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The impact of unprecedented growth in public investment on stimulating the Indian economy

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Abstract. The aim of the article is to compare the effects of public investment and public consumption in the Indian economy. This issue is particularly relevant in the context of the unprecedented increase in public investment in India, which is becoming one of the biggest economies globally. The empirical research is based on a New Keynesian model. The novelty of the applied methodology lies both in the inclusion of public capital as a factor of production, and the partial substitution between public and private consumption in the model. The results show that government gross capital formation in the short run is a slightly more effective method of stimulating the Indian economy than government final consumption expenditure. However, the biggest differences between the effects of public investment and public consumption are evident in the long term. The impact of public consumption on GDP fades out quickly, while public investment raises the level of output for a long period. Government gross capital formation also affects employment and consumption more strongly than government final consumption expenditure does. Thus, the main implication of the study is to recommend increasing public investment in emerging markets, to boost their economies.

Keywords: public investment, the Indian economy, fiscal policy.

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1. INTRODUCTION

India is not only the world's most populous country, but also one of the largest economies globally. It became the world's sixth biggest economy in 2022, overtaking France. Moreover, India's economic growth is projected to be rapid in the coming years, with growth rate up to 7% in 2023, making the Indian economy the fifth largest economy in 2023, ahead of the UK's.

According to the Indian authorities, a substantial increase in public investment, especially in infrastructure, will be an important driver of economic growth. India's budget for 2023–24 assumes a rise in infrastructure capital spending by 33%, and stimulation of the economy is indicated as one of main reasons for this unprecedented growth in government gross capital formation.

In this context, the issue of the impact of public investment on the Indian economy becomes especially important. In particular, the question of whether the increase in public investment stimulates the Indian economic growth more effectively than public consumption is of special relevance.

The theoretical rationale for the differing efficiency of public investment and public consumption in stimulating an economy lies in their heterogeneous impact on productive capacity and private consumption of households. Firstly, public investment affects public capital, and as a consequence increases the productive capacity of the economy, whereas public consumption does not affect the production function (Baxter and King, 1993; Kamps, 2004; Bom and Ligthart, 2014; Dinlersoz and Fu, 2020). Secondly, public investment, unlike public consumption, is not a substitute for private consumption, which leads to weaker crowding-out of private consumption (Karras, 1994; Kwan, 2006; Ercolani and Azevedo, 2014; Ambler et al., 2017; Asimakopoulos et al., 2021).

The former mechanism is widely explored in the literature; however, the latter one is rarely taken into account in comparative analyses of the macroeconomic effects of public consumption and public investment. In particular, there is a lack of such studies for emerging economies.

This article presents the first comparative analysis of the macroeconomic effects of public investment and public consumption for the Indian economy, based on a model that takes into account the heterogeneity of government spending, in terms of its substitutability with private consumption and its impact on public capital. Such an analysis is especially justified in the contexts of:

- unprecedented growth in government capital spending in India, which is becoming one of the largest economies in the world,
- the increased role of fiscal stimulus during projected global economic slowdown (Afonso et al., 2018).

Therefore, the aim of the paper is to verify whether increasing public investment is a more effective tool for stimulating the Indian economy than boosting public consumption. The added value of the article is that it estimates macroeconomic effects of public investment at a time of its unprecedented growth in India.

The research belongs to the strand of literature on the heterogeneous effects of government spending. This is a burgeoning field of study that includes, among others, research on the impact of interest rates on fiscal multipliers (Klein and Winkler, 2021; Ngo, 2021), fiscal effects of heterogeneity of households (Cantore and Freund, 2021; Andrés et al., 2022; Auclert et al., 2023; Guo et al., 2023), and impact of the household leverage cycle on the heterogeneity of government spending multipliers (Bernardini et al., 2020; Jones et al., 2022; Klein et al., 2022).

The structure of the article is as follows. The first section explains the assumptions of the New Keynesian model, which forms the theoretical framework for empirical analyses of the macroeconomic effects of public investment. This is followed by the presentation of the empirical results, focused on highlighting the most relevant differences between the impacts of public investment and public

consumption on GDP, employment, and private consumption in the Indian economy. The final section concludes.

2. METHODOLOGY

This paper analyses the effects of a rise in public investment in the Indian economy by using a New Keynesian model, which takes into account both the supply-side and demand-side impacts of fiscal policy (Becerra-Vicario et al., 2020). Thus, the model is an extension of the supply-side RBC model (see Gazda, 2010), by incorporating the demand-side mechanisms. The model distinguishes two types of public spending: government final consumption expenditure (that is, public consumption), and government gross capital formation (i.e., public investment). Each of these expenditures has a different impact on households' behaviour and on the productive capacity of the economy.

Regarding the economy's productive capacity, the difference between the effects of public investment and public consumption lies in their different impact on the production function. Unlike public consumption, public investment affects public capital, which in turn is a component of the production function.

The model assumes the following production function, which takes into account both private and public capital:

$$y_t = k_t^{\alpha} l_t^{1-\alpha} (k_t^{PUBL})^{\alpha_{PUBL}}, \quad (1)$$

where:

y_t – output,

k_t – private capital,

k_t^{PUBL} – public capital,

α – elasticity of output with respect to private capital,

α_{PUBL} – elasticity of output with respect to public capital,

$\alpha \in (0,1)$, $\alpha_{PUBL} > 0$.

This assumes a production function with fixed economies of scale, with respect to private factors of production (Kamps, 2004). Both public capital and private capital increase according to the standard capital accumulation equation:

$$k_t^{PUBL} = (1-\delta) k_{t-1}^{PUBL} + g_t^I, \quad (2)$$

$$k_t = (1-\delta) k_{t-1} + i_t, \quad (3)$$

where:

g_t^I – government gross capital formation (public investment),

i_t – private investment,

δ – depreciation rate,

$\delta \in (0,1)$.

Thus, public investment, analogously to private investment, through the capital accumulation equation, affects the level of capital and, consequently, the economy's productive capacity (Leeper et al., 2014; Dinlersoz and Fu, 2020). In contrast, as mentioned earlier, public consumption does not affect the productive capacity of the economy.

Public consumption and public investment also affect the utility function of households in different ways. Unlike public investment, public consumption, being partly a substitute for private consumption,

directly affects household utility (Ercolani and Azevedo, 2014). This impact depends on the degree of substitutability between private and public consumption.

It is assumed that households maximise the expected value of the following sum of discounted utilities (Christiano and Eichenbaum, 1992):

$$E_t \sum_{t=0}^{\infty} \beta^t ln(c_t + \gamma g_t^C) + \vartheta(1 - l_t) \ , \tag{4}$$

where:

E_t – expected value in period t,

c_t – private consumption,

l_t – labour,

g_t^C – government final consumption expenditure (public consumption),

β – discount factor,

ϑ – parameter describing the role of spare time in utility function,

γ – rate of substitution between private consumption and public consumption,

$\beta \in (0,1), \gamma \in (0,1), \vartheta > 0$.

As a consequence, when maximising utility, households take into account the level of public consumption, because this type of government spending is partly a substitute for private consumption (Asimakopoulos et al., 2021). Conversely, public investment is not included in the household utility function, because it is not a substitute for private consumption.

The above assumptions are the most relevant to the differences between the macroeconomic effects of public consumption and public investment. Other assumptions of the model are as follows.

A final good is manufactured on the basis of intermediate goods, in a monopolistically competitive market. The final good can be allocated for private consumption, private investment, or public consumption and public investment; this means that both public consumption and public investment increase an aggregate demand to the same extent. However, as indicated earlier (equations (1) and (2)), only public investment contributes to the supply capacity of the economy.

Interest rate is determined by monetary policy, in accordance with the standard Taylor (1993) rule. Monetary policy has a significant impact on output, due to the presence of nominal price rigidity. Prices are set according to the Calvo (1983) scheme, what means that the probability that a firm will set the price is independent of its previous decisions (Erceg et al., 2000).

Monopolistic competition exists in the labour market. The labour supplied by households is heterogeneous, which means that households have some monopoly power in the labour market. Thus, aggregate labour is determined by the Dixit–Stiglitz (1977) function. It is also assumed in the model that wage is not flexible; rather, it is set on the basis of the Calvo (1983) scheme (Kollmann, 2001).

The presented specification of the model means that changes in government spending have both supply and demand impacts on the economy. Both these effects occur in the model due to price and wage rigidities, and the inclusion of public capital as one of factors of production.

Changes in both the analysed types of government spending (public consumption and public investment) are described by autoregressive processes:

$$g_t^C = (1 - \rho_g)\bar{g}_C + \rho_g g_{t-1}^C + \zeta_{gC,t} \ , \tag{5}$$

$$g_t^I = (1 - \rho_g)\bar{g}_I + \rho_g g_{t-1}^I + \zeta_{gI,t} \ , \tag{6}$$

where:

ρ_g – persistence of government spending changes,

$\bar{g}_C$ – average level of public consumption,

$\bar{g}_I$ – average level of public investment,
$\zeta_{C,t}$ – public consumption impulses,
$\zeta_{I,t}$ – public investment impulses,
$\rho_g \in (0,1)$, $\bar{g}_C > 0$, $\bar{g}_I > 0$,
$\zeta_{gC,t} \sim N(0, {\sigma_{gC}}^2)$,
$\zeta_{gI,t} \sim N(0, {\sigma_{gI}}^2)$.

The formal specification of the entire model is presented in Appendix 1.

3. EMPIRICAL RESULTS AND DISCUSSION

The impact of growing public investment in the Indian economy was examined using the presented New Keynesian model, estimated for India. The empirical study was conducted on the basis of World Bank data on the main macroeconomic variables characterising the Indian economy, covering the period 1960–2021.

Parameters of the model were estimated using the Bayesian approach (Adolfson et al., 2007; Kormilitsina & Zubairy, 2017). For the purpose of this study, the most important values are for the following two parameters:

- the effect of public investment on the production function (parameter α_{PUBL}),
- the substitution between private and public consumption (parameter γ).

On the one hand, the greater the impact of public capital on the production function, the more significant the long-run effects of public investment. On the other hand, the higher the rate of substitution between private and public consumption, the stronger the crowding-out effect of government final consumption expenditure; this makes public investment a relatively more effective method of stimulating the economy in the short term.

The estimated values of the key parameters of the model are shown in Table 1. The prior means of the parameters were set based on previous studies concerning developed countries (Hulten & Schwab, 1993; Heijdra & Ligthart, 1997).

Table 1

The Bayesian estimates of parameters α_{PUBL} and γ

Parameter	Prior mean	Posterior mean
Public capital elasticity of output (α_{PUBL})	0.03	0.0412
Rate of substitution between private and public consumption (γ)	0.23	0.2791

Source: Authors' results on the basis of World Bank data.

The posterior estimate of the parameter α_{PUBL} indicates that in the Indian economy, the impact of public capital on productive capacity is stronger than in developed economies. This is presumably due to the relatively low level of public capital in India recorded so far, which makes increasing public capital more capacity-enhancing than in developed countries. Moreover, the posterior estimate of parameter γ shows that in India, public consumption is substituted for private consumption more than in developed economies. The reason for India's higher substitution rate is probably people's relatively lower accessibility to public services, which drives the private sector to incur expenditures that are close substitutes for public consumption (e.g. private spending on health and education).

The impact of public investment on the Indian economy is analysed in terms of the impulse response functions calculated for estimated parameters of the model. The presented impulse response functions show the effects of one percentage of GDP growth in public investment on percentage change from the baseline of GDP and other analysed macroeconomic variables in the Indian economy. The changes in GDP are calculated from the model characterised by equations (1)–(4) (and presented in detail in Appendix 1), and occur after the fiscal stimulus described by equations (5)–(6). For comparison purposes, the results for public investment (government gross capital formation) are compared with the effects of a rise in public consumption (government final consumption expenditure).

The impact of public investment and public consumption on GDP in the Indian economy is presented in Figure 1.

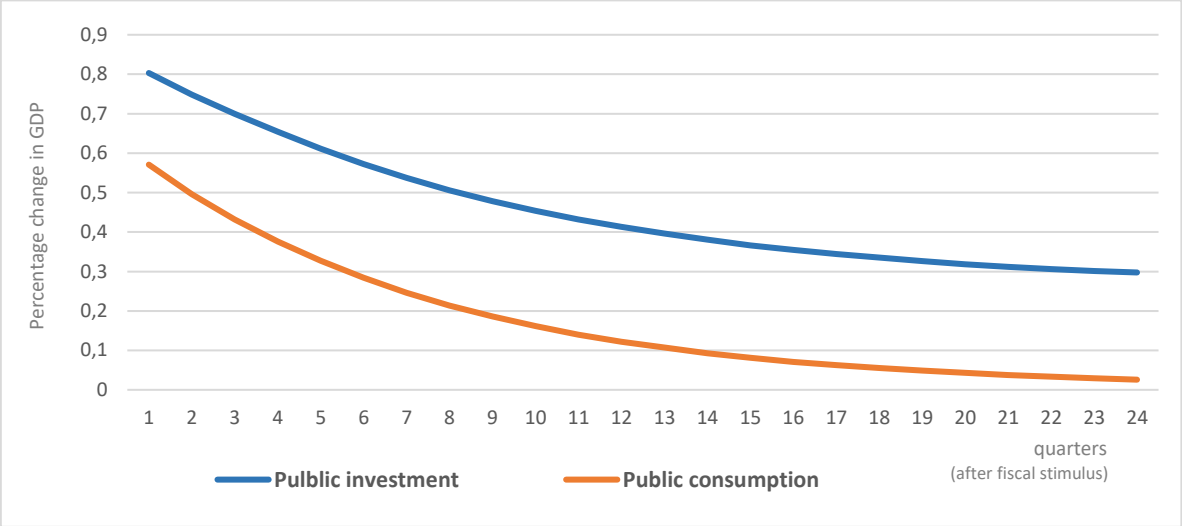

Figure 1. Impact of rise in public investment and public consumption on GDP in India

Source: Authors' results on the basis of World Bank data.

Public investment has a significant impact on GDP in India. The results of the empirical study indicate that an increase in public investment strongly influences economic activity in the Indian economy, both in the short and long term. The strong short-run impact of such government spending on India's GDP is due to the lack of substitution between public investment and private consumption, which reduces the crowding-out effect. The reason for the persistent and robust long-run effect of public investment is its impact on public capital, which in turn is a factor that boosts the Indian economy's productive capacity.

A comparison of the impact of government gross capital formation and government final consumption expenditure shows that public investment has a much more powerful effect on the Indian economy than public consumption. Particularly pronounced differences are seen in the long run. Table 2 compares government gross capital formation and government final consumption expenditure multipliers in the short and long terms, calculated on the basis of the model presented in the previous section and detailed in Appendix 1.

Table 2

Government spending multipliers in the Indian economy

Multiplier	Government gross capital formation	Government final consumption expenditure
Contemporaneous multiplier	0.8031	0.5709
Four-year aggregate multiplier	2.1014	0.9766

Source: Authors' results on the basis of World Bank data.

The government gross capital formation multiplier is much higher than the government final consumption expenditure multiplier, because of a relatively high substitution rate between private and public consumption in the Indian economy (the *a posteriori* parameter γ estimate is 0.2791). This limits the power of government final consumption expenditure to stimulate the economy, as an increase in public consumption has a relatively strong crowding-out effect on households' private consumption. By contrast, this effect does not occur with government gross capital formation (because public investment is not a substitute for private consumption).

The significant difference between the long-term effects of government gross capital formation and government final consumption expenditure on GDP is due to the strong impact of public capital on potential output (production function) in the Indian economy. The estimate of parameter α_{PUBL} indicates that the public capital elasticity of output in the Indian economy is 0.04, which translates into a considerable long-run impact of public investment on GDP. Conversely, in the case of public consumption, this effect is absent, so that the impact of this type of expenditure is only short- to medium-term, and it expires in the long run.

The paper also examines the effects of an increase in public investment on employment and consumption in India. The changes in employment and consumption, similarly to the case of GDP, are computed based on the model characterised by equations (1)–(4), and result from the fiscal stimulus described in equations (5)–(6). The impacts of public investment and public consumption on employment in the Indian economy are compared in Figure 2.

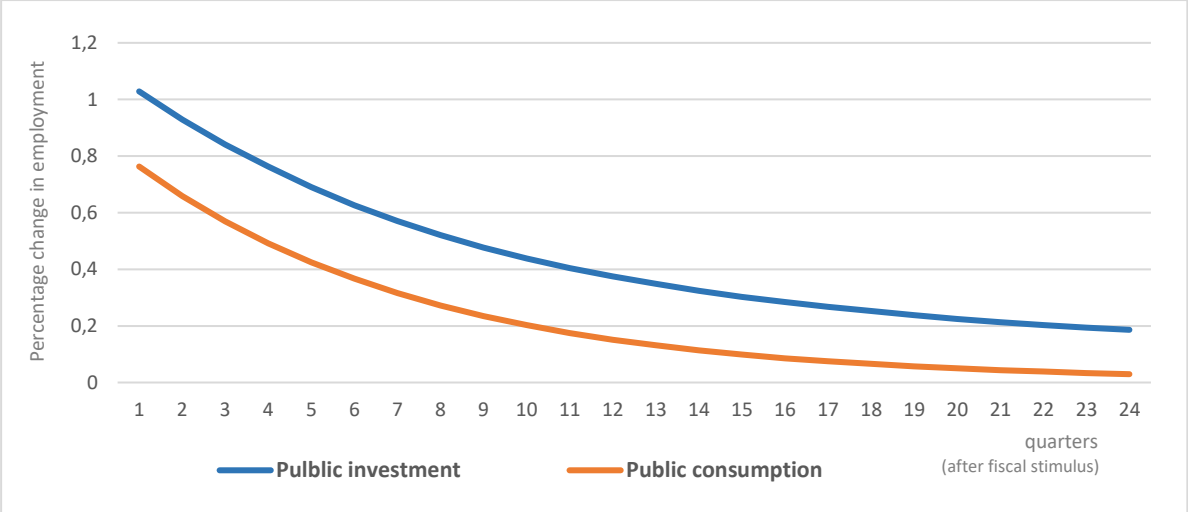

Figure 2. Impact of the rise in public investment and public consumption on employment in India

Source: Authors' results on the basis of World Bank data.

The impulse response functions show that the increase in government gross capital formation affects employment more strongly than the rise in government final consumption expenditure. Moreover, the effect of public investment on employment is more permanent than that of public consumption. The results are thus similar to those for GDP.

However, there are two important differences between public investment's impact on GDP and employment in the Indian economy. Firstly, the initial increase is much stronger for employment than GDP; this is because employment responds faster to fiscal stimulation than the amount of capital responds. Secondly, in the long term, as a result of the increase in public investment, GDP grows more than employment. The reason for this is that GDP growth in the long term is driven by increases in both private factors of production and in productive public capital.

The impacts of public investment and public consumption on consumption in the Indian economy are presented in Figure 3.

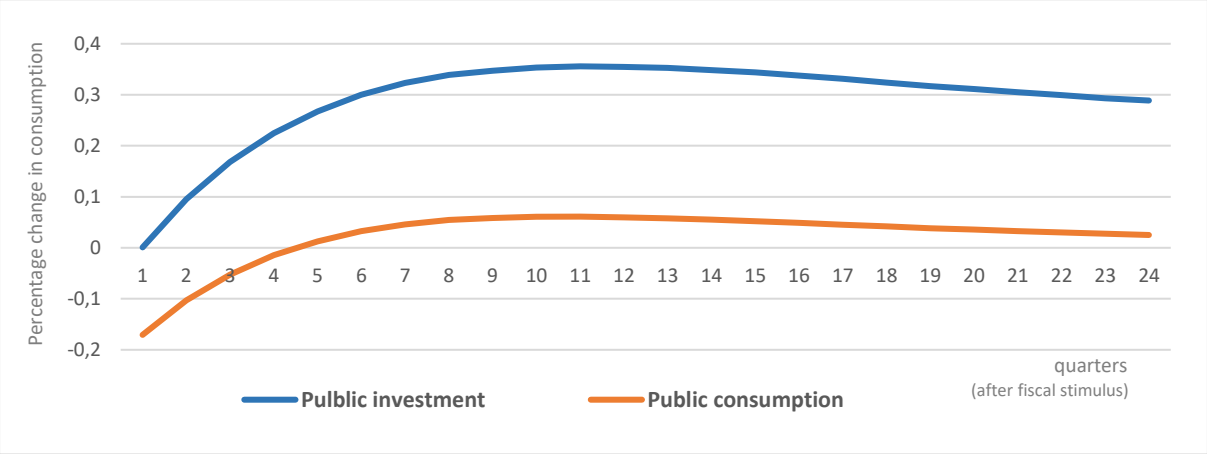

Figure 3. Impact of the rise in public investment and public consumption on private consumption in India

Source: Authors' results on the basis of World Bank data.

The results of the research indicate that the effects of public consumption and public investment on private consumption of households differ significantly.

First, in the short run, an increase in the government's final consumption expenditure causes a decline in private consumption, while a rise in government gross capital formation boosts private consumption. Higher public consumption leads to a decline of private consumption, because of the strong crowding-out effect (more about this effect, see e.g. Balcerzak & Rogalska, 2014). This effect is strong in the Indian economy due to the high substitution between public and private consumption (that is, the high value of parameter γ). In contrast, in the case of government gross capital formation this effect does not occur, because public investment is not a substitute for private consumption.

Also in the long term, there are significant differences between the effects of higher government gross capital formation and government final consumption expenditure. An increase in public consumption does not have a significant impact on private consumption in the long term, because this kind of government spending does not stimulate long-run GDP growth, and therefore does not increase household income in the long term. Conversely, an increase in public investment translates into persistent GDP growth and, as a result, a long-term rise in household income and private consumption.

4. CONCLUSION

This research reveals the impact of public investment on GDP growth in India. Such an analyses is of particular relevance following the recent, rapid rise in public investment in the Indian economy.

The empirical results, obtained using a New Keynesian model estimated for the Indian economy, indicate that the growth in the government's gross capital formation strongly stimulates economic activity in India. Moreover, the impulse response functions show that the increase in public investment strongly affects output in both the short and long term.

The paper not only estimates the effects of public investment on the Indian GDP, but also compares the government gross capital formation multiplier with the government final consumption expenditure multiplier. It is found that short-run public investment is a slightly more effective method of stimulating the economy than public consumption. On theoretical grounds, this is because public investment is not a substitute for private consumption, which reduces the crowding-out effect.

However, the largest differences between the effects of the government gross capital formation and the government final consumption expenditure occur in the long term. The impact of public consumption on GDP in India fades out quickly, while public investment raises the output level for a long period. Impulse response functions show that even after six years, the impact of public investment on GDP is only slightly smaller than initially. Thus, the results of the study indicate that in the Indian economy, government gross capital formation significantly affects the productivity of private factors of production.

The study also estimates the impact of public investment on other key macroeconomic variables: the employment and consumption of households. As in the case of the impact on GDP, the empirical results show that the government gross capital formation affects employment and private consumption more strongly than the government final consumption expenditure. Also in this case, particularly large differences between the effects of public investment and public consumption occur in the long term.

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APPENDIX 1. MODEL SPECIFICATION

The budget constraint of households:

$$\sum_{t=1}^{\infty} \frac{c_t}{(1+r_1)(1+r_2)\ldots(1+r_t)} = k_0 + \sum_{t=1}^{\infty} \frac{w_t - tax_t}{(1+r_1)(1+r_2)\ldots(1+r_t)} \quad (1)$$

where:

c_t – private consumption,

k_t – private capital,

w_t – gross wage,

tax_t – taxes,

r_t – interest rate.

Average level of a gross wage:

$$w_t = \left(\xi_w w_{IND,t}^{-\frac{1}{\lambda_w}} + (1-\xi_w) w_{OPT,t}^{-\frac{1}{\lambda_{w,t}}} \right)^{-\lambda_{w,t}}, \quad (2)$$

where:

$w_{IND,t}$ – indexed wage,

$w_{OPT,t}$ – optimized wage,

λ_w – mark-up in the labour market,

ξ_w – probability that households will index wage,

$\lambda_w > 0, \xi_w \in (0,1)$.

Aggregate labour:

$$l_t = \left(\int_0^1 l_t(j)^{\frac{1}{1+\lambda_w}} dj \right)^{1+\lambda_w}, \quad (3)$$

where:

l_t – labour,

$l_t(j)$ – labour supplied by j-th household.

Capital accumulation:

$$k_t = (1-\delta)k_{t-1} + i_t, \quad (4)$$

where:

i_t – private investment,

δ – depreciation rate,

$\delta \in (0,1)$.

Utility function:

$$E_t \sum_{t=0}^{\infty} \beta^t ln(c_t + \gamma g_t^C) + \vartheta(1-l_t) \ , \quad (5)$$

where:

E_t – expected value in period t,

g_t^C – government final consumption expenditure (public consumption), following the autoregressive process: $g_t^C = (1-\rho_g)\bar{g}_C + \rho_g g_{t-1}^C + \zeta_{gC,t}$, where: $\rho_g \in (0,1)$, $\bar{g}_C > 0$, $\zeta_{gC,t} \sim N(0, {\sigma_{gC}}^2)$,

β – discount factor,

ϑ – parameter describing the role of spare time in utility function,

γ – rate of substitution between private consumption and public consumption,

$\beta \in (0,1), \gamma \in (0,1), \vartheta > 0.$

Aggregate output:

$$y_t = \left(\int_0^1 y_t(i)^{\frac{1}{1+\lambda}} di\right)^{1+\lambda}, \quad (6)$$

where:

y_t – output,

$y_t(i)$ – intermediate good of type i,

λ – mark-up,

$\lambda > 0$.

Aggregate demand:

$$c_t + i_t + g_t^C + g_t^I = y_t. \quad (7)$$

Production function:

$$y_t = k_t^{\alpha} l_t^{1-\alpha} (k_t^{PUBL})^{\alpha_{PUBL}}, \quad (8)$$

where:

k_t^{PUBL} – public capital,

α – elasticity of output with respect to private capital,

α_{PUBL} – elasticity of output with respect to public capital,

$\alpha \in (0,1), \alpha_{PUBL} > 0$.

The budget constraint of government:

$$\sum_{t=1}^{\infty} \frac{g_t^C + g_t^I}{(1+r_1)(1+r_2)\ldots(1+r_t)} = \sum_{t=1}^{\infty} \frac{tax_t}{(1+r_1)(1+r_2)\ldots(1+r_t)} \quad (9)$$

Public capital accumulation:

$$k_t^{PUBL} = (1-\delta) k_{t-1}^{PUBL} + g_t^I, \quad (10)$$

where:

g_t^I – government gross capital formation (public investment), following the autoregressive process: $g_t^I = (1-\rho_g)\bar{g}_I + \rho_g g_{t-1}^I + \zeta_{gI,t}$, where: $\rho_g \in (0,1)$, $\bar{g}_I > 0$, $\zeta_{gI,t} \sim N(0, {\sigma_{gI}}^2)$,

Interest rate:

$$r_t = r^* + \alpha_\pi(\pi_t - \pi^*) + \alpha_y(y_t - y^*), \quad (11)$$

where:

r^* – natural interest rate,

π_t – rate of inflation,

π^* – inflation target,

y^* – potential output,

α_π – parameter describing the impact of inflation deviation from its target level on central bank's interest rate,

α_y – parameter describing the impact of output gap (difference between current GDP and potential output) on central bank's interest rate,

$\alpha_\pi > 0, \alpha_y > 0$.

Average price level:

$$p_t = \left(\xi_p {p_{IND,t}}^{-\frac{1}{\lambda}} + (1-\xi_p){p_{OPT,t}}^{-\frac{1}{\lambda}}\right)^{-\lambda}, \quad (12)$$

where:

$P_{IND,t}$ – indexed price,

$P_{OPT,t}$ – optimized price,

ξ_P – probability that a firm will index price,

$\xi_P \in (0,1)$.