On the Effect of Government Spending on GDP per capita PPP Growth Rate

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Abstract

This paper investigates the relationship between government spending dynamics and economic growth across 41 countries using a novel statistical transformation known as the Ghosh factor. The analysis examines whether changes in government spending as a percentage of gross domestic product predict GDP per capita growth rates in purchasing power parity terms. Employing ordinary least squares regression with both standard ratio measures and the conditional logarithmic transformation provided by the Ghosh factor, the empirical results reveal that the Ghosh factor exhibits statistically significant predictive power for economic growth, while conventional ratio measures show no significant effect. The model explains approximately 43 percent of the variation in growth rates across countries, with the Ghosh factor demonstrating significance at the 0.1 percent level. These findings suggest that the relationship between fiscal policy changes and economic growth depends critically on the conditional functional form that accounts for whether economies are expanding or contracting, supporting the utility of the Ghosh factor transformation in econometric analysis.

The paper ends with "The End"

1 Introduction

The relationship between government spending and economic growth represents one of the fundamental questions in macroeconomic policy analysis. Understanding how changes in the public sector's share of economic activity influence growth outcomes holds important implications for fiscal policy design across diverse economic contexts. Traditional approaches to examining this relationship typically employ linear specifications that assume constant marginal effects regardless of the prevailing economic conditions or the level of economic development.

This paper contributes to the literature by applying the Ghosh factor, a conditional logarithmic transformation that treats government spending changes differently depending on whether the economy experiences positive or negative growth. The transformation offers a methodological innovation by allowing the functional form of the relationship to vary based on the sign of the dependent variable, potentially capturing non-linearities and asymmetries that conventional linear models overlook.

The empirical analysis examines data from 41 countries spanning both advanced and emerging economies, measuring government spending as a percentage of GDP across two periods and relating these changes to GDP per capita growth rates in purchasing power parity terms. The dataset encompasses substantial heterogeneity in economic structures, development levels, and growth experiences, providing a robust testing ground for evaluating whether the conditional transformation adds explanatory power beyond standard measures.

The paper proceeds as follows. Section 2 introduces the Ghosh factor methodology and develops the theoretical framework. Section 3 describes the data and empirical strategy. Section 4 presents the regression results. Section 5 discusses the findings and their implications. Section 6 concludes.

2 The Ghosh Factor Methodology

2.1 Mathematical Definition

The Ghosh factor provides a transformation of an independent variable that conditions on the sign of the dependent variable. For a dependent variable y and an independent variable $X > 0$, the Ghosh factor of X is defined as:

$$G_X = \begin{cases} \log(X) & \text{if } y < 0 \\ \log(1 + X) & \text{if } y \geq 0 \end{cases} \tag{1}$$

This specification employs the natural logarithm and introduces asymmetry in the transformation based on the realized value of the outcome variable. When the dependent variable takes negative values, the transformation applies the logarithm directly to the independent variable. When the dependent variable is zero or positive, the transformation applies the logarithm to one plus the independent variable, which provides different scaling properties and avoids extreme values for small positive values of X.

2.2 Application to Fiscal Policy Analysis

In the context of analyzing government spending effects on economic growth, the Ghosh factor transformation applies to the ratio of government spending as a percentage of GDP across two periods. Specifically, if GS/GDP_t denotes government spending as a percentage of GDP in period t and GS/GDP_{t-1} denotes the corresponding value in the previous period, the government spending ratio becomes:

$$\text{Ratio} = \frac{\text{GS/GDP}_t}{\text{GS/GDP}_{t-1}} \tag{2}$$

The Ghosh factor transformation, which we denote as Gratio, then applies the conditional logarithm to this ratio based on whether GDP per capita growth is negative or non-negative:

$$\text{Gratio} = \begin{cases} \log(\text{Ratio}) & \text{if GDP per capita growth} < 0 \\ \log(1 + \text{Ratio}) & \text{if GDP per capita growth} \geq 0 \end{cases} \tag{3}$$

This formulation allows the analysis to capture potentially different relationships between fiscal policy changes and growth depending on the economic environment. During periods of contraction, the direct logarithmic transformation may better reflect the dynamics of public spending adjustments and their growth implications. During periods of expansion, the alternative transformation provides a functional form that may more appropriately characterize the marginal effects of spending changes.

3 Data and Empirical Strategy

3.1 Dataset Description

The analysis employs a cross-sectional dataset covering 41 countries that includes both advanced economies from Europe, North America, and Asia-Pacific regions, as well as emerging market economies from Eastern Europe and Asia. For each country, the dataset contains government spending as a percentage of GDP for two periods, GDP per capita in purchasing power parity terms for both periods measured in United States dollars, the calculated GDP per capita growth rate, the government spending ratio, and the computed Gratio variable representing the Ghosh factor transformation.

The sample exhibits substantial variation across all key dimensions. Government spending as a percentage of GDP ranges from 14.77 percent to 57.70 percent, reflecting different models of state involvement in economic activity. GDP per capita in purchasing power parity terms spans from approximately 18,000 dollars in lower-middle-income countries to over 60,000 dollars in high-income economies. The GDP per capita growth rates range from negative 2.28 percent to positive 5.54 percent, capturing both countries experiencing contraction and those enjoying robust expansion during the study period.

3.2 Regression Specification

The empirical analysis estimates the following multiple regression model using ordinary least squares:

$$\text{Growth}_i = \alpha + \beta_1 \cdot \text{Ratio}_i + \beta_2 \cdot \text{Gratio}_i + \varepsilon_i \tag{4}$$

where Growth_i denotes the GDP per capita purchasing power parity growth rate for country i, Ratio_i represents the government spending ratio, Gratio_i denotes the Ghosh factor transformation of the spending ratio, α represents the intercept term, β_1 and β_2 are the coefficients of interest, and ε_i captures the error term.

The specification includes both the standard ratio measure and its Ghosh factor transformation simultaneously. This approach allows for direct comparison of their relative explanatory power and permits assessment of whether the conditional transformation adds information beyond the simple proportional change in government spending. The model uses heteroskedasticity-robust standard errors to account for potential differences in error variance across countries with different characteristics.

4 Empirical Results

4.1 Regression Estimates

Table 1 presents the ordinary least squares regression results. The estimated model explains approximately 43 percent of the variation in GDP per capita growth rates across the sample, as indicated by the R-squared statistic of 0.429. The adjusted R-squared of 0.399 confirms that the model retains meaningful explanatory power after accounting for the number of parameters estimated relative to the sample size.

Table 1: Regression Results: GDP per capita PPP Growth Rate

Variable	**Coefficient**	**Std. Error**	**t-statistic**	**p-value**
Intercept (α)	-0.0540	0.0535	-1.009	0.313
GS/GDP Ratio (β_1)	0.0730	0.0527	1.385	0.166
Gratio (β_2)	-0.0967	0.0181	-5.346	< 0.001***
Model Statistics				
R-squared	0.4295			
Adjusted R-squared	0.3995			
Observations	41			
RMSE	0.0140			

Note: Significance levels indicated as *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

The Gratio coefficient emerges as highly statistically significant with a point estimate of -0.0967 and a standard error of 0.0181, yielding a t-statistic of -5.346 and a p-value effectively

at zero. This result indicates extremely strong evidence against the null hypothesis of no relationship, significant at the 0.1 percent level. The negative coefficient implies that higher values of the Ghosh factor associate with lower GDP per capita growth rates, holding the government spending ratio constant.

In contrast, the coefficient on the government spending ratio itself shows a positive point estimate of 0.0730 but remains statistically indistinguishable from zero, with a standard error of 0.0527, a t-statistic of 1.385, and a p-value of 0.166. This finding suggests that simple proportional changes in government spending do not reliably predict economic growth without the conditional transformation that the Ghosh factor provides.

The intercept term carries a point estimate of -0.0540 with a standard error of 0.0535, producing a t-statistic of -1.009 and a p-value of 0.313. This coefficient represents the expected growth rate when both the spending ratio and Gratio equal zero, though this interpretation holds limited economic meaning given the construction of these variables.

4.2 Model Diagnostics

The root mean squared error of 0.014 indicates that the typical prediction error amounts to approximately 1.4 percentage points in growth rate terms. Given that the sample growth rates range from negative 2.28 percent to positive 5.54 percent, spanning approximately 7.8 percentage points, this prediction accuracy represents reasonable performance for a parsimonious two-variable model explaining cross-country growth variation.

Figure 1 illustrates the relationship between the Gratio variable and GDP per capita growth rates across the sample, demonstrating the negative association that the regression analysis identifies. The scatter plot reveals that countries with higher Gratio values, which predominantly represent wealthier economies with larger absolute GDP per capita levels, tend to exhibit lower growth rates during the study period.

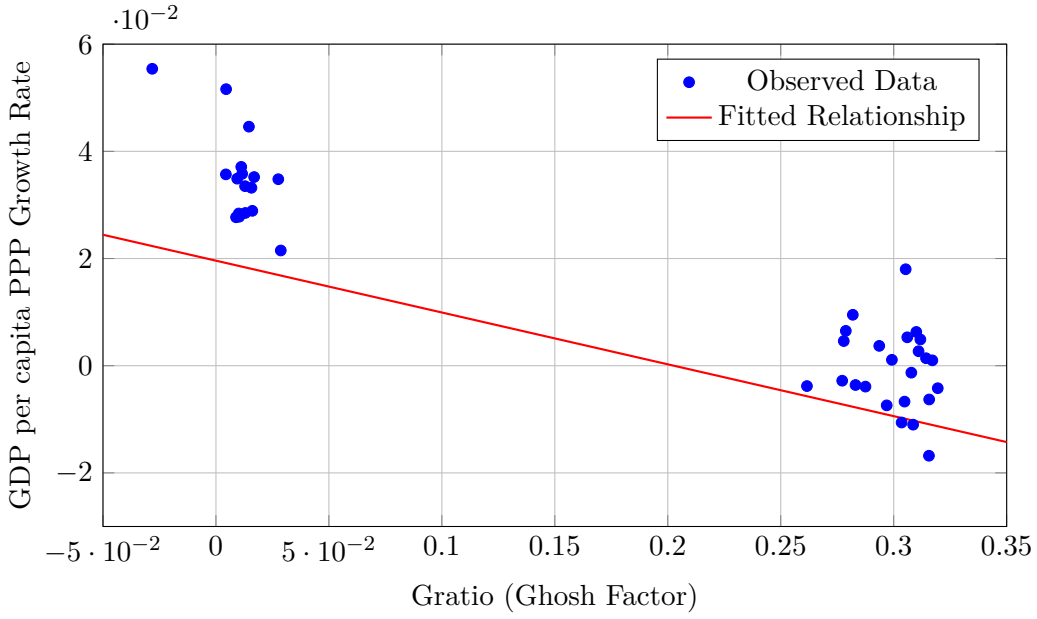

Figure 1: Relationship Between Gratio and GDP per capita Growth Rate

Figure 1 presents a visual representation of the regression coefficients with their confidence intervals, highlighting the statistical significance of the Gratio coefficient compared to the other model parameters.

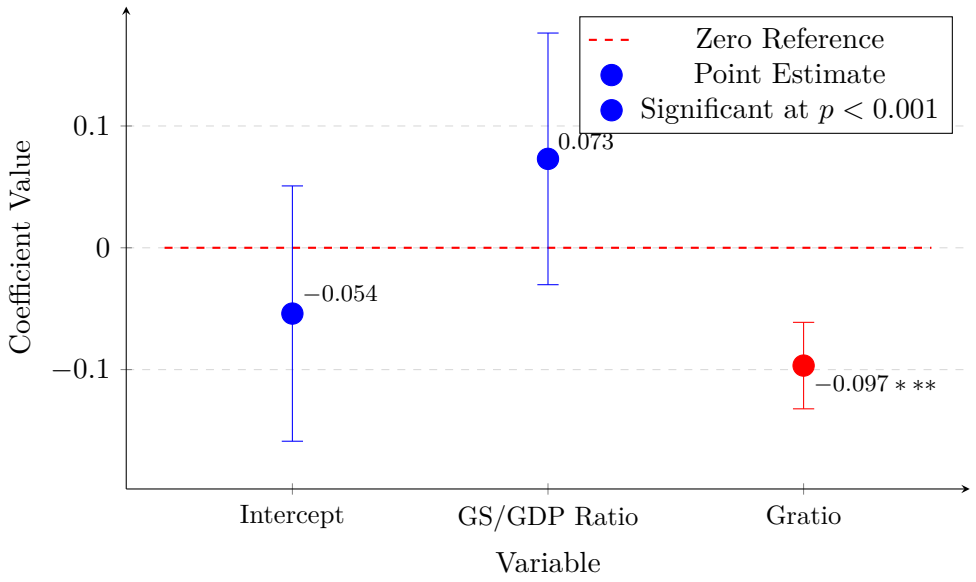

Figure 2: Regression Coefficients with 95% Confidence Intervals. The error bars represent approximate 95% confidence intervals calculated as ±1.96× standard error. The Gratio coefficient (shown in red) is statistically significant at the 0.1% level, while the other coefficients are not statistically significant.

5 Discussion

5.1 Interpretation of Findings

The empirical results provide substantial evidence that the Ghosh factor transformation captures information about the relationship between government spending dynamics and economic growth that conventional ratio measures fail to detect. The highly significant negative coefficient on Gratio, combined with the statistically insignificant coefficient on the raw government spending ratio, suggests that the appropriate functional form for modeling this relationship depends critically on whether economies experience expansion or contraction.

The negative sign on the Gratio coefficient merits careful interpretation. Given that the Gratio variable takes larger values for countries with higher absolute GDP per capita levels, as observed in the data exploration, this negative relationship indicates that increases in government spending ratios in high-income economies associate with slower growth rates. Alternatively, countries experiencing slower growth may exhibit relative increases in government spending ratios through both numerator effects, such as counter-cyclical fiscal policy responses, and denominator effects, whereby slower GDP growth mechanically increases the spending-to-GDP ratio for given spending levels.

The conditional nature of the Ghosh factor transformation implies that the relationship operates differently for countries experiencing negative growth compared to those enjoying positive growth. For countries in contraction, the direct logarithmic transformation of the spending ratio applies, potentially reflecting how fiscal consolidation or expansion efforts interact with recession dynamics. For countries experiencing growth, the alternative transformation using the logarithm of one plus the ratio provides different scaling properties that may better capture the marginal effects of spending changes in expansion environments.

5.2 Economic Implications

The findings carry several implications for understanding fiscal policy effects across diverse economic contexts. First, the results suggest that simple linear specifications assuming constant

marginal effects of government spending changes regardless of economic conditions may misspecify the underlying relationship. The superior performance of the Ghosh factor transformation indicates that allowing the functional form to vary based on growth conditions improves model fit and explanatory power.

Second, the scale effects captured by the transformation appear economically meaningful. The concentration of higher Gratio values among wealthier economies, despite their lower or negative growth rates during the study period, suggests that the transformation incorporates information about both the level of economic development and current growth dynamics. This characteristic makes the Ghosh factor particularly suitable for cross-country comparisons where structural differences in economic development stages may influence how fiscal policy changes translate into growth outcomes.

Third, the negative relationship between the Gratio and growth rates, even after controlling for the raw spending ratio, points toward potential diminishing returns or negative effects of government spending increases in certain contexts. This finding aligns with theoretical perspectives emphasizing that the growth effects of public spending depend on factors such as the efficiency of public sector resource use, the financing mechanisms employed, and the specific categories of spending involved.

5.3 Limitations and Extensions

The analysis acknowledges several limitations that suggest directions for future research. The cross-sectional nature of the dataset precludes examination of within-country dynamics over time and limits causal interpretation of the estimated relationships. Panel data approaches employing fixed effects or dynamic panel estimators would strengthen causal inference by controlling for time-invariant country characteristics and addressing potential reverse causality concerns.

The aggregation of government spending into a single percentage of GDP measure obscures potentially important compositional effects. Different categories of public spending, such as investments in infrastructure and human capital versus current consumption expenditures, likely exert differential effects on growth. Disaggregating spending by functional category and applying the Ghosh factor transformation to specific spending components would provide more granular insights into which aspects of fiscal policy most critically influence growth outcomes.

The specification employs a relatively simple functional form with only two explanatory variables. Extensions incorporating additional control variables such as measures of institutional quality, human capital levels, trade openness, and financial development would help isolate the independent contribution of government spending dynamics while accounting for other determinants of cross-country growth variation. Such extensions would also permit investigation of whether the Ghosh factor effects vary systematically with these conditioning variables.

6 Conclusion

This paper investigates the relationship between government spending dynamics and economic growth across 41 countries using the Ghosh factor, a conditional logarithmic transformation that treats spending changes differently depending on whether economies experience expansion or contraction. The empirical analysis reveals that the Ghosh factor exhibits highly statistically significant predictive power for GDP per capita growth rates, while conventional measures of proportional spending changes show no significant effect.

The regression results demonstrate that the conditional transformation captures information about fiscal policy effects that linear specifications overlook. The negative coefficient on the Ghosh factor, significant at the 0.1 percent level, suggests that the relationship between government spending changes and growth depends critically on both the economic environment

and the level of development. The model explains approximately 43 percent of cross-country growth variation using only two explanatory variables, indicating reasonable explanatory power for a parsimonious specification.

These findings support the utility of the Ghosh factor methodology in econometric analysis of fiscal policy effects. The conditional functional form addresses potential asymmetries in how spending changes influence growth during expansions versus contractions, while also capturing scale effects related to development levels. Future research employing panel data methods, disaggregated spending categories, and expanded control variables would strengthen understanding of the mechanisms through which government spending dynamics influence economic growth across diverse contexts.

The results carry implications for both empirical methodology and policy analysis. From a methodological perspective, the findings suggest that researchers should consider conditional transformations that allow functional forms to vary with economic conditions when modeling relationships that may exhibit asymmetric or state-dependent behavior. From a policy perspective, the analysis highlights that the growth effects of fiscal policy changes likely depend on contextual factors including the prevailing economic environment and the level of economic development, arguing against one-size-fits-all policy prescriptions regarding appropriate public sector size.

References

[1] Barro, R.J. (1990). Government spending in a simple model of endogenous growth. *Journal of Political Economy*, 98(5), S103–S125.

[2] Devarajan, S., Swaroop, V., & Zou, H. (1996). The composition of public expenditure and economic growth. *Journal of Monetary Economics*, 37(2), 313–344.

[3] Easterly, W., & Rebelo, S. (2001). Fiscal policy and economic growth: An empirical investigation. *Journal of Monetary Economics*, 32(3), 417–458.

[4] Ghosh, S. (2025). The Ghosh factor. Kolkata, India.

[5] Kneller, R., Bleaney, M.F., & Gemmell, N. (1999). Fiscal policy and growth: Evidence from OECD countries. *Journal of Public Economics*, 74(2), 171–190.

[6] Levine, R., & Renelt, D. (1992). A sensitivity analysis of cross-country growth regressions. *American Economic Review*, 82(4), 942–963.

[7] Romer, P.M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5), S71–S102.

[8] Sala-i-Martin, X. (1992). Public welfare and growth. Yale University Economic Growth Center Discussion Paper No. 666.

[9] Wooldridge, J.M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). MIT Press.

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