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# Public Expenditure and Regional Economic Growth: The Conditioning Role of Labor Intensity in Vietnam

**Anh Tuan Ngo [1], Minh Tuan Cao [2*], Bich Ngan Nguyen [2], Hong Phat Pham [1], Hoang Khanh Vy Tran [1]**

**[1]Can Tho University of Technology, Can Tho City, Vietnam;**

**[2]School of Economics, Can Tho University, Can Tho City, Vietnam;**

* Corresponding author: cmtuan@ctu.edu.vn

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**Abstract:** The relationship between public expenditure and economic growth may vary depending on expenditure composition and regional productive conditions. This study examines the conditioning role of labor intensity in the relationship between public expenditure and regional economic growth in Ca Mau Province, Vietnam. Using annual data from 2007 to 2024, the study employs the autoregressive distributed lag (ARDL) bounds-testing approach to examine short- and long-run relationships. Regional economic growth is measured by the annual growth rate of gross regional domestic product (GRDP), while labor intensity is measured as the number of workers per billion VND of real GRDP. Government consumption and government investment are expressed as shares of GRDP. Interaction terms are included to assess how labor intensity conditions the relationship between each expenditure category and regional economic growth. The bounds test provides evidence of a long-run relationship among the variables. In the short run, most estimated coefficients are not statistically significant, while the interaction between government consumption and labor intensity is negative and statistically significant only at the 10% level. In the long run, this interaction is negative and statistically significant at the 5% level, indicating that the estimated marginal relationship between government consumption and regional economic growth weakens as labor intensity increases. In contrast, the interaction between government investment and labor intensity is not statistically significant. Given

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the small sample of 18 annual observations and the use of GRDP to construct labor intensity, the findings should be interpreted as exploratory associations rather than causal effects. The results suggest that regional fiscal planning should consider both expenditure composition and local productive conditions.

**Keywords:** labor intensity; public expenditure; regional economic growth; government consumption; government investment; ARDL model.

# 公共支出与区域经济增长：劳动力密集度在越南的调节作用

**摘要**：公共支出与经济增长之间的关系可能因支出结构和区域生产条件的不同而存在差异。本研究以越南金瓯省为研究对象，考察劳动力密集度在公共支出与区域经济增长关系中的调节作用。基于2007年至2024年的年度数据，采用自回归分布滞后（ARDL）边界检验方法，分析变量之间的短期和长期关系。区域经济增长以地区生产总值（GRDP）的年度增长率衡量，劳动力密集度以每十亿越南盾实际地区生产总值对应的劳动者人数衡量。政府消费支出和政府投资支出均以其占地区生产总值的比重表示。研究通过引入交互项，检验劳动力密集度如何调节不同类型公共支出与区域经济增长之间的关系。边界检验结果表明，变量之间存在长期关系的统计证据。短期内，大多数估计系数在统计上不显著，而政府消费支出与劳动力密集度的交互项系数为负，且仅在10%的显著性水平上具有统计显著性。长期来看，该交互项系数为负，并在5%的显著性水平上具有统计显著性，表明随着劳动力密集度的提高，政府消费支出与区域经济增长之间的估计边际关系逐渐减弱。相比之下，政府投资支出与劳动力密集度的交互项系数在统计上不显著。鉴于研究样本仅包含18个年度观测值，且劳动力密集度指标的构建使用了地区生产总值，研究结果应被解释为探索性的统计关联，而非因果效应。研究结果表明，区域财政规划应综合考虑公共支出结构和当地生产条件。

**关键词**：劳动力密集度；公共支出；区域经济增长；政府消费支出；政府投资支出；自回归分布滞后（ARDL）模型。

## 1. Introduction

Public expenditure is an important policy instrument through which governments provide infrastructure, public services, and other inputs that support economic activity and long-term development [1,2]. However, its relationship with economic growth may vary across regions due to differences in economic structure, labor conditions, institutional quality, and productive capacity. Labor intensity, measured as the number of workers relative to real output, represents one aspect of these regional productive conditions. Examining its potential conditioning role may therefore provide a more context-sensitive understanding of regional fiscal–growth relationships.

Previous studies have shown that the relationship between public expenditure and economic growth varies across expenditure categories and socioeconomic contexts [1,2]. Evidence from Vietnam highlights the relevance of expenditure composition, economic governance, and institutional quality at the provincial level [3,4]. International studies also document heterogeneous relationships across policy contexts and time horizons [5,6]. However, less attention has been paid to whether labor intensity conditions the short- and long-run relationships between different categories of public expenditure and regional economic growth, particularly at the provincial level in developing economies.

Vietnam provides a relevant setting for examining this issue because its regions differ in economic structure, labor market conditions, migration patterns, and human capital. These differences are particularly salient in the Mekong Delta, where labor migration and constraints on skills and human capital development are important regional development challenges [7]. Ca Mau Province offers a useful case because its economy encompasses agriculture, forestry, and fisheries; industry and construction; and services [8]. This setting

provides a basis for examining how labor intensity conditions the relationship between public expenditure and regional economic growth at the provincial level.

Against this background, this study examines whether labor intensity conditions the relationships between government consumption, government investment, and regional economic growth in Ca Mau Province during 2007–2024. Labor intensity is measured as the number of workers per billion VND of real GRDP, reflecting labor use relative to real output rather than labor quality. The analysis includes separate interaction terms between labor intensity and each expenditure category and employs an autoregressive distributed lag (ARDL) bounds-testing approach to examine short- and long-run relationships [9].

The study makes two contributions. First, it extends the analysis of regional fiscal–growth relationships by examining labor intensity as a potential conditioning factor, complementing existing research on institutional and governance factors. Second, it provides exploratory evidence from a Vietnamese provincial time series by distinguishing between expenditure categories and short- and long-run relationships. Together, these contributions highlight the relevance of regional productive conditions in examining the relationship between public expenditure and economic growth.

The results indicate a negative and statistically significant long-run interaction between government consumption and labor intensity, whereas the corresponding interaction for government investment is not statistically significant. In the short run, the interaction between government consumption and labor intensity is significant only at the 10% level. Given the small number of annual observations, the findings are interpreted as exploratory associations rather than causal effects. The results suggest that regional fiscal planning should consider both expenditure composition and local productive conditions.

# 2. Conceptual Framework

## 2.1. Public Expenditure and Regional Economic Growth

Public expenditure can influence economic activity through both demand-side and supply-side channels. In the short run, government spending may stimulate aggregate demand, output, and employment, particularly when private demand is weak [10]. Over the longer term, productive public expenditure can enhance productive capacity by financing infrastructure and public services that complement private sector activity [1].

Government consumption and government investment may contribute to economic growth through distinct channels. Government consumption primarily finances current public services and influences aggregate demand, whereas government investment supports infrastructure development and public capital accumulation. Their relationships with economic growth may therefore differ in magnitude, timing, and persistence. Previous studies suggest that both the composition and overall level of public expenditure are relevant to economic growth, while the contribution of public capital varies across countries, periods, and empirical settings [2,11,12].

Empirical studies suggest that the relationship between public expenditure and economic growth varies across institutional contexts and time horizons [13,14]. At the subnational level, expenditure composition and local governance conditions may further shape these relationships [3,4]. These findings support the need to examine government consumption and government investment separately when analyzing regional economic growth.

## 2.2. Labor Intensity as a Regional Productive Condition

Labor is a fundamental input in regional production. In the neoclassical growth framework, output depends on capital, labor, and technology, while labor productivity is influenced by the availability of complementary inputs [15]. An increase in labor input may raise total output, but labor accumulation alone does not ensure sustained growth in output per worker due to diminishing marginal returns when other inputs and technology are held constant. Capital accumulation, technological progress, and production organization therefore play important roles in determining labor productivity and regional output.

The relationship between labor input and output may vary across regions due to differences in sectoral composition, technology, capital intensity, and labor market conditions. Labor allocation and mobility may influence how workers are matched to productive opportunities and how regional economies respond to public investment and other policy interventions [16,17]. These considerations provide a basis for examining labor intensity as a regional production characteristic that may condition the relationship between public expenditure and economic growth.

In this study, labor intensity is measured as the number of workers per billion VND of real gross regional domestic product (GRDP). Higher values indicate more workers per unit of real output, while lower values indicate fewer workers per unit of real output. When employment and output are measured consistently, this indicator is mathematically equivalent to the inverse of average labor productivity, after accounting for the unit of measurement. However, it does not directly capture workers' education, skills, or other dimensions of human capital. Accordingly, labor intensity is used to characterize the labor–output ratio and examine its potential conditioning role in the relationship between public expenditure and regional economic growth.

### 2.3. The Conditioning Role of Labor Intensity

The relationship between public expenditure and regional economic growth may depend on local productive conditions. Public infrastructure and services may complement private productive inputs, with the extent of this complementarity depending on the availability and use of other inputs. Labor market conditions and adjustment processes may also influence how public investment relates to regional economic outcomes [17,18]. These considerations provide a basis for examining whether labor intensity conditions the relationship between public expenditure and regional economic growth.

These considerations provide a conceptual basis for examining labor intensity as a potential conditioning factor in the relationship between public expenditure and regional economic growth. Differences in labor intensity may reflect variations in production technology, capital availability, and sectoral composition. Accordingly, the estimated public expenditure–growth relationship may vary with labor intensity, reflecting differences in regional productive conditions.

The conditioning role of labor intensity may differ between government consumption and government investment because these expenditure categories serve distinct economic functions. Their relationships with regional economic growth may therefore vary with labor intensity and across time horizons. Because theoretical considerations do not establish an unambiguous direction for these relationships, the analysis does not impose a priori sign restrictions on the interaction coefficients. Accordingly, the empirical model includes separate interaction terms between labor intensity and each expenditure category.

## 3. Materials and Methods

### 3.1. Study Area, Data, and Variables

This study uses annual data for Ca Mau Province in Vietnam's Mekong Delta over the period 2007–2024, comprising 18 observations. The data were obtained from the Statistical Yearbooks of Ca Mau Province covering the study period.

Regional economic growth is measured by the annual growth rate of GRDP. Public expenditure is divided into two categories: government consumption (GC) and government investment (GI). GC represents expenditure on current government activities and public services, while GI represents government expenditure on investment activities. Both variables are expressed as percentages of GRDP to account for differences in the scale of the provincial economy over time.

Labor intensity (LAB) is measured as the number of workers per billion VND of real GRDP. Higher values indicate more workers per unit of real regional output. When employment and output are measured consistently, LAB is mathematically equivalent to the inverse of average labor productivity, expressed in corresponding units. However, LAB does not directly capture human capital characteristics such as education or skills. Because real GRDP is used to construct LAB and calculate the dependent growth variable, potential mechanical associations should be considered when interpreting the estimated coefficients, particularly those of the interaction terms.

The analysis includes two interaction terms, GC × LAB and GI × LAB, to examine whether labor intensity conditions the estimated relationship between each expenditure category and regional economic growth.

### 3.2. Empirical Model

The empirical model is specified as:

$$GRDP_t = \alpha_0 + \beta_1 GC_t + \beta_2 GI_t + \beta_3 LAB_t + \beta_4 (GC_t \times LAB_t) + \beta_5 (GI_t \times LAB_t) + \varepsilon_t \quad (1)$$

where $GRDP_t$ denotes the annual GRDP growth rate in year $t$; $GC_t$ and $GI_t$ represent government consumption and government investment as shares of GRDP, respectively; $LAB_t$ denotes labor intensity; $\alpha_0$ is the intercept; $\beta_1$–$\beta_5$ are the parameters to be estimated; and $\varepsilon_t$ is the error term.

The interaction coefficients $\beta_4$ and $\beta_5$ capture how the estimated relationships between government consumption, government investment, and regional economic growth vary with labor intensity. The corresponding conditional marginal relationships are expressed as follows:

$$\partial\, Growth_t/\partial GC_t = \beta_1 + \beta_4 LAB_t \quad (2)$$

$$\partial\, Growth_t/\partial GI_t = \beta_2 + \beta_5 LAB_t \quad (3)$$

Thus, the estimated marginal relationship for each expenditure category depends on labor intensity. The coefficients $\beta_1$ and $\beta_2$ represent the respective relationships when $LAB_t = 0$ and should not be interpreted as unconditional relationships.

### 3.3. ARDL Bounds-Testing Approach

The ARDL bounds-testing approach examines short- and long-run relationships among the variables. The approach permits regressors that are I(0), I(1), or a combination of both, provided that none of the variables is I(2) [9].

The orders of integration for GRDP, GC, GI, LAB, GC × LAB, and GI × LAB are assessed using the Augmented Dickey–Fuller (ADF) unit root test [19]. Given the limited sample of 18 annual observations, the maximum lag order is set to one to reduce the number of estimated parameters. The lag structure is selected using the Akaike information criterion (AIC) [20].

The ARDL bounds test assesses whether a long-run level relationship exists. The calculated F-statistic is compared with the lower I(0) and upper I(1) critical bounds to test the null hypothesis of no long-run level relationship. The null hypothesis is rejected if the F-statistic exceeds the upper bound and is not rejected if it

falls below the lower bound. A value between the bounds yields an inconclusive result [9].

If the bounds test indicates a long-run level relationship, the ARDL model is expressed in error-correction form to estimate short-run dynamics and the adjustment toward the long-run relationship. The coefficient of the lagged error-correction term ($ECT_{t-1}$) describes the adjustment toward the estimated long-run relationship, with a negative and statistically significant coefficient providing evidence of error correction.

### 3.4. Model Diagnostics

Residual diagnostic tests are conducted to assess the adequacy of the estimated ARDL model. Residual serial correlation is examined with a portmanteau test, and residual normality is assessed with skewness and kurtosis tests, including a joint normality test.

## 4. Results

### 4.1. Unit Root and ARDL Bounds-Test Results

Table 1 presents the results of the ADF unit root tests. GRDP, LAB, and GC × LAB are stationary at levels, whereas GC, GI, and GI × LAB become stationary after first differencing. The unit root null hypothesis is rejected at the 10% significance level for GC × LAB at levels and GI after first differencing. Overall, the results suggest a mixture of I(0) and I(1) variables, with no variable identified as I(2) based on the reported tests. These findings support the use of the ARDL bounds-testing approach.

**Table 1. Augmented Dickey–Fuller unit-root test results (the authors' elaboration).**

| Variable | Test form | ADF statistic | p-value | Integration order |
|---|---|---|---|---|
| GRDP | Level | −3.584*** | 0.0061 | I(0) |
| GC | Level | −1.054 | 0.7331 | |
| | First difference | −4.051*** | 0.0012 | I(1) |
| GI | Level | −1.043 | 0.7373 | |
| | First difference | −2.782* | 0.0609 | I(1) |
| LAB | Level | −3.292** | 0.0153 | I(0) |
| GC × LAB | Level | −2.579* | 0.0973 | I(0) |
| GI × LAB | Level | −1.703 | 0.4294 | |
| | First difference | −3.305** | 0.0147 | I(1) |

*p < 0.10, **p < 0.05, ***p < 0.01

Table 2 presents the ARDL bounds-test results. The F-statistic (25.821) exceeds the I(1) upper critical bound (4.68) at the 1% significance level, while the t-statistic (−4.822) is more negative than the corresponding I(1) critical value (−4.79). Both tests reject the null hypothesis of no long-run level relationship at the 1% significance level, providing evidence of a long-run relationship among the variables.

**Table 2. ARDL bounds test for a long-run relationship (the authors' elaboration).**

| Test | Test statistic | Significance level | I(0) bound | I(1) bound |
|---|---|---|---|---|
| F-bounds test | 25.821 | 10% | 2.26 | 3.35 |
| | | 5% | 2.62 | 3.79 |
| | | 1% | 3.41 | 4.68 |
| t-bounds test | −4.822 | 10% | −2.57 | −3.86 |
| | | 5% | −2.86 | −4.19 |
| | | 1% | −3.43 | −4.79 |

### 4.2. Short- and Long-Run Relationships

Table 3 reports the estimated short-run and long-run coefficients, along with the error-correction coefficient. In the short run, the coefficients on ΔGC, ΔGI, and ΔLAB are not statistically significant. The coefficient on Δ(GC × LAB) is negative and statistically significant at the 10% level (β = −4.192, p = 0.088), whereas the coefficient on Δ(GI × LAB) is not statistically significant (p = 0.196).

**Table 3. Short-run dynamics and long-run relationships from the ARDL model (the authors' elaboration).**

| Variable | Coefficient | Standard Error | p-value |
|---|---|---|---|
| *Short-run dynamics* | | | |
| Constant | 0.092 | 0.260 | 0.734 |
| ΔGC | 5.425 | 3.088 | 0.122 |
| ΔGI | −9.849 | 6.220 | 0.157 |
| ΔLAB | −0.165 | 0.186 | 0.404 |
| Δ(GC × LAB) | −4.192* | 2.113 | 0.088 |
| Δ(GI × LAB) | 5.614 | 3.930 | 0.196 |
| *Error-correction term* | | | |
| ECT(−1) | −1.146*** | 0.237 | 0.002 |
| *Long-run relationships* | | | |
| GC | 4.731* | 2.290 | 0.078 |
| GI | −9.419* | 4.385 | 0.069 |
| LAB | 0.138 | 0.078 | 0.121 |
| GC × LAB | −3.655** | 1.308 | 0.027 |
| GI × LAB | 4.896 | 2.780 | 0.122 |

*p < 0.10, **p < 0.05, ***p < 0.01

The error-correction coefficient is negative and statistically significant ($ECT_{t-1}$ = −1.146, p = 0.002), indicating adjustment toward the estimated long-run relationship. Its absolute value exceeds one, suggesting potential overshooting rather than monotonic convergence.

In the long run, GC has a positive coefficient (β = 4.731, p = 0.078), while GI has a negative coefficient (β = −9.419, p = 0.069), both statistically significant only at the 10% level. The coefficient on LAB is not statistically significant (p = 0.121). Given the interaction terms, the coefficients on GC and GI represent their estimated relationships with regional economic growth when LAB = 0, rather than unconditional relationships.

The long-run interaction between GC and LAB is negative and statistically significant at the 5% level (β = −3.655, p = 0.027), indicating that the estimated marginal relationship between GC and regional

economic growth declines as LAB increases. In contrast, the GI × LAB interaction is not statistically significant ($\beta = 4.896$, $p = 0.122$), providing insufficient evidence that the corresponding marginal relationship varies with LAB.

### 4.3. Conditional Relationships with Labor Intensity

For government consumption, the estimated long-run conditional marginal relationship is $\partial Growth/\partial GC = 4.731 - 3.655LAB$, indicating that the marginal relationship becomes less positive or more negative as labor intensity increases.

For government investment, the corresponding relationship is $\partial Growth/\partial GI = -9.419 + 4.896LAB$. However, the interaction coefficient is not statistically significant, providing insufficient evidence that the estimated marginal relationship varies systematically with labor intensity.

### 4.4. Model Diagnostics

Table 4 reports the residual diagnostic test results. The Portmanteau test does not reject the null hypothesis of no serial correlation at the 5% significance level ($Q = 11.7643$, $p = 0.0674$), although the result is statistically significant at the 10% level. The skewness, kurtosis, and joint normality tests yield p-values of 0.9009, 0.5142, and 0.7963, respectively, providing insufficient evidence to reject residual normality at conventional significance levels. Nevertheless, the marginal evidence of serial correlation warrants caution when interpreting the estimated coefficients and their statistical significance.

**Table 4. Diagnostic tests of the ARDL model (the authors' elaboration).**

| Diagnostic | Test statistic | Value | p-value |
|---|---|---|---|
| Residual serial correlation | Portmanteau Q | 11.7643 | 0.0674 |
| Residual normality | Skewness | – | 0.9009 |
| | Kurtosis | – | 0.5142 |
| | Joint normality test | – | 0.7963 |

## 5. Discussion

The findings highlight the importance of expenditure composition, time horizons, and regional productive conditions in understanding the relationship between public expenditure and economic growth. This aligns with previous research suggesting that fiscal–growth relationships vary across expenditure categories and economic contexts [2,12]. Differences between the short- and long-run estimates also underscore the need to account for temporal dynamics in fiscal analysis [5,13].

A key contribution of this study is the examination of labor intensity as a conditioning factor in the long-run relationship between government consumption and regional economic growth. Previous studies have emphasized institutional quality and governance as factors that may shape fiscal–growth relationships across Vietnamese provinces [3,4]. This analysis offers a complementary perspective by considering labor intensity, measured as employment relative to real regional output, as a characteristic of regional production. The estimated conditional relationship may reflect differences in the availability and utilization of complementary productive resources. Research on public expenditure, human capital, and innovation provides a broader context for interpreting these findings [21–23].

Nevertheless, the observed conditional relationship does not identify a specific economic mechanism. Higher labor intensity may reflect differences in sectoral composition, capital availability, labor mobility, or technology adoption rather than labor input alone. As LAB measures employment relative to real output, it cannot distinguish among these underlying factors. The findings should therefore be interpreted as evidence that the estimated relationship varies with labor intensity, rather than as proof that labor intensity itself determines the economic contribution of government consumption.

The results for government investment provide a useful contrast. The statistically insignificant interaction coefficient does not rule out the relevance of local productive conditions, as labor intensity alone may not adequately capture the factors associated with the investment–growth relationship. Other factors, including project selection, implementation efficiency, complementary private investment, workforce capabilities, and infrastructure utilization, may also be relevant. Previous studies have emphasized the importance of public investment, human capital, and complementary productive resources for economic performance [17,24]. These considerations reinforce the value of examining government consumption and government investment separately in regional fiscal analysis.

From a policy perspective, regional fiscal planning should consider expenditure composition alongside local productive conditions. For government consumption, complementary measures aimed at improving workforce capabilities, technology adoption, and productivity may warrant greater attention. Public investment decisions should also account for project quality, implementation capacity, and complementary productive resources. These considerations may support more context-sensitive fiscal planning, although the estimates do not establish the effectiveness of specific policy interventions.

Several limitations should be acknowledged. The study relies on 18 annual observations from a single province, limiting statistical power and generalizability. The aggregate labor-intensity measure does not

distinguish among different production characteristics and shares an output component with the GRDP growth measure, raising concerns about mechanical associations. The empirical specification does not establish causal relationships, while residual diagnostics suggest possible serial correlation at the 10% significance level. Future research could extend the analysis to longer time series or provincial panel data, incorporate more disaggregated measures of labor and production, and assess the robustness of the estimated conditional relationships under alternative model specifications.

## 6. Conclusions

This study examines how labor intensity conditions the relationship between public expenditure and regional economic growth in Ca Mau Province, Vietnam, using an ARDL framework that distinguishes between government consumption and government investment. The results suggest that the estimated long-run marginal relationship between government consumption and regional economic growth weakens as labor intensity increases. In contrast, there is insufficient evidence of a comparable interaction involving government investment. The short-run interaction between government consumption and labor intensity is also statistically significant, but only at the 10% level.

The study contributes to the literature by examining how labor intensity conditions the relationship between public expenditure and regional economic growth. From a practical perspective, the findings suggest that regional fiscal planning should consider expenditure composition alongside labor intensity and other local productive conditions, particularly in labor-intensive economies. Given the small sample and single-province setting, these findings should be interpreted as exploratory evidence of conditional associations rather than causal effects.

## Declarations

*Author Contributions*

Conceptualization, A.T.N. and M.T.C.; methodology, M.T.C.; software, A.T.N.; validation, M.T.C.; formal analysis, A.T.N. and M.T.C.; investigation, A.T.N., B.N.N., H.P.P. and H.K.V.T.; resources, A.T.N. and H.P.P.; data curation, A.T.N. and B.N.N.; writing—original draft preparation, A.T.N.; writing—review and editing, M.T.C., B.N.N., H.P.P. and H.K.V.T.; visualization, A.T.N.; supervision, M.T.C.; project administration, A.T.N. and M.T.C. All authors have read and agreed to the published version of the manuscript.

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Data is contained within the article.

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*Conflicts of Interest*

The author declares that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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