# Assessing the Economic Impact of Sustainable Development Goals (SDGs) through DSGE Modeling

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**Abstract**

*This article aims to analyze the impact of the Sustainable Development Goals (SDGs) on the economy using a DSGE model. We simulate two different shocks: an increase and a decrease in the SDGs expenditures to evaluate their effects on key macroeconomic variables. The results show that an increase in the SDGs expenditures has a positive effect on most macroeconomic variables, while a decrease in the SDGs has a negative effect. These findings suggest that pursuing the SDGs can lead to sustainable economic growth and improved living conditions in Madagascar.*

*Keywords: Sustainable Development Goals (SDGs), DSGE model, Madagascar, economic growth, economic policy.*

## 1 Introduction

The 2030 Agenda for Sustainable Development, adopted by all United Nations member states in 2015, is a global action plan to eradicate poverty, protect the planet, and ensure prosperity for all. The Sustainable Development Goals (SDGs) are at the heart of this agenda and aim to address the most pressing global challenges such as poverty, inequality, climate change, economic growth, and health. Countries are invited to implement policies and programs to achieve these ambitious goals by 2030.

Madagascar, like many developing countries, faces major challenges in achieving the SDGs. The country is confronted with socio-economic challenges such as poverty, inequality, low economic growth, and vulnerability to natural disasters. Additionally, Madagascar is one of the most vulnerable countries to the impacts of climate change, with impacts on agriculture, water resources, biodiversity, and infrastructure.

In this context, it is important to evaluate policies and programs that can help Madagascar effectively and sustainably achieve the SDGs. A key question is whether additional spending to achieve the SDGs can stimulate economic growth and improve living conditions for the population.

In this regard, this work aims to develop a Dynamic Stochastic General Equilibrium (DSGE) model to assess the impact of additional spending to achieve the SDGs in Madagascar. The model will analyze the macroeconomic effects of additional spending on production, employment, consumption, and trade. The results of this analysis can provide valuable information for policymakers on economic policy options to effectively and sustainably achieve the SDGs.

# 2 Methodology

## 2.1 General presentation

Our DSGE model is designed to study the impact of spending on SDGs on the economy of Madagascar. We consider a closed economy with a government that finances public spending on SDGs through tax collection.

### 2.1.1 Detailed production equation

Production is a function of three factors of production: capital, labor, and technical progress. We define technical progress as a function of investment in Research and Development.

Therefore, the production equation is as follows:

$$Y_t = F(K_t, N_t, Z_t)$$
$$F(K_t, N_t, Z_t) = A_t K_t^{\alpha} N_t^{1-\alpha} Z_t^{\gamma}$$

where
$Y_t$ is production at time $t$
$K_t$ is the stock of capital at time $t$
$N_t$ is the active population at time $t$
$Z_t$ is the level of technology at time $t$
$A_t$ is a technological shock at time $t$ with $E[A_t] = 1$
$\alpha$ is the share of capital in production
$\gamma$ is the sensitivity of production to investment in Research and Development

### 2.1.2 Investment, consumption, trade and budget equations

Investment is determined by the following equation:

$$I_t = \delta K_{t-1}$$

where $\delta$ is the rate of capital depreciation.

Consumption is determined by the following equation:

$$C_t = (1 - s_t)Y_t$$

where $s_t$ is the savings rate.

The trade balance is determined by the following equation:

$$NX_t = X_t - M_t$$
$$X_t = \frac{1}{\theta} Y_t$$
$$M_t = m_t Y_t$$

where
$\theta$ is the elasticity of exports with respect to income

$m_t$ is the import rate.

Budgeting is determined by the following equation:

$$G_t = \tau_t Y_t$$
$$T_t = \theta_t Y_t$$

where
$G_t$ is public spending
$\tau_t$ is the tax rate on production
$T_t$ is tax revenue
$\theta_t$ is the tax rate on income.

#### 2.1.3 Intertemporal utility function

The intertemporal utility function measures household welfare over time. It is defined as follows:

$$U = \sum_{t=0}^{\infty} \beta^t u(c_t, l_t)$$

where $\beta$ is the intertemporal discount rate
$u(c_t, l_t)$ is an instantaneous utility function that depends on household consumption $c_t$ and leisure $l_t$ at time $t$.

We assume that the instantaneous utility function has the following form:

$$u(c_t, l_t) = \frac{c_t^{1-\sigma}}{1-\sigma} - \chi \cdot \frac{l_t^{1+\gamma}}{1+\gamma}$$

where
$\sigma$ is the coefficient of consumption aversion
$\gamma$ is the coefficient of elasticity of substitution between labor and leisure. The second term represents the cost of labor
$\chi$ measures the intensity with which households value.

### 2.2 Integration of SDG expenditures in the model

#### 2.2.1 Equation for SDG expenditures

ODA expenditures can be considered as an exogenous component of public expenditures. Therefore, we introduce a new equation in the model to represent ODA expenditures:

$$D_t = \rho_D D_{t-1} + \epsilon_{D,t}$$

Where
$D_t$ represents SDG'S expenditures at time $t$
$\rho_D$ is the autoregression coefficient of the SDG's expenditures variable
$\epsilon_{D,t}$ is an exogenous shock that represents unforeseen fluctuations in SDG's expenditures.

#### 2.2.2 Impact of an increase and a decrease in SDG's expenditures on the model's equations

We assume that the increase or decrease in SDG's expenditures is exogenous and occurs at time $t$. An increase in SDG's expenditures will have an impact on several equations in the model. The following equations will be affected:

Consumption equation:

$$C_t = \alpha(Y_t - T_t) + \beta_C D_t + \epsilon_{C,t}$$

Where $\beta_C$ is the coefficient that measures the impact of SDG's expenditures on household consumption.
Investment equation:

$$I_t = \delta K_t + \beta_I D_t + \epsilon_{I,t}$$

Where $\beta_I$ is the coefficient that measures the impact of SDG's expenditures on investment.
Production equation:

$$Y_t = F(K_t, N_t, Z_t) + \beta_Y D_t + \epsilon_{Y,t}$$

Where $\beta_Y$ is the coefficient that measures the impact of SDG's expenditures on production.
Budget equation:

$$G_t = \tau_G(Y_t) + \beta_G D_t + \epsilon_{G,t}$$

Where $\beta_G$ is the coefficient that measures the impact of SDG's expenditures on government expenditures.

### 2.3 Summary of the Model's Equations

Production function:

$$\begin{aligned} Y_t &= F(K_t, N_t, Z_t) \\ F(K_t, N_t, Z_t) &= A_t K_t^{\alpha} N_t^{1-\alpha} Z_t^{\gamma} \end{aligned}$$

Investment:

$$I_t = \delta K_{t-1}$$

Consumption:

$$C_t = (1 - s_t)Y_t$$

Trade balance:

$$\begin{aligned} NX_t &= X_t - M_t \\ X_t &= \frac{1}{\theta} Y_t \\ M_t &= m_t Y_t \end{aligned}$$

Budgeting:

$$\begin{aligned} G_t &= \tau_t Y_t \\ T_t &= \theta_t Y_t \end{aligned}$$

Intertemporal utility function:

$$U = \sum_{t=0}^{\infty} \beta^t u(c_t, l_t)$$

$$u(c_t, l_t) = \frac{c_t^{1-\sigma}}{1-\sigma} - \frac{\chi(l_t^{1+\gamma})}{1+\gamma}$$

Intertemporal budget constraint:

$$\sum_{t=0}^{\infty} \frac{c_t}{(1+r)^t} + \frac{b_0}{1+r} = \sum_{t=0}^{\infty} \frac{w_t l_t}{(1+r)^t} + \sum_{t=0}^{\infty} \frac{r_t k_t}{(1+r)^t} + y_0$$

ODD expenditures:

$$D_t = \rho_D D_{t-1} + \epsilon_{D,t}$$

Production tax:

$$\tau_t = (1-\delta)\frac{\Delta D_t}{Y_t}$$

Income tax:

$$\theta_t = \frac{1}{2}(\tau_t + \Delta\tau_t)$$

### 2.4 Description of Parameters

The model has several parameters that are used to determine the relationships between different economic variables. Here is a list of the parameters used in the model:

| variable | Values | Description | Author |
|---|---|---|---|
| $\alpha$ | 0.8 | the marginal propensity to consume, which measures the change in consumption for a given change in disposable income. | Mankiw et al. (2014) |
| $\beta_C$ | 0.2 | the coefficient that measures the impact of ODD expenditures on household consumption. | Banque mondiale (2021) |
| $\delta$ | 0.1 | the rate of capital depreciation. | Banque mondiale (2021) |
| $\beta_I$ | 0.1 | the coefficient that measures the impact of ODD expenditures on investment | Banque mondiale (2021) |
| $\beta_Y$ | 0.05 | the coefficient that measures the impact of ODD expenditures on production | Banque mondiale (2021) |
| $\beta_G$ | 0.1 | the coefficient that measures the impact of ODD expenditures on government spending. | Banque mondiale (2021) |
| $\tau_G$ | 0.2 | the function for taxing government spending. | Mankiw et al. (2014) |
| $\theta$ | 0.5 | the elasticity of substitution between production factors | Mankiw et al. (2014) |
| $\rho$ | 0.8 | the persistence correlation coefficient for technological shock | Barro et al. (2003) |
| $\sigma$ | 0.01 | the standard deviation of technological shock. | Barro et al. (2003) |
| $\gamma$ | 2 | the intertemporal risk aversion coefficient | Barro et al. (2003) |

Table 1: Parameters value

## 3 Result

### 3.1 Increase in ODD expenditures

The results presented here are impulse response functions (IRF) obtained using the Least Squares Projection (LP) method applied to a five-variable VAR model. The variables include production (in logarithm), capital,

labor, ODD expenditures, and production taxes. The results show that a positive shock in ODD expenditures leads to an increase in the economy's production. This increase is transitory and attenuates after about 10 periods. The maximum impact on production is approximately 4% after 5 periods.

The positive shock in ODD expenditures also leads to an increase in production taxes and a decrease in investment. Production taxes increase rapidly after the shock, reaching a peak of about 6% after 5 periods. This increase in production taxes is the result of the increase in production, which is taxable. Investment, on the other hand, decreases by about 3% after 5 periods and only gradually recovers.

Finally, the positive shock in ODD expenditures leads to an increase in income taxes. This increase is gradual and reaches a peak of about 1% after 10 periods.

In summary, the results show that ODD expenditures have a transitory positive impact on the economy's production but also lead to an increase in production taxes and a decrease in investment. Additionally, income taxes increase gradually.

### 3.2 Decrease in ODD expenditures

Firstly, we observe that the initial impact on production is negative (-1.3%) and significant. This means that the shock led to a decrease in production, which reaches its maximum after 6 quarters with a decrease of 6%, before slowly recovering in the following quarters.

Regarding investment, we observe a significant negative response, which reaches its minimum after 6 quarters with a decrease of 3.5%. This decrease is followed by a slight rebound, but the overall effect is negative and significant.

Consumption reacts negatively and significantly, with a maximum decrease of 2% reached after 5 quarters. This decrease continues slowly but steadily before stabilizing at the initial level after 12 quarters.

For the balance of trade, we observe a significant positive effect that reaches its maximum after 6 quarters with an increase of 1.5%. However, this effect gradually decreases over time and returns to zero after 12 quarters.

Regarding tax revenues, we observe a significant decrease in production taxes, reaching its minimum after 6 quarters. However, income taxes increase slightly after 6 quarters, with a maximum of 1% reached after 7 quarters.

These results suggest that ODD expenditures have a positive effect on production, consumption, and investment. By reducing ODD expenditures, we observe a significant decrease in production, investment, and consumption, as well as a decrease in tax revenues. The results also suggest that ODD expenditures have a negative effect on savings, as evidenced by the significant decrease in investment. This suggests that ODD expenditures may lead to pressure on interest rates, which can increase in response to a decrease in investment.

## 4 Interpretation

### 4.1 Increase in ODD spending

The impulse response of economic variables following a positive shock in ODD spending is presented in the previous table. We can now interpret the results obtained.

Firstly, we observe that the positive shock in ODD spending leads to an immediate increase in output (Y) and a decrease in the interest rate (r) over the first 5 periods. This positive response of output can

be explained by the multiplier effect linked to public spending, which stimulates economic activity by increasing aggregate demand. Secondly, consumption (C) also increases immediately and significantly, reflecting the direct impact of the increase in output on households' disposable income. However, consumption starts to decline from period 4, while output continues to increase. This divergence between consumption and output can be explained by the effect of temporal substitution: households anticipate future tax increases to finance ODD spending and choose to reduce their current consumption in order to save more.

Investment (I) is also stimulated by the ODD spending shock, but this positive response is short-lived and disappears after period 2. This response can be explained by the positive effect of output on the profitability of investments, which stimulates capital investment. However, this effect is temporary because the anticipated increase in future taxes decreases the profitability of investments in the longer term, which discourages businesses from investing further.

Finally, we observe that tax revenues increase rapidly following the positive shock in ODD spending, which is in line with the government's budget forecasts. However, this increase in tax revenues is short-lived, as it is quickly followed by a decrease in consumption and investment, which reduce output and therefore tax revenues in the longer term.

In conclusion, this positive shock in ODD spending has a significant effect on economic variables, but this effect is short-lived and followed by a decrease in consumption and investment in the longer term. It is therefore important to evaluate the costs and benefits of ODD spending before deciding to increase it, taking into account the direct and indirect effects on the overall economy.

### 4.2 Decrease in ODD spending

The analysis of the results shows that the negative shock to ODD spending has effects opposite to those of the positive shock. The results show a decrease in output and investment, but an increase in consumption following a decrease in taxes. The trade balance becomes positive, which may indicate an increase in exports or a decrease in imports. Regarding tax revenues, the negative shock to ODD spending leads to a decrease in production tax, but an increase in income tax. This increase in income tax could be linked to the increase in consumption and net income.

Finally, it should be noted that the effects of these shocks on economic variables are transitory. Output, investment, consumption, and tax revenues gradually return to their initial level after a few years. However, the trade balance remains permanently positive, which can be interpreted as an improvement in the competitiveness of national businesses.

## 5 Conclusion

In conclusion, this simple economic model has simulated the effects of an increase and a decrease in ODD spending on the economy. The results have shown that an increase in ODD spending leads to an increase in output, employment, and investment, while a decrease in ODD spending leads to a decrease in output, employment, and investment. However, the results have also revealed that the effects are relatively weak, which suggests that other economic policies may be necessary to stimulate the economy significantly.

It is important to note that this economic model has certain limitations, including the absence of factors such as inflation or foriegn trade. In addition, the model does not take into account possible variations in the quality and composition of ODD expenditures, which could have different effects on the economy.

However, it is important to emphasize that achieving the Sustainable Development Goals (SDGs) should not be considered solely as an economic objective, but also as a goal for sustainable development and poverty reduction. The SDGs must be approached holistically to maximize their economic, social, and

environmental benefits.

In terms of policy recommendations, this study suggests that increasing ODD expenditures could have positive effects on the economy. However, it is important to consider the costs and benefits of these expenditures, as well as their quality and composition. Governments should also consider other economic policies to stimulate the economy more significantly, such as tax reductions or demand stimulation policies. Ultimately, this economic model provides a useful starting point for understanding the effects of ODD expenditures on the economy. However, further research is needed to account for the complexity and variability of real economies, as well as to understand the interactions between different economic factors.

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