Journal of Comparative Economics 51 (2023) 833–857

Contents lists available at ScienceDirect

Journal of Comparative Economics

journal homepage: www.elsevier.com/locate/jce

Rethinking fiscal rules[☆]

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ARTICLE INFO

JEL classification:
E62
H54
O23

Keywords:
Fiscal policy
Infrastructure
Public spending
Public deficit
Debt limits

ABSTRACT

The Covid 19 pandemic has caused both a decrease in tax revenues and an increase in public spending, forcing governments to increase fiscal deficits to unprecedented levels. Given these circumstances, it is foreseeable that fiscal rules will play a predominant role in the design of many countries' recovery policies. We develop a general equilibrium, overlapping generations model for a small, open economy in order to study the impact of several fiscal rules upon welfare, public expenditures and growth. We calibrate the model to the Peruvian economy. In this economy, fiscal rules have been widely used and, unlike in other Latin American countries, they have been relatively successful. We find that fiscal rules will generate better results in terms of output if, in addition to maintaining control over the fiscal result, they also preserve public investment. We also find that the performance of economies that implement structural rules tends to be better than the performance of economies that implement rules based on realized budget balance.

1. Introduction

The Covid-19 pandemic has generated an unprecedented crisis in the global economy. The world GDP [Gross Domestic Product] contraction for 2020 was 3.1%, in accordance with the IMF [International Monetary Fund] World Economic Outlook of October 2021 (IMF, 2021).[1] Governments have responded with massive fiscal and monetary public policies. The fall in tax revenues resulting from the recession, as well as direct measures adopted in order to expand public spending, in combination with the extensions for tax payments which have been applied in most countries, have increased fiscal deficits to unprecedented levels, which therefore have impacted the amounts of indebtedness. Faced with this situation, the countries which were applying fiscal rules when the pandemic arose have proceeded to suspend the limits imposed by these rules. Fiscal rules are intended to avoid discretion in the management of the fiscal policy.

Their primary objective is to achieve macroeconomic stability by eliminating or reducing fiscal deficit bias. This objective is equivalent to target an optimal level for the amount of public debt. In order to achieve this objective, fiscal rules must address two issues related to debt management. First, they should determine the optimal level of public debt that generates interest rates

☆ We thank Jonathan Heathcote, Alberto Barreix, Mikel Casares and Renzo Mini for valuable suggestions and comments. We also thank the Editor, Ruben Enikolopov, and two anonymous referees for many useful comments and suggestions. Jose E. Galdon-Sanchez acknowledges financial support from Spanish State Research Agency through project PID2021-127119NB-I00 and by "ERDF A way of making Europe". Julián Díaz-Saavedra acknowledges financial support from the Spanish State Research Agency through project PID2019-110783GB-I00/AEI/10.13039/501100011033. Open access funding provided by Universidad Pública de Navarra.

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[1] In the case of Latin America, GDP contraction for 2020 was 7%.

https://doi.org/10.1016/j.jce.2023.02.005
Received 26 March 2022; Received in revised form 17 February 2023; Accepted 18 February 2023
Available online 10 March 2023

low enough not to affect the optimal path of private investment and growth, allowing for the implementation of countercyclical fiscal policies in times of recession. Second, given the existing imperfections in the credit market and taking into account the initial conditions of the economy (for example, the initial size of its debt or its infrastructure gap), they should facilitate convergence to the level of public debt determined to be optimal.

If the output recovery is slow, those countries which were previously implementing fiscal rules will likely need to consider having a transition period before implementing them again. This implies that, once sanitary conditions are normalized, additional fiscal measures will be required in the future in order to stimulate demand. This is true to an even greater extent for countries where fiscal rules are applied according to levels rather than flows.

The need for adaptation of the fiscal rules provides an opportunity to study their complete redesign. This is even more the case given the high levels of indebtedness that most countries will have subsequently. In particular, Latin American countries will need to rethink their structural objectives regarding the reduction of infrastructure gaps. This is so since the implementation of fiscal rules also generally affects the optimal composition of public spending, in favor of current spending (which tends to be unproductive or has little impact on growth) and limiting capital spending (which tends to positively affect productivity). In this vein, Blanchard and Giavazzi (2004) criticize that the Stability and Growth Pact for European Countries does not put pressure on the country members to reduce current expenditure so as to make room to increase public investment and reduce taxes. Also, Ardanaz and Alejandro (2021) and Ardanaz et al. (2021) find asymmetric public spending responses during different stages of the economic cycle. During periods of economic expansion, when tax revenues increase, public spending also increases mainly explained by current expenditures. On the contrary, during periods of recession, when tax revenues fall, the public spending reduction is mainly explained by a reduction in capital expenditure. This asymmetric behavior is associated with the political nature of spending decisions, which is so dependent on the political cycle, and which is generally carried out by governments with finite time horizons. Moreover, this behavior is accentuated when the economy approaches elections (see Rogoff, 1990). Given the role that infrastructure plays in an economy's production capacity and productivity, this negative bias on infrastructure spending tends to negatively affect long-term growth (Aschauer, 1989; Easterly and Rebelo, 1993; Arslanalp et al., 2010; Carranza et al., 2014).

In our study, we are not interested in a problem of discretion versus commitment, but we rather present a proposal for rethinking fiscal rules which have the objective of optimizing the fiscal policy response to the apparent dilemma between growth and stabilization. Our starting point is that fiscal rules are better than discretionary fiscal policy. We also assume that countries, once output starts recovering, will redesign and implement fiscal rules again. As in Dovis and Kirpalani (2021), the assumption ... "is that society can credibly impose rules on policy makers and that policy makers can commit to follow these rules".

To carry out our analysis, we build a dynamic, general equilibrium, overlapping generations model economy to study the long term aggregate and welfare consequences of implementing various fiscal rules. In our model economy, the households differ in age and decide how much to optimally work, consume, and save. Production is carried out by a neoclassical representative firm that behaves competitively in its product and factor markets, where production factors are labor, and private and public capital (infrastructure). We also model a government, which runs a pay-as-you-go pension system financed with payroll taxes, and which uses consumption, capital and income taxes to finance the provision of a government public consumption good, public investment, and interest payments on public debt. We compute the solution for both the Social Planner and the decentralized economy where we explicitly assume a government that faces a static maximization problem. In other words, the government mainly cares about current public consumption. We also assume imperfections in the financial markets, due to both the economy's default risks and its own limits on indebtedness.

Since we aim to assess the relative success of various fiscal rules, we calibrate our theoretical model to a typical Latin American economy such as that of Peru.[2] Justification for this selection is provided in Section 3. Next, we introduce and simulate the impact of four different fiscal rules. The first two stabilize the current and structural fiscal deficits, respectively, while the third and fourth rules add a restriction on the composition of public spending which prevents the government from favoring current spending to the detriment of investment in infrastructure. We want to analyze which rule best solves the dilemma between stability and growth, and which rule generates greater well-being over the long term. Similarly, we analyze the performance of the economy under the aforementioned four rules when it is affected by various shocks. Therefore, simulations of the most common shocks faced by Latin American economies such as commodity price shocks, increased variability of product given the dependence on primary activities, and financial stress will be computed.

The use of an overlapping generations model within the literature of fiscal rules constitutes a novelty. Our choice is due to the following reason. Peru, like many other countries, is undergoing a demographic transition process, or more precisely, a process of population aging. Consequently, this economy will experience significant changes in the age distribution of its population. That is, over the next decades, the demographic dependency ratio will increase. According to the Peruvian Instituto Nacional de Estadística e Informática, (INEI [National Institute of Statistics and Informatics]), the ratio of the number of people aged 65 and over on the number of people aged between 20 and 64, will go from the current 13 percent to 27 percent in 2050. This population aging has mainly two consequences, which are not reflected in the quantitative results presented by previous literature. First, the change in the age distribution of the population affects the potential output of the economy, a relevant variable within the literature. Specifically, the future population aging should reduce the expected potential output over the next few decades. Second, and despite the low coverage of social spending in Latin American countries, this aging implies an increase in public spending for the retirement and

[2] Overall, and despite calibrating the model to Peruvian data and the Peruvian institutional setting, our findings can be generalized to other Latin American countries.

health systems during the next decades, for which the implementation of the fiscal rules carry an additional benefit in terms of lower income taxes and higher wages.

We obtain three main results. First, we find strong evidence that introducing fiscal rules improves welfare in the economy, especially over the long term. Second, designing rules which address not only the bias for fiscal deficit, but also take into account the bias for current expenditure, is of critical importance in order to induce a public expenditure composition which is closer to optimal. Put differently, protecting public investment is a key policy objective. And third, we also find that the gap in output between economies with and without fiscal rules raises when there are commodity price shocks and increases in volatility that affect the economies.

To the best of our knowledge, our paper is the first attempt to facilitate the debate related to the long term welfare gains or losses derived from the implementation of fiscal rules that include explicit restrictions on the composition of public expenditures.[3] At the same time, our work is placed in a literature that analyzes the effects of fiscal rules on fiscal outcomes (e.g., Dahan and Strawczynski, 2013; Hallerberg et al., 2009; Fabrizio et al., 2006; Neyapti, 2013), interest rates (e.g., Iara and Wolff, 2014), output volatility (e.g., Fatás and Mihov, 2006), or welfare (e.g. Alfaro and Kanczuk, 2019). Our paper is also related with those papers that analyze fiscal rules under external shocks (e.g., Halac and Yared, 2014; Fernández-Villaverde et al., 2011). Our work has also connections with the literature that assesses the permanent negative effects of fiscal consolidations on long term output (e.g. Blanchard Olivier and Leigh, 2013; Fatás and Summers, 2018; House et al., 2020). However, our paper does not consider the possibility of default (as it is the case in Alfaro and Kanczuk, 2019, or Hatchondo et al., 2022), nor in our model economy fiscal rules arise because the government intend to signal its type (e.g., Dovis and Kirpalani, 2021).

Our model and the solutions for both the social planner and a decentralized economy are presented in Section 2. Section 3 is devoted to the calibration of our model economy. The policy experiments, the demographic and fiscal scenarios in which the experiments take place, the simulation of the optimal and benchmark model economies, and the different fiscal rules studied appear in Section 4. In Section 5, we present the results of simulating our model economy under these fiscal rules. Section 6 concludes.

2. Model economy

We build a general equilibrium overlapping generations model economy with imperfect credit markets in a small open economy. In our model, each period corresponds to one year. The economy is populated by households, firms, and a government that we will describe below.[4]

Once we set up the model, we will proceed as follows. First, we will specify the solution for a centralized economy, i.e. the Social Planner. Then we will establish an economy where agents take decisions in a decentralized way. Into this economy, we will introduce a government elected for every period which has a defined preference function and a budget constraint. As we will see, the differences between the solutions of a centralized economy and a decentralized economy vary in conjunction with two factors: (i) the efficiency losses resulting from the distortions that appear when taxes are introduced and (ii) the bad decisions of the government, which translate into high indebtedness and a greater bias towards current spending given the government's preferences.

The objective of the paper is to explain precisely how fiscal rules can help reduce both the bias to increase the deficit and the bias to increase current expenditures.[5]

2.1. Environment

Demographics. The economy is populated by overlapping generations of individuals of measure $\mu_{j,t}$ who enter the economy at age $j = 20$ and live until the maximum of $J = 100$ years. Parameter $\psi_{j,t}$ denotes the conditional probability of surviving from age j to age $j+1$ at period t.

Employment status. Individuals in our economy are either workers or retirees, and every individual enters the economy as a worker. Once an individual has reached the mandatory retirement age, j_r, she leaves the labor market and becomes a retiree.

Endowments. Workers receive an endowment of efficiency labor units every period. This endowment depends on the household's age, and we use it to characterize the earnings life-cycle profile. We model this profile using the following quadratic function:

$$\epsilon_j = e_1 + e_2 j - e_3 j^2 \tag{1}$$

[3] Mendoza et al. (2021) analyze the impact of fiscal rules on public investment for the case of Peru. Despite the fact that they also use a DSGE model to analyze different types of fiscal rules, they assume exogenous processes for both current expenditure and public investment, and do not introduce any explicit restriction for the country´s indebtedness capacity.

[4] As it has been already mentioned in the introduction, the use of a model of overlapping generations makes it possible to incorporate the population dynamics of Peru during the next decades. This is important because the simulation results show the sustained increase in pension spending due to population aging.

[5] From the point of view of the endogenous growth theory, other channels for macroeconomic stability positively affecting long-term growth (greater financing for innovation, greater public investment that generates increasing returns to scale, greater private investment that generates learning-by-doing, etc.) can be noted. However, in this paper, we want to focus exclusively on the channels for reducing both deficit biases and current spending exhibited by the economies.

where ϵ_j is the deterministic productivity profile of households at age j, and letters e_i $(i = 1, 2, 3)$ denote parameters. We choose this functional form because it allows us to represent the life-cycle profile of the productivity of workers in a very parsimonious way.

Preferences. Each period individuals derive utility from consumption and leisure. Specifically, we assume

$$u(c_{j,t}; 1 - l_{j,t}) = log(c_{j,t}) + \chi \frac{(1 - l_{j,t})^{1-\sigma}}{1 - \sigma} \tag{2}$$

where $l_{j,t}$ is the share of time at age j in period t that individuals devote to labor market activities. Consequently, $1 - l_{jt,}$ is leisure at age j in period t, χ is the relative utility weight on leisure, and $-\sigma$ is the elasticity of marginal utility regarding leisure. Finally, consumption at age j in period t, $c_{j,t}$, is given by the Cobb–Douglas function $c_{j,t} = (c^p_{j,t})^\theta (c^g_{j,t})^{1-\theta}$, where $c^p_{j,t}$ is the consumption of the private good and $c^g_{j,t}$ is the consumption of the public good provided by the government. The utility function in (2), a separable preference defined over consumption in log and leisure, is commonly used in the real business cycle literature (see, for example, Campbell, 1994).

Technology. The economy produces an internationally tradable composite commodity. Firms choose optimal quantities of labor and private capital taking factor prices and public capital as given. The technology is represented by a standard Cobb–Douglas production function. Consequently, the production of output at period t, Y_t, requires labor input, L_t, private capital, K_t, and public capital (infrastructures), $K_{g,t}$. We also assume that both goods and factor markets are perfectly competitive. The technology used by the representative firm is given by:

$$Y_t = Z_t K_t^\alpha (H_t L_t)^\zeta K_{g,t}^\eta \tag{3}$$

where Z_t is a productivity shock, whose law of motion is given by $ln\, Z_t = (1 - \rho)\, ln\, \overline{Z} + \rho\, ln\, Z_{t-1} + \varepsilon_t$, and $\varepsilon \sim N(\mu_\varepsilon, \sigma_\varepsilon)$. And H_t denotes a deterministic exogenous labor-augmenting productivity factor whose law of motion is $H_{t+1} = (1 + g)\, H_t$. Parameters α, ζ, and η are the respective output elasticities to private capital, labor, and public capital. We also assume constant returns to scale, that is $\alpha + \zeta + \eta = 1$. Finally, we also assume that both types of capitals depreciate geometrically at a constant rate δ, $0 < \delta < 1$.

Note that the public capital stock (infrastructure) positively affects the product in the present, thus increasing the profitability of capital and wages, which feeds back with greater private investment. These positive effects of infrastructure on output were originally presented in the seminal paper by Aschauer (1989).

Credit market. In our model economy, we assume imperfections in the financial markets, due to both the economy's default risks and its own limits on indebtedness. Specifically, we assume that the interest rate faced by domestic agents, r_t, is increasing in the ratio of public foreign debt, B, to domestic output, Y. That is, the domestic interest rate is given by

$$r_t = r^* + \varrho \frac{B_t}{Y_{t-1}} \tag{4}$$

where $r^* = \frac{1}{1+\beta}$ denotes the world interest rate, ϱ is a parameter that reflects the country-specific interest premium, B_t is the beginning of period public foreign debt, and Y_{t-1} is output at period $t - 1$.

Finally, we also assume that there is a maximum level of public debt to output ratio given by the parameter $\overline{B}$. This additional restriction on the sensitivity of the interest rate to the level of debt is due to the fact that, when a country reaches excessive levels of indebtedness, the financial markets stop lending and therefore the country can only access out-of-market placements, through bilateral debt or the multilateral development banks.[6]

2.2. Social planner problem

In this economy, a benevolent central planner takes decisions to maximize social welfare. Specifically,

$$\max_{(c_t, l_t, A_{t+1})} E\{ \sum_{j=20}^{J=100} \beta^{j-20} \psi_{j,t} [log(c_{j,t}) + \chi \frac{(1 - l_{j,t})^{1-\sigma}}{1 - \sigma}]\} \tag{5}$$

where β is the time preference discount factor, and A_t are net financial assets. This maximization is carried on subject to the feasibility constraint:

$$\sum_{j=1}^{J} c^p_{j,t} + \sum_{j,t}^{J} c^g_{j,t} + I_t + I_{g,t} + A_{t+1} = Y_t + (1 + \overline{r}_t) A_t \tag{6}$$

and

$$K_{t+1} = (1 - \delta) K_t + I_t \tag{7}$$

and

$$K_{g,t+1} = (1 - \delta) K_{g,t} + \gamma I_{g,t} \tag{8}$$

[6] For simplicity, we choose Y_{t-1} for the debt-output ratio.

where I_t and $I_{g,t}$ are investment in private and public physical capital respectively, and γ is a parameter that measures the efficiency in public investment, following Pritchett (2000). Moreover, for the interest rate, we have that:

$$\bar{r}_t = \begin{cases} r^* & \text{if } A_t \geq 0 \\ r_t & \text{if } A_t < 0 \end{cases} \tag{9}$$

where $\bar{r}_t$ evolves in accordance with the credit market imperfections given the domestic net foreign asset position.

2.3. Decentralized economy (benchmark model economy)

An alternative setting to the Social Planner Problem is the competitive market environment, in which each agent makes her own decisions in order to maximize her respective objective function. Let us now consider the characterization of this decentralized economy.

Individual's problem. In our benchmark model economy, individuals maximize the expected discounted lifetime utility,

$$\max_{(c_{j,t},l_{j,t},a_{j,t+1})} E\{\sum_{j=20}^{J=100} \beta^{j-20}\psi_{j,t}[log(c_{j,t}) + \chi\frac{(1-l_{j,t})^{1-\sigma}}{1-\sigma}]\} \tag{10}$$

In addition, individuals are subject to the following period constraint

$$c^p_{j,t} + a_{j,t+1} + \tau_{j,t} = y_{j,t} + a_{j,t} \tag{11}$$

where

$$\tau_{j,t} = \tau_k y^k_{j,t} + \tau_y y^b_{j,t} + \tau_{s,t} y^l_{j,t} + \tau_{c,t} c^p_{j,t} \tag{12}$$

$$y_{j,t} = y^k_{j,t} + y^l_{j,t} + p_t + \pi_t \tag{13}$$

$$y^k_{j,t} = a_{j,t} r_t \tag{14}$$

$$y^l_{j,t} = w_t \epsilon_j l_{j,t} \tag{15}$$

$$y^b_{j,t} = (1-\tau_{s,t})w_t\epsilon_j l_{j,t} + (1-\tau_k)a_{j,t}r_t + p_t + \pi_t \tag{16}$$

and where w_t is the wage rate, r_t denotes the interest rate given by expression (4), $\tau_{j,t}$ is total taxes, τ_y is the income tax rate, $\tau_{c,t}$ is the consumption tax rate, τ_k is the capital income tax rate, $\tau_{s,t}$ is the payroll tax rate, p_t is the retirement pension, π_t are firm's profits, $y_{j,t}$ is total income, $y^k_{j,t}$ is capital income, $y^l_{j,t}$ is labor income, $y^b_{j,t}$ is total income (net of payroll and capital income taxes), and $a_{j,t}$ is the amount of assets at the beginning of the period. We also assume that net assets are constrained as being non negative, and that $a_{1,t} = a_{J,t+J} = 0$.[7] Notice that, in our economy, every household can earn capital income, only workers can earn labor income, and only retirees can receive retirement pensions.[8]

Firms. The Firm's maximization problem can be stated as

$$\max_{(K_t,L_t)} \pi_t = Y_t - R_t K_t - w_t L_t$$

where π_t are profits, and $R_t = r_t + \delta$ is the gross interest rate at period t. The First Order Conditions of this static problem are:

$$R_t = \alpha Z_t K_t^{\alpha-1}(H_t L_t)^{1-\alpha}$$

$$w_t = (1-\alpha) Z_t K_t^{\alpha} H_t^{1-\alpha} L_t^{-\alpha}$$

that is, prices are the factor marginal productivities of private capital and labor.

Government. The government has two roles in our model economy. It establishes the fiscal policy and runs a public pension system, which we describe in turn.

Fiscal policy. In order to determine how the government allocates total revenues between the public consumption good and infrastructure, we assume that the government's objective function is given by:

$$G(C_{g,t}, I_{g,t}) = C^{\omega}_{g,t} I^{(1-\omega)}_{g,t} \tag{17}$$

Eq. (17) obviously depends on the expenditure variables of the Government. As we have seen on both Section 3, where we discuss the Peruvian case, and the evidence presented by Ardanaz and Alejandro (2021), there is a clear bias towards current spending by politicians in addition to the overwhelming empirical evidence of deficit bias (Alesina and Drazen, 1991; Persson and Tabellini,

7 We assume that households receive the same rental rate as the one faced by the government in the international market due to arbitrage conditions.

8 For the experiments that we perform, we maintain the tax rates for capital and total income as constant. The payroll tax is adjusted to balance the pension system, and the consumption tax rate may change according to the implemented fiscal rule. See below.

2000). In this way, we present a simplification of the government's preferences, leaving aside taxes, which tend to show marginal changes, unless the country is in a severe fiscal crisis.

This is basically a static maximization problem that must be solved for every period t. Furthermore, it is straightforward to note from this maximization problem, that the shares of public revenues allocated to the provision of the public consumption good and infrastructure are ω and $(1-\omega)$ respectively. Therefore, if the government has a bias towards current spending on the public consumption good, measured by the parameter ω, the economy would tend to have a low level of public capital in comparison to its private capital.

On the other hand, the government in our model economy collects tax revenues using a proportional tax on total income, a proportional tax on capital income, and a proportional tax on consumption. It also issues one period real foreign debt. For simplicity, we also assume that the government confiscates unintentional bequests. The government uses these revenues to finance spending in infrastructure, which raises total factor productivity. It also makes transfers to households in the form of a public consumption good and repays the principal plus the interest on the endogenous stock of public debt. Therefore, government spending must be equal to its revenue:

$$C_{g,t} + I_{g,t} + (1 + r_t(1 - \tau_k))B_t = T_{y,t} + T_{k,t} + T_{c,t} + E_t + B_{t+1} \tag{18}$$

where $T_{y,t}$, $T_{k,t}$, and $T_{c,t}$ are total tax collections from the total income, capital income, and consumption taxes respectively, E_t is unintentional bequests, B_t is the beginning of period stock of foreign public debt, $C_{g,t}$ is the flow of the public good, and $I_{g,t}$ is the spending on infrastructure.[9]

In addition to the credit imperfection introduced in Eq. (4), we incorporate two additional restrictions. First, an 80 percent limit for the public debt indebtedness to output ratio, reflecting cases like Argentina in which access to capital markets is severely limited after a certain level is reached and the spread in the secondary market tends to grow exponentially, discounting a greater probability of default.[10] Second, we assume that the maximum limit for the fiscal deficit is 5 percent of GDP per year, up to the limit of 80 percent of the debt-to-GDP ratio.[11]

Pension system. To complete the specification of our model economy we must describe its pay-as-you-go pension system. The system imposes a payroll tax, $\tau_{s,t}$, over gross labor income, and it also delivers a retirement pension, p_t, to all households aged j_r or older. The budget constraint for the pension system is defined as:

$$P_t = \sum_{j=j_r}^{J} p_t \mu_{j,t} = \tau_{s,t} w_t L_t \tag{19}$$

where P_t is total pension payments, and $w_t L_t$ is gross labor income.

3. Calibration

As it has been mentioned, our baseline economy is calibrated to the Peruvian economy. In what follows, we fully characterize our model economy and evaluate the calibration results obtained.

3.1. Parameters and targets

To fully characterize our model economy, we must choose the values of a total of 25 parameters. Of these parameters, 4 describe household preferences, 3 describe the labor efficiency units allocation process, 10 describe the production technology, and 8 describe the remaining components of the fiscal and pension policies. To choose the values of these 25 parameters we need 25 equations or calibration targets which we describe below. The values of these 25 parameters are reported in Table 1.

The life-cycle profile of earnings. We estimate the values of the 3 parameters of the quadratic function that we describe in expression (1), using the five-year age groups distribution of monthly wages in 2015 reported by the INEI. We represent this function in Fig. 1. This procedure allows us to identify the values of those 3 parameters directly. The parameters e_1, e_2, and e_3 take values 1.1276, 0.0468, and 0.007 respectively.

9 We assume that the income and capital income tax rates remain constant during our quantitative exercises, in their initial steady state value. The rationality is that the fiscal rules we study in this paper primarily address the fiscal aggregates (debt, deficit, and expense). Fiscal rules on public revenues only appear when there are exceptional fiscal revenues.

10 For developed countries, Reinhart and Rogoff (2010) consider a limit of 90 percent in the debt to output ratio, above which the growth of the countries is seriously affected. In the case of emerging economies, the IMF (2002) recommends debt limits of 40 percent to avoid affecting long-term growth due to the volatility of tax revenues.

11 The fiscal rule was introduced for the first time in Peru in 1999. According to the statistics of the Central Reserve Bank of Peru, at that time the debt was at 51.4 percent of GDP and the deficit closed at 3.4 percent of GDP, having had to contract public investment around 2 percent of GDP because the access to private financial markets was very limited. In Latin America, in general, countries with debt levels around 80 percent or higher have problems accessing financial markets and their spreads become very sensitive. However, there are some differences due to structural reasons. For example, and according to the statistics of the International Monetary Fund, Brazil ended 2021 with debt levels of 93 percent of GDP and no problems accessing capital markets, especially domestic ones, while Ecuador ended up that year with a debt to GDP ratio of 64.6 percent and no access whatsoever to private financial markets. For Peru, the maximum limit of 80 percent for the debt to GDP ratio seems, under these circumstances, reasonable.

Table 1
Parameter values.

	Parameter	Value
Earnings Life-Cycle		
	e_1	1.1276
	e_2	0.0468
	e_3	0.0007
Preferences		
Curvature	σ	4.0000
Time preference	β	0.9815
Utility weight on leisure	χ	1.0000
Private consumption share	θ	0.8000
Technology		
Efficiency public investment	γ	1.0000
Private capital share	α	0.2500
Public capital share	η	0.0800
Labor share	ζ	0.6700
Depreciation rate	δ	0.1000
Labor productivity growth	g	0.0040
Long run value TFP	$\overline{Z}$	1.0000
Autoregressive coefficient	ρ	0.9500
Mean (TFP shock)	μ_ε	0.0000
Standard deviation (TFP shock)	σ_ε	0.0076
Fiscal policy		
Capital income tax rate	τ_k	0.5571
Total income tax Rate	τ_y	0.1252
Consumption tax Rate	$\tau_{c,t}$	0.1708
Government consumption share	ω	0.8000
Interest rate premium	ϱ	0.0500
Maximum Debt-Output ratio	$\overline{B}$	0.8000
Pension policy		
Mandatory retirement age	j_r	65
Payroll tax rate	$\tau_{s,t}$	0.0440

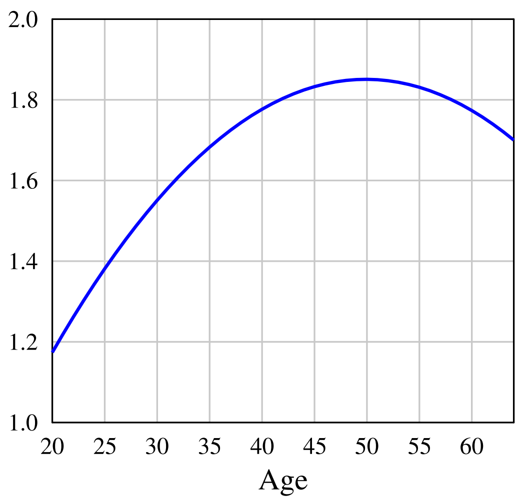

Fig. 1. The labor efficiency units.
Source: Own elaboration based on INEI.

Preferences. To determine the household's preferences, we must establish the values of four parameters. First, we assume that the discount factor is $\beta = 0.9815$, such that the value for the risk-free world interest rate is $r^* = 0.0188$. We also assume that σ is 4.0, as it is standard in the literature. This choice implies that the Intertemporal Elasticity of Substitution (IES) varies over the life-cycle as a function of leisure relative to work hours.[12] We also assume that the share of consumption of the private good is $\theta = 0.8$. The rationale for this choice is that, according to the statistics of the Central Reserve Bank of Peru (BCRP [Banco Central de Reserva del Perú]), for the years 2014–2018, private consumption in Peru had a participation rate of around 0.8 with respect to total consumption.

Finally, for simplicity, we assume that the scale parameter used to replicate the average share of time dedicated to labor market activities, χ, is one. The rationale behind this assumption has to do with the fact that Peru, like many other Latin American countries, has a high degree of informality in its labor market, which makes it difficult to know the average number of effective hours worked in the economy.[13] We could assign different values to that parameter, however, it will not change the essence of the main results that we obtain in our exercises.

Technology. To fully describe technology in our model economy, we must establish the values of 10 parameters. First, we choose $\gamma = 1$, indicating that the stock of public physical capital in period $t+1$ ($K_{g,t+1}$) is equal to total public investment ($I_{g,t}$) in addition to the existing stock of undepreciated public capital stock in period t ($(1-\delta)K_{g,t}$). We then follow Castillo and Rojas (2014), by assuming $\alpha = 0.25$, $\zeta = 0.67$ and $\eta = 0.08$. These coefficients are also consistent with the values reported by the BCRP. Consequently, we assume that the economy is subject to constant returns to scale, such that firms will produce extraordinary profits of the magnitude ηY_t. This is the reason why we include these positive profits in the households' budget constraint. This is also the approach followed by Cassou and Lansing (1998). For the depreciation rate we assume a value of $\delta = 0.1$, a value that is standard in the literature. The constant growth rate for labor augmenting productivity is set in $g = 0.004$, a value that is consistent with the average growth rate of labor productivity in the Peruvian economy for the 1995–2015 period according to the INEI. Finally, we must establish the values that characterize the stochastic process for the total factor productivity Z_t. Following Montoro and Moreno (2007), we assume $\overline{Z} = 1$, $\mu_\varepsilon = 0$, $\sigma_\varepsilon = 0.0076$, and $\rho = 0.95$

Government. To characterize the government sector in our model economy, we must set the values for 8 parameters. Regarding the fiscal policy, we target the output shares of $T_{c,t}, T_{k,t}$, and $T_{y,t}$ such that they replicate the GDP shares corresponding to Sales and Gross Receipt Taxes, Corporate Profit Taxes, and Individual Income taxes. According to the INEI, the average numbers for the period 2007–2015 were 8.56, 4.19, and 1.66 percent of GDP, respectively. These numbers directly establish the values for $\tau_{c,t}, \tau_k$, and τ_y. We also assume that the maximum level for the Public debt to output ratio is $\overline{B} = 0.8$. This number can be seen as an average of those observed for a sample of Latin American countries before the COVID-19 crisis. For example, Ecuador, with a public debt to GDP ratio of around 50 percent in 2019, did not had access to international credit markets by that year until it reach an agreement with the International Monetary Fund (IMF). On the other hand, Brazil had access to these markets despite having a public debt to GDP ratio of almost 90 percent that same year.

The weight of public consumption in the government's objective function is another key parameter since it determines the average level of public capital under-accumulation in the benchmark economy. As already mentioned, since 2000, in Peru, 3 periods are clearly distinguished in relation to the fiscal rules implemented. First, from 2000 to 2006, a period in which a limit is imposed on the current fiscal deficit of 1 percent of GDP and a rule for the annual growth of real general government spending of no more than 2%. Second, between 2007 and 2011, where an annual growth of the real central government consumption is established not greater than 3 percent but maintaining the limit to the current fiscal deficit of 1 percent of GDP. Third, between 2012 and 2019, where the rule that limited the growth of the central government's real consumption is eliminated and the current deficit rule is replaced by a structural deficit rule less than or equal to 1 percent of GDP. When fiscal rules do not distinguish between consumption and capital expenditure (public investment), there is a predominance of public consumption over public investment, that is, the government's preferences clearly favor higher current spending. This is the case during the periods 2000 to 2006 and from 2012 to 2019. Specifically, and in these periods, the share of government current spending within the total government consumption was around 80 percent of total government expenditure, according to the BCRP statistics. Consequently, we impose that the share of public consumption in the government's objective function is $\omega = 0.8$. Finally, and for the parameter that reflects the country-specific interest premium, we choose a value of $\varrho = 0.05$, since this number falls within the 0.03–0.09 range, which is standard in the literature.

The remaining two parameters define the public pension system of our model economy. First, we assume that the mandatory retirement age is $j_r = 65$, since this number is standard in life-cycle models where the retirement decision is exogenous. Second, we target the output share of P_t, so that it replicates the GDP share of public pension payments. According to the Economy and Finance Ministry of Peru, the average of this share for the period 2000 to 2010, was 2.7 percent. This value directly determines the value for the payroll tax rate, $\tau_{s,t}$.

3.2. Calibration results

We begin this section by showing the calibration results related to the main aggregates and ratios of the Peruvian economy. Subsequently, we consider the life-cycle profiles generated by our model economy in the initial steady state.

Macroeconomic aggregates and ratios. In Table 2 we report selected macroeconomic ratios in Peru and in the benchmark model economy. We find that the benchmark model economy does a good job in replicating most of the values for the reported ratios.

[12] The IES is given by $\frac{1}{\sigma}\frac{1-l_j}{l_j}$. In the initial steady state of our model economy, the value for the average IES is 0.76.

[13] According to a report by the National Chamber of Commerce, Production, Tourism and Services of Peru [Cámara Nacional de Comercio, Producción, Turismo y Servicios de Perú], labor informality was 71.1 percent in 2019.

Table 2
Macroeconomic ratios in Peru and in the benchmark model economy* (%).

	T_c/Y^*	T_k/Y^*	T_y/Y^*	P/Y^*	K/Y^*	K_g/Y^*
Peru	8.56	4.19	1.66	2.7	1.67	0.56
Model	8.56	4.19	1.66	2.7	1.68	0.44

*Variable Y^* denotes GDP at market prices. The Peruvian data for the tax collections are taken from the INEI. The Peruvian data for the capital stock are taken from the IMF (Investment and capital stock dataset, 1960–2017), and correspond to the year 2017.

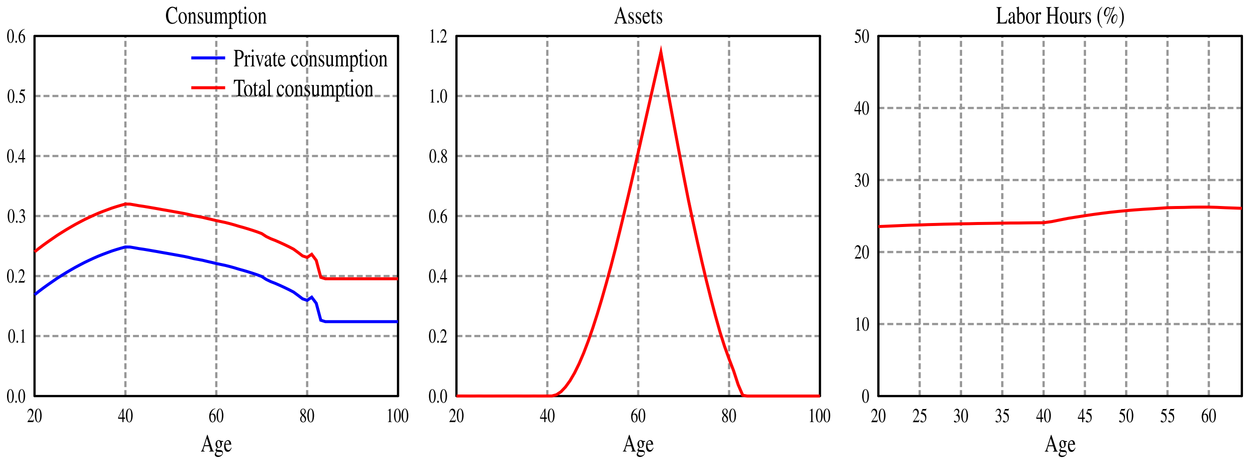

Fig. 2. Life-cycle profiles of consumption, assets and labor hours in the benchmark Model Economy.

Specifically, the model exactly replicates the ratios related to tax collection. This was expected, given that these ratios were calibration targets. The model also almost exactly replicates the ratio of private physical capital to output. We find this result very encouraging since we did not target explicitly this statistic in our calibration procedure. Finally, the model underestimates the ratio of public capital to output by 12 percentage points. As in the previous case, we did not target explicitly this statistic in our calibration procedure.

Life-cycle profiles. Fig. 2 shows life-cycle profiles of consumption, assets, and hours worked as a percentage of disposable time. We find that hours worked are mainly in the range of 20 and 30 percent of disposable time. Consumption shows the usual increasing profile at the beginning, then decreases, and finally remains constant because it is entirely financed by pensions as well as the public consumption good.

Fig. 2 also displays the usual patterns of average asset holdings over the life cycle. The figure shows not only that agents begin to accumulate assets late in the working lifetime, but also that these assets are almost totally consumed as soon as the agents reach 80 years old. Put differently, households in our model economy have little incentive to save, and the reasons are: (i) households are not altruistic, so they do not leave voluntary inheritances; (ii) there is no uncertainty in the income received by households, so they do not have a precautionary reason to save; (iii) the government assured them a flow of consumption with the provision of the public consumption good, during the different stages of the life cycle; and (iv) during the time of retirement, the government pays retirement pensions.

4. Policy experiments, scenarios, and fiscal rules

In this section, we describe both the experiments, and the demographic and fiscal scenarios that we use in our simulations. We also simulate the optimal and the benchmark model economies. Finally, we define the four fiscal rules that we are going to use in our final simulations.

4.1. Experiments

All the simulations that we describe below, involve the computation of an initial and final steady state, and the transition path between them. Additionally, all simulations share the following features. The initial steady state ($t = 1$) is characterized by a public debt to output ratio of 60 percent, such that the domestic interest rate is 4.88 percent. Moreover, in this initial steady state, total public revenues (net of public debt interest payments) are split between public consumption and investment in infrastructure according to the government preferences. From period $t = 2$ to $t = 200$, all model economies are exposed to the same productivity shocks. Subsequently, we assume that the productivity shock reaches its long-term mean value $Z_t = 1$. Fig. 3 plots the realization of this productivity shock between periods $t = 2$ to $t = 200$.

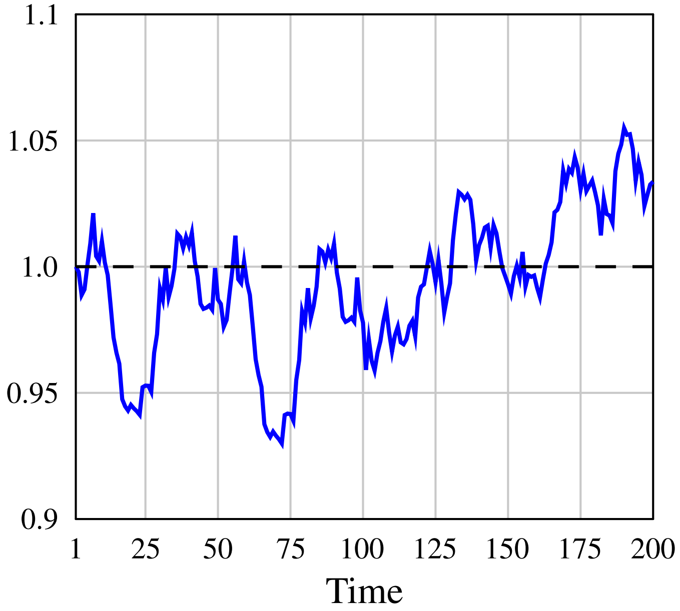

Fig. 3. Total factor productivity (Z_t).

4.2. Scenarios

All of the model economies we are going to study share the demographic and fiscal scenarios that we now describe.

Demographics. We take the measure $\mu_{j,t}$ for all $j = \{20, 21, \ldots, 100\}$ directly from the demographic projection (middle hypothesis) of the Peruvian INEI, for the period 2000 to 2050. After this last year, we assume that this measure remains constant at its 2050 value. We also take the conditional probabilities of surviving $\psi_{j,t}$ between 2017 and 2050 from the INEI. We assume that between 2000 and 2016, these probabilities are those estimated for the year 2017. We also assume that these probabilities remain constant at their 2050 value after that same year.[14] In Fig. 4 A, we plot the implied old-age dependency ratio, which we define as the number of people with 65+ years old to the number of agents aged 20 to 64. In Fig. 4B, we plot the age-dependent survival probabilities for both 2000 and 2050.

Pension policy. Recall that, in our model economy, the pension system budget constraints is:

$$P_t = \tau_{s,t} w_t L_t \tag{20}$$

In all model economies, the payroll tax rates vary across the economies because we change them to finance pensions. Every other variable in these expressions also varies in time and varies across economies because they are all endogenous.

4.3. Optimal and benchmark model economies

In what follows, we simulate the optimal and the benchmark model economies, following the simulation strategy mentioned in Section 4.1. **The optimal model economy (social planner problem).** In the Optimal Model Economy (as stated in Eqs. (5) to (9)),

the optimal allocations of public and private capital given the maximization problem faced by the benevolent social planner are

$$r_{t+1} + \delta = F_{K,t+1} = F_{K_g,t+1} \tag{21}$$

where $F_{k,t+1}$ and $F_{k_g,t+1}$ are the marginal productivities of both private and public capital. Note also that public investment in infrastructure for period t can be obtained from the law of motion of public capital

$$I_{g,t} = K_{g,t+1} - (1-\delta)K_{g,t} \tag{22}$$

On the other hand, the optimal allocations for both the private and public consumption goods imply that at any age j,

$$c^g_{j,t} = ((1-\theta)/\theta)c^p_{j,t} \tag{23}$$

[14] The Peruvian INEI reports the population projection for five-year age groups: 20–24 years, 25–29 years, etc. We assume, within each age group, that there is the same number of people at each age. Similarly, this demographic projection is done for 5-year intervals. In this case, we perform a linear interpolation, for each age group, between two immediately consecutive periods.

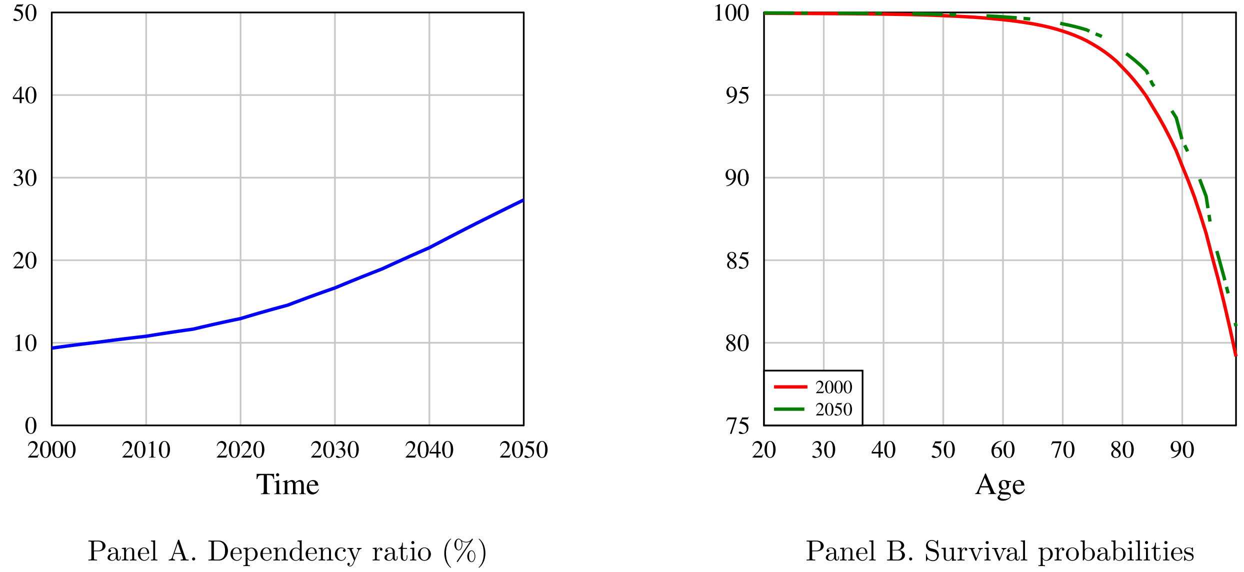

Fig. 4. The dependency ratio and the survival probabilities.
Source: Own elaboration based on INEI.

The benchmark model economy. Our benchmark model economy assumes that the mix of public expenditures is set according to the government's preferences. Moreover, we assume that between periods $t = 2$ and $t = 5$, the government runs a fiscal deficit of 5 percent of output, such that at the end of period $t = 5$, the ratio Public Debt to output becomes 80 percent (the maximum allowed value for this ratio), and it remains constant at this same value throughout the transition path.

If we compare the evolution of output during the transition path both in the Social Planner economy and in the Benchmark case, we note significant differences (see Fig. 5). Specifically, and with both economies starting from the same initial conditions, output under the Social Planner grows significantly from the outset, while Benchmark case output remains at relatively stable levels, although slightly below its initial value. The latter is, in turn, due to the increase in domestic interest rates (caused by the increase in public indebtedness) which reduces the accumulation of capital. On the contrary, the sustained increase in output under the social planner is a consequence of the substantial increase in public capital, motivated by the optimality conditions between both types of capital, and by increased private capital. In other words, the investment in infrastructure in the case of the Social Planner's problem is substantially higher.

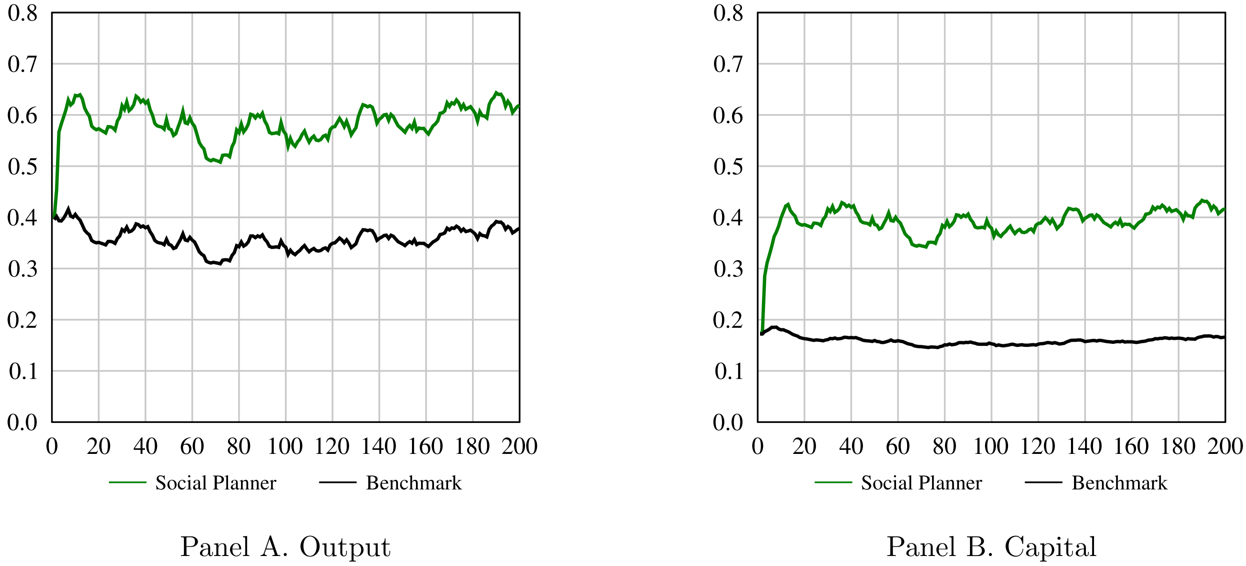

Fig. 5. Output and public capital: social planner vs benchmark.

There is a significant difference in output performance between the Social Planner economy and the Benchmark economy with imperfect financial markets and one-period Government. The primary explanation for such a difference is the bias towards large fiscal deficits, which results in high interest rates affecting private capital accumulation and, therefore, economic growth. In order to correct for this problem, institutional arrangements were implemented during the last two decades, primarily imposing restrictions on the level of debt and/or the level of the fiscal deficit, with a large amount of research devoted to addressing the convenience of targeting current or structural fiscal deficits (Wyplosz, 2013; Luc et al., 2018). However, in recent years, after achieving macroeconomic stability and keeping both fiscal deficits and total public debt under control, significant dissatisfaction has arisen among policy makers related to output performance given the strong bias towards public consumption and the limited reduction in the debt to output ratio observed in most countries (Ardanaz and Alejandro, 2021; Ardanaz et al., 2021).

4.4. Fiscal rules

In what follows, we define the fiscal rules that we are going to use in our final simulations. We introduce four different rules. The first two deal with the problem of deficit bias, imposing a current deficit rule equal to zero and a structural deficit equal to zero. The other two rules incorporate an additional expenditure rule into both the current deficit rule and the structural deficit rule, imposing that public capital spending be aligned with the optimality condition given by Eq. (21). In other words, for the first two rules we alter the budget constraint, while for the latter two rules the government's preference function is also altered.[15]

Realized balance fiscal rule (FR1). This rule implies a balanced current fiscal budget for every period, i.e. the observed fiscal deficit is equal to zero.[16] In this model economy, we continue to assume that the government runs a fiscal deficit of 5 percent of output between periods $t = 2$ and $t = 5$. However, and once the Public Debt to Output ratio reaches 80 percent, the government runs a primary fiscal surplus to pay the interest of public debt. This assumption has two consequences. First, the nominal amount of government debt at the end of period $t = 5$ remains constant along the transition path. Second, the public debt to output ratio varies during the transitional dynamics. In fact, and once the productivity shock reaches its long run mean value $Z_t = 1$, this ratio decreases because the output grows. Specifically, the government budget constraint becomes:

$$C_{g,t} + I_{g,t} + r_t(1 - \tau_k)B_t = T_{y,t} + T_{k,t} + T_{c,t} + E_t \tag{24}$$

Structural balance fiscal rule (FR2). This rule implies a balanced structural fiscal budget for every period. As in the Benchmark model economy, the government runs a fiscal deficit equivalent to 5 percent of output between periods $t = 2$ and $t = 5$. From period $t = 6$ onwards, the government follows a *structural balance fiscal rule*, aimed at eliminating the cyclic effects of output on the fiscal deficit. Therefore, an increase in the output over its trend would lead to an increase in revenue without an increase in public spending, with the consequent reduction in public debt. Stated differently, extraordinary tax revenues resulting from the expansive phase of the cycle are saved for the time in which the output is in its recessive phase. Finally, as in the previous simulations, once the productivity shock reaches its long run mean value $Z_t = 1$, this ratio decreases because the output grows. In this case, the government budget constraint becomes:

$$C_{g,t} + I_{g,t} + r_t(1 - \tau_k)B_t = \hat{T}_{y,t} + \hat{T}_{k,t} + \hat{T}_{c,t} + E_t \tag{25}$$

where $\hat{T}_{x,t}$ is the structural tax revenues collected by the tax on x (Y, K, or C). Specifically,

$$\hat{T}_{x,t} = \tau_x \hat{X}_t \tag{26}$$

Naturally, the changes in the age distribution that occur in the model during the path of transition to a final steady state, modify labor force and savings, and therefore capital. In other words, the potential output of the economy changes each period until the model converges asymptotically towards that final steady state. Consequently, and to obtain the value of the potential output during the transition path, we proceed as follows. We simulate the benchmark economy, but assume that total factor productivity remains at its long-term value. This prevents the economy from being exposed to unexpected shocks that increase or decrease output relative to the one observed in the absence of such disturbance. The rest of the scenarios, such as the demographic and fiscal scenarios, remain exactly the same as those used in the benchmark economy.

Notice that with FR1 and FR2 we are imposing a stronger restriction on the Government's problem, forcing it not to increase the stock of debt (FR1) or forcing it to take debt only when current fiscal income is below the structural fiscal income (FR2). However, under these two rules, the government continues to use its one-period preferences to determine the expenditure composition between public consumption and public investment. The next two rules deal with this issue.

We simulate two additional economies that resemble the two previous model economies, but with the significant difference that the share of government expenditure allocated to public investment in infrastructure follows the optimality condition described in the *Optimal Model Economy*. Specifically, the optimality condition determines the amount of public investment in period t, such that the public consumption good is obtained residually from the government budget constraint. We also assume that this is the rule followed by the government for every period $t \geq 2$.

[15] There are multiple possibilities to impose fiscal rules. For simplicity, we choose a canonical rule giving by the optimality conditions in order to illustrate the differences. A rule like the golden rule imposes another type of restriction, allowing public investment to be financed by debt. However, in an economy with a high level of initial debt and interest rates highly dependent on the stock of debt, the golden rule of allowing fiscal deficits to finance public investment converges to the benchmark economy with maximum debt levels, high spreads, low debt capacity and low levels of public investment.

[16] In other words, this rule includes capital revenues and expenditures.

Therefore, the next two fiscal rules are the following: **Realized balance with investment preservation fiscal rule (FR3).** This rule is the FR1 to which an expenditure rule has been added. **Structural balance with investment preservation fiscal rule (FR4).** This rule is the FR2 to which an expenditure rule has been added.

Note that under the fiscal rules FR3 and FR4, the government behavior is restricted by Eqs. (21) and (24). The only difference is that public consumption is obtained residually from Eq. (24) under the FR3, and from Eq. (25) under the FR4. Put differently, under the last two fiscal rules, the expenditure rule forces the government to decide first on public investment in order to achieve the optimal ratio between private and public capital.

From the point of view of the implementation of public policies, two observations are worth mentioning. First, the expenditure rule imposed by the optimality condition (Eq. (21)) is unrealistic, but it helps us to have an intuition about the welfare loss in the long term due to the lack of protection of public investment against the bias for executing current expending. From the perspective of the implementation of the rule, a viable alternative is the Peruvian solution, described in Appendix A.2 of Appendix. According to it, between 2007 and 2011 the growth of real current spending was limited, allowing public investment to grow without any direct restriction, which led to two-digit public investment growth rates in the period.

Second, the structural rules FR2 and FR4 are difficult to implement because for such implementation, the estimation of the structural GDP is required. Likewise, for those economies with a strong dependence on fiscal revenues generated by commodity prices, an additional volatility is added. To overcome this difficulty, the Chilean experience has proved to be useful. Chile created committees of independent experts to estimate both the long-term prices of copper (the main export commodity) and the potential GDP, inputs that are used to estimate structural income.

5. Results

In this section, we first introduce our simulations for the four different fiscal rules, comparing the results obtained. Then, we study the performance of the economies adopting each of the four fiscal rules proposed under three different shocks: commodity shock, higher output variability and financial stress.[17]

5.1. *Fiscal rules's performance*

Aggregates. Fig. 6 A and B and Table 3 show the output performance for the benchmark economy and the economies implementing the four rules described in the previous section. It is not surprising that, in all cases, the output performance in the economies with rules is better than in the economy with no rules (benchmark economy). Among the economies with rules, the best performer is the economy implementing the FR4 and the worst performer is the economy implementing the FR1. It is also interesting to notice that the FR3 tends to outperform the FR2, clearly implying that having an expenditure rule protecting public investment is more useful than addressing the shift from the current to the structural deficit.

Fig. 6B shows the time series for the potential output. The evolution of the potential output during the transition path is mainly determined by the population aging expected in Peru during the next decades. Specifically, population aging reduces the workforce and increases the payroll tax needed to balance the pension system budget. Additionally, the higher payroll tax reduces saving, and consequently, private capital.[18]

We are interested in the two channels available for improving output: the private channel, by lowering interest rates and increasing private capital, and the public channel, by increasing public investment.

With respect to the private channel, Panel A of Fig. 7 shows that the debt to output ratio of the benchmark economy remains constant at 80%. The public debt to product ratio has a well-differentiated behavior among the economies that adhere to a zero-deficit rule as compared to those that follow a structural deficit rule. For economies that have implemented rules based upon the current fiscal deficit (FR1 and FR3), the output ratio slowly converges towards values close to 30 percent over the long term, primarily due to output growth. For economies that have implemented rules based upon the structural fiscal deficit (FR2 and FR4), the ratio converges to zero, more rapidly in the case of FR4 (because of the higher output) and more slowly in the case of FR2. The interest rate follows the same pattern as the debt to output ratio (see Panel B Fig. 7); affecting investment decisions in the private sector (see Panel A of Fig. 8).

The main reason for this differentiated behavior in the ratio across economies is precisely the management of public debt during those periods of time in which output departs from its potential level. If we take the case of FR2, we see that until around period $t = 130$, output tends to be below its potential level almost every period, which means that the ratio of public debt to output is at or near the maximum ratio, 80 percent. Nonetheless, when the output of FR2 exceeds its potential value because of the sequence

[17] For every case, we present the de-trended Labor Augmenting Growth results.

[18] Note that in all simulated economies, there is a sustained decline in output until, almost, the first 80 periods. This is due to two main reasons. The first, as we have just pointed out, is population aging, which reduces the labor force. The second has to do with the decreasing dynamics of the TFP [Total-Factor Productivity] during those 80 periods (see Fig. 3). From then on, the recovery of the TFP, together with the fact that the distribution of the population remains constant, imply an upward dynamic of output in all model economies.

Table 3
Aggregates and welfare (variations respect to the benchmark model economy, %).

	FR1	FR2	FR3	FR4
Period $t = 100$				
Output	2.07	1.49	5.15	11.12
Private Capital	9.82	4.64	13.79	36.37
Public Capital	0.14	0.20	28.14	53.33
Effective Hours	−0.43	0.48	−0.28	−0.95
Wage Rate	2.52	0.98	5.43	12.17
Total Consumption	2.52	1.56	7.68	8.65
Welfare (CEV)	2.10	0.00	3.92	8.75
Period $t = 200$				
Output	5.38	8.01	9.36	15.81
Private Capital	21.71	44.34	28.17	54.77
Public Capital	0.84	−2.83	46.93	77.43
Effective Hours	−2.22	−3.05	−1.71	−2.42
Wage Rate	5.47	10.04	9.92	17.26
Total Consumption	3.03	5.92	11.55	16.60
Welfare (CEV)	4.36	7.69	6.65	10.77
Period $t = 300$				
Output	5.16	8.77	9.93	15.83
Private Capital	24.88	45.39	31.14	54.87
Public Capital	1.65	0.00	48.66	75.60
Effective Hours	−0.98	−1.40	−0.73	−1.07
Wage Rate	6.19	10.31	10.70	17.10
Total Consumption	4.21	6.67	6.16	9.11
Welfare (CEV)	4.86	7.68	7.33	10.67

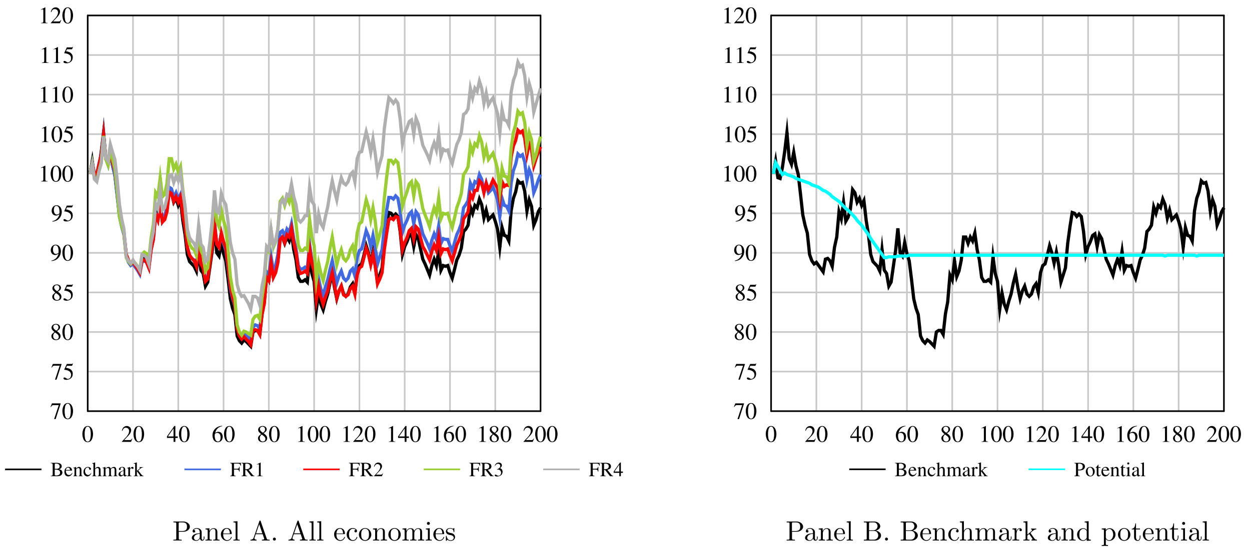

Fig. 6. Output (Period 1=100).

of positive exogenous shocks on TFP [Total-Factor Productivity] (see Fig. 3), the government uses the additional tax revenues to reduce public debt, which generates a sharp decline in the public debt to output ratio.[19]

In the case of FR4 there is an additional effect. When the government goes into debt to offset the decline in the tax revenues, which results from lower output as compared to potential output, a significant portion of this new debt is aimed at financing investment in infrastructure, which translates into subsequent increases in output due to a greater capitalization of the economy. Note that this is not the case for FR2, since the new public debt generated by the government finances mostly the expenditure of the

[19] Over the long run, the public debt to output ratio would tend towards zero under the FR1 and FR3 economies due to the growth of output. However, and since this process is slow, it would force us to simulate a large number of periods to complete the transition path, until reaching a stationary situation in the economy that would allow an asymptotic convergence towards the final steady state. To shorten the number of simulated periods, we assume that the labor augmenting growth rate is 0 percent from period 250 onwards, hence the stabilization of the public debt to output ratio going forward from that period.

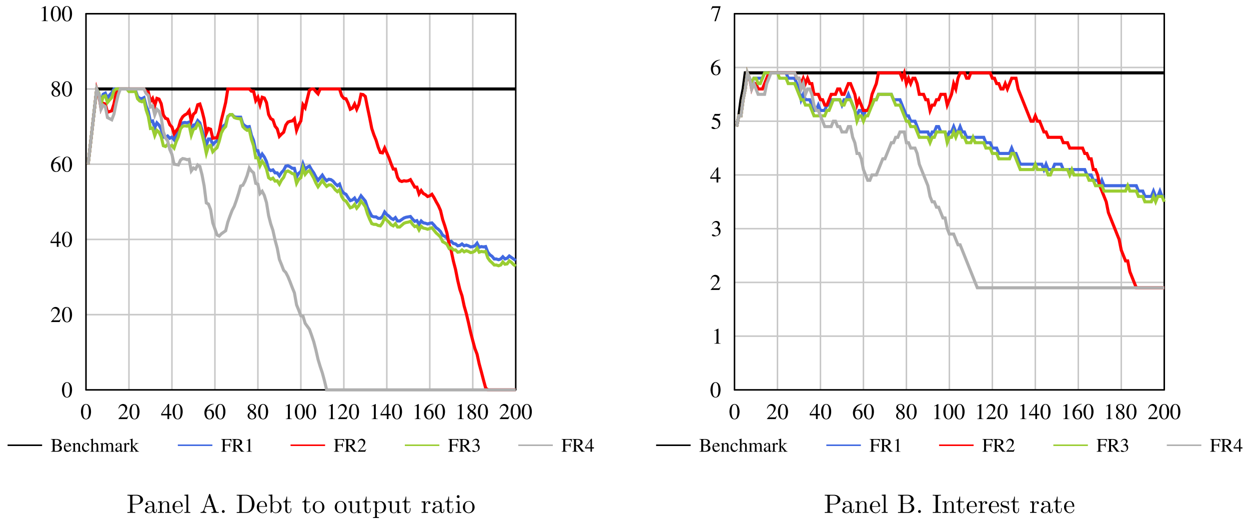

Fig. 7. Debt to output ratio and the interest rate (%).

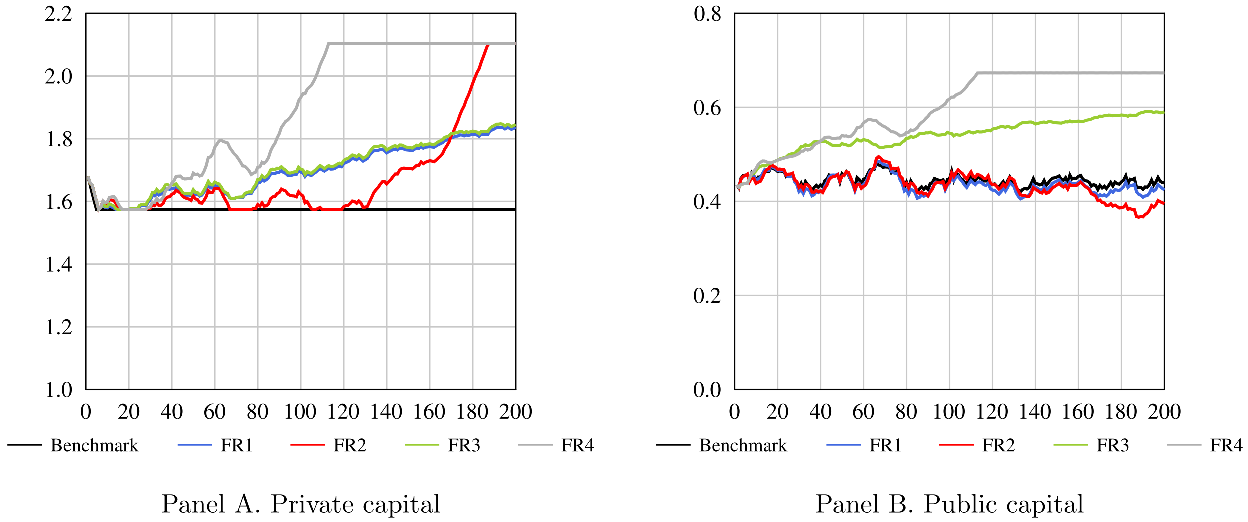

Fig. 8. Private and public capital to output ratio.

public consumption good. That is, given the implementation of the spending rule, the output in FR4 quickly reaches and exceeds potential output, which generates a rapid drop in the public debt to output ratio, all thanks to the rule of structural deficit.

The conclusion is that, in the case of structural rules, output growth has two effects on the debt to output ratio. First, it reduces this ratio due to the increase in the denominator. Second, through its effect on the fiscal rule itself, since the increase in both output and tax revenues force the government to reduce public debt, which reduces the interest rate, and increases the accumulation of private capital and output.

With respect to the second channel, the public one, we can note in Panel B of Fig. 8 that, for the economy implementing FR4, the public capital to output ratio converges to its equilibrium level more rapidly. In this case, given the expenditure rule imposed on the economy under FR3, the public capital to output ratio also increases, although it does so at a slower pace than the economy under FR4. For economies under the FR1 and FR2, there is no substantial difference as compared to the benchmark economy.

When we study the ratio between private and public capital (see Panel A of Fig. 9), as it is anticipated by construction, the economies under FR3 and FR4 rapidly converge to the optimal ratio provided by the coefficients in the Cobb–Douglas production function. In contrast, the ratios obtained under the benchmark economy and the economies implementing FR1 and FR2 are not optimal. In fact, those economies have too much private capital given the level of public capital, because private capital is relatively large as compared to the low level of public infrastructure. This is especially the case for the economy that is implementing FR2 when the interest rate is at its lowest level given that the public debt ratio is equal to zero.

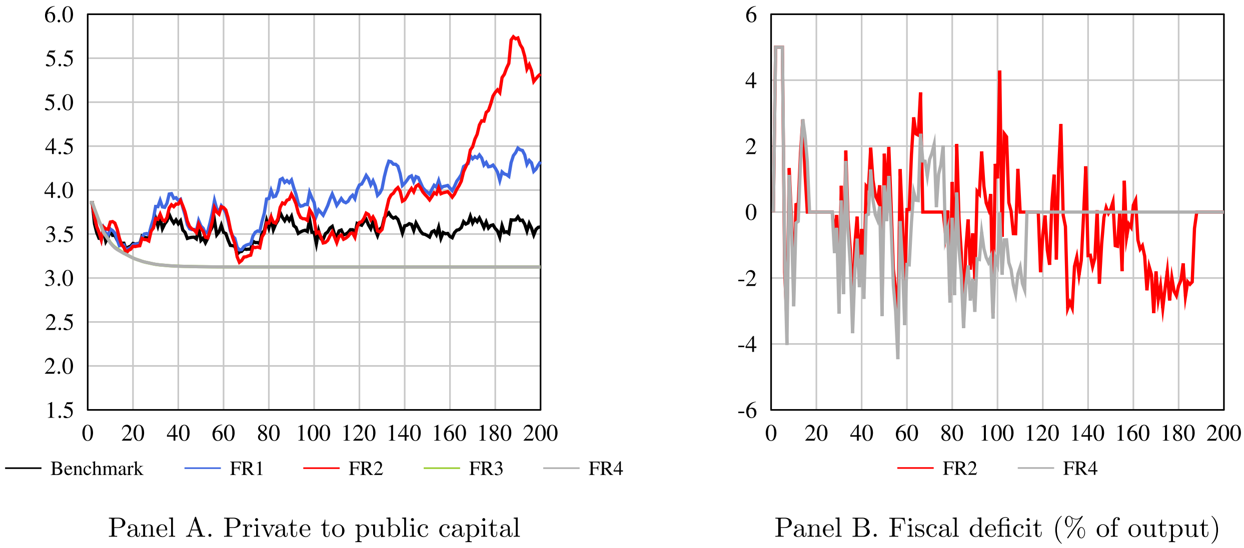

Fig. 9. Private to public capital ratio and fiscal deficit.

It is interesting to note the evolution of the fiscal result for the various rules. By construction, in the case of FR1 and FR3, the fiscal result is zero for each of the periods, while for FR2 and FR4 the current fiscal result is something other than zero, but the structural result is zero (see Panel B of Fig. 9). For the case of FR4, the economy converges more rapidly to the zero fiscal result, given the higher growth and the faster decrease in debt. However, this result is obtained by way of increased volatility of the fiscal result at the beginning. Thus, for the first 100 periods, the average result is 0.4 percent and the standard deviation is 1.9, while for FR2, the average fiscal result is 0.2 percent and the standard deviation is 1.8.[20]

Overall assessment. Our results clearly show a ranking when they are based on a metric that depends on long run output growth. Specifically, we find that long run output increase is inverse to the order of our fiscal reforms, i.e the long run order increase of output is FR4>FR3>FR2>FR1. And this is due to two main reasons. First, a structural fiscal deficit reform performs better than a simple zero current deficit rule, mainly because there is an upper limit for the debt to output ratio. That is, when there is a recession, the government can "only" increase public debt to raise public resources until a debt to output threshold (80 percent in our model economy), but when the economy is on an expansionary cycle, the government can reduce debt so that the government debt to output decreases steadily, reducing the domestic risk premium and fostering the accumulation of private capital. This also reduces the interest payments, and increases fiscal resources to devote to investment in public capital. Contrarily, the zero fiscal deficit rule imposes a balanced budget, regardless of the business cycle, making FR1 a very procyclical rule, so that the long run order increase of output is FR2>FR1.

Second, those fiscal policies where fiscal revenues tend to be expended in favor of public capital investment, further increase output, due to the additional public physical capital stock. Consequently, we find that the long run order increase of output is FR4>FR2 and FR3>FR1. At this point, it is not clear that a metric based on output growth would generate the aforementioned order, i.e FR4>FR3>FR2>FR1. However, we find that, in general, this is the most common case mainly since we find that devoting more fiscal resources on public physical capital turns to be superior to a structural fiscal rule where most of government expenditure is directed to the public consumption good.

On the other hand, we find that in the event of an economy facing a very persistent negative TFP shock, a structural fiscal reform as FR2 might perform worst than a zero deficit reform FR1, as the first increases debt (until the debt limit) to compensate for the low tax collections. We also find that the FR4 continues to perform better than the remaining rules, since the additional revenues brought about by the public debt are devoted mainly to the investment in public capital, which increases both public capital and output above the potential output. In other words, we find that, if the economy is exposed to a persistent negative TFP shock, the long run order increase of output becomes FR4>FR3>FR1>FR2.

Welfare. We follow Conesa and Krueger (1999) and compute the consumption equivalent variation measure (CEV) for newborns before and after the fiscal reforms in the final steady states. Specifically, we compute the welfare change of a reform for a newborn, by asking by how much this newborn's consumption has to be increased in the benchmark steady state, holding leisure constant,

[20] The observed high volatility of the fiscal deficit under these two fiscal rules is mainly due to the volatility of the TFP (see Fig. 3), since this volatility directly affects tax collections. For example, in the case of a negative TFP shock, tax revenues collected from the taxes on consumption, capital income, and total income decrease, triggering a primary fiscal deficit.

Table 4
Consumption equivalent variation for newborns in the long run[a] (CEV, %).

	CVE (%)[a]
FR1	4.86
FR2	7.68
FR3	7.33
FR4	10.67

[a]Relative to the Benchmark economy.

so that her expected utility equals that under the specific fiscal rule. Consequently, and given the form of the utility function, we compute

$$CEV = e^{(V^{*}-V)/\kappa} - 1 \tag{27}$$

where V and V^{*} are the value functions of a newborn under the benchmark and the reformed fiscal system, respectively, and $\kappa = \theta \sum_{j=20}^{J-1} \beta^{j-20}\psi_j$. For example, a CEV of 0.01 implies that a newborn will enjoy an increase in welfare equivalent to receive 1 percent higher consumption over her lifetime under the benchmark economy.

Recall that household's welfare depends on consumption (of both, private and public goods) and leisure. Moreover, from the preceding section, we find that output increases (relative to the Benchmark case) are higher under fiscal rules which address not only the bias for fiscal deficit, but also take into account the bias for current expenditure, i.e. FR4 and FR3. Then, one might expect that the higher the output (and the higher the wage), the higher household's consumption, so the higher expected lifetime utility.[21] Consequently, the rank order of the welfare outcomes would mimic the same order observed under the aggregated consequences, i.e FR4>FR3>FR2>FR1.

However, note again that household's consumption depends of the consumption of both, the private and the public good. And the supply of the public consumption good is higher when it is determined according to government's (short run) preferences, i.e under rules FR1 and FR2. Consequently, it may happen that, despite the higher wage, total household's consumption is higher under these two first fiscal rules, due to higher transfers of public consumer goods. And this is precisely what our model economy predicts. Specifically, we find that FR2 delivers higher household's welfare than FR3, with the FR4 continuing to deliver the higher welfare gains. Put differently, higher public transfers to households may lead the population to choose fiscal policies that are not the most efficient in terms of output, so that a metric based on household's welfare shows that structural fiscal rules perform better than zero current deficit rules, i.e. FR4>FR2>FR3>FR1.

This is shown in Tables 3 and 4, and our results show that the adoption of a fiscal rule implies sizeable welfare gains relative to the absence of a rule. As it was said, introducing rules which address not only the bias for fiscal deficit, but also take into account the bias for current expenditure, seems to be of critical importance to induce a public expenditure composition which is closer to optimal. Thus, the greater capitalization of the economy under Fiscal Rule IV entails a significant increase in wages, and consequently, in consumption, so that it translates in no minor welfare gains for newborn households.

5.2. Fiscal rules and the efficiency of public investment

Our previous results were obtained under the assumption that there is full public-sector investment efficiency, i.e. $\gamma = 1$ in the law of motion of public capital, Eq. (8). However, several studies have found that the economic and social impact of public investment depends on the degree of efficiency through which investment spending is managed (Davoodi and Tanzi, 1997; Pritchett, 2000; Chakraborty and Dabla-Norris, 2011). As noted by Pritchett (2000), in many countries only a fraction of the actual accounting cost of investment passes into the value of capital. And these inefficiencies from public investment may be due to several reasons, such as poor selection and implementation of projects due to limited information, waste and leakage of resources, or even weak technical expertise.

To this end, we continue to simulate our model economies to analyze how our previous results differ when we introduce some level of inefficiency of public investment. Consequently, we run again our previous model economies, but this time assuming that $\gamma = 0.7393$. The rationale for this choice comes from Dabla-Norris et al. (2012).[22] They build an index of public investment management efficiency, composed of 17 indicators grouped into different stages of the public investment management cycle, and they found that Peru has a 73.93 percent of the public investment efficiency of South Africa, which is the top efficient country in the sample.[23]

[21] Recall that income, capital income, and consumption tax rates remain the same across the different model economies, and that there are no significant differences in the labor income tax rate, despite the fact that this tax rate adjusts in order to close the pension system budget.

[22] This number is also in line with the findings of IMF (2015), which reports that the average inefficiencies in public investment processes is around 30 percent across countries.

[23] Specifically, they choose 4 stages for the public investment management cycle (strategic guidance and project appraisal, project selection, project implementation, and project evaluation and audit). Their data cover the 2007–2010 period, and include 71 countries, where 40 of them are low-income countries and the remaining 31 are middle-income countries.

Table 5
Output, welfare and debt differences with the benchmark model economy in the long run.

	Output variation (%)		CEV (%)		Debt to output[a]	
	Partial efficiency	Full efficiency	Partial efficiency	Full efficiency	Partial efficiency	Full efficiency
FR1	5.06	5.16	4.85	4.86	−50.16	−50.18
FR2	8.74	8.77	7.69	7.68	−80.00	−80.00
FR3	9.70	10.05	7.09	7.33	−51.28	−51.41
FR4	15.81	16.33	10.30	10.67	−80.00	−80.00

[a]The differences in the debt to output ratio are measured in percentage points.

Our results show that assuming some degree of inefficiency in the investment process of public capital has no significant effect on GDP when the amount to be invested is, somehow, residual, i.e., FR1 and FR2 (see Table 5). Consequently, the effect of this type of inefficiency on GDP becomes more relevant as the share of public revenues devoted to investment in public capital increases. As Table 5 shows, the output increase under the fiscal rules FR3 and FR4 (respect to the Benchmark economy), becomes smaller during the public investment management cycle due to this inefficiency. Our results are consistent with the findings reported by Gupta et al. (2014), IMF (2015), and Abiad et al. (2016), among others, who found that public investment is more effective in boosting output in countries with higher public investment efficiency.

Of course, the results should be sensitive to both the elasticity of output respect to public capital and the depreciation rate of public infrastructure. Following Dabla-Norris et al. (2012), it is expected that the lower (higher) the output elasticity (or the depreciation rate) with respect to public capital, the lower (higher) the effect on output growth of the aforementioned inefficiencies.

5.3. Fiscal rules's performance under different shocks

In what follows, we analyze the performance of the four fiscal rules described when exposed to three different shock events: a commodity shock, increased output variability and financial stress.

5.3.1. Commodity shock

In this section, we assume that the domestic economy is exposed to a temporary commodity price shock that affects the fiscal revenues collected by the government. Note that this type of shock should have also terms of trade and demand implications, as modeled by García et al. (2011).[24] However, our model economy lacks of such consumption channel, so that our simulation strategy makes the shock more closely aligned with a supply shock of a state owned non-energy commodity. The rationale for our modeling choice is that, under the above fiscal rules, it allows us to analyze the response of the main macroeconomic aggregates to this shock in a very parsimonious way.

We rely on the data of the fiscal revenues generated by the mining sector of Peru, between the years 2000 and 2021. Specifically, we compute the average taxes payed by this sector, as a share of GDP, and consider that a shock is observed in the price of this commodity, when the tax collections during a current year diverge from that average.[25] In Panel A of Fig. 10, we plot the time series of the taxes payed by the Peruvian mining sector, as deviations from that period average, and we assume that this temporary shock evolves between periods 5 and 27 of our model economy.

We focus exclusively on the short run in order to emphasize the short-term responses of the main macroeconomic aggregates to this commodity shock. We find two main results. First, there is not significant difference in the output response after a commodity shock, when the fiscal rules in place are those that prioritize the public expenditure on the public consumption good, i.e. FR1 and FR2 (see Table 6). This is mainly because most of the fiscal revenues are devoted to the expenditure on the public consumption good, so that the difference in the amount invested in public capital is not significant. Moreover, and similarly to Kumhof and Laxton (2013), we also find that under the FR1, and after a temporal increase (decrease) in fiscal revenues, the government responds by distributing them in the form of increased transfers, so that households consume more (less) and slightly reduce (increase) working hours.

Table 6
Output differences between fiscal rules (%).

	Period $t = 10$		Period $t = 20$	
	No commodity shock	With commodity shock	No commodity shock	With commodity shock
FR2 vs FR1	0.29	0.52	0.23	0.19
FR4 vs FR3	0.58	−0.70	0.11	1.72

[24] Other significant differences between our work and that by García et al. (2011) is that they use an infinite horizon model economy where some households have full access to credit markets (Ricardian consumers) while others do not have that possibility and therefore consume all of their disposable income.

[25] During the period 2000 to 2021, the average taxes payed by the Peruvian mining sector was 1.5 percent of GDP.

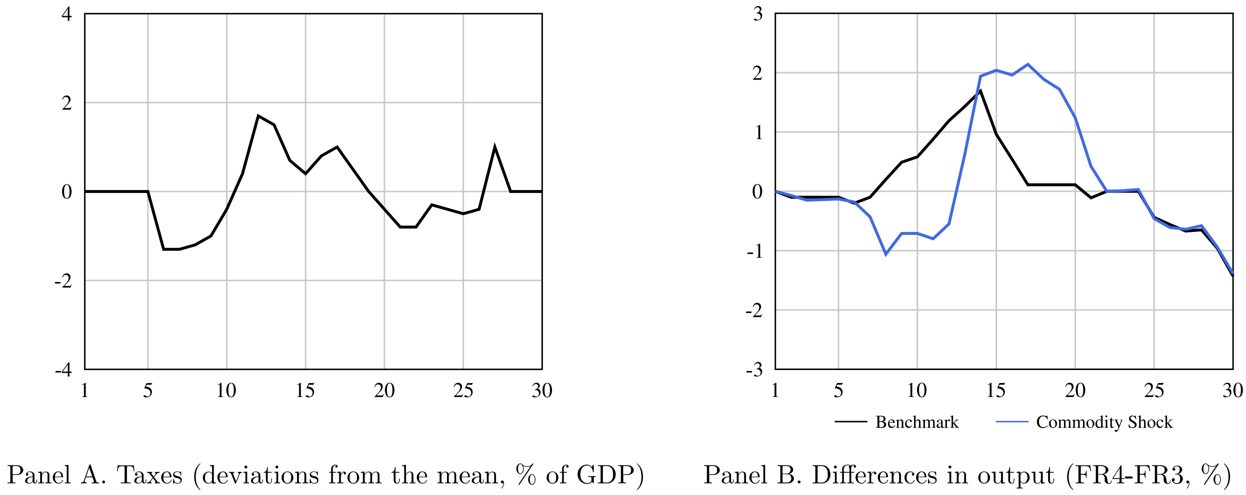

Fig. 10. Taxes payed by the mining sector and output differences.

Second, and contrarily to the previous result, there exist important differences in output when comparing FR3 and FR4. On the on hand, the greater the extraordinary tax revenue due to the commodity shock, the greater the investment in public capital under FR3 relative to FR4. On the other hand, the greater the extraordinary tax revenue due to the commodity shock, the greater the decrease of public debt is (and the risk premium) under the FR4, which induces a greater accumulation of private capital. It turns out that the second effect dominates, so that a positive (negative) commodity price shock implies a difference of output in favor of FR4 (FR3). See Panel B of Fig. 10.[26]

5.3.2. Higher GDP variability

Next, we examine the performance of the rules when the TFP variability increases by a factor of 2. Under this scenario, we must generate a new series of shocks with higher variability and compute the new output performance for the economies. In this case, it is useful to compare the relative performance of the fiscal rules described under two different regimes: a regime with low output volatility ($\sigma_\epsilon = 0.0076$) and a regime with high output volatility ($\sigma_\epsilon = 0.0152$). This exercise is presented in Fig. 11. Note that over the long term, the difference in performance converges to the same value but, during the first 100 periods, the FR4 produces significant better output performance as compared to the FR3. In short, the more volatile the economy becomes, the more useful a structural based fiscal rule is.

5.3.3. Financial stress

Finally, we investigate the case in which our economies are affected by financial stress. The rationale to do so is as follows. Using a simple OLS regression of the spread (dependent variable) on the debt-to-output ratio (explanatory variable) for the Latin American countries, we found that for the countries implementing fiscal rules, like Peru or Colombia, the coefficient that reflects the country-specific interest premium is close to 0.05, which has been the number that we have used in all our exercises. However, if we run that same simple regression for countries with high levels of debt and no fiscal rules in place, like Argentina or Ecuador, we find coefficients between 0.25–0.30.

Consequently, in this section we will assume that the coefficient that reflects the country-specific interest premium increases from 0.05 to 0.25, and then remains at that level. This exercise can be seen as an exogenous shock, where the price of government bonds reflects a change of market confidence in governments' commitment towards sustainable fiscal policies. Note also that this exercise is linked with the literature that study the relation between interest rates and business cycles in emerging economies (see for example Mendoza (1991), Correia et al. (1995), Neumeyer and Perri (2005), and Fernández-Villaverde et al. (2011)).

We find that the general results stand. However, it is interesting to note the relative performance of the fiscal rules under this scenario. Specifically, and for obvious reasons, we will focus on the economies implementing FR1 and FR2. In Fig. 12, we present the performance for FR1 and FR2 as compared to the benchmark economy under normal conditions and under a financial stress situation. We find that, under financial stress, it is more relevant for an economy to implement a fiscal rule because a higher interest

[26] While the main focus of the papers by García et al. (2011) and Kumhof and Laxton (2013) is that in model economies of non-oil commodity exporters (with non-Ricardian features), fiscal policy can have a significant business cycle stabilizing role, our paper mainly focuses on the effect of fiscal policy upon public capital, growth and welfare. See Snudden (2016) for an analysis of the role of fiscal policy as a macroeconomic stabilization tool in the case of a small open oil exporter.

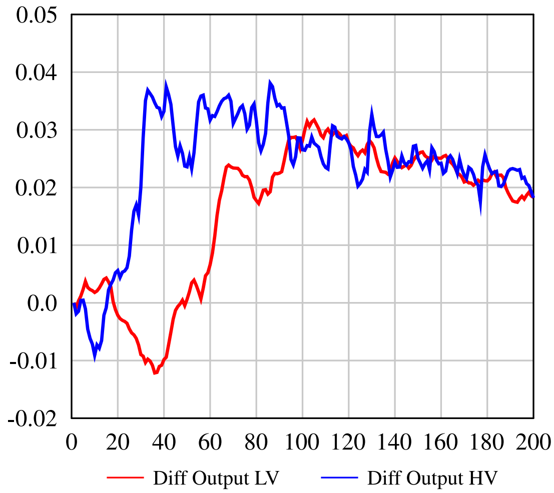

Fig. 11. Output differential (FR4-FR3) with low and high variability.

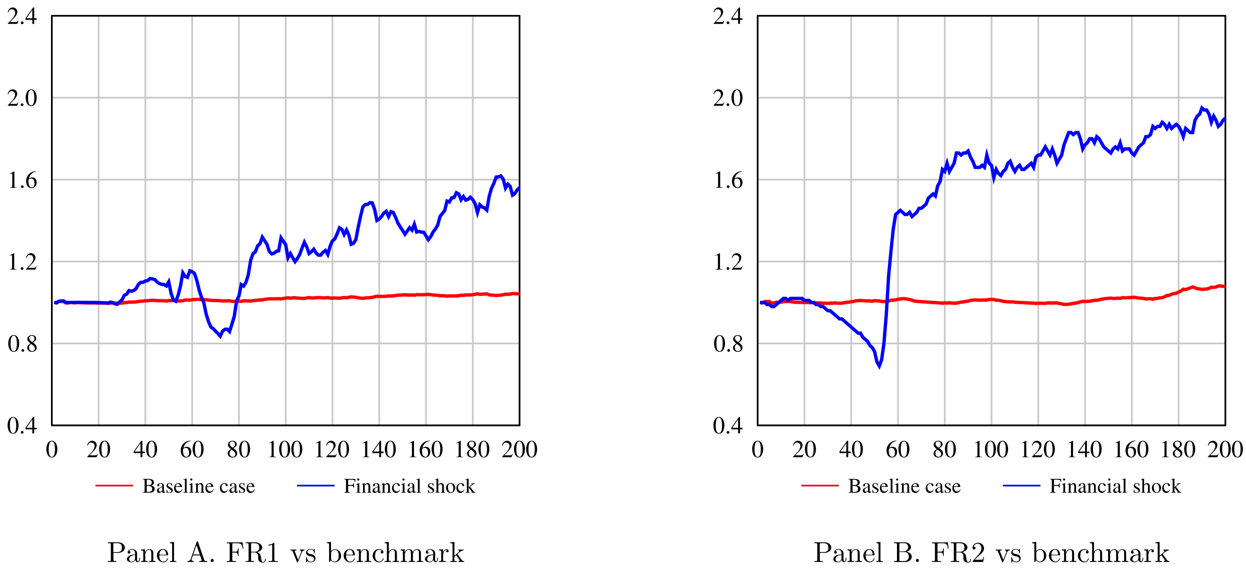

Fig. 12. Output ratios of FR1 and FR2 vs benchmark.

rate will have a stronger negative impact on private capital accumulation and therefore on the growth of output. Our results are related to the findings of Fernández-Villaverde et al. (2011), who report that an increase in the interest rate volatility triggers a fall in output, consumption, and investment.

We also find that under a scenario of very high sensitivity of interest rates to the level of public indebtedness, the reduction in the public debt to output ratio translates into significant reductions in the risk premium, thus strongly encouraging the accumulation of physical capital by the private sector. Additionally, the government devotes a lower amount to interest payments, allowing fiscal resources to be allocated to other public spending, such as public investment. Stated differently, the output growth differences across model economies become larger (see Table 7).

6. Conclusions

Fiscal rules are useful instruments for achieving macroeconomic stability, this being understood as debt levels that are sustainable over the medium-term. However, in terms of long-term growth, their performance has not been so auspicious. Although it is true that, on the one hand, fiscal sustainability leads to reduced financial costs, given fiscal stability, and therefore drives growth through private investment; on the other hand, public investment is de-emphasized by the government, which, in the context of a restricted-spending scenario, tends to favor the increasing of current spending. Hence, as we demonstrate with our exercises, the fiscal rule will be more efficient if, in addition to maintaining control over the fiscal result, it also eliminates the bias against public investment.

Table 7
Output, welfare and debt differences with the benchmark model economy.

	Output variation (%)		CEV (%)		Debt to output[a]	
	Baseline case	Financial shock	Baseline case	Financial shock	Baseline case	Financial shock
Period $t = 100$						
FR1	2.07	28.38	2.10	7.28	−22.00	−33.04
FR2	1.49	67.03	0.00	6.02	−8.52	−80.00
Period $t = 200$						
FR1	5.38	56.05	4.36	10.12	−45.64	−54.10
FR2	8.01	89.88	7.69	17.31	−80.00	−80.00

[a]The differences in the debt to output ratio are measured in percentage points.

In this paper, we assume a spending rule that determines the level of public investment to be that which is compatible with the optimal private capital ratio. Since this is clearly not implementable, simpler schemes, such as those applied by Peru for example, are required. As demonstrated in our simulations, protecting public investment is a key policy objective.

It is interesting to note that the gap between economies with and without fiscal rules raises when there are commodity price shocks and increases in volatility that affect the economies. Similarly, the results of economies that implement structural rules tend to be better than the results of economies that implement rules based on realized budget balance.

It is also interesting to note that when we compare a structural rule with a rule based on realized budget balance, the structural rule performs better. But, when economies face a scenario of financial stress, structural rules tend to reduce debt less quickly, tolerating higher fiscal deficits for longer periods of time. This is clearly due to the manner in which we have defined potential output and the structural fiscal result arising from this definition. In that sense, from the policy-implementation point of view, and in line with Caselli et al. (2022), when dealing with a structural balance rule we should consider other institutional arrangements such as medium-term fiscal frameworks, independent forecast to increase credibility, or additional fiscal buffers to deal with unusual highly adverse shocks. The main conclusion of our research is that it is critical that the Government does not use the structural results as and excuse for delaying the necessary fiscal adjustments.

Appendix

A.1. The need for fiscal rules as an instrument of fiscal policy

During the last decade, an increasing number of countries have incorporated fiscal rules in the managing of their fiscal policies in order to improve transparency and control of the fiscal deficit (Luc et al., 2018). Faced with the need to respond to the economic crisis caused by the pandemic, most of these countries have been forced to abandon the objectives set by the fiscal rules that they were implementing. However, it is predictable that once the effects of the crisis pass, the countries will return to the implementation of fiscal rules, having to re-analyze the corresponding transition and objectives. It seems important, therefore, to discuss the reasons why countries have been adopting fiscal rules in the first place.

Fiscal rules, understood as quantitative restrictions on either the level or the rate of growth of specific fiscal variables (usually current debt or fiscal deficit, or with some adjustment for the economic cycle), are intended to avoid discretion in the management of the fiscal policy.[27] Discretion generates a significant increase in public spending, which in turn causes debt size to increase over time as well. Moreover, the need to address higher financial expenses in the future makes debt more persistent. This bias towards increasing fiscal deficits (deficit bias) has been widely discussed in the economic literature (Alesina and Drazen, 1991; or Persson and Tabellini, 2000, among others). There are two fundamental reasons for the existence of this fiscal deficit bias:

(i) The short-term incentives for policymakers, which intensify during the elections period, i.e. the so-called political spending cycle (Alesina and Tabellini, 1990), and are related to the fact that administration periods are finite.
(ii) The existence of the "common pool problem", which occurs when interest groups compete for increased public spending without internalizing the negative effects of higher future taxes, generating the so called "voracity effect" (Tornell and Lane, 1999).

The effects of this fiscal deficit bias are very detrimental for the economy. First, the excessive size of public debt ends up negatively affecting long-term growth. Reinhart and Rogoff (2010) find that debt-to-GDP levels over 90 percent negatively affect the growth of countries. The mechanism through which higher levels of debt translate into lower growth is the presence of higher interest rates (Haugh et al., 2009; Baldacci and Kumar, 2010; or Schuknecht et al., 2010). Higher interest rates end up negatively affecting private investment and, ultimately, long run growth (Blanchard and Perotti, 2002; Fatas and Mihov, 2003, among others).

[27] For a definition of fiscal rules and their typology, see Kopits and Symansky (1998).

This line of thinking includes the hypothesis proposed by Giavazzi and Pagano (1990), according to which, a contraction of public spending can be expansive if interest rates are reduced. The studies of Bertola and Drazen (1993), and Alesina and Perotti (1996) have confirmed this hypothesis. However, Perotti (2013) finds that a fiscal contraction is expansive if it is accompanied by both a real depreciation of the exchange rate and an expansive monetary policy. Similarly, Baldacci et al. (2015) find that a contractive fiscal policy is expansive as long as the credit restrictions in the economy are not severe.

Second, in the presence of a shock, it is not possible to implement an anti-cyclical fiscal policy if there are high levels of indebtedness. In their seminal contribution, Gavin and Perotti (1997) show that fiscal policy tends to be pro-cyclical. This would be the result of increasing expenses when cyclical revenues rise (in times of expansion) and decreasing expenses when cyclical revenues diminish (in times of recession), since there is no room to increase the deficit due to the excessive size of the public debt and the imperfections of the credit market (Riascos and Vegh, 2003). The impossibility of implementing an anti-cyclical fiscal policy is even more serious because the fiscal multipliers tend to be greater in times of recession (Baum et al., 2012). Finally, and derived from the aforementioned characteristics, we observe that, prior to discretionary fiscal policy results in pro-cyclical behavior, the fiscal policy tends to amplify economic cycles by inducing greater volatility, further weakening the structural vulnerabilities of the economy either in terms of the structure of the tax revenues (Talvi and Vegh, 2005) or external factors (Radelet et al., 1998).

In this context, the institutional response to mitigate fiscal policy deficit bias has been the implementation of fiscal rules. This implementation can be seen as: (i) commitment device, imposing direct restrictions on governments (Alesina and Tabellini, 1990); (ii) signaling device, sending information to the market in order to reduce uncertainty in decision making (Debrun and Kumar, 2007); and (iii) coordination device, facilitating the establishing of coalitions to reduce the common pool problem (Cordes et al., 2015). A broad debate has arisen in the economic literature regarding the effectiveness of fiscal rules at achieving the objectives of macroeconomic stability and the reduction of deficit bias. This debate has placed the emphasis on institutional factors (coverage, flexibility, simplicity, budgetary institutions, etc.) in order to determine when fiscal rules are most effective (Luc et al., 2018). However, there is little debate so far related to the long run welfare gains or losses derived from the implementation of such fiscal rules, and how their potential negative effects can be mitigated. Facilitating this debate is the objective of this paper.

A.2. Fiscal rules: the Peruvian case

Peru is an interesting case of the application of fiscal rules. The first fiscal rule was implemented in late 1999, when the country was facing the negative effects of both the Russian crisis (late 1998) and the Brazilian debt crisis (January 1999). These exogenous shocks negatively affected growth and fiscal results. According to the INEI, the year 1999 ended with a fiscal deficit of 3.4 percent of GDP and a level of public debt of 51.4 percent of GDP. In order to ensure the return to macroeconomic stability, the fiscal rule established a ceiling for the fiscal deficit at 1 percent of GDP, capping the real growth of non-financial government spending, which was established at 2 percent per year. Despite successive modifications to the fiscal rule, Peru's fiscal history has been successful in terms of achieving macroeconomic stability. As shown in Fig. A.1, debt to GDP reached 21.6 percent in 2011 and finished 2019 at 26.8%, with Peru being one of the countries with the lowest debt levels in the Latin American region.

However, in terms of the composition of spending, the story was not homogeneous, and the fiscal rule underwent significant modifications. In this regard, there have been three important milestones during the whole period affecting not only the behavior of the fiscal deficit and the debt to GDP ratio, but also the behavior of current spending and public investment. A first period (from 2000 to 2006) in which, as already mentioned, there were two rules: a limit to the current fiscal deficit of 1 percent of GDP and a ceiling of 2 percent for the annual growth of real non-financial government spending. A second period (from 2007 to 2011) in which the limit for fiscal deficit remained at 1 percent of GDP, but the limit of the real rate of growth for government spending

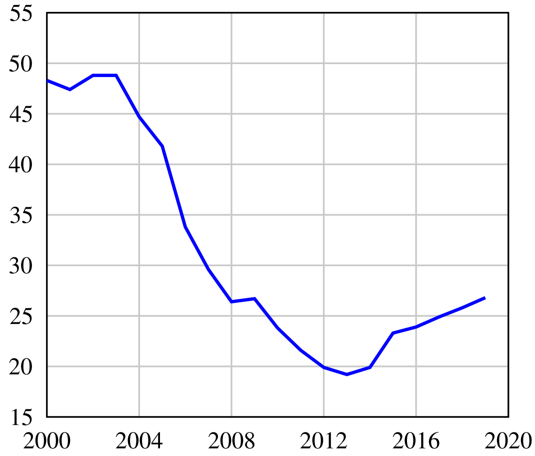

Fig. A.1. Debt to GDP ratio (Peru, 2000–2019, %).
Source: Own elaboration based on INEI.

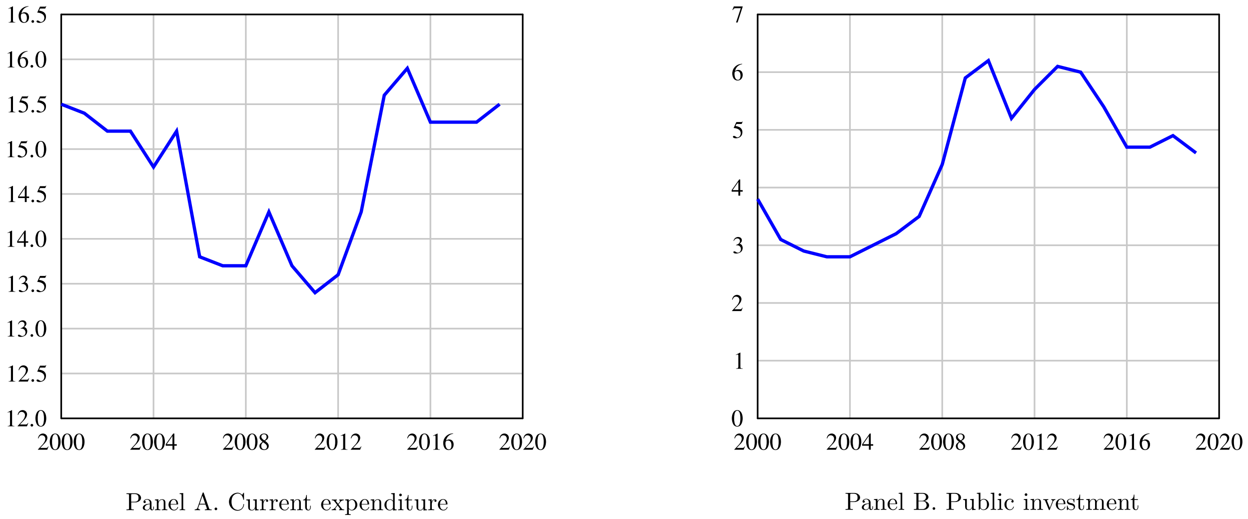

Fig. A.2. Current expenditure and public investment to GDP (Peru, 2000–2019, %).
Source: Own elaboration based on INEI.

was restricted only for current spending and set at 3%. A third period (from 2012 to 2019) in which, initially, in 2012 the current spending rule was suspended and, finally, in 2013 both rules for the fiscal deficit and for the public spending were replaced by a limit of 1 percent of GDP for the structural fiscal deficit.[28]

What is relevant to highlight here is that during the period 2007–2011 there was no direct restriction on public investment, only on current spending, while through the fiscal deficit there was an indirect restriction on public investment. However, in the other two periods, there was no distinction between current and capital expenditure.

The Peruvian experience reflects two important stylized facts. First, when fiscal rules do not distinguish between current spending and capital expenditure (public investment), there is a predominance of current expenditure over public investment, i.e. government preferences clearly opt for higher current expenditure. As we observe in Fig. A.2A and A.2B, only in the period 2007–2011, when public investment ceases to have a direct restriction in the fiscal rule, we observe a strong growth of public investment in relation to GDP while current spending remains stable against GDP.[29] In the period 2000–2006, current expenditure remained relatively constant to GDP, with the fiscal deficit rule being restrictive, forcing a smooth convergence to the maximum deficit of 1%. On the other hand, in the period 2012–2019 there is a decreasing trend in public investment in terms of GDP, while current expenditure soared both in growth rate and relative to GDP, and then remained relatively stable.

Second, the Peruvian case also shows that governments with finite time horizon have a bias towards current spending and against public investment. The reason is simple: there is more pressure from politicians in favor of current spending because the impact on voters is more visible in the short-term, while in the case of public investment the impact is materialized in the long term. This is the reason why, when there are budget constraints, it is of crucial importance to protect public investment.[30]

Overall, these facts give us an intuition of what a hypothetical government objective function would look like, with public consumption and public investment expenditures as arguments. See Section 4.3 for a more detailed description of such objective function.

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[28] In 2003 and 2008, minor changes were introduced to the spending growth limit and, in 2009 and 2020, the rules were suspended due to the international financial crisis and the COVID-19 crisis, respectively.

[29] In 2009, the suspension of the fiscal rule due to the international financial crisis generated an increase in current spending as part of the fiscal stimulus for the recovery of aggregate demand.

[30] The changes experienced by the composition of government spending in the Peruvian case are in line with what has been found in Blanchard and Giavazzi (2004), Ardanaz and Alejandro (2021) and Ardanaz et al. (2021).

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