The Macroeconomic and Distributional Effects of Public Investment in Developing Economies

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Abstract

This paper provides empirical evidence of the macroeconomic and distributional effects of public investment in developing economies. Using public investment forecast errors to identify the causal effect of government investment, the paper finds that increased public investment raises output and reduces unemployment, both in the short term and in the long term. On average, increased public investment is also found to reduce inequality in developing economies. These macroeconomic and distributional effects are stronger in countries with a high degree of public investment efficiency.

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I. INTRODUCTION

The global demand for infrastructure investment is estimated to be currently at about US$ 3.7 trillion annually, and the total worldwide infrastructure faces an annual gap of about US$ 1 trillion. (See World Economic Forum 2014). Although public investment has increased in developing countries since the last decade, infrastructure gaps remain still sizeable. For example, estimates provided in World Bank reports suggest that developing economies should almost double their current level of investment to close their infrastructure gaps (see Foster and Briceño-Garmendia, 2010 and Ruiz-Nuñez and Wei, 2015).

Given the importance of public investment as a potential engine of growth, it is not surprising that a vast economic literature has tried to assess their macroeconomic effects. Barro (1990), Barro and Sala-i-Martin (1992), Futagami et al. (1993) and Glomm and Ravikumar (1994) analyze the growth impact of public investment in the context of endogenous growth models. More recently, Chatterjee and Turnovsky (2007), Agenor (2010), Buffie et al (2012), among others, explore the importance of some developing countries' features to shape the growth effect public investment in the economies. In particular, several studies have tried to assess the macroeconomic effects of aid-financed public investment expansions (e.g., Adam and Bevan, 2006); Cerra et al. 2008; and Berg et al. 2010).

In contrast, the distributional consequences of public infrastructure investment have been less explored. From a theoretical point of view, the effect of public investment on inequality is uncertain, and to a large extent depends on: (i) whether infrastructure investment lead to productivity gains only in the sector involved or whether gains are diffused across all

sectors; (ii) if the workers in the sector which mostly benefits from infrastructure investment have higher initial wages than workers in other sectors.

The main purpose of this paper is to explore the macroeconomic and distributional effects of public investment in developing economies. Furthermore, we look into the public investment efficiency and its macroeconomic and distributional implications, and provide answers to the questions. What are the economic benefits and costs of increasing public investment in developing economies? How does it affect the economy's inequality? How do the effects vary with key characteristics of the economy, such as the efficiency of public investment, financial inclusiveness, and the informality?

In order to address the questions, we examine the historical evidence on the macroeconomic and distributional effects of public investment for an unbalanced sample of 63 developing countries over the period (1995-2014). Following the methodology pioneered in the recent work by Auerbach and Gorodnichenko (2013a, 2013b), we identify the causal impact of higher public investment on output, private investment, unemployment, and inequality using public investment forecast errors as a measure of unanticipated shocks to government investment. Once these shocks are identified, we uese the local projections approach of Jordà (1995) to trace out the short- and medium-run response of macroeconomic aggregates and the Gini inequality coefficients to unexpected changes in public investment. We then examine the role of key factors that can potentially shape these responses: the efficiency of public investment, the financial inclusiveness, and the informality in the economy.

This paper contributes to the literature in different aspects. First, it reexamines the role of infrastructure and public investment in economic development. A large body of

literature has focused on the optimal scale of public investment by estimating the long-term elasticity of output to public and infrastructure capital using a production function approach (see Romp and de Haan 2007; Straub 2011; and Bom and Ligthart 2014, for surveys of the literature). Empirically, however, it is difficult to obtain estimates using this approach, which could be given a causal interpretation. Unobservable factors may affect both economic performance and government investment decisions, and the relationship between the two likely runs in both directions. In contrast, our analysis adopts a novel empirical strategy that allows estimation of both the short- and medium-term causal effects of public investment on a range of macroeconomic variables, as well as the inequality. Also, the paper builds on the extensive literature on the macroeconomic effects of fiscal policy and how these might be shaped by the state of the business cycle and other factors (see, among others, Blanchard and Perotti 2002; Favero and Giavazzi 2009; Romer and Romer 2010; Kraay 2012; Auerbach and Gorodnichenko 2013a, 2013b; and Blanchard and Leigh 2013). Most of these papers do not distinguish between the effects of government consumption and government investment; nor do they examine the longer term effects of fiscal shocks. Few exceptions to identify exogenous changes in fiscal shocks in developing economies are Kraay (2012) and Eden and Kraay (2014) and applies primarily to low-income countries. In their papers, which focus only on low income countries, a key assumption is that loans from official creditors such as the World Bank and other multilateral and bilateral aid agencies finance a significant fraction of government spending. The disbursements of these loans and the spending they finance are spread out over many years following the approval of the loans. Hence, part of the fluctuation in government investment is predetermined, as it reflects loan approvals in previous years. If one assumes that loan approval decisions made by creditors do not

anticipate future macroeconomic shocks that affect output, this predetermined component of spending can be used as an instrument for total government investment to identify the causal impact of public investment on output.

Our paper distinguishes from the literature that studies the distributional effects of public investment by (1) analyzing the distributional effects of public investment empirically, and (2) focusing on the developing countries in particular. Existing empirical evidence on the relationship between infrastructure investment and inequality is less definitive and more anecdotal (Calderón and Serven, 2004; Calderón and Servén, 2010). Fan and Zhang (2004), Ferranti et al. (2004), and Lopez (2004) find that public investment has both promoted growth and helped mitigate inequality. In addition, Brakman et al. (2002) find that government spending on infrastructure has increased regional disparities within Europe. On the other hand, Artadi and Sala-i-Martin (2003) suggest excessive public investment has contributed to rising income inequality in Africa.

Our main finding is that more and better public infrastructure in developing economies is associated with higher output and reduced inequality. In particular, we find that an unexpected change in public investment has led to an increase (a decrease in inequality) in output of about 0.19 (0.26) percent in the very short-term—one year after the shock—and by about 0.37 (2.33) percent in the medium term—5 years after the shock.

Moreover, the macroeconomic and distributional benefits of higher public investment in infrastructure crucially depend on its efficiency: while the effects are larger and more precisely estimated in countries with a relatively high degree of investment efficiency, they are smaller and typically not statistically significant in countries with relatively low investment process efficiency.

The rest of the paper is organized as follows. Section II presents some stylized facts. Section III presents the empirical analysis used to assess the macroeconomic effect of public investment and describes the data. Section IV presents the main findings and several robustness checks of the empirical results. Section V concludes summarizing the main findings and policy implications.

II. DATA AND EMPIRICAL METHODOLOGY

This section explains the empirical estimation methods used in the empirical analysis. Following the statistical approach proposed by Auerbach and Gorodnichenko (2013a, 2013b), we identify the causal effect of public investment on output and inequality by isolates unanticipated changes in public investment—that is, public investment forecasts errors. Namely, the measure of government investment shocks considered in the analysis is the difference between the share of actual public investment in GDP and the value of this variable which is forecast by analysts as of October of the same year.

This methodology overcomes two factors that often confound the causal estimation of the effect of fiscal policy on economic performance. First, using forecast errors eliminates the problem of "fiscal foresight" (see Forni and Gambetti 2010; Leeper, Richter, and Walker 2012; Leeper, Walker, and Yang 2013; and Ben Zeev and Pappa 2014). Agents receive news about changes in fiscal spending in advance and they may alter their consumption and investment behavior well before the changes occur. An econometrician who uses just the information contained in the change in actual public investment would be relying on an information set that is smaller than that used by economic agents, which could lead to inconsistent estimates of the effects of public investment. By using forecast errors, the

Auerbach and Gorodnichenko (2013a, 2013b) methodology effectively aligns the economic agents' and the econometrician's information sets.

Second, using forecast errors minimizes the likelihood that the estimates capture the potentially endogenous response of fiscal policy to the state of the economy. Even if public investment shocks are unanticipated, they may still be in response to business cycle conditions: for example, public projects may be stepped up if growth turns out to be unexpectedly weak, or alternatively, they may be postponed if fiscal space is tight and revenues surprise on the downside. For this to be a concern, however, such adjustments to public investment need to happen within the same quarter news about the state of the economy is received (i.e. between October and December), since all information about both public investment and economic performance up until October are incorporated in the October forecasts. This is highly unlikely. Furthermore, we later demonstrate that our findings are robust to purging the public investment shocks from forecast errors in growth.

Using these measures of unanticipated public investment shocks, we estimate two econometric specifications. The first establishes the average impact of public investment shocks on real GDP and the Gini inequality coefficient. The second examines whether the effects of public investment vary with across countries based on country-specifics characteristics such as public investment efficiency, financial inclusiveness, and the informality.

We use the local projection method, proposed by Jordà (2005) to estimate impulse-response functions of the public investment shocks onto the macroeconomic variable and the inequality variable. This approach has been advocated by Stock and Watson (2007) and Auerbach and Gorodichencko (2013a), among others, as a flexible alternative that does not

impose the dynamic restrictions embedded in vector autoregression (autoregressive-distributed lag) specifications and is particularly suited to estimating nonlinearities in the dynamic response. The first regression specification is estimated as follows:

$$y_{i,t+k} - y_{i,t} = \alpha_i^k + \vartheta_t^k + \beta^k FE_{i,t} + \varepsilon_{i,t}^k, \qquad (1)$$

in which *y* is the dependent variable (alternatively the log of output, the unemployment rate or the Gini coefficient); α_i are country fixed effects, included to control for all time-invariant differences across countries (such as in countries' trend growth rates); ϑ_t are time fixed effects, included to control for global shocks such as shifts in oil prices or the global business cycle; and $FE_{i,t}$ is the forecast error of public investment of country *i* in year *t* as a share of GDP, computed as the difference between actual and forecast series. Equation (4) is estimated for each $k = 0, \ldots, 4$, where $k = 0$ is the year of the public investment shock. Impulse-response functions are computed using the estimated coefficients β^k, while the confidence bands associated with the estimated impulse-response functions are obtained using the estimated standard errors of the coefficients β^k, based on clustered robust standard errors.

In the second specification, the response of the variable of interest is allowed to vary with the state of the economy or with the degree of public investment efficiency. The second regression specification is estimated as follows:

$$y_{i,t+k} - y_{i,t} = \alpha_i^k + \vartheta_t^k + \beta_1^k G(z_{it}) FE_{i,t} + \beta_2^k \big(1 - G(z_{it})\big) FE_{i,t} + \varepsilon_{i,t,}^k \qquad (2)$$

with

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

in which *z* is an indicator of the state of the economy (or the degree of public investment efficiency), normalized to have zero mean and unit variance, and $G(z_{it})$ is the corresponding

smooth transition function of the degree of public investment efficiency. We proxy investment efficiency with a survey-based measure of the wastefulness of government spending, from the World Economic Forum's (WEF) *Global Competitiveness Report.*[2] As in Abiad and et al (2015) we set $\gamma = 1.0$. The results do not qualitatively change if we use alternative values of γ.

As discussed in Auerbach and Gorodnichenko (2013a, 2013b), the local projection approach to estimating non-linear effects is equivalent to the smooth transition autoregressive (STAR) model developed by Granger and Teravistra (1993). The main advantage of this approach relative to estimating STVARs for each regime is that it uses a larger number of observations to compute the impulse response functions of only the dependent variables of interest, improving the stability and precision of the estimates. This estimation strategy can also more easily handle the potential correlation of the standard errors within countries, by clustering at the country level.

III. RESULTS

A. Baseline

The results obtained by estimating equation (4) show that public investment shocks have statistically significant effects on output (Figure 1). An unanticipated 1 percentage point

[2] We use this in the absence of a direct measure of public investment efficiency, such as the Public Investment Management Index (PIMI), for advanced economies. Similar results obtain when we use alternative proxies based on "government efficiency" or "overall quality of infrastructure," both also from the WEF's *Global Competitiveness Report.* None of these measures is perfect; the wastefulness and efficiency measures do not specifically refer to infrastructure spending, while the infrastructure measure reflects overall provision of infrastructure, which could be poor due to low efficiency but also because of inadequate spending. Berg et al. (forthcoming) has a more extensive discussion of public investment efficiency, including problems in its measurement.

of GDP increase in government investment spending increases the level of output by about 0.2 percent in the same year. Using the sample average of government investment as a percentage of output (about 6 percent of GDP), this implies short-term investment spending multipliers of about 0.2.

As expected the effect of public investment on output increases over time, by increasing the stock capital in the economy. In particular, we find that four years after an unanticipated shock to government investment spending of 1 percentage point of GDP, the level of real output is 0.4 percent higher, which corresponds to a medium-term fiscal multiplier of about 0.5.

These output effects are smaller than those found for advanced economies. For example, Abiad and others (2015) find that an unanticipated shock to government investment spending of 1 percentage point of GDP increases output by 0.4 in the very short term and by about 1.5 percent in the medium term. While different factors may explain these smaller effect in developing economies than in advanced (including trade openness, institutional characteristics) a prominent explanation that has been put forward in the literature (e.g. Pritchett 2000) is the lower investment process efficiency—a factor which we empirically examine in the next section.

The results also suggest that public investment shock are associated with a reduction of unemployment both in the short and in the medium term (Figure 2): a one percent of GDP unexpected increases in public investment reduces, on average the unemployment rate by 0.1 percentage point in the short term and by about 0.7 percentage point in the medium term.

Finally, we find empirical evidence that an increase in public investment not only has positive macroeconomic effects but also distributional ones (Figure 3). In particular, we find

that A\an unanticipated 1 percentage point of GDP in government investment spending reduces inequality—proxied by the Gini coefficient of net inequality—by about 0.2 percent in the same year and by about 2½ for year after the increase. The effect is also economically significant, given the high persistence over time in the Gini coefficient. In particular, the magnitude of the medium-term effect is approximately equivalent to a one standard deviation of the average change in the Gini coefficient (2.4 percent) in the sample.

B. The role of investment efficiency

The macroeconomic effects of public investment shocks are also substantially stronger in countries with a high degree of public investment efficiency, particularly in the medium term (Figure 5). In countries with high efficiency of public investment, a public investment spending shock increases the level of output by about 0.3 percent in the same year and by 2.5 percent four years after the shock. But in countries with low efficiency of public investment, the output effect is not statistically significant in the same year and actually negative in the medium term, possibly reflecting a crowding out effect on public investment. As a result, although public investment shocks are found to lead to a significant medium-term reduction in unemployment rate in countries with high public investment efficiency, they tend to increase unemployment in countries with low public investment efficiency. Finally, the effects on inequality reduction are larger in countries with a high level of investment efficiency, while not statistically significantly different from zero in country with a low level of investment efficiency. In sum, these results that public investment can increase medium-term output and reduce inequality and unemployment only if done in an efficient manner.

Could these results be driven by some relationship between public investment efficiency and the frequency and size of public investment shocks? We find no statistically significant relationship between the measure of investment spending shocks used here and the degree of investment efficiency.[3] This suggests that the result that macroeconomic effects are larger in countries with higher investment efficiency is not driven by the fact that investment spending shocks tend to occur more frequently and to be larger in countries with higher degrees of public investment efficiency.

IV. Robustness Checks (to be completed)

To check the robustness of our results, several different empirical exercises have been carried:

1- Alternative estimations (VAR)

2- Different regions

3- Different country groups: emerging vs. low income countries

4- Different time samples

5- Alternative measures of investment efficiency

The results are qualitatively and in several cases quantitatively robust to those presented)

V. Conclusions

In this paper, we examine the macroeconomic and distributional impact of increased public investment in developing economies. We find that public investment raises output in

[3] The correlation between investment spending shocks and the degree of efficiency is –0.11.

both the short and long term in LIDCs. Gains in private sector productivity associated with infrastructure improvements have a direct positive impact on the output. On average, public investment expansions have also reduced inequality and unemployment.

Our results also show that the impacts vary across countries depending on the efficiency of the public investment processes and the country-specific features. For more efficient economies, the results of public investment on output are more substantial, and it also significantly reduces the income inequality measured by the Gini coefficient both in the short and in the medium term.

As the infrastructure gap remains large for developing economies, our findings suggest an important role for the public investment to keep bridging the infrastructure gap. On average, our empirical results suggest a positive role of the public investment in boosting the macroeconomic output and improving the inclusiveness in the economy. However, a key priority in many developing economies, particularly in those with relatively low efficiency of public investment, is to raise the quality of infrastructure investment and public governance in order to improve the maximize the effects of public investment on inclusive growth.

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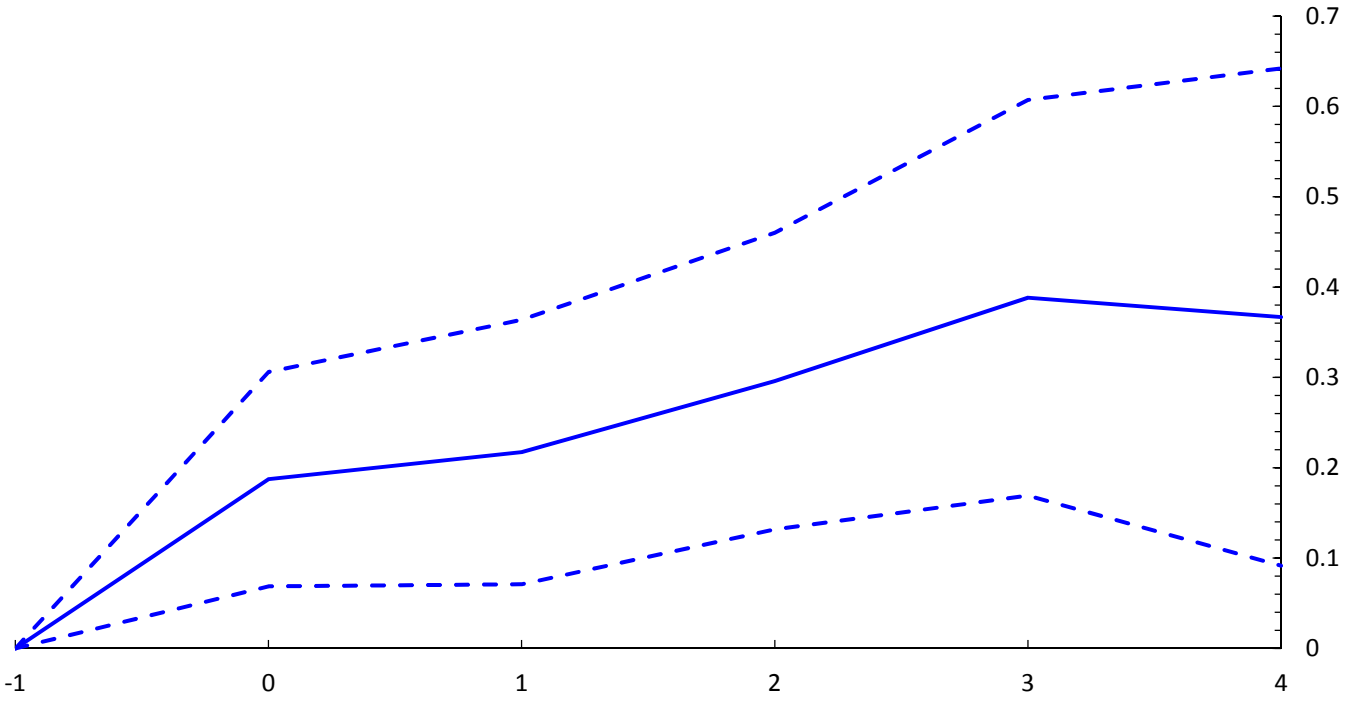
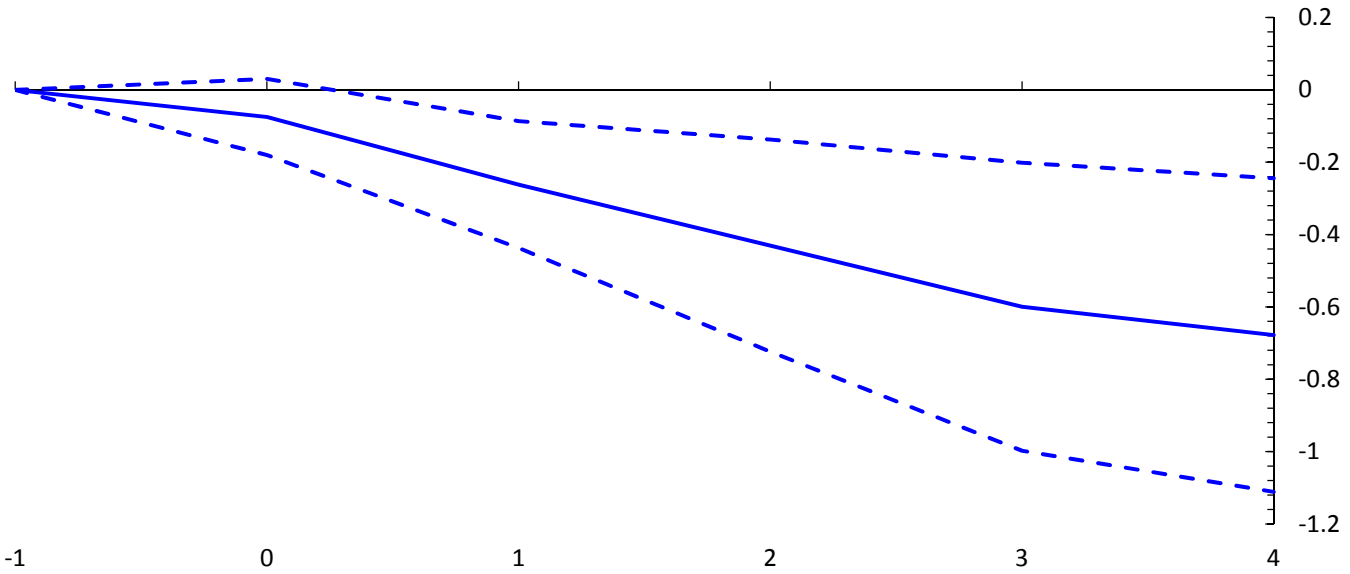
Figure 1. The effect of public investment shocks on output (percent)



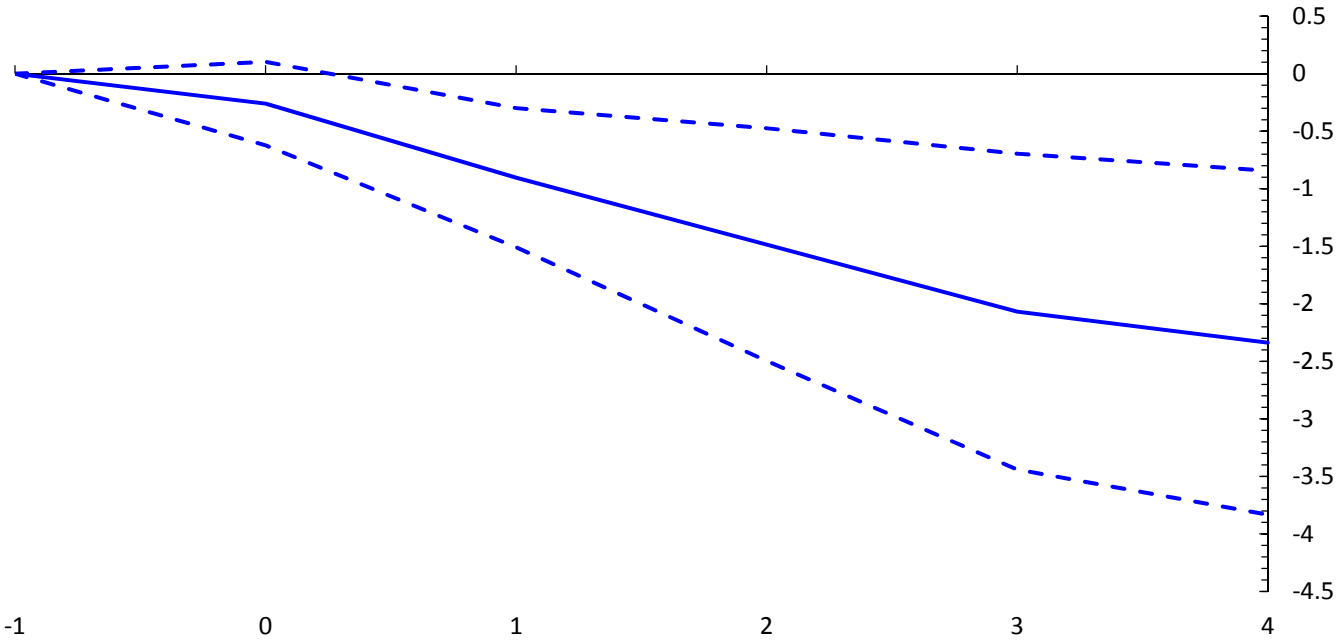
Note: t=0 is the year of the shock. Solid blue lines denote the response to an unanticipated one percent point of GDP increase in public investment, and dashed lines denote 90 percent confidence bands. Estimates based on equation (1).

Figure 2. The effect of public investment shocks on unemployment (percentage point)



Note: t=0 is the year of the shock. Solid blue lines denote the response to an unanticipated one percent point of GDP increase in public investment, and dashed lines denote 90 percent confidence bands. Estimates based on equation (1).

Figure 3. The effect of public investment shocks on inequality (percent)



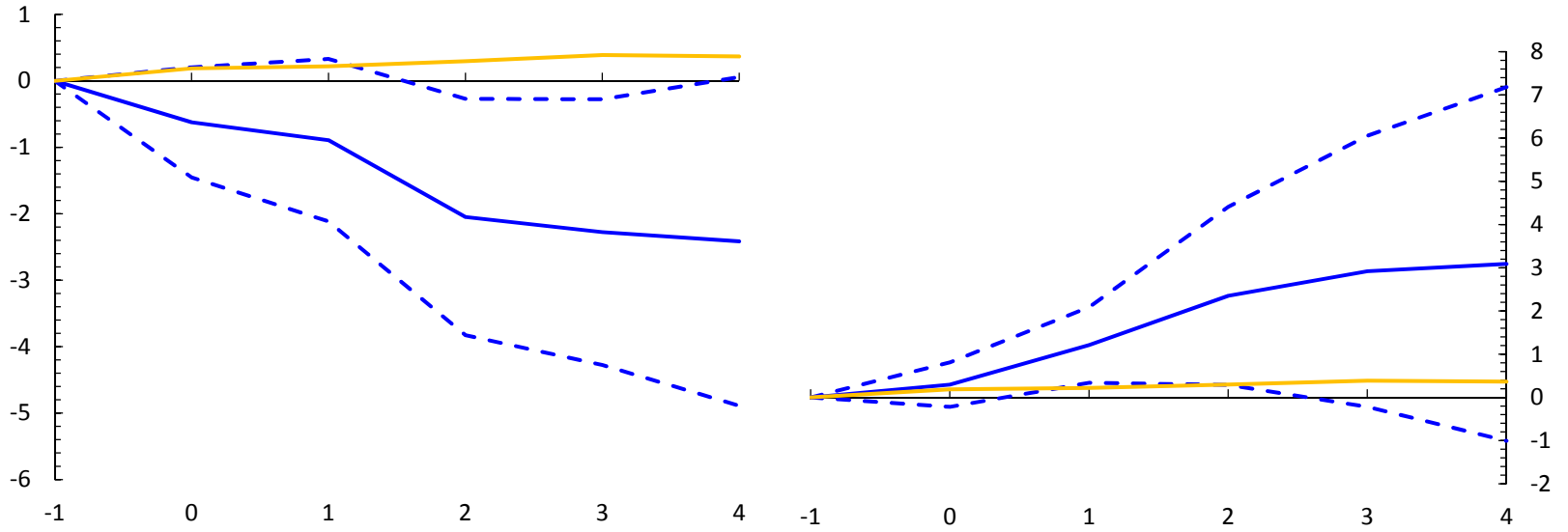
Note: t=0 is the year of the shock. Solid blue lines denote the response to an unanticipated one percent point of GDP increase in public investment, and dashed lines denote 90 percent confidence bands. Estimates based on equation (1).

Figure 4. The effect of public investment shocks on output, the role of investment efficiency

(percent)

Panel A. Very low efficiency

Panel B. Very high efficiency

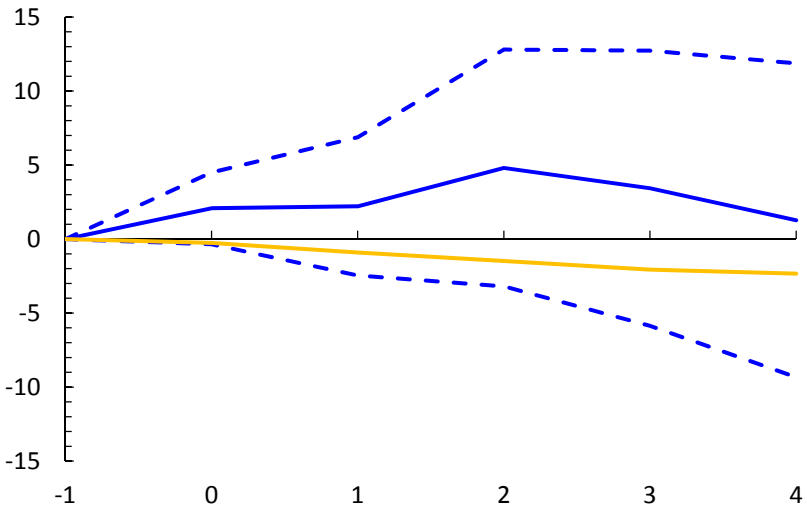


Note: t=0 is the year of the shock. Solid blue lines denote the output response in countries with relatively higher (lower) investment efficiency, and dashed lines denote 90 percent confidence bands. Solid yellow lines denote the unconditional (baseline) response presented in Figure 3.1.

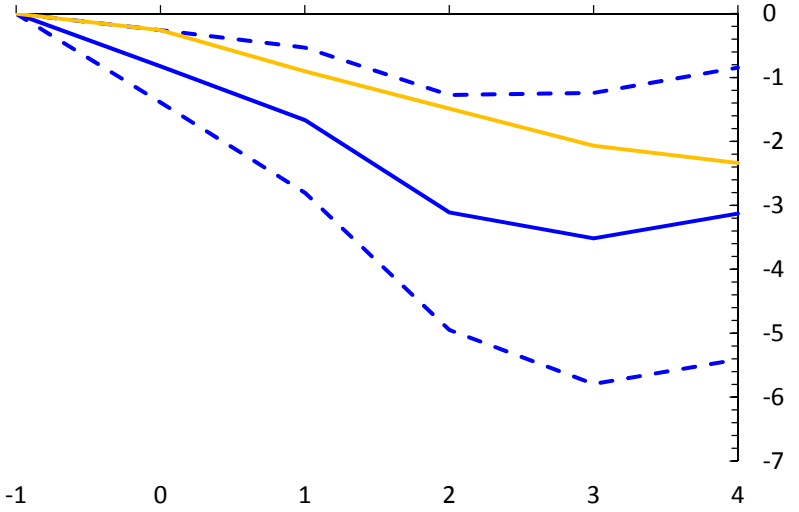
Figure 5. The effect of public investment shocks on inequality, the role of investment efficiency

(percent)

Panel A. Very low efficiency



Panel B. Very high efficiency



Note: t=0 is the year of the shock. Solid blue lines denote the inequality response in countries with relatively higher (lower) investment efficiency, and dashed lines denote 90 percent confidence bands. Solid yellow lines denote the unconditional (baseline) response presented in Figure 3.1.