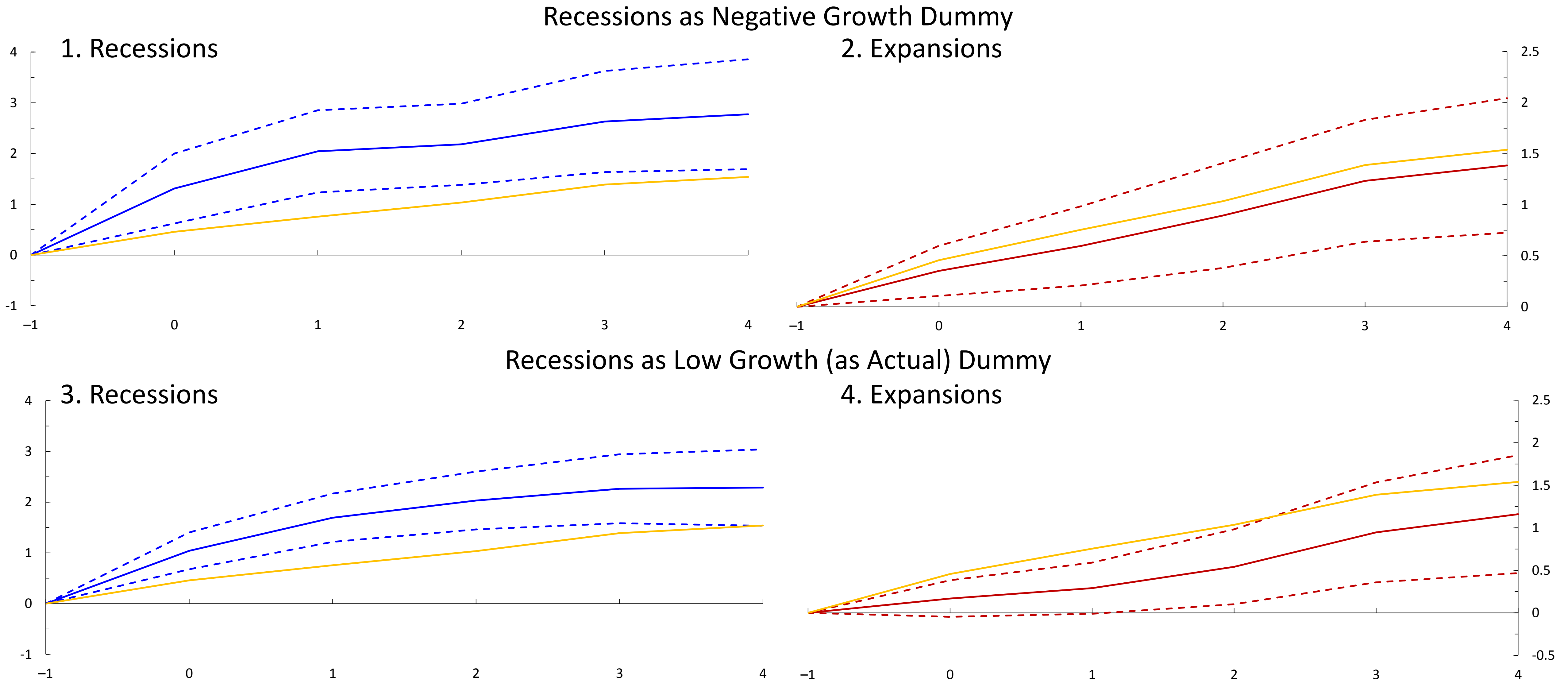
	Baseline	April forecast	Previous October Forecast	Purging Forecast Errors of Forecast Errors in			Negative Shocks
				Growth	Demand components <sup>1</sup>	Positive Shocks	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Impact of public investment shock on output at $k =$							
0	0.457 (0.147)	0.264 (0.160)	0.332 (0.118)	0.418 (0.147)	0.502 (0.143)	1.013 (0.447)	0.316 (0.181)
1	0.755 (0.238)	0.581 (0.216)	0.697 (0.216)	0.702 (0.241)	0.844 (0.264)	1.240 (0.619)	0.584 (0.309)
2	1.035 (0.322)	0.966 (0.270)	1.004 (0.288)	0.993 (0.323)	1.241 (0.339)	1.576 (0.763)	0.888 (0.431)
3	1.389 (0.394)	1.099 (0.349)	1.124 (0.330)	1.354 (0.393)	1.625 (0.405)	1.706 (0.754)	1.242 (0.547)
4	1.539 (0.441)	1.318 (0.402)	1.219 (0.383)	1.507 (0.439)	1.864 (0.489)	1.459 (0.715)	1.393 (0.617)

<sup>1</sup> Demand components include private consumption, investment, and government consumption.



# AEs results- robustness checks

**Figure 17. Effect of Public Investment Shocks on Output, Recessions vs. Expansions: Robustness Checks** (*Percent; years on x-axis*)

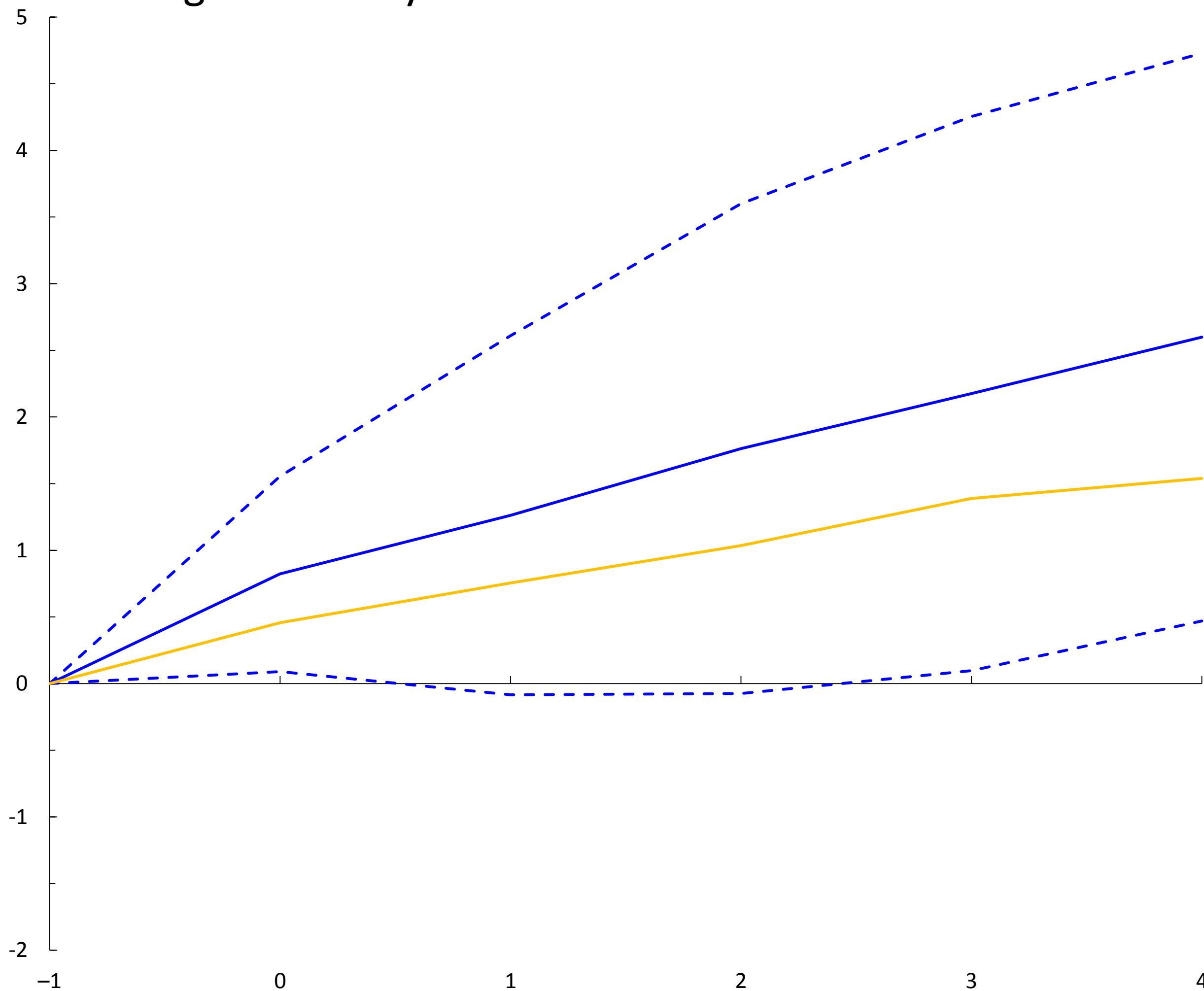




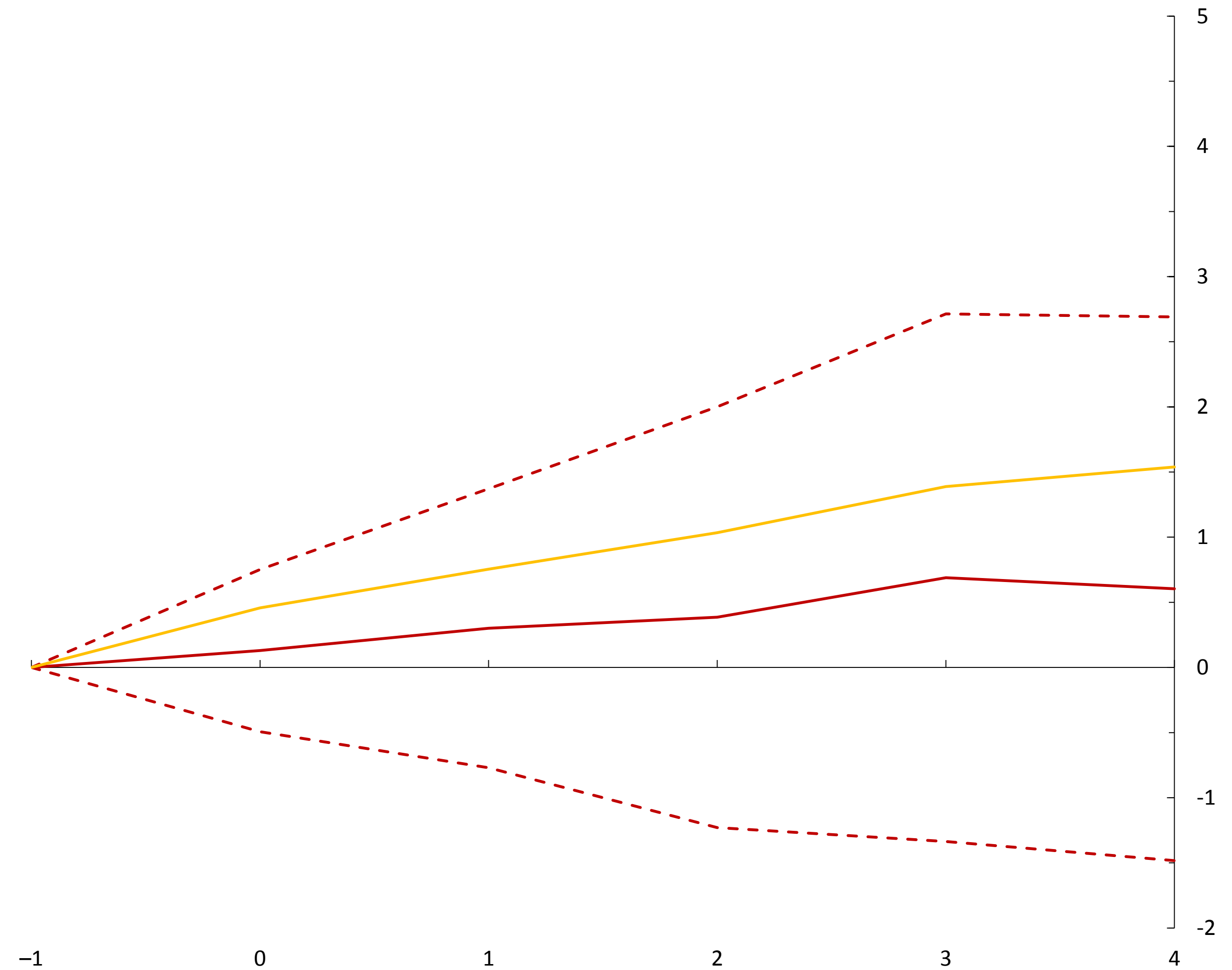
# AEs results- robustness checks

**Figure 18. Effect of Public Investment Shocks on Output, High vs. Low Efficiency: Robustness Checks** (*Percent; years on x-axis*)

1. High Efficiency

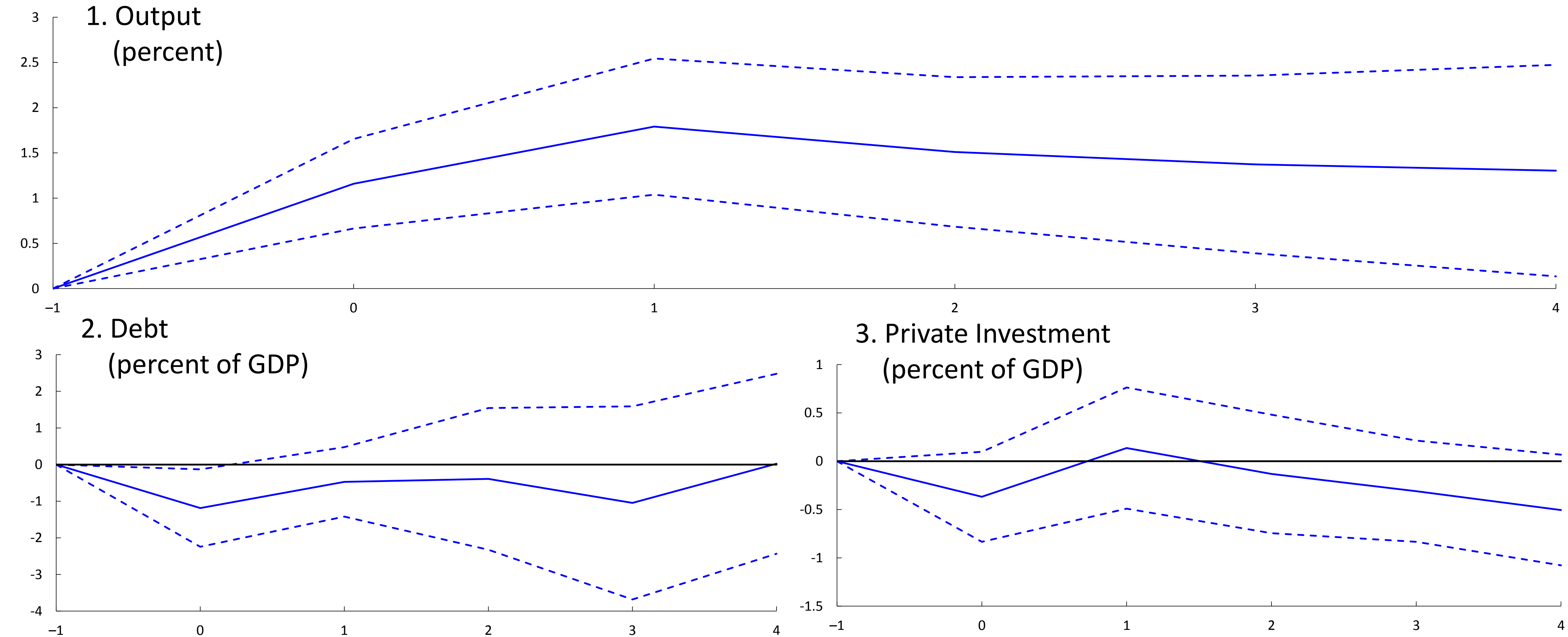


2. Low Efficiency



# AEs results- robustness checks

Figure 19. Effect of Changes in Public Investment in Advanced Economies (*Years on x-axis*)

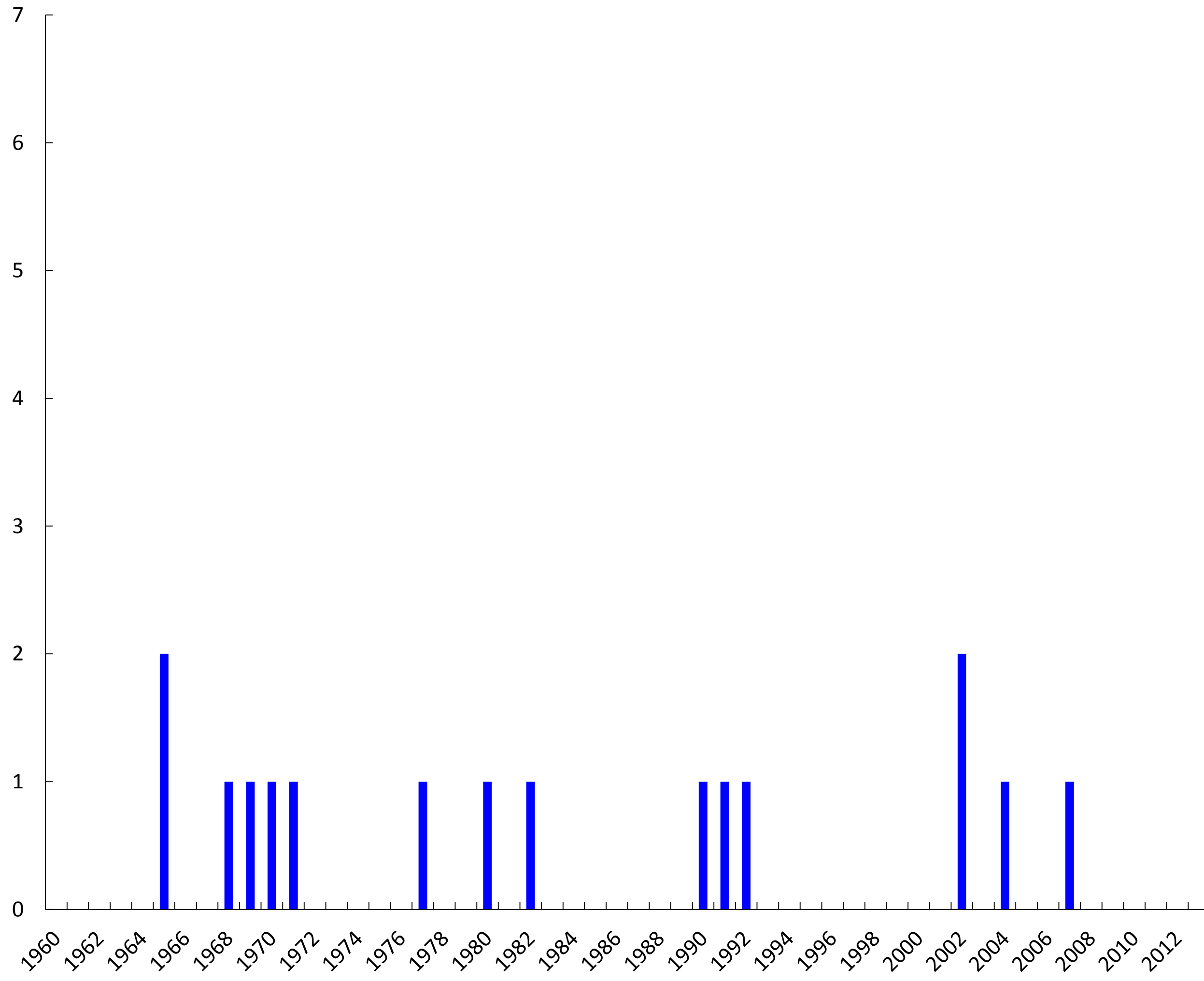




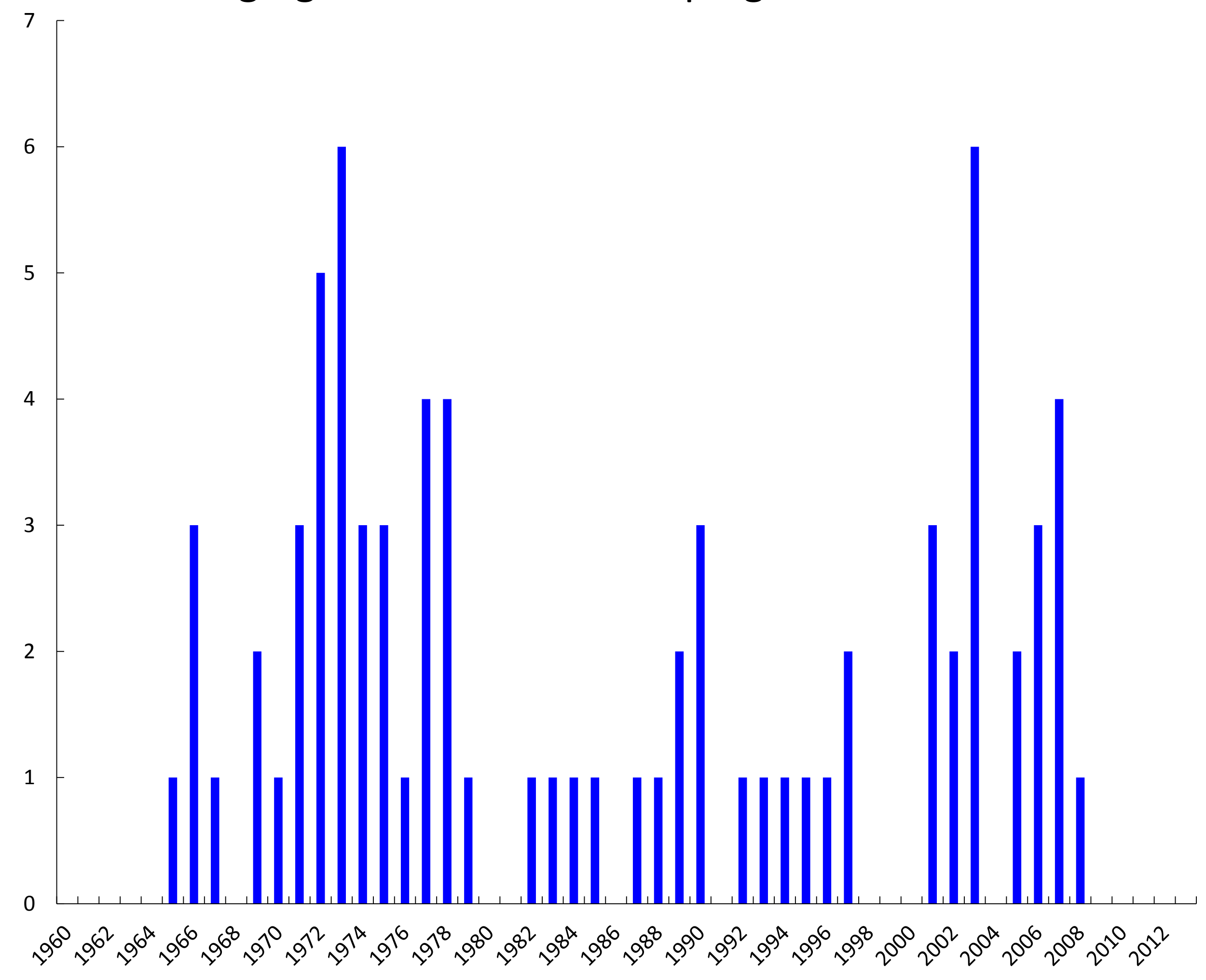
# Distribution of public investment booms

Figure 20. Distribution of Public Investment Booms over Time (*Number of Countries*)

## 1. Advanced Economies

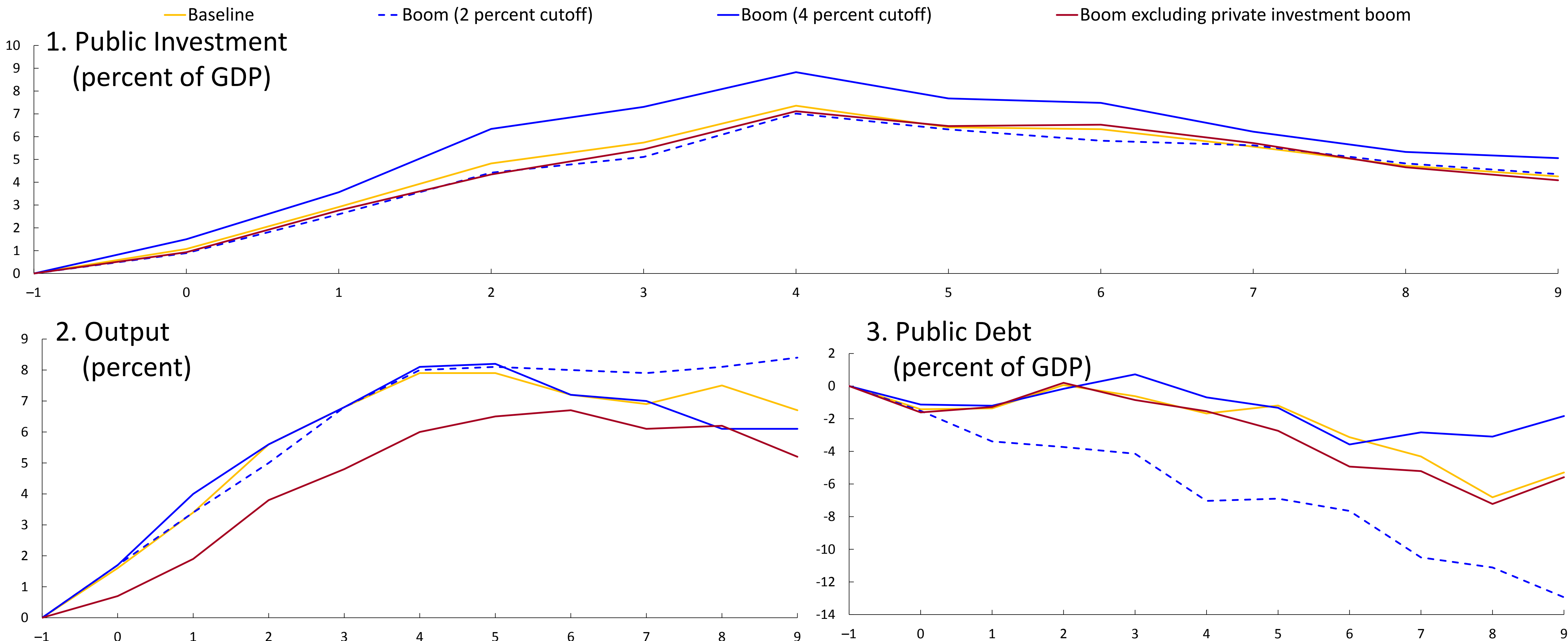


## 2. Emerging Market and Developing Economies



# Effects of public investment booms-robustness checks

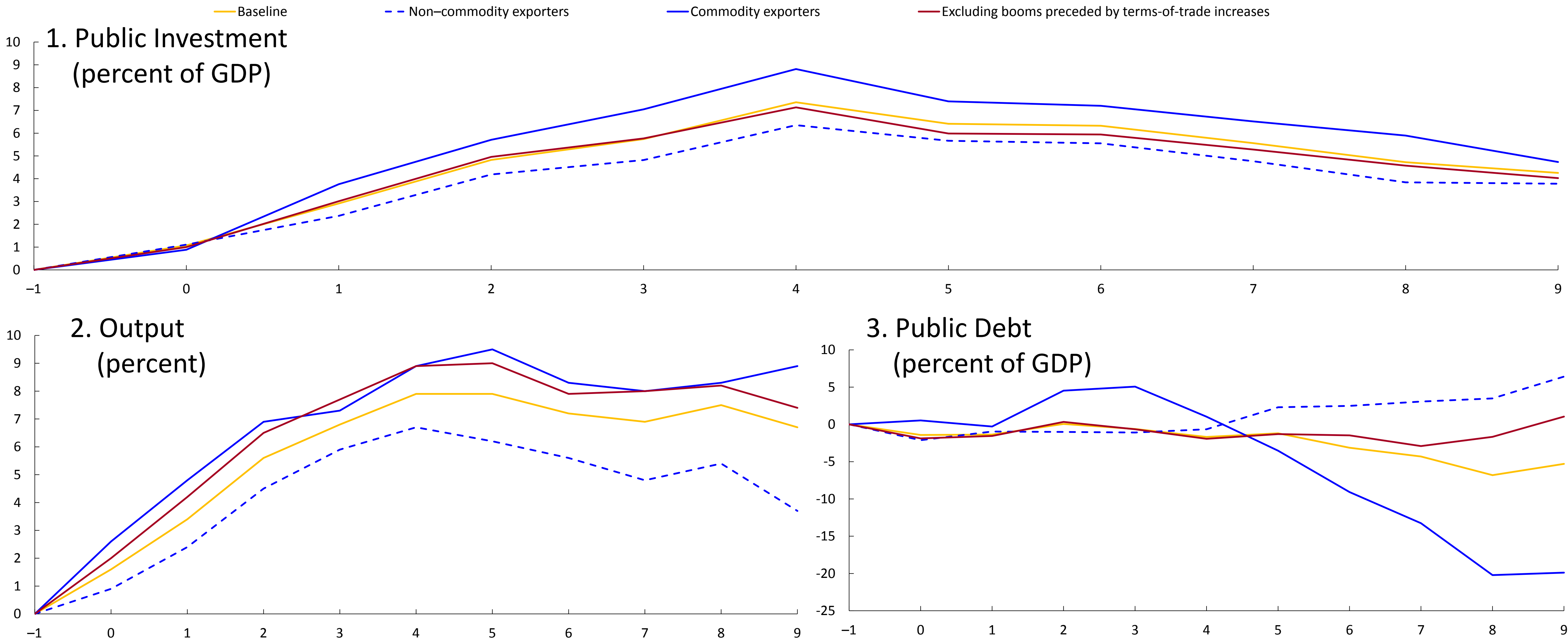
**Figure 21. Output and Public Debt in the Aftermath of Public Investment Booms: Robustness Checks** (*Years on x-axis*)





# Effects of public investment booms-robustness checks

**Figure 22. Output and Public Debt in the Aftermath of Public Investment Booms: Role of Natural Resources** (*Years on x-axis*)





# Effects of public investment in EMDs-robustness checks

**Table 2. Effect of Public Investment on Output in Emerging Market and Developing Economies: Public Investment Shocks Derived from a Fiscal Policy Rule**

k	Baseline 1/		Full sample		Top and Bottom 5 Percent of Shocks Trimmed	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
	(1)	(2)	(3)	(4)	(5)	(6)
−1	0	0	0	0	0	0
0	0.252	(0.066)	0.144	(0.074)	0.324	(0.100)
1	0.340	(0.096)	0.193	(0.086)	0.571	(0.142)
2	0.331	(0.126)	0.187	(0.100)	0.567	(0.191)
3	0.384	(0.152)	0.225	(0.119)	0.728	(0.238)
4	0.497	(0.189)	0.239	(0.174)	1.010	(0.313)

Note: Columns (1), (3), and (5) present the estimated coefficients on the public investment shock from a series of regression estimates for each k in {0,4}. Standard errors (SEs) of the estimated coefficients, which are shown in columns (2), (4), and (6), are corrected for heteroscedasticity and clustered at the country level. There are 128 economies in the sample, with data from 1990–2013. All regressions include a full set of country and year fixed effects. k = 0 is the year of the shock.

<sup>1</sup>In the baseline specification, the top and bottom 1 percent of public investment shocks are trimmed.



# Effects of public investment in EMDs-robustness checks

**Table 3. Effect of Public Investment on Output in Emerging Market and Developing Economies: Public Investment Instrumented by Predicted Official Loan Disbursement**

	Baseline	High Disbursement Countries	IDA
	(1)	(2)	(3)
<b>1. First Stage: Dependent Variable—Change in Public Investment as Percent of GDP</b>			
Change in Predicted Disbursements	0.146 (0.063)	0.170 (0.070)	0.122 (0.063)
First stage F-statistic	3.705	5.344	7.217
Number of Observations	3,245	2,294	1,864
Number of Countries	95	66	58
<b>2. Two-Stage Least Squares: Dependent Variable—Output Growth</b>			
Impact of Change in Public Investment on Output at k =			
0	0.655 (0.484)	0.716 (0.418)	0.765 (0.641)
1	1.700 (0.841)	1.691 (0.748)	1.801 (1.146)
2	1.425 (1.009)	1.570 (0.912)	1.396 (1.329)
3	1.359 (1.112)	1.700 (1.017)	1.156 (1.534)
4	1.018 (1.243)	1.548 (1.112)	0.438 (1.675)

Source: IMF staff calculations.

Note: k = 0 is the year of the change in public investment instrumented by the change in predicted loan disbursement. Panel (1) reports ordinary least-squares estimates of the first-stage regression of change in public investment on change in predicted loan disbursements. Panel (2) shows the two-stage least-squares estimates of the effect of change in public investment on real output from a series of regressions estimated for each k in {0,4}. Standard errors (in parentheses) are corrected for heteroscedasticity and clustered at the country level. Data are from 1970–2010. All regressions include a full set of country and year fixed effects. Results from three different samples are presented in columns (1), (2), and (3)—respectively, the full set of countries, only countries where disbursements of loans from official creditors

# **Macroeconomic Effects of Public Investment Shocks- Model Simulations**



# Technical assumptions

## **AEs : US, Japan and euro area(GIMF)**

- Elasticity of government capital to output= 0.17 [alternatives: 0.122, 0.193, Bonn and Ligthart (2013)]
- No waste [i.e. all public investment is productive [alternative 23% of investment is wasteful ,WEF]
- Monetary policy accommodates for the first 2 years [alternatives, mp policy tightens immediately]
- Steady state short real interest rate at 1%
- Investment shock is debt financed for the first 5 years. Debt is stabilized and general transfers adjust afterward

## **EMs : Emerging Asia and LAC (GIMF)**

- Elasticity of government capital to output= 0.17
- 35% of investment is wasteful [average PIMI]
- Steady state short real interest rate at 1%
- MP tightens immediately
- Investment shock is debt financed for the first 5 years. Debt is stabilized and general transfers adjust afterward

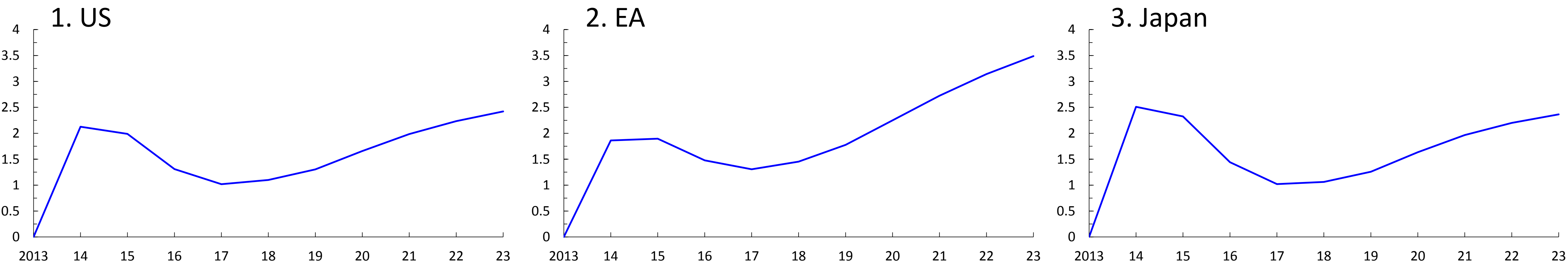
## **LICs (Buffie et al. 2012)**

- Elasticity of government capital to output= 0.17
- 50% of investment is wasteful [average PIMI]
- 50 percent of investment shock financed by concessional loans, 50 percent by raising VAT

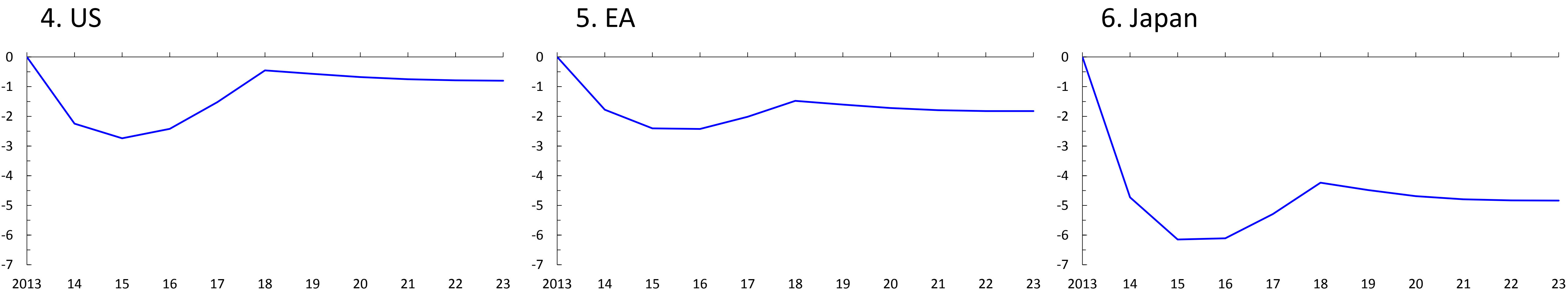
# Current scenario for US, EA, Japan

Figure 23. Effect of Public Investment in US, Euro Area, and Japan in the Current Scenario

Output (percent deviation from baseline)



Debt (percentage-point-of-GDP deviation from baseline)





# The Role of Fiscal Institutions

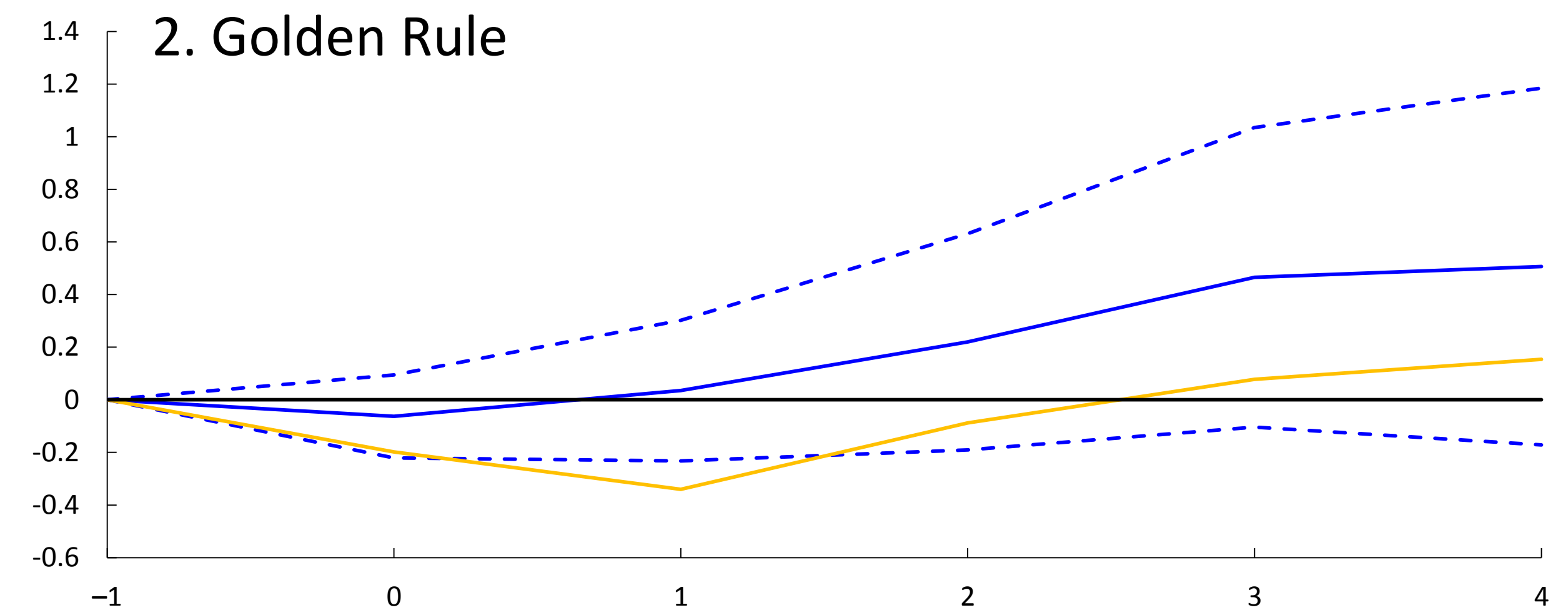
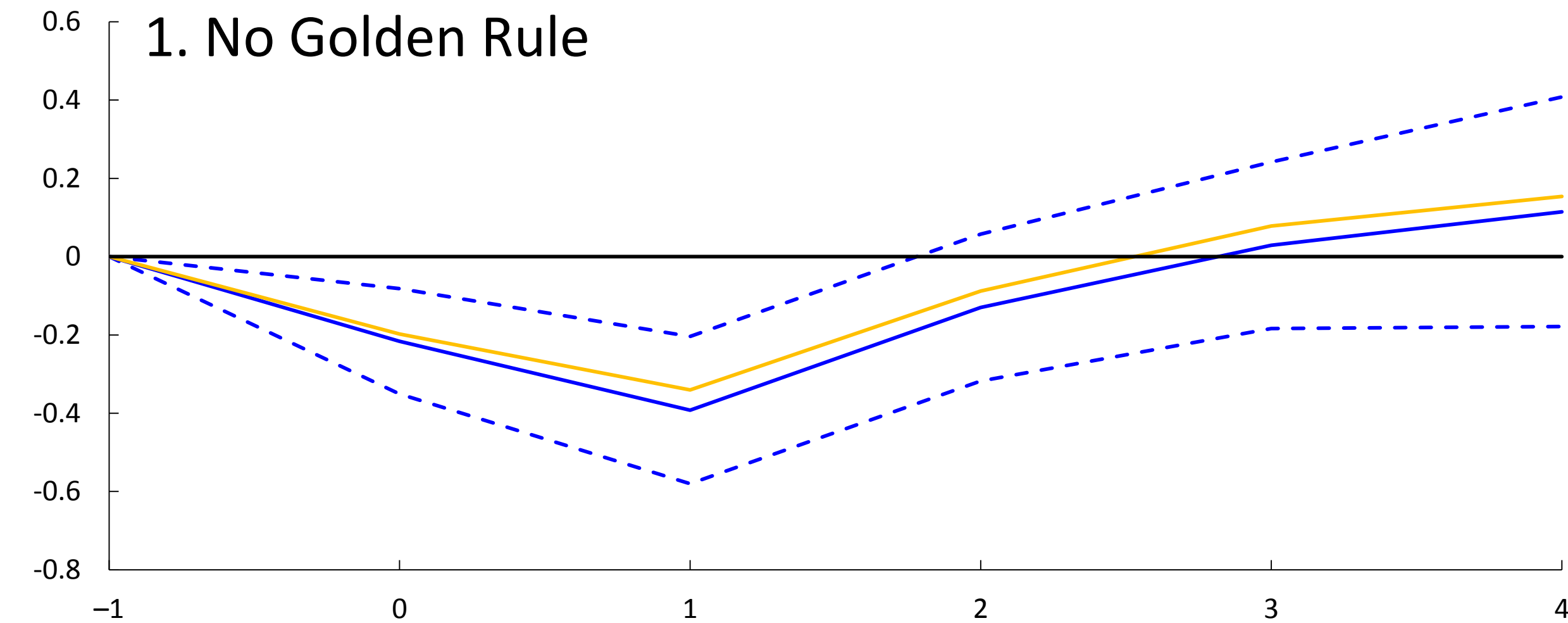
**Figure 24. Protection of Capital Expenditure** (*change in public investment; percent of total spending, 2010-12*)



# The Role of Golden Rule

Figure 25. Golden Rule, Public Investment, and Fiscal Policies

Fiscal Adjustments



Fiscal Expansions

