The Impact of U.S. Government Education Expenditure on Labor Productivity

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1. Introduction

Numerous scholars and managers have long been interested in the relationships between economic growth and various macroeconomic variables. Externalities and various indirect effects, including enhanced child achievement and educational attainment, decreased child mortality, improved individual health, and reduced birth rates, are anticipated to contribute to the economic system through education expenditure. These factors collectively result in increased productivity, evidenced by increased earnings and greater participation in the labor force (Michaelowa, 2000).[1] Thus, governments increase their expenditure on education. In terms of the United States, with 35% of the total, elementary and secondary education was the largest category of general fund spending. Together with Medicaid (19.3%) and higher education (9.7%), this category makes up about two-thirds of all general fund expenditures in the United States (Bertocchi *et al.*, 2020).[2]

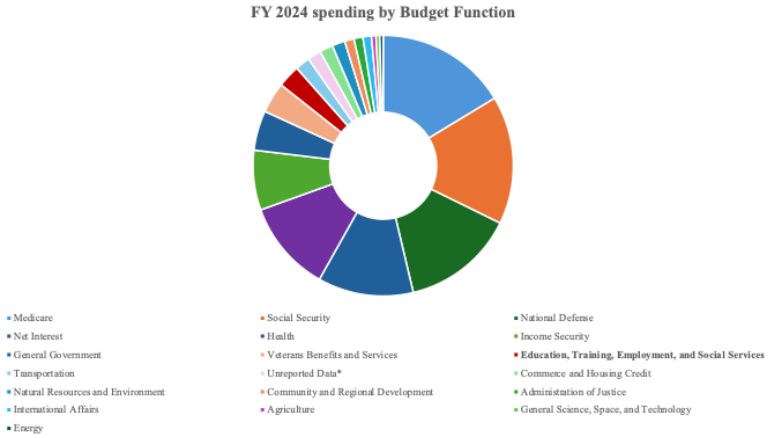

Figure 1: 2024 U.S. government spending by budget function

The U.S. government allocates funding to various sectors to serve the public. According to the data from the official website (see Figure 1), the category "Education, Training, Employment, and Social Services" comprised approximately 3% of the total U.S. federal budget last year.[3] Considering the historical data, the line chart (Figure 2) shows U.S. education expenditures on a clear upward trend since 1988, indicating the growing government investment in education over the decades.

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[1] Michaelowa, K. (2000) 'Returns to education in low income countries: Evidence for Africa'.

[2] Bertocchi, G., Dimico, A., Lancia, F. and Russo, A. (2020) 'Youth enfranchisement, political responsiveness, and education expenditure: Evidence from the US', *American Economic Journal: Economic Policy,* 12(3), pp. 76-106.

[3] USAspending.gov：https://www.usaspending.gov/explorer/budget_function

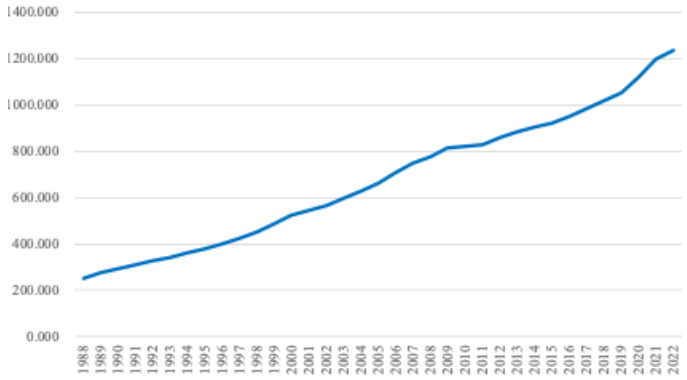

Figure 2: U.S. government education expenditure (1988-2022)

Radcliffe (2020) suggests that education serves as a tool to enhance labor productivity and address economic inefficiencies resulting from human capital externalities, providing strong economic reasons for governments to invest in education. However, the existing research lacks a strong consensus on their relationship.

The paper aims to investigate the relationship between labor productivity and the U.S. government educational expenditure by using the data covering the period from 1988 to 2022. The research questions come out that:

1) How does U.S. government education expenditure impact labor productivity?

2) How does this effect differ across various industries?

The following parts are structured. Firstly, existing literature will be discussed to see the previous perspectives and their contradiction. Second, the paper focuses on the general impact of education expenditure by applying OLS model. In the third part, a further study on the disparities among different industry sectors is conducted in the third part. Finally, the conclusion to address the research question and this paper's limitations is presented in the last part.

2. Literature Review

Lucas (1990) is one of the most well-known studies that indicated a positive relationship between these two. The most common sense is as he pointed out that labor productivity development and sustainable economic growth require higher education investment.[1] Blankenau, Simpson, and Tomljanovich (2007) examined the data set encompassing 23 industrialized nations and came to the same conclusion regarding government spending.[2] Also, according to Radcliffe (2020), compared to countries with less educated workers, those with a higher percentage of their population enrolled in and graduating from school experience higher labor output. As a result, many nations finance education in an effort to boost economic output.

In this way, spending on education contributes to higher worker productivity.[3] However, the relationship is not universally agreed upon. Some researchers suggest that increased education costs may slow down labour productivity and hinder economic growth. For instance, Pelinescu (2015) examined Romania and other EU nations from 2000 to 2012 and discovered a negative correlation between GDP per capita and education spending.[4] Similar to this, Zervas, Proserpio and Byers (2017), who analyzed how labor productivity was affected by health and education investment in an Organization for Islamic Cooperation research that covered the years 1990–2015, pointed out that spending on education lowers worker productivity.[5]

Economists also look into the influence that varies by industry in addition to the direct impact. An increase in government spending is usually concentrated on a small number of industries, as noted by Ramey and Shapiro (1998). As a result, the consequences of various industries experiencing an increase or drop in government spending vary greatly.

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[1] Lucas, R. (1990) 'Why doesn't capital flow from rich to poor countries? american Economic Review, v. 80'.

[2] Mankiw, N. G., Romer, D. and Weil, D. N. (1992) 'A contribution to the empirics of economic growth', *The quarterly journal of economics,* 107(2), pp. 407-437.

[3] Radcliffe, B. (2020) 'How education and training affect the economy', *Journal on Economy*, pp. 1-4.

[4] Pelinescu, E. (2015) 'The impact of human capital on economic growth', *Procedia Economics and finance,* 22, pp. 184-190.

[5] Zervas, G., Proserpio, D. and Byers, J. W. (2017) 'The rise of the sharing economy: Estimating the impact of Airbnb on the hotel industry', *Journal of marketing research,* 54(5), pp. 687-705.

3. Methodology

3.1. Main Hypothesis

The primary hypothesis posits that government education expenditure exerts a significant positive lagged effect on labor productivity, independent of contemporaneous macroeconomic conditions. Besides, the impact of education expenditure on labor productivity varies across sectors due to differences in production methods, labor demand, etc., in different sectors.

3.2. Model Specification

To empirically test this hypothesis, an Ordinary Least Squares (OLS) multiple regression framework is employed, adopting a log-log specification to estimate elasticities. The econometric model is formalized as:

$$\ln(Lp_t) = \beta_0 + \beta_1 \ln(EduExp_{t-1}) + \beta_2 \ln(FDI_t) + \beta_3 GDP_t + \beta_4 Unemp_t + \varepsilon_t$$

Where：

$\ln(Lp_t)$: the natural logarithm of labor productivity in year t, constructed as the unweighted arithmetic mean of 12 sectoral productivity indices (e.g., Mining, Retail, Finance). Labor productivity reflects the efficiency of labor input in generating economic output. This aggregation mitigates sector-specific volatility and avoids arbitrary weighting assumptions.

$\ln(EduExp_{t-1})$: the natural logarithm of U.S. government education expenditure in year t−1. Measures public investment in education to analyze its long-term impact on labor productivity. The lagged term captures delayed productivity effects of education investments, reflecting the time required for human capital to materialize.

$\ln(FDI_t)$: natural logarithm of net Foreign Direct Investment inflows in year t. FDI may enhance productivity through technology spillovers, managerial expertise, and capital deepening. Controlling for FDI isolates its independent effect on efficiency. Logarithmic transformation standardizes absolute values into proportional changes, aligning with elasticity interpretations.

GDP_t: annual real GDP growth rate (%). Controls for macroeconomic growth, as economic expansion often correlates with technological progress and resource optimization, which may positively influence productivity.

$Unemp_t$: seasonally adjusted unemployment rate (%). High unemployment may indicate labor market inefficiencies or skill mismatches, which could suppress productivity.

ε_t: The random error term, which captures all unobserved factors not explained by the independent variables.

3.3. Data Source and Processing

The analysis relies on a longitudinal dataset spanning 1988–2022 for the United States, compiled from the following sources:

i) Primary Data

Macroeconomic Indicators: Annual U.S. government education expenditure, GDP growth, and FDI data are sourced from the World Bank database.

Labor Productivity: Sectoral productivity indices (12 sectors) are obtained from the U.S. Bureau of Labor Statistics (BLS) Industry Productivity Viewer. The composite productivity measure is derived as an unweighted mean of sectoral indices, circumventing biases from unavailable sector-specific GDP or labor-hour weights.

Unemployment Rate: Monthly seasonally adjusted unemployment rates are retrieved from Federal Reserve Economic Data (FRED) and converted to annual averages to reduce short-term volatility.

ii) Data Transformations

Logarithmic Adjustments: Education expenditure and FDI are log-transformed to stabilize variance and mitigate skewness from extreme values (e.g., FDI fluctuations during economic crises).

Temporal Alignment: All variables are harmonized to an annual frequency. Unemployment rate monthly data are aggregated via arithmetic averaging, while education expenditure is lagged by one year to operationalize the hypothesized delayed effect.

4. Economic Analysis and Statistical Findings

4.1. The overall impact of education expenditure on labor productivity

Figure 3: OLS Regression outcome

Variable	Coefficient	Std. Error	t-Statistic	Prob.
β_0	2.045312	0.079896	25.59955	0.0000
LNEDUEXP(-1)	0.391007	0.018882	20.70791	0.0000
LNFDI	-0.011172	0.011355	-0.983817	0.3333
GDP	0.004035	0.002966	1.360114	0.1843
UNEMP	-0.011448	0.003279	-3.490831	0.0016

R-squared	0.982329
Adjusted R-squared	0.979892
F-statistic	403.0249
Prob(F-statistic)	0.000000

i) Government Education Expenditure (LNEDUEXP(-1))

The coefficient of 0.391 ($p<0.01$) indicates that a 1% increase in one-period lagged government education expenditure significantly raises labor productivity by approximately 0.39%. This lagged effect suggests that the productivity-enhancing impact of educational investments requires time to materialize. Such investments drive long-term productivity growth by improving workers' skills, enhancing technological innovation efficiency, and fostering human capital accumulation.

ii) Unemployment Rate (UNEMP)

The coefficient of -0.011 ($p<0.01$) implies that a 1-percentage-point rise in unemployment reduces labor productivity by approximately 1.14%. Elevated unemployment, often associated with economic recessions, leads to reduced aggregate demand and cuts in corporate R&D spending. Additionally, labor market frictions—such as difficulties in transitioning manufacturing workers to digital service sectors—may exacerbate structural unemployment and productivity losses.

iii) Non-Significant Variables (LNFDI and GDP)

The coefficients for foreign direct investment (LNFDI) and GDP growth rate failed to reach statistical significance ($p>0.1$). This may stem from the dominance of mergers and acquisitions (e.g., in pharmaceuticals and energy) over greenfield investments (e.g., new factories or R&D centers) in U.S. FDI during the sample period, limiting technology spillovers. The insignificance of GDP

growth could reflect its high correlation with education expenditure (e.g., expanded education budgets during economic booms due to higher tax revenues), masking its independent effects through multicollinearity.

4.2. The heterogeneous impacts of education expenditure on different sectors

In order to further study the impact of government education expenditure on labor productivity in different sectors, this paper conducts a heterogeneity test. Based on the classification method of the World Bank, the total economy is divided into twelve heterogeneous sectors from Mining to Entertainment. And the respective data is from the original dataset from World Bank Open Data. As the results show above, most coefficients of education expenditure in these different sectors are positive and significant, which implies that education expenditure has a consistently positive impact on labor productivity across most sectors. These results suggest that the more U.S. government spends on education, the higher the labor productivity of these sectors is.

In specific, there is only Transportation and Warehousing sector has a negative impact from education expenditure with a coefficient of -0.169. This sector contains industries like truck transportation and postal service which rely more on physical labor rather than knowledge or professional skills. As the government spends more on education, resulting in higher quality of labor, people may tend to choose more skill-intensive jobs, leading to labor shortages in this sector.

In terms of those positive coefficients, government education expenditure has the strongest impact on the Administrative sector (which mainly includes some industries such as travel agencies and executive services) and Information sector (which includes some industries like software publishers and newspaper publishers), with a coefficient of 1.043 and 0.952. The explanation for these strong effects may be: Both sectors are knowledge- and skill- intensive, highly relying on a well-educated workforce. For example, in the information sector, especially software publishing, education improves technical, analytical, and creative capabilities that directly drive productivity. Also, education improves professionalism and efficiency which attributes to client satisfaction and service innovation. Therefore, government education expenditure may have a stronger impact on these sectors by improving the workforce quality.

Figure 4: Heterogeneity Test

VARIABLES	(1) Mining	(2) Utilities	(3) Wholesale Trade	(4) Retail Trade	(5) Accommodation and Food Services
lnEduExp_lag1	0.527***	0.205**	0.545***	0.776***	0.198***
	(0.123)	(0.083)	(0.034)	(0.032)	(0.019)
lnFDI	-0.235***	0.121**	0.011	-0.052**	-0.013
	(0.074)	(0.050)	(0.021)	(0.019)	(0.012)
GDP	0.023	-0.000	0.003	0.006	0.006**
	(0.019)	(0.013)	(0.005)	(0.005)	(0.003)
unemp	-0.076***	0.000	-0.006	-0.018***	-0.002
	(0.021)	(0.014)	(0.006)	(0.006)	(0.003)
Constant	2.660***	2.579***	0.841***	-0.325**	3.342***
	(0.522)	(0.351)	(0.146)	(0.136)	(0.081)
Observations	34	34	34	34	34
R^2	0.502	0.757	0.974	0.985	0.923
Adjusted R^2	0.433	0.723	0.970	0.983	0.912

VARIABLES	(6) Transportation and Warehousing	(7) Information	(8) Finance and Insurance	(9) Real Estate and Rental	(10) Professional	(11) Administrative	(12) Entertainment
lnEduExp_lag1	-0.169*	0.952***	0.377***	0.240**	0.393***	1.043***	0.038
	(0.087)	(0.079)	(0.048)	(0.091)	(0.034)	(0.091)	(0.062)
lnFDI	0.097*	-0.090*	0.114***	0.131**	-0.047**	-0.172***	0.005
	(0.053)	(0.048)	(0.029)	(0.055)	(0.020)	(0.055)	(0.038)
GDP	-0.011	0.015	-0.003	-0.004	0.004	0.001	0.015
	(0.014)	(0.012)	(0.008)	(0.014)	(0.005)	(0.014)	(0.010)
unemp	0.017	-0.021	0.031***	-0.013	-0.001	-0.032*	-0.015
	(0.015)	(0.014)	(0.008)	(0.016)	(0.006)	(0.016)	(0.011)
Constant	5.123***	-1.442***	1.243***	2.405***	2.178***	-1.482***	4.331***
	(0.370)	(0.335)	(0.205)	(0.384)	(0.142)	(0.387)	(0.264)
Observations	34	34	34	34	34	34	34
R^2	0.133	0.938	0.948	0.774	0.931	0.919	0.275
Adjusted R^2	0.0132	0.930	0.941	0.743	0.922	0.908	0.175

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

On the contrary, Entertainment sector is least affected by government education expenditure in this test. Since the result is not significant, this paper will not interpret this coefficient. Then, Accommodation and Food Services sector is second least affected by education expenditure, with a

positive and significant coefficient of 0.198. This sector primarily involves tasks such as food preparation, cleaning and hospitality. These tasks highly rely on practical or on-the-job training rather than formal education. Besides, this sector tends to experience high levels of employee turnover that many people work on a part-time or temporary basis, especially in lower-skilled positions. As a result, in this industry with high turnover, investments in education may not have the same long-term effects on productivity as they do in more stable one.

5. Policy Implications

Given the findings of this study, government education expenditure plays a significant role in shaping labor productivity outcomes. However, the variation in impact across sectors and regions suggests that a one-size-fits-all approach may be insufficient. The following policy implications aim to provide practical strategies for maximizing the return on educational investment through targeted, adaptive, and regionally informed approaches. One of the policies can be prioritizing education investment. To meet the rising demand for high-skilled labor, the federal government should boost investment in STEM education, especially in high schools, community colleges, and underfunded universities. Funding should support updated facilities, teacher training, and curricula aligned with tech-driven industries like AI and renewable energy. Targeted scholarships can also help diversify the talent pipeline. By focusing on STEM, the U.S. can better prepare its workforce for a rapidly evolving, innovation-based economy. Additionally, in times of economic downturn, expanding vocational training and reskilling programs are key to reducing the negative effect on productivity. The government should collaborate with industry to offer short, job-oriented courses and provide financial support to help adults return to training. Focusing on in-demand sectors like healthcare, IT support, and logistics ensures displaced workers can quickly re-enter the labor market with relevant skills.

6. Limitations

While this study offers valuable insights into the relationship between education spending and labor productivity, it is not without limitations. Several methodological and data-related constraints may influence the interpretation and generalizability of our findings. Recognizing these limitations is essential for refining future research and ensuring more robust conclusions. Firstly, the dataset does

not account for differences in education quality. For example, disparities between elite institutions and underfunded schools may lead to overestimating the impact of education expenditure. Moreover, the data ends in 2022 and does not reflect recent developments such as the rise of generative AI, which could significantly affect labor demand in low-skilled sectors. Secondly, the regression model applies a one-year lag for education spending, which may not fully capture the long-term nature of educational returns. In addition, Residual autocorrelation (Durbin-Watson=0.604) may affect the reliability of standard errors. Thirdly, although the paper performed sector-level analysis, the use of aggregate productivity data may obscure differences within sectors. The model also does not distinguish between types or levels of education (e.g., K–12 vs. higher education, or STEM vs. humanities), limiting the ability to assess the impact of specific programs. Finally, the model does not include important institutional or policy variables, such as state education regulations, labor market policies, or local governance quality, that could influence how education spending translates into productivity gains.

7. Conclusion

In conclusion, the study confirms that U.S. government education expenditure exerts a significant and sustained positive impact on labor productivity, reinforcing the core predictions of human capital theory. Unemployment emerges as a critical inhibitor of productivity growth, underscoring the importance of economic cycle management. Through regression analysis over the period from 1988 to 2022, it finds that a 1% increase in lagged education expenditure leads to approximately a 0.39% rise in labor productivity, with statistical significance at the 1% level. This effect reflects the long-term nature of educational investments, which require time to develop skills and accumulate human capital. At the same time, the heterogeneity analysis reveals that this positive effect is not uniform across sectors. Knowledge-intensive sectors such as administration and information benefit the most, where a better-educated workforce directly enhances efficiency, innovation, and client satisfaction. In contrast, labor-intensive sectors like transportation and warehousing show a negative response, likely due to educated workers shifting toward skill-intensive jobs, creating labor shortages. Sectors like accommodation and food services experience only marginal gains, constrained by high turnover and limited reliance on formal education. In the final part, policy implications and limitations are discussed.

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