Federal Spending on Education and Its Relation to Global and Provincial Standardized Testing Scores*

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This paper provides a comprehensive analysis of government spending on education policies and their correlation with academic performance, as indicated by scores from the Programme for International Student Assessment (PISA). By examining various countries' financial investments in their education systems, such as Chile, Finland, and Canada, this paper aims to identify patterns and outcomes that highlight the effectiveness of these expenditures. Through a comparative approach, it assesses how different levels and methods of funding impact student achievement in international benchmarks like PISA, which evaluates reading, mathematics, and science literacy among 15-year-olds.

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*Code and data are available at: https://github.com/davidjamesdimalanta/Federal_Education_Policy

1 Introduction

The correlation between educational expenditures and academic performance, particularly in the context of standardized assessments like the Programme for International Student Assessment (PISA), has long intrigued policymakers and educators. This paper aims to delve into the complexities of this relationship by examining the influence of government spending on education across various countries with a focus on Canada, Chile, Finland, and Hong Kong. Each of these nations exhibits unique educational policies and funding levels, providing a rich comparative landscape to explore the efficacy of financial investments in education.

Central to our study is the hypothesis that increased financial investment in education does not unilaterally translate to improved academic outcomes on standardized tests such as PISA. By analyzing PISA scores, which assess 15-year-old students' abilities in reading, mathematics, and science, this research seeks to identify patterns and outcomes that illuminate the real effects of these investments.

Our investigation is rooted in a comprehensive data collection effort involving the PISA datasets and extensive financial data on educational spending from reliable sources such as Statistics Canada and the World Bank. Through meticulous data cleaning and analysis, using advanced statistical tools and methods, this paper provides a nuanced understanding of how the allocation of educational resources impacts student performance internationally.

In this introduction, we set the stage for a detailed exploration of the interconnected dynamics of educational funding and academic achievement. The findings from this research are intended to contribute to the ongoing global dialogue on educational policy and reform, offering evidence-based insights that could guide future decisions aimed at enhancing student outcomes through targeted financial strategies. By critically assessing the role of government

spending in education, this paper endeavors to add clarity to the debate on how best to allocate resources in the pursuit of academic excellence.

2 Data

2.1 Data Collection

Data for this study was meticulously sourced to analyze the impact of government educational spending on academic performance. This involved collecting data from the Programme for International Student Assessment (PISA).

- PISA Data: Acquired from the Learning Tower package, this dataset provides international assessment scores of 15-year-old students in reading, mathematics, and science, capturing student performance across various countries and assessment years.
- World Bank Data Federal Education Policy: Sourced from World Bank Data, this dataset details educational expenditures from public and private sources across different education levels, facilitating an analysis of spending patterns related to PISA outcomes.

2.2 Data Cleaning Tools and Procedure

R (R Core Team 2023) was the language and environment used for this paper as well as throughout the data cleaning process, with different packages such as tidyverse (Wickham et al. 2019), ggplot2 (Wickham 2016), dplyr (Wickham et al. 2023), tidyr (Wickham et al. 2024), knitr (Xie 2023), janitor (Firke 2023), lubridate (Spinu, Grolemund, and Wickham 2023) packages. PISA data from the Wang et al. (n.d.) R package and ((2023)) underwent extensive cleaning and transformation processes to ensure consistency and accuracy for analysis.

2.2.1 Loading and Initial Cleaning

- PISA data were loaded using `read_xlsx` and `load_student("all")` functions respectively.
- Federal spending data from (2023) was imported using `read_csv` from the Wickham et al. (2024) package.

2.2.2 Filtering and Selecting Relevant Data

- PISA datasets and federal education spending data were filtered to include only the relevant countries (Finland, Hong Kong, Canada, and Chile) and necessary columns (year, country, math, reading, science scores).
- Missing values were systematically removed with `na.omit()`.

2.2.3 Data Aggregation

PISA data was grouped by year and country to compute minimum, maximum, and average reading scores to observe trends over time.

2.2.4 Government Spending Data Cleaning

This dataset was refined to include only fields relevant to educational expenditures, ensuring alignment with the study's analytical needs.

2.2.5 Integration and Consolidation

All cleaned datasets were integrated into a comprehensive data frame to facilitate a comparative analysis between educational spending and academic performance.

2.3 Ethical Considerations

All datasets utilized in this study are publicly available and anonymized, adhering to strict ethical guidelines to protect individual privacy. The data was used solely for academic purposes, in accordance with the provisions set by the respective data providers, ensuring that all analyses uphold the highest standards of research integrity.

3 Results

In the analysis of PISA scores for literacy across three distinct countries—Canada, Chile, and Finland—we observe varied performance trends which may reflect the impact of different educational policies and investments. The following tables summarize the results extracted from the cleaned datasets for each country and subject:

3.1 Federal Education Budget Analysis

The following tables depict the federal education budgets of Canada, Chile, Hong Kong, and Finland. The allocation of federal funds towards education can significantly influence the effectiveness of educational policies and the academic performance of students. The following table provides a detailed breakdown of the educational spending as a percentage of GDP for these countries over recent years. This financial commitment reflects the priority each government places on education and its potential correlation with the PISA scores observed.

Table 1: PISA Literacy Scores Canada

year	lowest	highest	average
2000	153.3700	881.3800	526.4042
2003	100.3026	818.6678	516.0883
2006	7.7413	826.5329	512.4287
2009	45.8200	871.1200	511.5319
2012	131.5007	822.9887	511.2359
2015	109.4520	812.4140	514.9260
2018	130.6070	878.8620	509.4665

Figure 1: PISA Literacy Scores In Canada

Table 2: PISA Literacy Scores Chile

year	lowest	highest	average
2000	135.1900	660.5100	417.3755
2006	0.1215	771.7155	447.8332
2009	145.7900	710.9700	453.4669
2012	186.1934	720.9304	459.9996
2015	96.0190	772.6280	474.8886
2018	146.7130	763.4630	469.8036

Figure 2: PISA Literacy Scores in Chile

Table 3: PISA Literacy Scores Finland

year	lowest	highest	average
2000	160.2800	808.6600	550.5784
2003	162.3844	817.2378	541.1218
2006	234.2518	810.6438	547.2232
2009	146.4400	802.8800	530.9767
2012	74.5626	827.7545	510.9055
2015	73.3770	778.1980	527.8609
2018	153.1810	812.0930	519.9440

Figure 3: PISA Literacy Scores in Finland

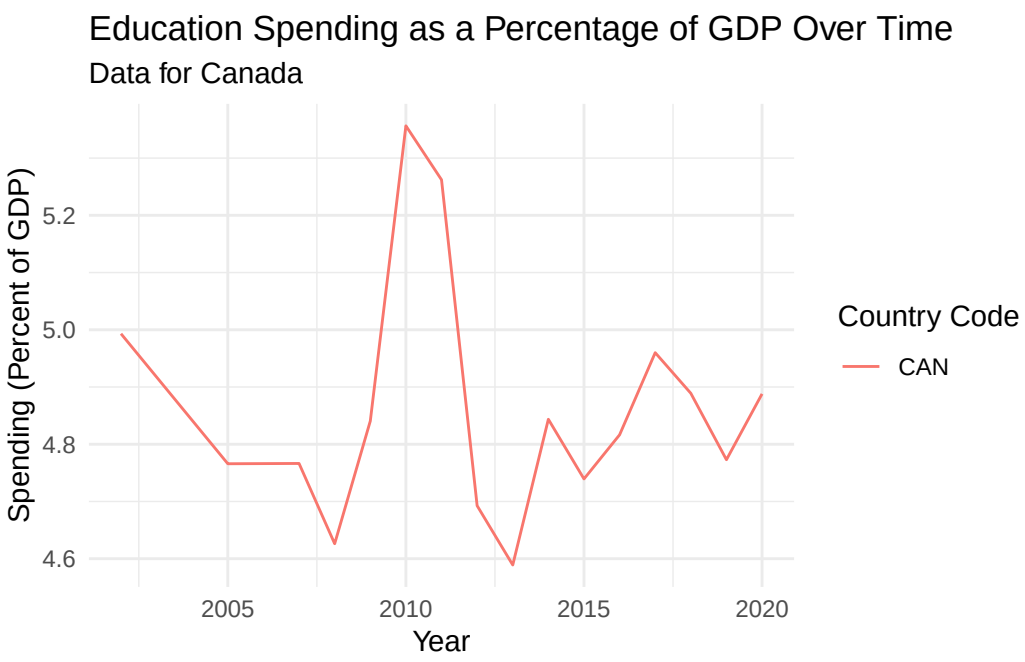

Figure 4: Canada Federal education Budget

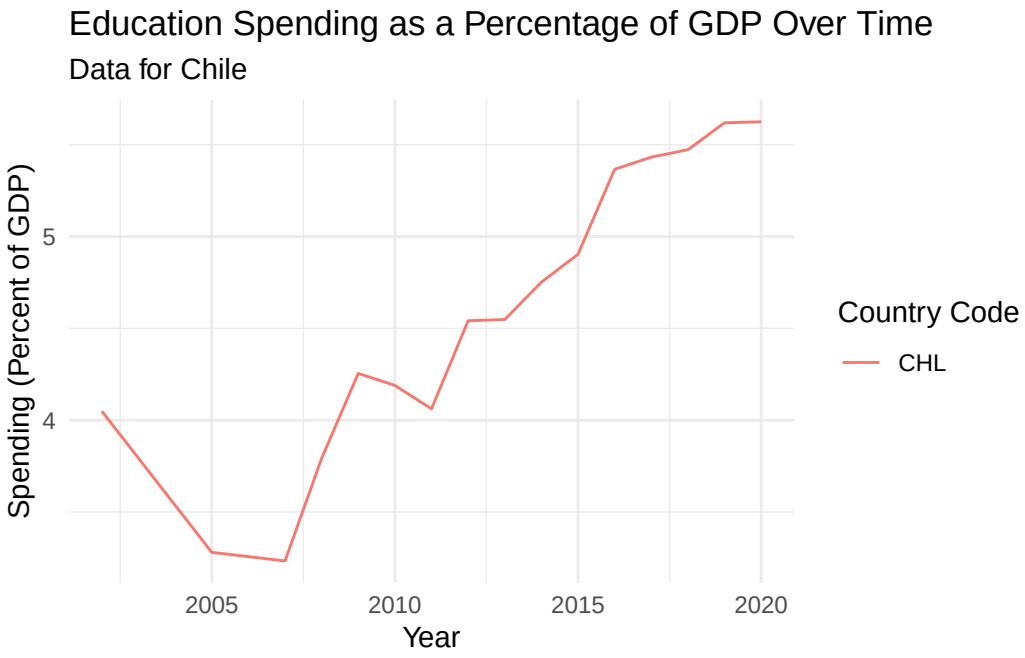

Figure 5: Chile Federal education Budget

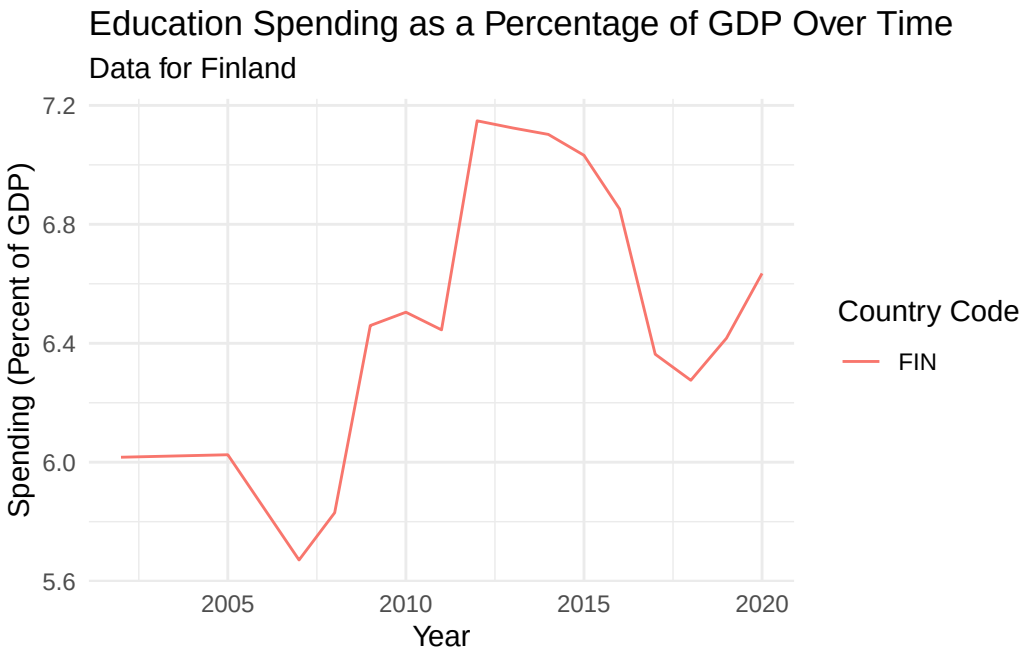

Figure 6: Finland Federal education Budget

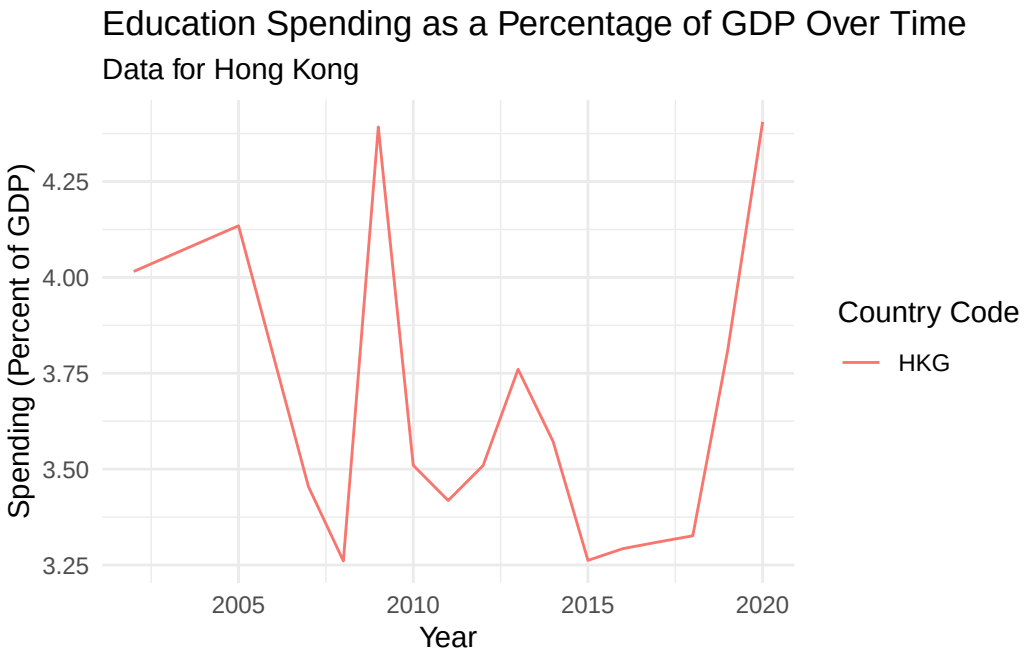

Figure 7: Hong Kong Federal education Budget

4 Discussion

This analysis of PISA scores, juxtaposed against the educational expenditures of Canada, Chile, Finland, and Hong Kong, provides a better understanding of the dynamics between government spending on education and student performance on an international scale. The findings from this research suggest that higher educational expenditures do not necessarily correlate with improved PISA scores, highlighting the complex interplay of additional factors that influence educational outcomes.

4.1 Variability in Outcomes Despite Similar Spending Levels

In examining the PISA scores and educational budgets across these countries, it is apparent that similar levels of spending do not uniformly lead to parallel academic outcomes. For example, despite Finland's high investment in education, which is reflective of its commitment to quality education (Figure 3), its PISA scores do not always surpass those of Hong Kong, which spends a comparable percentage of its GDP on education yet frequently achieves superior PISA results, particularly in science and mathematics (Figure 7) (Sahlberg 2011; Cheung and Chan 2008). This discrepancy underscores that financial inputs alone do not dictate educational quality or outcomes. Effective allocation and strategic use of these funds, possibly driven by cultural values towards education in Hong Kong, play a crucial role (Darling-Hammond 1991; Sahlberg 2011).

4.2 Cultural and Societal Influences on Education

The impact of cultural and societal contexts on education is markedly evident when comparing PISA outcomes and educational practices. East Asian countries like Hong Kong not only prioritize education highly but also integrate rigorous academic expectations and testing regimes, which differ significantly from the educational approaches in Western countries such as Canada and Finland. This cultural prioritization is reflected in higher PISA scores, suggesting that societal attitudes towards education can enhance the efficacy of the money spent on it. Indeed, societal expectations and the value placed on education contribute to student performance as much as, if not more than, the financial expenditures alone (Cheung and Chan 2008; Sahlberg 2011).

The analysis also underscores the significant role of cultural factors. For instance, countries in East Asia, including Hong Kong, typically emphasize rigorous educational regimes and have a cultural emphasis on academic success, which are less prevalent in Western countries like Canada and Chile. These cultural priorities may enhance the effectiveness of educational expenditures and lead to higher PISA scores without necessarily increasing the spending ratio (Sahlberg 2011; Cheung and Chan 2008). Thus, the impact of educational expenditure cannot be fully understood without considering the societal and cultural context in which it occurs.

4.3 Diminishing Returns on Educational Investments

An intriguing aspect of these findings is the manifestation of diminishing returns in educational investments. Finland's fluctuating PISA scores over the years, despite consistent high spending on education (Figure 6), suggest that there is a threshold beyond which additional investment yields minimal improvements in student outcomes (Hursh 2007). This phenomenon indicates the necessity for optimizing educational expenditures by focusing on the quality of educational delivery, the relevance of the curriculum, and the integration of innovative teaching methods rather than merely increasing financial inputs (Darling-Hammond 1991). Enhancing teacher training, curriculum development, and student engagement might be more effective strategies for improving educational outcomes than straightforward increases in budget allocations.

4.4 Limitations

Despite the comprehensive approach and meticulous data analysis presented in this study, there are several limitations that must be acknowledged.

4.4.1 Cross-Cultural Comparisons

Educational systems vary widely in terms of their goals, cultural norms, and societal expectations. What constitutes 'academic performance' can be culturally dependent, and thus, direct comparisons using a standardized test might not fully capture the educational quality or effectiveness across different cultural contexts. This study attempts to mitigate this through a comparative analysis but cannot entirely eliminate the inherent biases of standardized assessments.

4.4.2 Interpretation of Expenditures

The interpretation of what constitutes 'educational spending' also presents a limitation. The data from the World Bank and other sources classify expenditures in broad categories, which may not account for the specific allocations that directly impact student learning, such as teacher training, infrastructure, or technological resources. This broad categorization might obscure the nuanced impacts of specific types of educational investments.

4.4.3 Causal Inferences

Additionally, the observational nature of the data limits the ability to make causal inferences. While this research highlights correlations between educational spending and PISA scores, establishing causation would require more controlled experimental or longitudinal studies. The

current analysis can suggest trends and potential relationships but cannot definitively assert causality between increased educational spending and improved academic outcomes.

5 Conclusion

This analysis highlights that while financial investment in education is crucial, it is not the sole determinant of educational success as measured by PISA scores. The interplay of cultural values, societal norms, strategic fund allocation, and systemic educational policies plays a pivotal role in shaping the educational landscape. As such, policymakers should consider a multifaceted approach that not only increases financial investment in education but also strategically channels these funds towards areas that will yield substantial improvements in educational outcomes. This approach should also be sensitive to the cultural and societal contexts that significantly influence educational effectiveness and student performance on global benchmarks like the PISA.

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