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Public Spending Shocks and Economic Growth in Fragile States: Calibration and Empirical Evidence for Sustainable Development and Poverty Alleviation

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Abstract:

This paper examines the dynamics of fragile states by analyzing how shocks to public expenditure affect private sector output, household welfare, and overall economic growth. Public spending shocks are modeled as stochastic events governed by a Bernoulli process, initially impacting government expenditure and subsequently propagating through the entire economy. The theoretical framework is based on a dynamic general equilibrium model in which public expenditure plays a central role in sustaining aggregate demand, shaping technological progress or backwardness, and fostering productivity growth. The analysis demonstrates that persistent reductions in public spending generate cumulative declines in per capita consumption and output, thereby weakening household resilience and constraining sustainable development. The empirical approach combines descriptive statistics, parameter calibration, and vector autoregression models to assess growth dynamics across multiple time horizons. The results indicate that increases in public spending have a positive and statistically significant effect on household consumption and GDP per capita. Overall, the paper highlights the importance of stable and strategically oriented public expenditure for enabling fragile states to adapt to a reconfigured globalization process and to mitigate structural power asymmetries in the global economy. From a policy perspective, the paper emphasizes the importance of stable, predictable, and strategically targeted public spending frameworks in fragile states. Such frameworks would strengthen economic resilience, support inclusive growth, and enhance the capacity of these states to pursue the Sustainable Development Goals, particularly those related to poverty reduction.

Keywords: Fragile States, public spending, economic growth, shocks, general equilibrium models, parameter calibration.

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1. Introduction

Department For International Development (DFID) defines fragile States as: “those where the government cannot or will not deliver core functions to the majority of its people, including the poor” (DFID, 2005). Commonly, fragile States are described as incapable to assume basic security, maintain rule of law and justice, or provide basic services and economic opportunities for their citizens. Fragile States are mostly developing countries, facing violence and conflict, political instability, severe poverty, and other threats to security and development (Nay O., 2013). In fragile states, government stability and public expenditure are subject to significant uncertainty. Nevertheless, when effectively allocated, public spending has the potential to substantially improve population welfare.

Indeed, the first decade of the 21st century concluded with financial crises reminiscent of the 1929 Great Depression in the United States, generating economic repercussions that necessitated systematic and large-scale government intervention. During the U.S. subprime mortgage crisis, “the first major federal response to the crisis was a $168 billion program of federal spending and temporary tax rebates enacted in February 2008” (Kincaid, 2010). As Kincaid further explains, “a second major response was the Housing and Economic Recovery Act (HERA) of July 2008, which addressed the subprime mortgage crisis.” In 2009, the U.S. federal government injected substantial financial resources into key sectors of the economy—such as the automotive industry, energy, and research and development—to prevent systemic collapse and stimulate recovery.

Stiglitz (2003) further argues that, contrary to conventional wisdom, the government has frequently played a direct or indirect interventionist role in key sectors of the American economy. The relationship between public spending and economic growth has been examined from various perspectives: the quality of public expenditure by Afonso et al. (2005); the size of the state and its fiscal implications by Barro (1990), as well as Afonso and Furceri (2010); the composition and nature of public spending by Varoudakis (1996); and the influence of the business cycle on public expenditure by Backus et al. (1995).

How can the impact of shocks to public spending on the broader economy be effectively captured? Several studies have sought to address this question using different methodological approaches. For instance, Baxter and King (1993) employ calibration methods, while Backus et al. (1995) use vector autoregressive (VAR) models to analyze the dynamic effects of fiscal policy. More recently, Furceri et al. (2018) constructed a dataset of unanticipated government spending shocks for 103 developing countries spanning the period from 1990 to 2015, in order to examine their effects on income distribution. Their findings indicate that unanticipated fiscal consolidations tend to result in a persistent increase in income inequality, whereas fiscal expansions are associated with a reduction in inequality.

Fantcho and N’gouan (2022) identify public expenditure as a key driver of economic growth and technological progress in unstable countries. Their analysis shows that increases in public expenditure stimulate private-sector production and enhance household consumption. Building on the framework developed by Fantcho and N’gouan (2022), this study examines the dynamics of fragile states within the context of a globalized economy undergoing profound structural transformation driven by technological change. In particular, it investigates how shocks to public expenditure—reflecting institutional fragility and limited fiscal capacity—affect private-sector output, household welfare, and long-term economic growth. Public expenditure levels in developed economies are substantially higher than those prevailing in poor and fragile states, highlighting the critical role of fiscal capacity in supporting economic development.

The study demonstrates that increases in public spending can contribute significantly to economic growth and development in fragile states, thereby promoting convergence toward the higher living standards observed in industrialized economies. By sustaining aggregate demand, supporting private-sector activity, and fostering productivity-enhancing processes, public expenditure can serve as an important mechanism for strengthening economic resilience and accelerating structural transformation in fragile contexts.

The aim of the study is to examine how shocks to public expenditure affect private production, economic growth, and household welfare. To this end, we develop a dynamic general equilibrium model tailored to the specific context of fragile states. These countries are often characterized by conflict, insecurity, and widespread poverty. In such environments, the future is highly uncertain, and reliable economic forecasts are frequently unavailable. It is often impossible to predict whether the government will undertake productive public spending - such as building roads or opening public hospitals. Public expenditure is therefore inherently uncertain. In this paper, we conceptualize this uncertainty as shocks, which may significantly influence economic growth and the welfare of the population.

In this study, the shocks are modeled as discrete random variables that follow a Bernoulli process, occurring in public expenditure and transmitting their effects throughout the rest of the economy. Through shocks on public spending, we explain a potential source of economic growth. Through these shocks to public spending, we identify a potential source of economic growth and offer new insights into what is commonly referred to by economists as technological progress[1]. We consider a small, closed economy in which the long-run growth rate is endogenous and dynamic - capable of rising or falling in response to fluctuations in public spending. The theoretical framework is based on a dynamic general equilibrium model in which public expenditure plays a central role in sustaining aggregate demand, shaping technological progress or backwardness, and fostering productivity growth. The analysis demonstrates that persistent reductions in public spending generate cumulative declines in per capita consumption and output, thereby weakening household resilience and constraining sustainable development.

In fragile states, the level of public expenditure is largely determined by uncertain and volatile resources, such as the volume of foreign aid and donations received, exposure to climate shocks, political instability, and the burden of debt servicing. From a policy perspective, the paper emphasizes the importance of stable, predictable, and strategically targeted public spending frameworks in fragile states. Such frameworks would strengthen economic resilience, support inclusive growth, and enhance the capacity of these states to pursue the Sustainable Development Goals, particularly those related to poverty reduction.

The paper is organized as follows. Sections 2 presents the theoretical framework. Subsection 2.1 describes the dynamics of private production and demonstrates how increases in public spending can stimulate output growth. Subsection 2.2 analyzes household behavior, showing that both consumption and welfare are fully determined by the historical trajectory of public spending shocks. Section 3 explain the methodology. Section 4 outlines the results. Principal Component Analysis (PCA) provides a suitable framework for visualizing the relationship between government expenditure and economic growth across countries. Finally, parameter calibration and empirical analysis is employed to forecast growth trajectories in fragile states over different time horizons.

[1] Indeed, labor and capital alone are insufficient to fully account for economic growth. The unexplained portion of growth is often captured by what is known as the "Solow residual" or "technological shocks" which represents the share of output growth that cannot be attributed to the accumulation of labor and capital inputs.

2. Theoretical approach

2.1 The production sector and role of public spending

Let us consider an economy with a private production sector that employs two private inputs - capital *K* and labor *L*, to produce a single final consumption goods, denoted by *Y*. Public expenditures are not predetermined; they are subject to uncertainty until realized. These expenditures act as externalities for the private production sector and enter directly as inputs into the production of the final goods *Y*. We assume that all firms in the private sector are identical, using the same technology to produce the same good. For simplicity, the number of firms is normalized to one, implying a single representative firm that produces on behalf of the entire economy. We adopt the classical approach to public goods, which are defined as non-rival and non-excludable. When public spending occurs, it benefits all economic agents equally. Each private firm benefits from the entirety of public expenditure; the utilization of public resources by one firm does not diminish their availability to others. In line with Barro (1990), we assume that the production function of the private sector follows a Cobb-Douglas specification.

$$Y_t = K_t^{\alpha} L_t^{1-\alpha} G_t^{1-\alpha} \qquad (1)$$

Where α: $0 < \alpha < 1$ represents the capital intensity; Y_t denotes the quantity of the consumption goods produced by the private sector at time t; G_t denotes the level of public expenditure. The private sector production function exhibits constant returns to scale with respect to the private inputs: labor *L* and capital *K*.

We assume that the level of public expenditure is entirely determined by the government's discretionary and uncertain decisions. The government finances its spending by levying taxes on household income and purchasing a portion of private sector output. These purchases are then used to provide free services to private producers. Public expenditure directly affects the level of output in the private sector. The government takes its spending decisions at the beginning of each year, and these decisions - unpredictable to private agents - are modeled as exogenous shocks. Public spending *G* can either enhance or diminish private sector production. Time is denoted by the index *t*, which is assumed to be discrete. In equation (1), an increase in public spending, raises the marginal productivity of both labor *L* and capital *K*.

Labor supply is provided by households. The population size N_t grows at a constant rate *n*, and unemployment is assumed to be nonexistent. At time $t = 0$, the initial population is normalized to $N_0 = 1$. Households do not derive utility from leisure. Given the absence of unemployment, labor supply in equilibrium grows at the same constant rate as the population:

$$L_t = N_t = (1+n)^t \qquad (2)$$

In contrast to Barro's model, the share of public expenditure in production is not constant. Instead, the level of public spending G_t depends on the entire history of the government's discretionary and uncertain decisions made at the beginning of each period t.

$$G_t = \begin{cases} uG_{t-1}\,; & with\ the\ probability \quad P \\ dG_{t-1}\,; & with\ the\ probability \quad 1-P \end{cases} \qquad (3.a)$$

With[2], $0 < d < 1 < u$, thus depending on the government's uncertain decision - unknown in advance - the level of public expenditure either increases with probability P or decreases with probability $1 - \mathrm{P}$, $0 \leq \mathrm{P} \leq 1$. However, the government balances its budget by levying a variable rate tax τ_t on gross households' income: $G_t = \tau_t . Y_t$. Accordingly, the level of government expenditure in equation (3.a) can be reformulated as follows:

$$G_t = u^{X_t} \cdot d^{1-X_t} \cdot G_{t-1} \qquad (3.b)$$

Where, X_t is a random variable is a random variable that follows a Bernoulli distribution. Specifically, $\mathrm{X_t}$ takes the value 1 with the probability P, and the value 0 with the probability 1-P. By expanding equation (3.b), we obtain.

$$G_t = u^{\sum_{j=1}^{t} X_j} \cdot d^{t-\sum_{j=1}^{t} X_j} \cdot G_0 \qquad (3.c)$$

Expression (3.c) clearly illustrates that the level of government spending depends on the entire history of the government's discretionary and uncertain spending decisions. Substituting equation (3.c) into expression (1), and recalling that in equilibrium labor supply equals labor demand, the production function can be written as:

$$Y_t = A_t^{1-\alpha} \cdot K_t^{\alpha} \cdot N_t^{1-\alpha}$$

Where, $A_t = u^{\sum_{j=1}^{t} X_j} \cdot d^{t-\sum_{j=1}^{t} X_j} \cdot G_0$, reflects technological progress or decline induced by public spending, with G_0 given. The variable A_t offers a new perspective on what economists typically refer to as technological progress. Indeed, labor and capital alone are insufficient to fully account for economic growth. The term A_t captures the influence of public expenditure on output, highlighting that the source of technological advancement - or decline - lies in the pattern of government spending decisions over time.

Indeed, if the government consistently chooses to reduce public expenditure over time—that is, $X_t = 0$, for all $t = 1,2, \ldots$, then, given that $0 < \mathrm{d} < 1$, private sector output will decline over time according to:

$$\mathrm{Y_t} = (d^t \cdot G_0)^{1-\alpha} \cdot K_t^{\alpha} \cdot N_t^{1-\alpha}$$

Furthermore, for a fixed level of capital, if population growth fails to offset the decline in public spending - i.e., if : $1 + \mathrm{n} \geq \mathrm{d}$, does not hold - private sector output will gradually decline and, in the long run, will approach zero. As a consequence, the population will experience widespread poverty and generalized deprivation. Conversely, if the government consistently increases public spending over time, private sector output will be significantly stimulated by this fiscal expansion. In this context, output evolves according to:

$$Y_t = (u^t G_0)^{1-\alpha} K_t^{\alpha} N_t^{1-\alpha}$$

With, $u > 1$. Thus, government budgetary decisions have a direct and significant impact on private sector output.

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[2]The parameters *P*, *d*, and *u* will be estimated for each fragile state and will be used to forecast growth over different time horizons. For a specific country, the parameter P can be estimated using the formula : $\widehat{\mathrm{P}} = \frac{1}{\mathrm{T}} \sum_{\mathrm{t}=1}^{\mathrm{T}} \mathrm{I}_{\mathrm{G_t} > \mathrm{G_{t-1}}}$. $\widehat{\mathrm{P}}$ represents the proportion of years in which public expenditure increased in the country under consideration. *T* denotes the total number of observation years. The indicator variablele $\mathrm{I}_{G_t > G_{t-1}}$ takes the value 1 if if $G_t > G_{t-1}$, and 0 otherwise. $\hat{\mathrm{u}} = \frac{\sum_{\mathrm{t}=1}^{\mathrm{T}} \frac{\mathrm{G_t}}{\mathrm{G_{t-1}}} \cdot \mathrm{I}_{\mathrm{G_t} > \mathrm{G_{t-1}}}}{\sum_{\mathrm{t}=1}^{\mathrm{T}} \mathrm{I}_{\mathrm{G_t} > \mathrm{G_{t-1}}}}$ and $\hat{\mathrm{d}} = \frac{\sum_{\mathrm{t}=1}^{\mathrm{T}} \frac{\mathrm{G_t}}{\mathrm{G_{t-1}}} \cdot \mathrm{I}_{\mathrm{G_t} \leq \mathrm{G_{t-1}}}}{\sum_{\mathrm{t}=1}^{\mathrm{T}} \mathrm{I}_{\mathrm{G_t} \leq \mathrm{G_{t-1}}}}$. $\hat{\mathrm{u}}$ (respectively, $\hat{\mathrm{d}}$) captures the average magnitude of increases (respectively, decreases) in public spending.

At each point in time *t*, firms producing the consumption goods choose the quantities of labor L_t and capital K_t that maximize their profit. The profit function is given by:

$$\pi_t = A_t^{1-\alpha} \cdot K_t^{\alpha} \cdot L_t^{1-\alpha} - w_t \cdot L_t - r_t \cdot K_t$$

Where w_t denotes the real wage rate, i.e., the number of units of the final good that the firm pays in exchange for one unit of labor, and $\mathrm{r_t}$ s the real rental price of capital, i.e., the number of units of the final good paid for one unit of capital. The consumption good Y_t is taken as the numeraire. The first-order conditions for the firm's profit-maximization problem imply:

$$r_t = \alpha \cdot \frac{Y_t}{K_t} = \alpha \cdot A_t^{1-\alpha} \cdot K_t^{\alpha-1} \cdot L_t^{1-\alpha}$$

$$w_t = (1-\alpha) \cdot \frac{Y_t}{L_t} = (1-\alpha) \cdot A_t^{1-\alpha} \cdot K_t^{\alpha-1} \cdot L_t^{1-\alpha}$$

Thus, in equilibrium, the firm earns zero profit: $\pi_t = Y_t - w_t \cdot L_t - r_t \cdot K_t$=0.

2.2 Household Behavior and Steady-State Dynamic in the Theoretical Framework

Households earn a wage $\mathrm{w_t}$ in exchange for supplying labor $\mathrm{N_t}$. Capital is owned by households, who rent it to firms in return for a rental rate r_t. All markets are assumed to be perfectly competitive and operate at each point in time *t*. Households allocate their after-tax income - derived from both labor and capital - to the purchase of consumption goods *Y*. The after-tax income of households is given by:

$$(1-\tau_t)(w_t L_t + r_t K_t) = (1-\tau_t) Y_t$$

Where $\tau_{\mathrm{t}} = \frac{\mathrm{G_t}}{\mathrm{Y_t}} = \frac{\mathrm{T_t}}{\mathrm{Y_t}}$ denotes the tax rate. τ_t is not a choice variable for firms or households; rather, it is a discretionary policy instrument determined by the government. The tax rate τ_t is set to balance the government budget. Using equation (3.b), we derive the following expression:

$$\tau_{\mathrm{t}} = \frac{\mathrm{u^{X_t} \cdot d^{1-X_t}}}{1+\gamma_{\mathrm{t}}} \tau_{\mathrm{t-1}}$$

Where $\gamma_t = \frac{Y_t - Y_{t-1}}{Y_{t-1}}$, represents the output growth rate. Accordingly, the tax rate increases when the government chooses to raise public spending.

We assume infinitely lived households. All households are identical. Each household supplies one unit of labor and consists of a single adult who participates in the production of the final good. At each time $t \geq 0$, the household's objective is to maximize its intertemporal utility, given by the following expected lifetime utility function:

$$\mathbb{E}_t \left[\sum_{s=0}^{+\infty} \beta^{t+s} \cdot U(C_{t+s}) \right] \qquad (4)$$

where $\beta \in]0,1[$ is the discount factor, reflecting the household's rate of time preference, and C_t denotes the level of consumption at time *t*. The instantaneous utility function is specified as:

$$\mathrm{U(C)} = \frac{\mathrm{C^{1-\sigma}}}{1-\sigma}$$

The utility function $\mathrm{U(C)}$ is a twice continuously differentiable function, strictly increasing and strictly concave. The parameter σ, $0 < \sigma \leq 1$, represents the intertemporal elasticity of substitution in consumption. The operator $\mathbb{E}_{\mathrm{t}}$ denotes the conditional expectation based on the information available at time *t*. Uncertainty is modeled by a probability space $(\Omega, \mathrm{F}, \mu)$ where $\mathrm{F} =$

$\{F_0 \subseteq F_1 \subseteq \cdots \subseteq F_t \subseteq F_{t+1}, \ldots\}$ is a filtration of σ-algebras, ordered by inclusion. The measure μ is a probability defined on the measurable space (Ω, F). The σ-algebra F_t is generated by the history of shocks up to time *t*, that is, by the process $X^t = \{X_0, X_1, X_2, \ldots, X_t\}$, which represents the sequence of hazardous and discretionary government's decisions up to date t.

The household's constraints at each date *t* are given by:

$$(1-\tau_t)\cdot Y_t = C_t + I_t \qquad (5.a)$$
$$Y_t = w_t \cdot L_t + r_t \cdot K_t = A_t^{1-\alpha} K_t^{\alpha} L_t^{1-\alpha} \qquad (5.b)$$
$$K_{t+1} = I_t + (1-\delta)K_t \qquad (5.c)$$

Where I_t denotes the level of investment, δ, $0 < \delta < 1$ is the depreciation rate of capital, and K_t is the stock of capital available at the time t. Constraint (5.a) reflects the fact that aggregate household income (net of taxes) is allocated between consumption and investment. Constraint (5.c) characterizes the law of motion of capital, describing how investment and depreciation determine the evolution of the capital stock over time. Equation (5.b) is an identity, which describes the equality between aggregate supply and aggregate demand. By combining constraints (5.a), (5.b), and (5.c), we derive the household resource constraint at each date *t*:

$$(1-\tau_t)Y_t = C_t + K_{t+1} - (1-\delta)K_t \qquad (5.d)$$

At each date *t*, the household's problem is to choose the level of consumption C_t and future capital K_{t+1} that maximize expression (4), subject to the resource constraint (5.d). To address this problem, we reformulate the variables in terms of efficient units. Specifically, we define:

$$\widehat{N}_t = A_t.N_t$$

$\widehat{N}_t$ is interpreted as *efficient labor*, which incorporates into labor the effects of public expenditure. We further define production, consumption, and capital per efficient unit as:

$$\hat{y}_t = \frac{Y_t}{\widehat{N}_t} = \hat{k}_t^{\alpha} \;\; ; \;\; \hat{c}_t = \frac{C_t}{\widehat{N}_t} \;\; ; \;\; \hat{k}_t = \frac{K_t}{\widehat{N}_t}$$

The resource constraint can thus be rewritten as:

$$(1-\tau_t)\cdot \hat{k}_t^{\alpha} = \hat{c}_t + (1+n)\cdot u^{X_{t+1}} \cdot d^{1-X_{t+1}} \cdot \hat{k}_{t+1} - (1-\delta)\hat{k}_t \qquad (6.a)$$

Subject to constraint (6.a), the household's problem can be formulated as:

$$\max_{\hat{c}_{t+s},\, \hat{k}_{t+s}} \mathbb{E}_t\left[\sum_{s=0}^{+\infty} \tilde{\beta}^s \frac{\hat{c}_{t+s}^{1-\sigma}}{1-\sigma}\right] \qquad (6.b)$$

The transformation of variables presents a twofold advantage. First, variables expressed in terms of efficient units correspond to per capita measures in which the effects of public expenditure are explicitly embedded. This reformulation therefore converts the aggregate household problem into the problem of a representative individual. Second, it enables the use of a variable discount factor that incorporates both population size and the impact of public expenditure.

$$\tilde{\beta}^t = \beta^t \cdot (1+n)^{(1-\sigma)t} \cdot A_t$$

The household problem consists of maximizing expression (6.b), subject to the consolidated resource constraint (6.a). To solve this problem, one can formulate the Lagrangian, from which the first-order conditions and the following Euler equation can be derived:

$$\hat{c}_t^{-\sigma} = \mathbb{E}_t\left[\beta (u^{X_{t+1}} d^{1-X_{t+1}})^{-\sigma} (1+n)^{-\sigma} \hat{c}_{t+1}^{-\sigma} \left\{\alpha(1-\tau_{t+1})\cdot \hat{k}_{t+1}^{\alpha-1} + 1 - \delta\right\}\right] \qquad (6.c)$$

Expression (6.c) represents the Euler equation for the household's problem. It characterizes how instantaneous utility changes when one unit of consumption is shifted from period *t* to period *t+1*, while maintaining the overall level of utility constant. The left-hand side captures the utility loss at time *t* resulting from the deprivation of one unit of the consumption good. Conversely, the right-hand side reflects the expected utility gain arising from the additional consumption in period *t+1*. In the Euler equation (6.c), this expected utility gain depends on the government's future budgetary decisions. Specifically, if the government opts to increase public spending, the anticipated benefit from future consumption correspondingly rises.

However, it is essential to determine whether a long-run steady state exists for consumption, production, and efficient capital. A steady state for $\hat{c}_t$, $\hat{k}_t$, and $\hat{y}_t$ assumes that these variables become constant over time: $\hat{c}_t = \hat{c}$, $\hat{k}_t = \hat{k}$ et $\hat{y}_t = \hat{y}$. Recall that the household income tax rate is given by:

$$\tau_t = \frac{u^{X_t} \cdot d^{1-X_t}}{1+\gamma_t}\tau_{t-1}$$

By expanding this expression for τ_t, substituting $1+\gamma_t$ with $\frac{Y_t}{Y_{t-1}}$, and dividing this latter term by $\widehat{N}_t$, we obtain:

$$\tau_t = \frac{1}{1+n} \cdot \frac{\hat{y}_{t-1}}{\hat{y}_t} \cdot \tau_{t-1} \qquad (7.a)$$

At the steady state of efficient production, this reduces to:

$$\tau_t = \frac{1}{1+n} \cdot \tau_{t-1} \qquad (7.b)$$

Thus, τ_t forms a decreasing sequence that converges to zero whenever the population growth rate n is strictly positive. We analyze the existence of the steady state along two principal scenarios, depending on whether $n = 0$ or $n > 0$.

The first case occurs when $n = 0$ (i.e., the population growth rate is zero); in this scenario, the tax rate remains constant, $\tau_t = \tau_{t-1} = \tau$. Using Euler's equation (6.c), we derive the steady-state value of efficient capital as follows:

$$\hat{k} = \left\{\left(\frac{1}{\beta[Pu^{-\sigma} + (1-P)d^{-\sigma}]} + \delta - 1\right)\frac{1}{\alpha(1-\tau)}\right\}^{\frac{1}{\alpha-1}} \qquad (8.a)$$

The corresponding steady-state efficient output is immediately obtained as:

$$\hat{y} = \hat{k}^{\alpha} \qquad (8.b)$$

By taking the expectation of the resource constraint (6.a) at the steady state, we deduce:

$$\hat{c} = (1-\tau)\cdot\hat{y} - [Pu + (1-P)d - (1-\delta)]\cdot\hat{k} \qquad (8.c)$$

(8.a), (8.b), and (8.c) characterize the steady state of the efficient variables. Recall that:

$$\hat{k} = \frac{K_t}{\widehat{N}_t} \text{ and thus } K_t = \hat{k} \cdot A_t.N_t$$

Since, $N_t = 1, \forall t \geq 0$, due to $n = 0$, it follows that:

$$K_t = \hat{k} \cdot u^{\sum_{j=1}^{t} X_j} \cdot d^{t-\sum_{j=1}^{t} X_j} \cdot G_0$$

The level of capital therefore depends on the history of government budget decisions. The same relationship holds for consumption, production, and public expenditure:

$$C_t = \hat{c} \cdot u^{\sum_{j=1}^{t} X_j} \cdot d^{t-\sum_{j=1}^{t} X_j} \cdot G_0$$
$$Y_t = \hat{y} \cdot u^{\sum_{j=1}^{t} X_j} \cdot d^{t-\sum_{j=1}^{t} X_j} \cdot G_0$$
$$G_t = \tau Y_t \ \ and \ \ \tau = \hat{y}$$

Thus, consumption, capital, and production reach their maximum levels if the government opts to increase public expenditure every year (i. e. , $X_t = 1$ for all $t \geq 1$). Conversely, if the government chooses to reduce public expenditure each year ($X_t = 0$, for all $t \geq 1$), then consumption, capital, and production will continuously decline, ultimately approaching zero in the long run. Under such circumstances, the economy will face severe difficulties, and the population will experience widespread hardship.

The second scenario arises when $n > 0$. In this case, the steady state of efficient production requires that the household income tax rate decline over time and converge to zero as the time horizon t approaches infinity, formally expressed as $\tau_t = \frac{1}{1+n} \cdot \tau_{t-1}$. It is important to note that, although τ_t tends toward zero as $t \to +\infty$, public spending $G_t = \tau_t \cdot Y_t$ does not necessarily converge to zero. Indeed, when the economy reaches a steady state of efficient production, output is given by:

$$Y_t = \hat{y} \cdot (1+n)^t \cdot u^{\sum_{j=1}^{t} X_j} \cdot d^{t-\sum_{j=1}^{t} X_j} \cdot G_0$$

and consequently,

$$G_t = \tau_t Y_t = \frac{\tau_0}{(1+n)^t} \hat{y}(1+n)^t u^{\sum_{j=1}^{t} X_j} \cdot d^{t-\sum_{j=1}^{t} X_j} G_0 = \tau_0 \hat{y} u^{\sum_{j=1}^{t} X_j} d^{t-\sum_{j=1}^{t} X_j} G_0$$

Thus, G_t does not approach zero even as τ_t declines toward zero. The decreasing tax rate is a consequence of population growth combined with the non-rival nature of public expenditures. Specifically, the supply of public goods remains unaffected by the number of consumers; that is, when households or firms use public goods, the remaining quantity is unchanged. However, this assumption is a simplification that deviates from reality. In practice, public goods depreciate over time, and this depreciation accelerates as population size increases. A more realistic model would incorporate both the depreciation of public goods and their depletion resulting from growing population demands.

By expressing the Euler equation, we derive the steady-state level of efficient capital as:

$$\hat{k} = \left\{ \left(\frac{1}{\beta[Pu^{-\sigma} + (1-P)d^{-\sigma}] \cdot (1+n)^{-\sigma}} + \delta - 1 \right) \frac{1}{\alpha} \right\}^{\frac{1}{\alpha-1}} \qquad (9.a)$$

It follows that: $\hat{y} = \hat{k}^{\alpha} \ \ and \ \ \hat{c} = \hat{y} - [Pu + (1-P)d - (1-\delta)]\hat{k}$, and then:

$$K_t = \hat{k}(1+n)^t u^{\sum_{j=1}^{t} X_j} d^{t-\sum_{j=1}^{t} X_j} G_0$$
$$C_t = \hat{c}(1+n)^t u^{\sum_{j=1}^{t} X_j} d^{t-\sum_{j=1}^{t} X_j} G_0$$
$$Y_t = \hat{y}(1+n)^t u^{\sum_{j=1}^{t} X_j} d^{t-\sum_{j=1}^{t} X_j} G_0$$
$$G_t = \tau_0 \hat{y} u^{\sum_{j=1}^{t} X_j} d^{t-\sum_{j=1}^{t} X_j} G_0$$

When the population growth rate is strictly positive, capital, consumption, and output grow at a common rate γ_t, defined by: $1 + \gamma_t = (1+n)u^{X_t}d^{1-X_t}$. This growth rate γ_t is not constant; rather,

it varies over time according to the government's decision to increase or decrease public expenditure. Aggregate growth thus depends both on population growth and government policy.

Likewise, per capita variables grow at the same rate, denoted by $\tilde{\gamma}_t$, defined as: $1 + \tilde{\gamma}_t = u^{X_t} d^{1-X_t}$. Per capita growth occurs if and only if the government opts to increase public expenditure. Specifically:

$$\frac{K_t}{N_t} = \hat{k} \cdot u^{\sum_{j=1}^{t} X_j} \cdot d^{t-\sum_{j=1}^{t} X_j} \cdot G_0$$

$$\frac{C_t}{N_t} = \hat{c} \cdot u^{\sum_{j=1}^{t} X_j} \cdot d^{t-\sum_{j=1}^{t} X_j} \cdot G_0$$

$$\frac{Y_t}{N_t} = \hat{y} \cdot u^{\sum_{j=1}^{t} X_j} \cdot d^{t-\sum_{j=1}^{t} X_j} \cdot G_0$$

It follows that government decisions on public expenditure constitute the sole driver of per capita growth. Assuming that the sequence $(X_t)_{t\geq 1}$, representing government decisions, consists of independent random variables, the expected values of capital, consumption, and output can be computed explicitly. Then, under the independence assumption, the sum, $\sum_{j=1}^{t} X_j$ follows a binomial distribution with parameters (t, P). Hence:

$$\mathbb{E}\left(u^{\sum_{j=1}^{t} X_j} d^{t-\sum_{j=1}^{t} X_j}\right) = \sum_{j=0}^{t} \binom{t}{j} P^j (1-P)^{t-j} u^j d^{t-j} = [Pu + (1-P)d]^t$$

Where $\binom{t}{j} = \frac{t!}{j!(t-j)!}$, with $j! = j \times (j-1) \cdots \times 1$, and $0! = 1$. Furthermore: $\mathbb{E}(u^{X_t} \cdot d^{1-X_t}) = Pu + (1-P)d = \mathbb{E}\left(\frac{G_t}{G_{t-1}}\right)$ is the expected growth rate of public expenditure. Using the above, expected per capita consumption is given by:

$$\mathbb{E}\left(\frac{C_t}{N_t}\right) = \hat{c} \cdot G_0 \cdot [Pu + (1-P)d]^t$$

Thus, the expected per capita consumption increases if and only if $Pu + (1-P)d > 1$, that is, if and only if the expected growth rate of public expenditure is strictly positive. The same conclusions hold for expected per capita capital and output. The term $[Pu + (1-P)d]^t - 1$, represents the expected growth rate of per capita consumption, capital and output after *t* periods.

Finally, the case of a negative population growth rate ($n < 0$) is problematic. Indeed, $n < 0$ implies that the tax pressure rate τ_t increases strictly and tends to infinity as t approaches infinity. Such a scenario rules out the existence of a steady state, even for efficient variables. Therefore, we exclude the possibility that fiscal pressure becomes unbounded.

3. Methodology

This study adopts a mixed methodological framework that combines theoretical modeling, parameter calibration, exploratory multivariate analysis, and econometric estimation to investigate the effects of public expenditure shocks on economic growth and household welfare in fragile states. The methodological strategy is designed to capture both the structural mechanisms through which public spending shocks influence economic dynamics and the empirical relationships observed across countries characterized by institutional fragility and limited fiscal capacity.

The theoretical component of the analysis is based on a stochastic dynamic general equilibrium framework specifically adapted to the context of fragile states. Public expenditure is modeled as a stochastic process governed by a Bernoulli distribution, reflecting the uncertainty surrounding

government spending decisions in environments affected by political instability, external aid dependence, conflict, and fiscal constraints. In this framework, government expenditure enters directly into the aggregate production function as a productive public input, generating positive externalities for private production. The model allows public spending shocks to propagate throughout the economy, influencing capital accumulation, household consumption, productivity, and long-run growth. The equilibrium conditions are derived from the optimization behavior of representative firms and infinitely lived households operating under perfect competition.

To characterize the long-run implications of public spending shocks, the model is solved analytically under alternative demographic scenarios. Steady-state solutions are derived for output, consumption, and capital expressed in efficient units, thereby allowing an assessment of how recurrent increases or decreases in public expenditure affect economic trajectories over time. The calibration procedure relies on historical observations of government expenditure and estimates three key structural parameters: the probability of expenditure expansion (P), the average proportional increase in spending during expansionary periods (u), and the average proportional decrease during contractionary periods (d). These parameters are subsequently employed to forecast expected per capita growth paths over horizons of 10, 20, and 30 years for the most fragile countries identified by the Fragile States Index.

This study employs a three-stage empirical methodology combining Principal Component Analysis (PCA), parameter calibration, and panel Vector Autoregression (PVAR) techniques to investigate the relationship between public expenditure shocks, household welfare, and economic growth in fragile states. These complementary approaches make it possible to examine the phenomenon from descriptive, structural, and dynamic perspectives.

The first stage of the analysis relies on Principal Component Analysis (PCA), a multivariate statistical technique used to explore the relationships between fragility indicators, public expenditure variables, and socioeconomic outcomes. PCA refers to a family of statistical techniques aimed at extracting and summarizing information from large datasets characterized by a high number of variables. These methods are essentially geometric approaches that provide a synthetic representation of complex data structures. By offering graphical visualizations of the relationships among variables and observations, they facilitate the identification of latent structures, major dimensions of variation, and homogeneous clusters within the data. Their principal strength resides in their capacity to simultaneously process large amounts of information, making them particularly suitable for the exploration and interpretation of multidimensional socioeconomic phenomena.
In our study, PCA is conducted using data from 171 countries obtained from the World Development Indicators (WDI) and the Fragile States Index (FSI). This method reduces the dimensionality of the dataset while preserving the maximum amount of information contained in the original variables. By projecting both countries and variables onto a reduced factorial space, PCA provides a graphical representation of the underlying structure of the data and facilitates the identification of the principal dimensions characterizing fragile and non-fragile states. In particular, the analysis highlights the association between government expenditure, political stability, household consumption, capital formation, and economic performance. The PCA therefore serves as an exploratory tool for identifying stylized facts and validating the theoretical assumptions underlying the study.

The second stage consists of calibrating the structural parameters of the theoretical model. Public expenditure dynamics are assumed to follow a stochastic Bernoulli process characterized by three parameters: the probability of an increase in public expenditure (P), the average proportional increase in expenditure during expansionary periods (u), and the average proportional decrease during contractionary periods (d). These parameters are estimated using annual government expenditure data covering the period 2006–2021. For each country, the parameter P is computed as the relative frequency of years in which public spending increased, while the parameters u and d

are calculated as the average growth magnitude associated with expenditure increases and decreases, respectively. Once calibrated, these parameters are used to derive forecasts of expected per capita growth according to the theoretical relationship governing the stochastic evolution of public expenditure. This calibration procedure provides country-specific projections of long-term growth trajectories over horizons of 10, 20, and 30 years.

The third stage of the analysis employs panel Vector Autoregression (PVAR) models to investigate the dynamic effects of public expenditure shocks on economic activity and household welfare. Unlike conventional regression models that impose a priori causal relationships, the VAR framework treats all variables as jointly endogenous and captures their dynamic interdependencies over time. The empirical specification includes public expenditure on education, public expenditure on health, GDP per capita, and household final consumption expenditure per capita. Using lagged values of the variables, the PVAR model estimates how innovations in government spending propagate through the economic system. Impulse Response Functions (IRFs) are subsequently derived to trace the effects of expenditure shocks over multiple periods and to evaluate both their magnitude and persistence. This approach allows for the identification of short-run and long-run fiscal multipliers and provides evidence on the transmission mechanisms linking public expenditure to growth and household welfare in fragile states.

Taken together, these three methodological components form a coherent analytical framework. Principal Component Analysis provides an exploratory assessment of the relationships among key variables, parameter calibration generates long-term growth projections based on the theoretical model, and panel VAR techniques identify the dynamic responses of output and consumption to public expenditure shocks. The combination of these methods strengthens the robustness of the analysis and enables a comprehensive understanding of the role of public spending shocks in fragile states.

4. Empirical results

4.1 Descriptive and exploratory statistics

We draw upon data from the Fund for Peace (FFP), an organization dedicated to preventing violent conflict and fostering sustainable security. According to the FFP, the Fragile States Index (FSI) is an annual ranking of 178 countries, based on various pressures that influence their levels of fragility. The FSI is constructed such that lower scores indicate greater stability and improvement, whereas higher scores reflect increased instability. The index is calculated using twelve equally weighted indicators, including *Security Apparatus*, *Group Grievance*, *Economic Decline*, *Human Flight and Brain Drain*, and *Refugees and Internally Displaced Persons (IDPs)*, among others. In addition, we incorporate macroeconomic data from the World Development Indicators (WDI) on household consumption, gross capital formation, and government expenditure to assess the impact of public spending in fragile states. Figure 1, produced by the Fund for Peace (2024), depicts the distribution of countries according to their level of fragility. The figure reveals that the most fragile states are predominantly located in Africa, Asia, and South America.

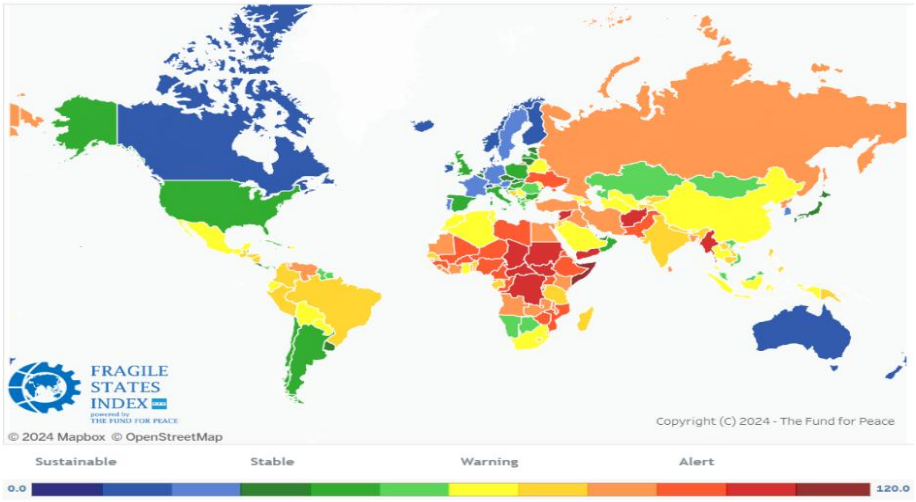


Fig. 1. Distribution of countries by level of fragility

Source: The Fund for peace, 2024. Fragile States Index Heat Map | Fragile States Index

Figures 2 and 3 below present the results of a Principal Component Analysis **(PCA)** conducted on a sample of 171 countries, using 2021 data obtained from the World Development Indicators[3] and the Fund for Peace.

[3]The data employed in this analysis are publicly available on the **World Bank's** website: http://data.worldbank.org/data-catalog/world-development-indicators.

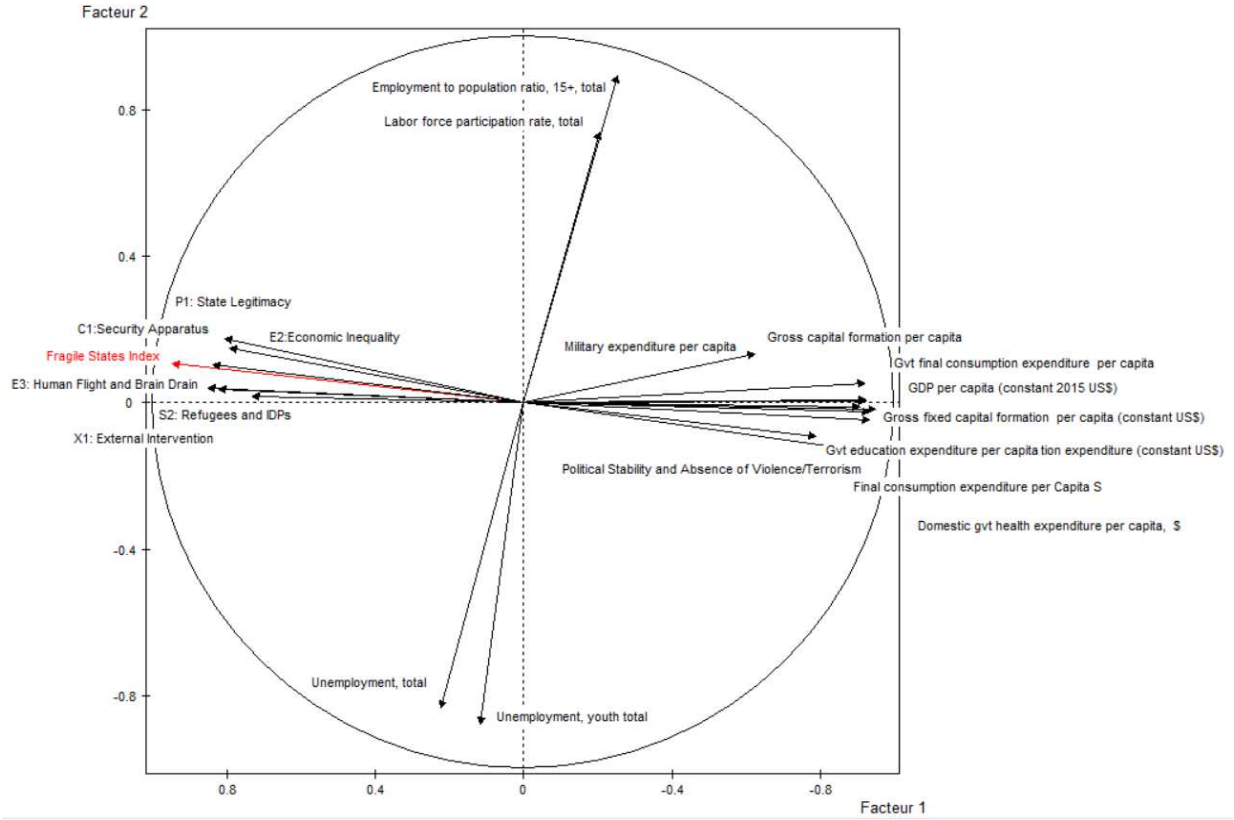


Fig. 2. ***Relationships between variables used to describe countries.***

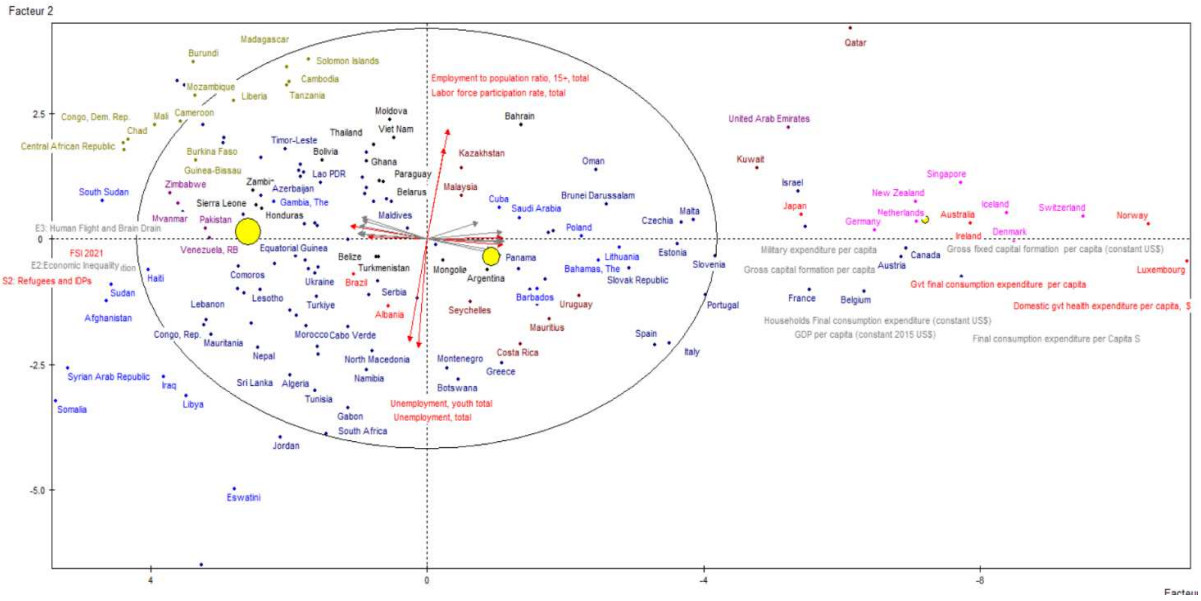


Fig. 3. ***Description of countries in the field of variables.***

Figure 2 presents the results of the dual analysis – variables represented in the space of individuals (countries). This visualization provides the most informative depiction of variables, illustrating both the correlations among them and their contributions to the construction of the factorial axes. For instance, the variables youth unemployment and total unemployment exhibit a strong positive correlation and contribute substantially to the formation of Factorial Axis 2. In general, the larger the graphical representation of a variable, the greater its contribution to the respective factorial axis.

The unemployment - related variables are negatively correlated with employment and labor force participation.

The factor analysis was conducted using SPAD software (version 5.5). Factorial Axis 1 contrasts the Fragile States Index (FSI), Security Apparatus, Economic Inequality, Refugees and IDPs, and similar indicators, with variables such as government expenditure per capita, political stability, and gross capital formation per capita. Factorial Axis 2 is primarily defined by variables related to unemployment and labor force participation.

Figure 3. illustrates the distribution of countries along the main factorial axes. This direct analysis (individuals represented in the space of variables) is complemented by barycentric relationships, enabling the integration of results from both the direct and dual analyses. This approach allows for a clear visualization of countries according to the variables that best characterize them. For example, countries such as Sudan, South Sudan, Somalia, Afghanistan, and the Syrian Arab Republic are marked by high FSI scores (Security Apparatus, Uneven Economic Development, Human Flight and Brain Drain, State Legitimacy, and Refugees and IDPs...). Conversely, countries such as Namibia, Botswana, Montenegro, and Albania are characterized by relatively low FSI scores but comparatively high unemployment rates. Finally, countries including Luxembourg, Norway, Denmark, Ireland, Canada, Australia, Austria, the Netherlands, and Germany exhibit the lowest FSI scores and the highest levels of public expenditure per capita, household consumption per capita, and gross capital formation per capita.

Figure 3 illustrates the distribution of countries according to the magnitude of their Fragile States Index (FSI) and their level of public expenditure. Progressing from left to right, the figure moves from countries exhibiting extremely low levels of public expenditure per capita coupled with very high fragility scores, to those with minimal fragility and substantially higher public spending per capita.

This exploratory analysis reveals that OECD member states—typically classified as developed economies—are generally characterized by high levels of public expenditure, particularly in sectors such as education and health. By contrast, fragile states tend to exhibit both low public spending and low GDP per capita. The analysis further indicates that public expenditure per capita, GDP per capita, gross fixed capital formation per capita, political stability, and household final consumption per capita are strongly and positively correlated. Consequently, one may infer that an increase in public spending within fragile states is likely to foster growth in GDP per capita, gross fixed capital formation per capita, and household final consumption per capita—patterns that are already well-illustrated in developed economies.

Our theoretical framework corroborates this relationship: if governments in fragile states commit to sustained annual increases in public spending, they can expect corresponding year-on-year improvements in per capita output, household consumption, and gross capital formation. Conversely, persistent reductions in public spending are likely to erode household welfare, precipitating deeper poverty in these contexts. In fragile states, a sustained rise in public spending operates analogously to a technological shock, stimulating long-term growth potential. In the subsequent subsection, we calibrate the model's parameters to project per capita growth trajectories across different time horizons for the most fragile states.

4.2 Calibration and forecasting

In this subsection, we estimate the model parameters and predict per capita growth in the most fragile countries after 10, 20 and 30 years. This involves estimating the parameters $P,\ u, d$ and deducing for each

country the growth rate of consumption per capita and output per capita, after T years. We have already seen that, for a specific country, the estimators of P, u and d are respectively:

$$\hat{P} = \frac{1}{T}\sum_{t=1}^{T} \mathrm{I}_{G_t > G_{t-1}} \quad \hat{u} = \frac{\sum_{t=1}^{T} \frac{G_t}{G_{t-1}} \cdot \mathrm{I}_{G_t > G_{t-1}}}{\sum_{t=1}^{T} \mathrm{I}_{G_t > G_{t-1}}} \quad and\ \hat{d} = \frac{\sum_{t=1}^{T} \frac{G_t}{G_{t-1}} \cdot \mathrm{I}_{G_t \leq G_{t-1}}}{\sum_{t=1}^{T} \mathrm{I}_{G_t \leq G_{t-1}}}$$

We have also seen that the expected growth rate of consumption per capita and output per capita, after T years is:

$$E\left(u^{\sum_{j=1}^{T} X_j} \cdot d^{T - \sum_{j=1}^{T} X_j}\right) = [Pu + (1-P)d]^T.$$

Thus, using WDI data on government spending between 2006 and 2021, we calibrate the model' parameters and forecast per capita growth after *T = 10, 20 and 30* years.

***Table 1*: Calibration of parameters and prediction of growth after T years, in the most fragile states.**

		Parameters			Expected growth rate per capita after T years.		
Countries	FSI average	$\hat{P}$	$\hat{u}$	$\hat{d}$	T = 10	T = 20	T = 30
Afghanistan	105.8	69%	1.19	0.73	1.56	2.44	3.81
Burundi	97.1	33%	1.05	0.94	0.78	0.61	0.48
Cameroon	94.4	60%	1.11	0.94	1.49	2.22	3.30
Central African Rep.	106.9	64%	1.06	0.87	0.89	0.80	0.71
Chad	108.6	33%	1.19	0.87	0.80	0.63	0.51
Congo, Dem. Rep.	109.2	47%	1.22	0.82	1.10	1.21	1.32
Ethiopia	98.6	60%	1.10	0.97	1.61	2.60	4.18
Guinea	97.6	60%	1.19	0.85	1.70	2.89	4.91
Haiti	101.4	33%	1.09	0.91	0.72	0.51	0.37
Iraq	102.5	53%	1.29	0.85	2.27	5.14	11.67
Libya	103.1	64%	1.21	0.71	1.33	1.77	2.36
Mali	95.0	73%	1.10	0.85	1.35	1.82	2.46
Mozambique	92.7	73%	1.09	0.94	1.60	2.55	4.08
Myanmar	96.8	40%	1.13	0.88	0.78	0.61	0.48
Niger	95.9	87%	1.11	0.83	2.03	4.13	8.39
Somalia	112.6	35%	1.21	0.84	0.76	0.58	0.44
South Sudan	105.1	54%	1.15	0.77	0.77	0.60	0.46
Sudan	109.7	53%	1.06	0.95	1.10	1.21	1.33
Syria	100.7	33%	1.22	0.93	1.31	1.71	2.24
Uganda	95.4	82%	1.11	0.96	2.20	4.83	10.61
Yemen, Rep.	105.7	20%	1.12	0.92	0.70	0.49	0.34
Zimbabwe	104.2	47%	1.31	0.82	1.58	2.49	3.93

Table 1 estimates the model' parameters for each country and gives the expected growth rate per capita after T years, for the most fragile states between the years 2006 and 2021. The selected countries were chosen based on the average of the Fragile States Index over the past 16 years. Countries such as Nigeria, Pakistan and Eritrea are among the 25 most fragile States, but they were excluded from our study due to the unavailability of macroeconomic data. On average, over the last few years, the most fragile country has been Somalia, with a fragility state index of 112.6 out of 120. In Somalia, the probability that the government increases public spending is estimated at 35%. In the event of a rise, public spending increases by an average of 21% ($\hat{u} = 1.21$). Whereas, in the case of a decline, public spending decreases on average by 16% ($\hat{d} = 0.84$). After

10 years, consumption per capita and output per capita in Somalia will be only 76% of their current levels (2021), a reduction of 24%, all else being equal. Per capita consumption in Somalia will be only 58% of its current level within 20 years, and 44% within 30 years. All else being equal, Yemen and Haiti will experience the largest declines in per capita growth. Per capita consumption in Yemen will be 34% of its current level, and 37% in Haiti, in 30 years.

Similarly, all else being equal, Iraq and Uganda (among the most fragile states) will be the champions of growth over the next 30 years. All else being equal, per capita consumption will increase 11.7 times after 30 years in Iraq and 10.6 times in Uganda. Table 1 presents the statistics, estimated values of the parameters and per capita growth forecasts in each country, after 10, 20 and 30 years. The parameters can be updated after each year, and the per capita growth forecasts adjusted year after year. In the next subsection, we use the VAR model on panel data to understand how a shock to public spending affects households' consumption and output.

4.3 Econometric modeling

In this subsection, we use econometric models to measure the effects of government spending on household consumption and GDP per capita. In Table 2, the dependent variable is GDP per capita. The explanatory variables are: public expenditure on education, public expenditure on health and military expenditure. Table 2 gives the results of the econometrics with panel data, carried out with the software, Eviews 12. Table 2 shows that in the absence of public spending, GDP per capita in average in the most fragile states would be around US$495.4. A one-unit increase in public health expenditure leads, all other things being equal, to an increase in GDP per capita of 2.22. Similarly, an increase in public spending on education by one unit leads, all else being equal, to an increase in GDP per capita of 1.44. The impact of an increase in military spending on GDP per capita is less important. An increase in military spending by one unit, all else being equal, leads to an increase in GDP per capita of 0.6.

Student's statistics and P-Values show that all explanatory variables are significant at the 5% risk threshold. The value of R-squared proves that changes in GDP per capita are explained 98.5% by changes in public spending. This strong and significant link between public expenditure and GDP per capita is consistent with the results of subsection 3.1. The descriptive and exploratory statistics graphically showed a strong positive correlation between public expenditure and GDP per capita. This result is close to that of d'Agostino and al. (2016). Indeed, d'Agostino and al. show that the interactions between corruption and investment and corruption and military spending have strong negative impacts on economic growth. Their results also indicate important complementarities between corruption and military spending, suggesting that combating corruption will not only have direct positive effects, but is also likely to have positive indirect effects, through reducing the size of the negative impact of the military burden. Thus, by adding "corruption" variable in their model, the impact of military spending on growth becomes negative. In this study, military spending has a small and sometimes insignificant impact on growth. Therefore, we removed this variable from the other regression models. Table 3 describes the links between government expenditure and per capita

consumption. The results in Table 3 are similar to those in Table 2 and can be interpreted in the same way. That is, an increase in public expenditure of 1 unit, leads, all things being equal, to an increase in consumption per capita of 1.16; while an increase in health expenditure of 1 unit leads to an increase in consumption per capita of 1.60 units.

Table 2: The effects of public spending on GDP per capita.

Dependent Variable: GDP_PER_CAPITA
Method: Panel EGLS (Cross-section weights)
Sample: 2006 2021
Periods included: 16 Cross-sections included: 18
Total panel (balanced) observations: 288

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GVT_EDUCATION_EXPENDIT_PER_CAPITA	1.443188	0.191804	7.524285	0.0000
GVT_HEALTH_EXPENDIT_PER_CAPITA	2.218311	0.625120	3.548617	0.0027
GVT_MILITARY_EXPENDITURE_PER_CAPITA	0.608205	0.150748	4.034581	0.0010
C	495.4080	48.57551	8.14872	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

Root MSE	510.2715	R-squared	0.985225
Mean dependent var	6111.181	Adjusted R-squared	0.984119
S.D. dependent var	4388.384	S.E. of regression	529.9585
Sum squared resid	74988563	F-statistic	890.2335
Durbin-Watson stat	0.594570	Prob(F-statistic)	0.000000

Table 3: The effects of public spending on Consumption per Capita.

Dependent Variable: HOUSEHOLDS_FINAL_CONSUMPTION_EXPENDITURE_PER_CAPITA
Method: Panel EGLS (Cross-section weights)
Sample: 2006 2021
Periods included: 16 Cross-sections included: 18
Total panel (balanced) observations: 288

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GVT_EDUCATION_EXPENDIT_PER_CAPITA	1.116770	0.122767	9.096663	0.0000
GVT_HEALTH_EXPENDITURE_PER_CAPITA	1.596432	0.374792	4.259515	0.0007
GVT_MILITARY_EXPENDIT_PER_CAPITA	0.494187	0.114151	4.329239	0.0006
C	230.4109	29.29173	7.866073	0.0000

Effects Specification

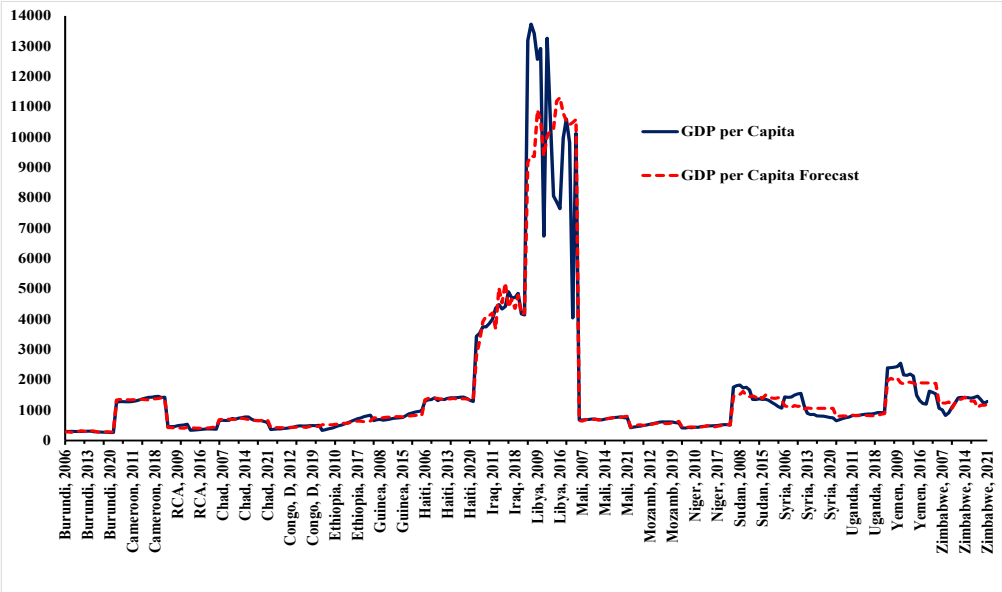
Cross-section fixed (dummy variables)

Weighted Statistics

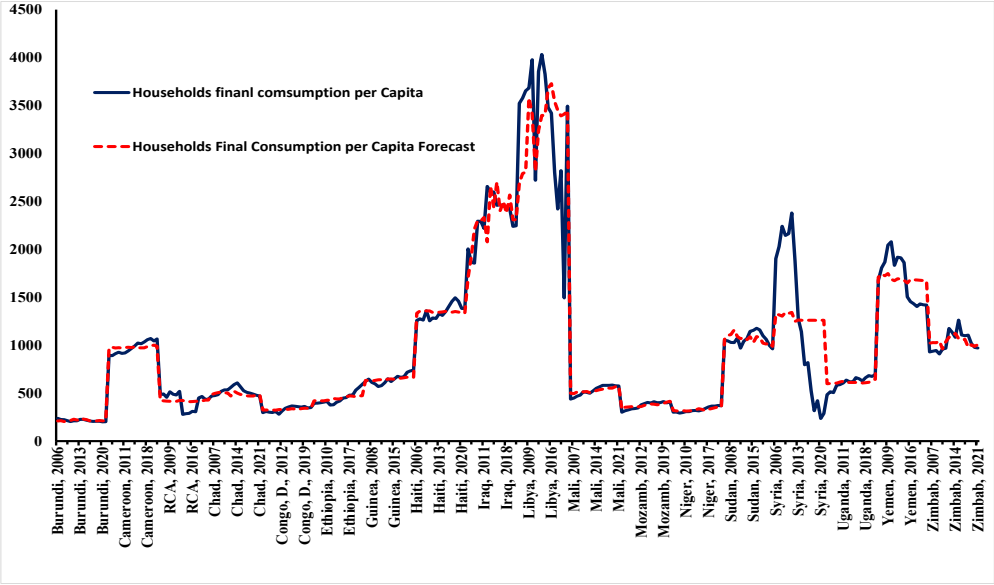
Root MSE	238.1143	R-squared	0.981258
Mean dependent var	2755.732	Adjusted R-squared	0.979854
S.D. dependent var	1291.284	S.E. of regression	247.3012
Sum squared resid	16329149	F-statistic	698.9433
Durbin-Watson stat	0.675404	Prob(F-statistic)	0.000000

Tables 2 and 3 show that there is a multiplier effect of government spending on household consumption and GDP per capita. Indeed, when the government collects taxes and builds new roads, hospitals or schools, then government spending meaningfully increases productivity of households and firms, and stimulates trade, production and consumption.

***Graph 3*: Evolution and prediction of GDP Per Capita in the most fragile states.**



***Graph 4*: Evolution and prediction of Consumption Per Capita in the most fragile states.**



Graph 3 shows the evolution of GDP per capita and its forecast, based on public spending in the most fragile states, between 2006 and 2021. Indeed, we have seen that knowledge of the level of public spending per capita in education, health and in army, makes it possible to predict, quite precisely the level of GDP per capita in fragile states. The highest levels of GDP per capita are observed in Iraq and Libya; while the lowest levels of public spending are observed in Burundi. On the graph 4, we realize that the evolution of household consumption per capita and its forecast based on public expenditure is quite close to the evolution of GDP

per capita. Graphs 3 and 4 are similar, demonstrating once again a close link between government spending, households' consumption and GDP per capita. In the following paragraphs, we use panel data VAR models to inspect the impulse responses of household consumption and GDP per capita to government spending innovations.

Table 4: The results of the VAR model.

Vector Autoregression Estimates
Sample (adjusted): 2007 2021
Included observations: 270 after adjustments
Standard errors in ( ) & t-statistics in [ ]

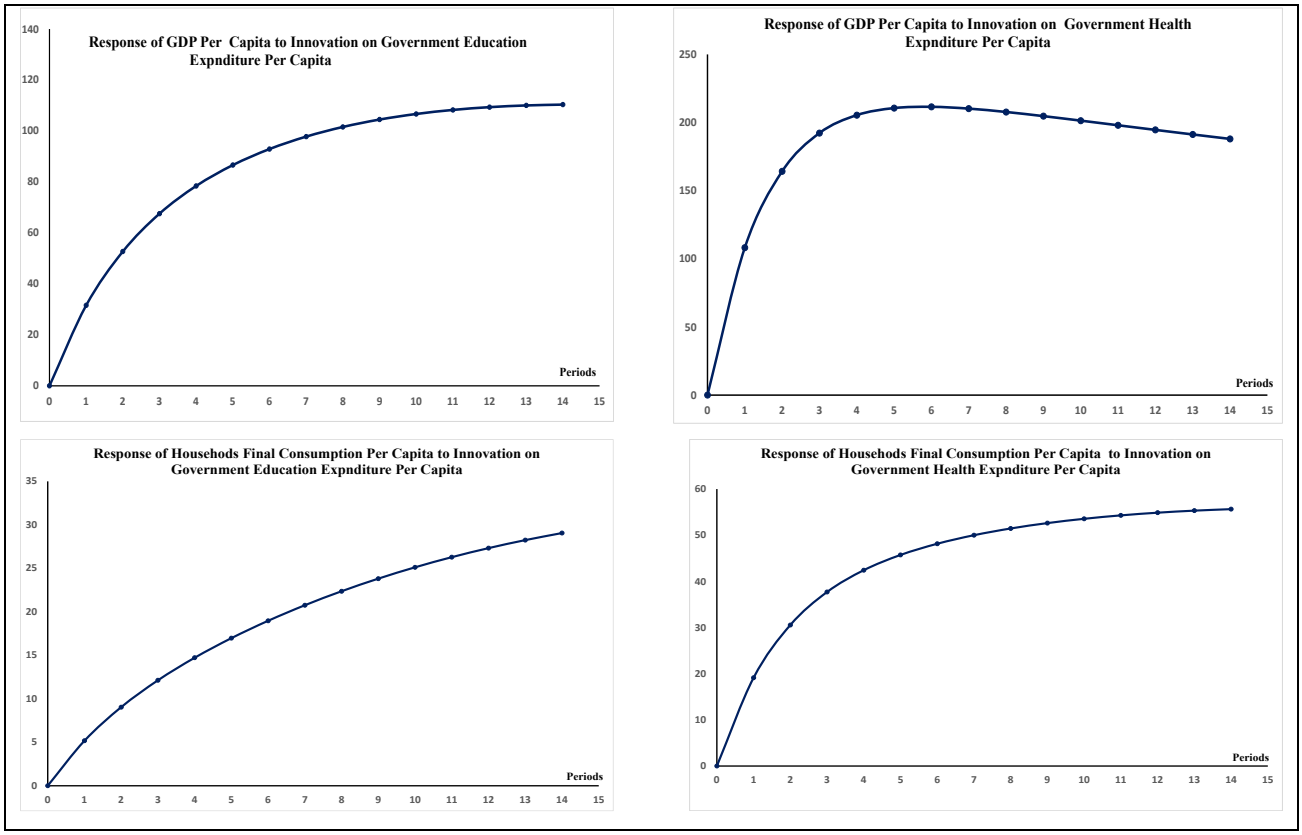
	GVT_EDUCT	GVT_HEALTH	GDP_PER_CAP	CONSUMPT
GVT_EDUCATION_EXPENDITURE_PER_CAPITA(-1)	0.879269	0.442791	0.680743	0.109265
	(0.02727)	(0.20122)	(0.11568)	(0.03155)
	[32.2430]	[2.20053]	[5.88470]	[3.46323]
GVT_HEALTH_EXPENDITURE_PER_CAPITA(-1)	0.670411	0.823702	1.308945	0.761810
	(0.073819)	(0.13786)	(0.48624)	(0.26916)
	[9.081821]	[5.97491]	[2.69197]	[2.83033]
GDP_PER_CAPITA(-1)	0.673451	0.410941	0.865041	0.030421
	(0.31123)	(0.10249)	(0.16478)	(0.00768)
	[2.16384]	[4.00957]	[5.24967]	[3.96094]
HOUSEHOLDS_FINAL_CONSUMPTION_PER_CAPITA(-1)	0.732959	0.26742	0.196083	0.934828
	(0.36381)	(0.05510)	(0.03282)	(0.16625)
	[2.01468]	[4.85336]	[5.97449]	[5.62303]
C	242.7965	35.9894	117.5014	56.57801
	(92.4113)	(11.1351)	(9.85788)	(22.2911)
	[2.627355]	[3.23203]	[11.9196]	[2.53814]
R-squared	0.888803	0.951347	0.897583	0.938089
Adj. R-squared	0.887124	0.950613	0.896037	0.937155
Sum sq. resids	3.50E+09	223384.1	1.52E+08	11292252
S.E. equation	3633.930	29.03376	756.3878	206.4274
F-statistic	529.5389	1295.432	580.6172	1003.843

Table 4 gives the results of the VAR model, and the last two columns of this table are particularly interesting for your analysis. In Table 4, the first row of the 3-digit blocks gives regressions' coefficients. The second rows of numbers in parentheses are the standard deviations of regressions' coefficients. The third rows of numbers in the brackets are Students' statistics associated with coefficients. The independent variables are all lagged by one period. In the different regressions in Table 4, all Student' statistics are significant at the 5% risk threshold. In the penultimate column of Table 4, it is shown that, if government spending on education increases by one unit in a given year, then, GDP per capita will increase by 0.68 units the following year, all else being equal. Similarly, an increase in public health expenditure of 1 unit in a given year, will increase GDP per capita by 1.3 in the following year, all else being equal. All others regression coefficients can be read and understood in the same way. The results of our regressions are similar to that of Adegboye and Akinyele (2022), which validate government spending as an input factor to achieve growing human development in Africa. Their result shows that the level of government spending efficiency depends on the

size of the economy and other factors. According to Adegboye and Akinyele natural resources could be used to address the burgeon government spending efficiency when effectively utilized.

Vector autoregression (VAR) models are widely used in financial and economic analysis. They are highly useful for forecasting future values of variables within a system. Impulse response analysis is an appreciated method for interpreting VAR models. It enables us to inspect how shocks or innovations to one variable affect a whole system over time. VAR models also allow to assess dynamic interactions within a system and provide information on short and long-term effects, identifying potential interdependencies. Graph 5 shows the impulse responses of household consumption and GDP per capita to public spending shocks.

<u>Graph 5</u>: Impulse Response of Households consumption and GDP Per Capita to Innovations on Government Health and Education Expenditure



The first graph at the top left shows that, an innovation of 100 units in government public spending on education, induces an increase in GDP per capita of 31.6 units after 1 year, 52.6 after two years, 67.6[4] in the third year, etc. The increases in GDP per capita progress from year to year, to stabilize around 109 after 15 years (periods). Shocks to government public spending on education and health have effects GDP per capita in both the short and long run. Similarly, the second graph at the top right of the box above shows that an innovation of 100 units in public health expenditure induces a strong increase in GDP per capita, of 108.2

[4] These numbers can be read in Tables 5 and 6, in the appendix to this work. These tables give details on the impulse responses to shocks on public spending.

after the first year, 164.2 after two years, 192.3 after 3 years, etc. GDP per capita increases to 207.7 units after 9 years, then it gradually decreases.

Our results differ somewhat from those of Cimadomo et al. (2011). Cimadomo and al. identify the effects of government spending shocks with and without expected reversal. Based on a structural VAR analysis, their results suggest that shocks associated with an expected spending reversal exert expansionary effects on the economy. Shocks associated with expected spending growth above trend, instead, are characterized by a contraction in aggregate demand. Unlike Cimadomo et al., our study does not focus on aggregate demand. Our study focuses on the effects of government spending on household consumption and production.

On the graphs below in the box, we observe that the effects of innovations on public spending induce weaker effects on households' consumption. An innovation of 100 units in public spending on education, slightly and gradually increases household consumption; per capita household consumption increases by 5 units after one year, to reach 29 units after 15 years. Similarly, an innovation of 100 units in public spending on health slightly and gradually increases household consumption; household consumption per capita increases by 19 units after one year, reaching 56 units after 15 years. Appended to this work are longer series of impulse responses to innovations. Thus, we have seen through exploratory statistics, parameter calibration, and the use of Vector autoregression (VAR) models that the increase in public spending has a positive and significant impact on the increase in household consumption and on the increase in GDP per capita.

5. Limitations and Future Research

While this paper provides both theoretical and empirical evidence on the role of public expenditure shocks in shaping economic growth and household welfare in fragile states, several limitations should be acknowledged.

First, the theoretical framework relies on a number of simplifying assumptions that facilitate analytical tractability but may not fully capture the complexity of fragile economies. Public expenditure shocks are modeled as a Bernoulli process characterized by two possible outcomes—an increase or a decrease in government spending. Although this specification effectively captures fiscal uncertainty, actual fiscal dynamics are often more complex and may involve multiple sources of volatility, including political transitions, armed conflicts, external debt pressures, fluctuations in commodity prices, climate-related disasters, and sudden variations in foreign aid inflows. Future research could extend the model by introducing richer stochastic processes and allowing for heterogeneous public spending shocks of varying magnitudes.

Second, the model assumes a small closed economy and abstracts from international trade, foreign direct investment, migration flows, external borrowing, and financial integration. Such an assumption is useful for highlighting the direct transmission mechanisms linking public expenditure to growth and welfare. However, contemporary fragile states operate within an increasingly interconnected global economy. Their fiscal capacity and development prospects are often influenced by international aid, remittances, global commodity

markets, multinational corporations, and geopolitical realignments. Future studies could therefore incorporate external-sector dynamics and investigate how globalization modifies the effectiveness of public expenditure policies.

Third, the empirical analysis focuses primarily on public expenditure variables and does not explicitly account for institutional quality, governance effectiveness, corruption, state legitimacy, or political stability beyond the indicators included in the Fragile States Index. Yet the impact of public spending on development outcomes depends not only on the quantity of expenditure but also on the quality of institutions responsible for allocating and implementing public resources. Future research could combine fiscal variables with measures of governance, transparency, public sector efficiency, and institutional resilience in order to better understand the conditions under which public expenditure generates sustainable growth.

Another limitation concerns the calibration procedure. The estimation of the parameters governing public expenditure dynamics is based on historical expenditure patterns observed between 2006 and 2021. Consequently, long-term projections assume a degree of continuity in fiscal behavior that may not hold in the future. The contemporary globalization process is undergoing profound transformations driven by technological innovation, climate change, geopolitical tensions, energy transitions, and the reorganization of global value chains. These structural changes may significantly alter the future trajectory of fragile states and affect the predictive accuracy of calibrated growth forecasts.

The panel regression and VAR analyses provide valuable insights into the dynamic effects of public spending shocks; however, they remain subject to the limitations commonly associated with macroeconomic panel datasets. Data availability and quality remain important challenges in fragile states, where statistical systems are often weak and economic information is frequently incomplete. Moreover, while VAR models capture dynamic interactions among variables, they cannot fully identify all causal mechanisms linking public expenditure, productivity, and welfare outcomes.

The ongoing transformation of globalization opens several promising avenues for future research. One important direction would be to examine how digital technologies, artificial intelligence, digital public infrastructure, and technological diffusion influence the relationship between public expenditure and economic growth in fragile states. Public investment in digital infrastructure may increasingly become a key determinant of competitiveness and development in the twenty-first century.

A second avenue concerns the interaction between public expenditure and climate resilience. Fragile states are often disproportionately exposed to environmental shocks, including droughts, floods, desertification, and food insecurity. Future studies could investigate whether investments in climate adaptation, renewable energy, sustainable agriculture, and environmental protection generate long-term growth dividends while simultaneously reducing vulnerability.

A third area for future investigation relates to changing global power structures and the emergence of new development partners. The growing economic influence of emerging economies, the expansion of South-South cooperation, and the diversification of international financing sources may create new opportunities and challenges for fragile states. Understanding how these transformations affect fiscal capacity, public investment strategies, and development outcomes remains an important research priority.

Finally, future work could extend the present framework by developing dynamic stochastic general equilibrium (DSGE) models with open-economy features, endogenous technological change, institutional heterogeneity, and climate-related risks. Such extensions would provide a richer understanding of how fragile states can strengthen economic resilience and pursue sustainable development in a rapidly evolving global environment.

Despite these limitations, the present study contributes to the literature by demonstrating that stable and sustained public expenditure remains a fundamental driver of economic growth and poverty reduction in fragile states. In an era characterized by profound transformations in globalization, technological change, and global governance, strengthening fiscal capacity and maintaining productive public investment appear more important than ever for promoting inclusive and sustainable development.

Conclusion

This Paper shed light on the sources of growth (or decline) and technological progress in fragile States. It analyzed the dynamics of fragile states in the context of a global economy undergoing profound transformation driven by technological change, sustainability pressures. The paper examined how shocks to public expenditure—reflecting institutional fragility and limited fiscal capacity—affect private sector output, household welfare, and long-term economic growth in economies weakly integrated into global value chains.

Public spending shocks was modeled as stochastic events governed by a Bernoulli process, initially affecting government expenditure and subsequently propagating throughout the entire economy. The theoretical framework is grounded in a dynamic general equilibrium model in which public expenditure plays a central role in sustaining aggregate demand, shaping technological progress or backwardness, and fostering productivity growth. The analysis demonstrated that persistent reductions in public spending generate cumulative declines in per capita consumption and output, thereby weakening household resilience and constraining sustainable development.

The empirical approach combined descriptive statistical analyses, parameter calibration, and vector autoregression models to assess growth dynamics across multiple time horizons. The results indicated that increases in public expenditure had a positive and statistically significant effect on household consumption and GDP per capita. From a policy perspective, the paper emphasized the importance of stable, predictable,

and strategically targeted public spending frameworks in fragile states. Such frameworks would strengthen economic resilience, support inclusive growth, and enhance the capacity of these states to pursue the Sustainable Development Goals, particularly those related to poverty reduction, economic growth, and the reduction of inequalities, while mitigating structural power asymmetries in the global economy.

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