

Warattaya Chinnakum et al.

Article

The socio-economic impact of university in Thailand: Evidence from Chiang Mai University

Economies

Provided in Cooperation with:

MDPI – Multidisciplinary Digital Publishing Institute, Basel

Suggested Citation: Warattaya Chinnakum et al. (2024) : The socio-economic impact of university in Thailand: Evidence from Chiang Mai University, *Economies*, ISSN 2227-7099, MDPI, Basel, Vol. 12, Iss. 12, pp. 1-23,
<https://doi.org/10.3390/economies12120339>

This Version is available at:

<https://hdl.handle.net/10419/329266>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by/4.0/>

Article

The Socio-Economic Impact of University in Thailand: Evidence from Chiang Mai University

Warattaya Chinnakum ¹, Chanamart Intapan ², Jittima Singvejsakul ³, Mattana Wongsirikajorn ¹,
Banjaponn Thongkaw ⁴, Paponsun Eakkapun ⁵ and Chukiat Chaiboonsri ^{5,*}

¹ Faculty of Economics, Chiang Mai University, Chiang Mai 50200, Thailand; warattaya.ch@cmu.ac.th (W.C.); mattana.w@cmu.ac.th (M.W.)

² Faculty of Agriculture, Chiang Mai University, Chiang Mai 50200, Thailand; somchanamart@gmail.com

³ Department of Agricultural Economy and Development, Faculty of Agriculture, Chiang Mai University, Chiang Mai 50200, Thailand; jittimasvsk@gmail.com

⁴ Office of Research Administration, Chiang Mai University, Chiang Mai 50200, Thailand; numphung36@gmail.com

⁵ Modern Quantitative Economic Research Centre (MQERC), Chiang Mai University, Chiang Mai 50200, Thailand; paponsun123@gmail.com

* Correspondence: chukiat.chai@cmu.ac.th

Abstract: For the success of efficient socioeconomic development, it is crucial that budget allocation in higher education is effectively managed, with a clear focus on targeting SDG 4 (Quality Education), which is vital for every country and should be prioritized globally. This research article attempts to assess the socio-economic impact of Chiang Mai University based on the impact of both its expenditure and teaching and training programs on the Northern Thailand economy. Moreover, it also aims to develop the best model to predict the SROI for academic projects before investing the budget for efficient financial management. All the data utilized in this research article come from official organizations such as Chiang Mai University, the Office of the National Economic and Social Development Council (NESDC), and the Provincial Comptroller's Office of each province in Northern Thailand, with the data collection covering the study period from 2023 to 2025. The key finding is that Chiang Mai University played a significant role in creating a socioeconomic impact on Northern Thailand's economy, both in the industry sector and the service sector, totaling more than an average of THB 3 billion per year for direct and indirect effects. In addition, every THB 1 million that this university spends can create more than 703 jobs in the agribusiness sector, and, for the same budget spending, it can create 241 jobs in the service sector and 113 jobs in the industry sector, respectively. Technically, for the prediction model to predict the SROI value, it was found that the best model is the Decision Tree model. If the findings of this research can be applied to other universities in Thailand or globally, it would represent a significant initiative in optimizing budget allocation, with a particular emphasis on supporting SDG 4 (Quality Education) as a priority.



Citation: Chinnakum, Warattaya, Chanamart Intapan, Jittima Singvejsakul, Mattana Wongsirikajorn, Banjaponn Thongkaw, Paponsun Eakkapun, and Chukiat Chaiboonsri. 2024. The Socio-Economic Impact of University in Thailand: Evidence from Chiang Mai University. *Economies* 12: 339. <https://doi.org/10.3390/economies12120339>

Academic Editor: Joao Ricardo Faria

Received: 16 September 2024

Revised: 19 November 2024

Accepted: 20 November 2024

Published: 11 December 2024

Keywords: SDG 4 (quality education); socio-economic impact; SROI; higher education; Thailand; Chiang Mai University



Copyright: © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

All of the countries around the world emphasize that economic sustainable development is the first priority for planning long-term development. The motto from the former president of South Africa from 1994 to 1999 stated that “*Education is the most powerful weapon which you can use to change the world*”. Therefore, the education system in all countries plays an important role in the long-term development of a country, especially economic long-term development. A high-standard education system at every level in the countries would enhance the skilled and educated workforce based on high standards, which can contribute to productivity and economic output. These factors are significant for sustained

economic growth in the long term, alongside alignment with high-standard knowledge contributing to environmental protection and social welfare development through high-quality knowledge.

The universities in every country are key institutions in the education sector, playing a significant role not only in providing knowledge-based research, higher education, and training for students in various fields but also in having an impact on the socioeconomic status of every country as well. In Figure 1, public spending on the education system as a share of the GDP around the world in the year 2020 is presented. This figure provides the perspective that high-income countries spend a higher share of their GDP on the education system than middle-income countries, approximately 2–4% of their GDP.

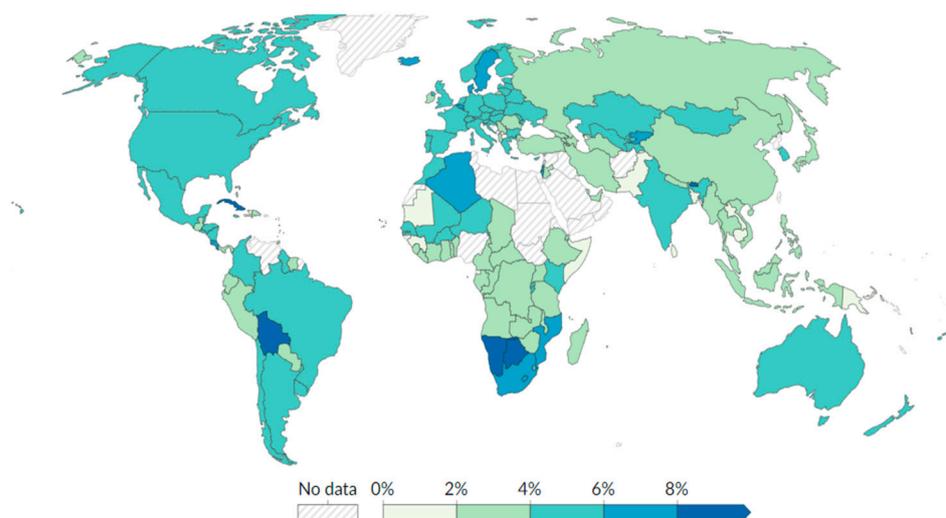


Figure 1. Public spending on the education system as a share of the GDP around the world for the year 2022. (Source: <https://ourworldindata.org/financing-education>, accessed on 5 October 2024).

However, for low-income countries, public spending on the education system as a share of the GDP is less than 2%. An interesting case is that of universities in the US contributing to socioeconomic development, especially in California. A report in 2021 indicates that this university may confirm its contribution to the socioeconomic impact on the US economy, such as directly employing about 228,824 workers, spending approximately \$37.2 billion in the fiscal year 2018–2019, and helping 1239 startups through UC research¹.

Figure 2 shows that total world public spending on the education system as a share of the GDP increased from 2000 to 2009. However, the trend of total world public spending on the education system as a share of the GDP decreased starting from 2010 to 2022, except for 2020. This finding implies that there is a trend of decreasing spending for every country in the world. This trend is a significant weakness in the long-term sustainable development of all countries globally. Therefore, this research result might still provide more beneficial information to warn and influence the public and private sectors to engage in efforts emphasizing the development and enhancement of the education system by efficiently allocating resources, especially by increasing investment in the education system, particularly higher education, following the Sustainable Development Goals (SDG 4, Quality Education) of the United Nations (UN).

Figure 3 illustrates the trend in Thailand’s public spending on education as a share of the GDP from 2000 to 2022. The data indicate a significant downward trend, with the proportion of spending decreasing from over 5% of the GDP to 2.5% of the GDP during this period. This marked decline suggests that public education institutions in Thailand, including schools, colleges, and universities, are increasingly operating under substantial budget constraints. Consequently, there is a growing need for these institutions to prioritize the efficient allocation of resources to maintain the quality and accessibility of education

despite reduced financial support. However, Thailand's public spending on education must recognize that reducing the budget to support Thailand's education system does not promote long-term development, especially sustainable economic growth and the achievement of social development goals.

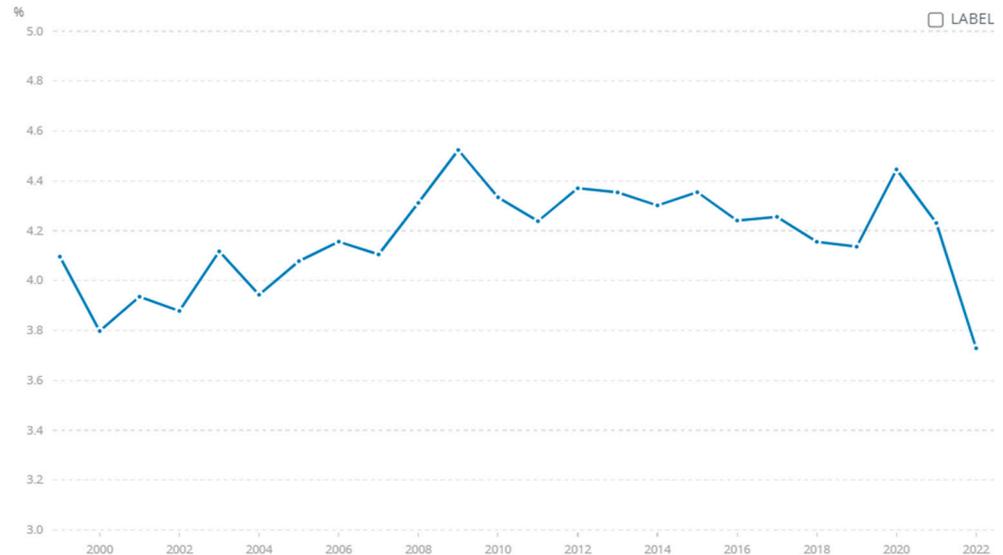


Figure 2. The total world public spending on the education system as a share of the GDP from the year 2000 to 2022. (Source: <https://data.worldbank.org/indicator/SE.XPD.TOTL.GD.ZS>, accessed on 5 October 2024).

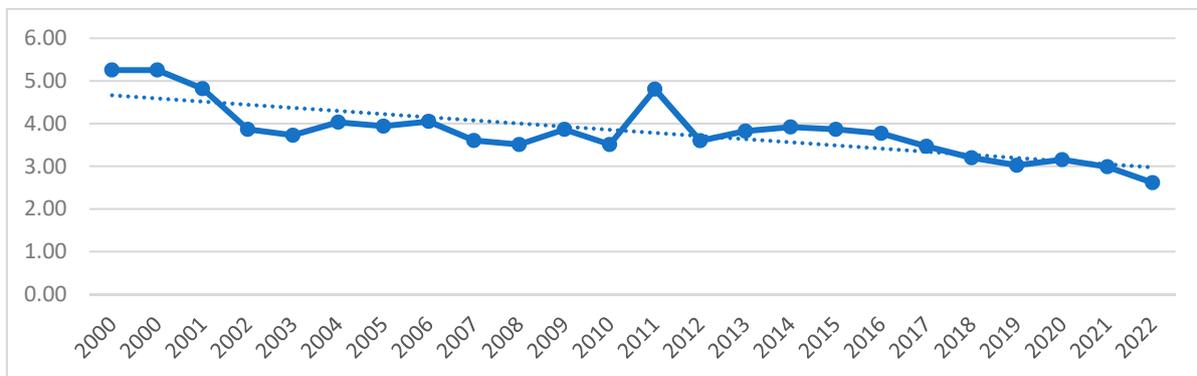


Figure 3. Thailand's public spending on the education system as a share of the GDP from the year 2000 to 2022. (Source: <https://apiportal.uis.unesco.org/bdds>, accessed on 5 October 2024).

Although the government of Thailand is still increasing the budget to support the overall higher education system of Thailand (but not long term), which involves support for public universities, the National Higher Education, Science, Research and Innovation Policy Council (Policy Council)² approved a budget of approximately THB 146,000 million for the year 2024, which is an increase of approximately THB 124,748 million from 2023. However, the National Higher Education, Science, Research, and Innovation Policy Council is targeting a reduction in the burden on the state budget that the government will support in the future³. Therefore, all public universities in Thailand should be concerned with allocating these important resources more efficiently and with a greater impact on socioeconomic development in Thailand, pushing forward for Thai long-term development based on the SDG 4 point of view.

University education in Thailand plays an important role in the country's economic and social development, as it is a source of producing highly knowledgeable and skilled

personnel to meet the demands of the labor market. However, university spending is still an important issue to consider, both in terms of student expenses and the budget that universities use for various operations. Research on university spending found that total university and student spending has an indirect impact on the gross domestic product and job creation in each area (Császár et al. 2019). At the same time, it was discovered that universities with larger funds are typically better able to deliver higher-caliber instruction and research, as well as the more effective use of available resources, leading to improved research and learning outcomes for students (Charoenkul 2015; Hazelkorn 2011). Furthermore, it is critical to analyze and identify strategies for enhancing budget management at Thai universities by promoting greater engagement in collaborative research projects with international universities (Mangrum 2023).

However, Chiang Mai University is located in Chiang Mai, which was established in 1964. This university plays a significant role mainly in the development of the higher education system in Thailand, especially in the area of Northern Thailand. This university has strong academic programs in a variety of fields such as agriculture, engineering, science, health sciences, and social sciences. In 2023, the Ministry of Higher Education, Science, Research, and Innovation (MHESI) of Thailand is a government agency. This agency announced that Chiang Mai University was allocated a budget supported by the government, ranked number two in the country, amounting to THB 5788 million. Therefore, this university must play a significant and responsible role in the utilization of the budget, impacting the socioeconomic status of Thailand. This budget needs to have comprehensive targets for the higher education system in Thailand by providing quality education, promoting scientific research and development across various disciplines, and encouraging innovation and technology development to drive economic growth in the future.

Despite these necessary targets, the central research question of this study continues to concentrate on the extent to which the yearly spending of Chiang Mai University influences the economy of Northern Thailand through various multiplier effects.

The objectives of this research study are, firstly, to analyze the socio-economic impacts of Northern Thailand, both from the annual expenditures of Chiang Mai University and the economic impact of the university's curriculum in achieving its intended outcomes. The second objective of this study is to develop a model for predicting the social impact (SROI) by selecting the best-enhanced machine learning algorithms to make Chiang Mai University's planning more effective.

This research article is structured into four sections: the first section elucidates the significance of the topic under research; the second section provides a comprehensive literature review and outlines the conceptual framework and methodology for this study; the third section is the empirical findings; and the final section displays the conclusions of this study along with policy recommendations.

2. Literature Review

The budget utilization of Chiang Mai University (CMU) is an important factor among many factors in developing higher education and research in Northern Thailand, and it has a significant influence on enhancing the northern region's economy. The university not only provides educational opportunities but also acts as a key economic engine, stimulating local businesses and contributing to the region's overall economic development. To fully understand and measure the economic impact of CMU, this study employs a regional Input–Output (IO) model, a powerful analytical tool that captures the complex relationships within local economies. An effective economic analysis requires tools that can show the relationships and interdependencies between different sectors of an economy. One important and popular tool is the Input–Output (IO) table, which is used to analyze the flow of goods and services between economic sectors within a region.

IO tables are important in studying economic impacts, such as the effects of changes in production, investment, or policy changes.

Studying through regional IO Tables allows us to understand the structure and flow of regional economies in detail. It can also be used in economic development planning and impact assessments of projects. Also, research by [Miller and Blair \(2009\)](#) demonstrates the use of IO Tables in analyzing economic impacts in different regions and their application in public policy. Research by [Isard \(1960\)](#) also provides guidelines for creating and using Regional IO Tables to assess the economic impacts of regional development.

The [Puttanapong and Sangsubhan \(2024\)](#) utilized the Regional IO Table as an important tool in analyzing and planning regional economic development. For example, research by the National Economic and Social Development Council (NESDC) used the IO Table to assess the economic impact of infrastructure development projects in different regions of the country. In terms of the economic impact based on the University's spending measurement by the IO model, there have been many studies. For example, [Vinhais and Guilhoto \(2012\)](#) attempted to analyze the economic impact of spending by the Federal University in Brazil, and they found that the spending expansion of the Federal University in Brazil had a significant impact on the GDP of Brazil, contributing more than 0.36% of the GDP. In 2015, a final report by New York University⁴ demonstrated that this university was able to generate an impact on New York City through both direct effects and indirect effects through the multiplier effect. This report stated that this university was able to create approximately 4030 jobs, generate approximately USD 276.5 million in wages and salaries, and create approximately USD 777.8 million in citywide economic output. Many universities have used the IO model to quantify the economic impact of their budget spending, such as the University of Calgary (2020)⁵ and the University of Wisconsin–Madison⁶ on the Wisconsin economy (2021). However, this research article did not utilize the Multiplier Product Matrix (MPM)⁷ because this matrix is more complex to be used for the interpretation of the economic impact analysis of the university's spending and is also difficult for policymakers to generate policy recommendations.

Moreover, the literature review to evaluate the socio-economic impact of the university's educational and training programs in achieving their intended outcomes can be found in many studies from an economist's point of view. For example, the studies conducted by [Beck et al. \(1995\)](#), [Caffrey and Isaacs \(1971\)](#), [Elliott et al. \(1988\)](#), [Siegfried et al. \(2007\)](#), and [Vaiciukevičiūtė et al. \(2019\)](#) provide valuable research results for this research article.

The function of the university in an economy can be regarded as a production firm that produces educational services. It also contributes to job creation, research, and human capital formation in a country ([Siegfried et al. 2007](#)). Our study specifically focuses on the university teaching and learning activities, the impacts of which are classified into two parts: the supply and demand side ([Garrido-Yserte and Gallo-Rivera 2010](#)). The demand side is the evaluation of the impact through spending on teaching and learning activities by the university ([Caffrey and Isaacs 1971](#)). This spending is injected into and directly impacts the local economy. The indirect, but longer-lasting, impact is the value added to human capital via education. This value is quantified by assessing the return to education of the graduates from different curricula ([Williams et al. 2021](#)). In this study, we refer to the impact on the demand side as the direct impact and the impact on the supply side as the indirect impact.

For the literature review to evaluate the social impact of the SROI (Social Return on Investment) regarding the university's expenditure on academic projects achieving their intended outcomes, many studies have been conducted previously. The SROI model has been used to analyze the evaluation of various research projects to enhance community–university collaboration, which can help in decision making for each project ([Chan et al. 2021](#)). The SROI plays a significant role in identifying the problems of the project, which helps the university to promote and push each department ([Banke-Thomas et al. 2015](#)).

The SROI is also a significant technique for identifying various characteristics, such as stakeholders and project activities, that are beneficial to the development of the university, which is the heart of the evaluation ([Rotheroe and Richards 2007](#)). Therefore, the SROI is a

very important part of each university project, which can significantly identify the impact of the university project so that executives or project developers can predict the impact that will occur (Yates and Marra 2017).

3. Conceptual Framework and Methodology

3.1. Conceptual Framework of This Research Study

Figure 4 illustrates the conceptual framework and methodology employed to quantify the socioeconomic impact of Chiang Mai University, utilizing the government-funded budget allocated for one year’s planning.

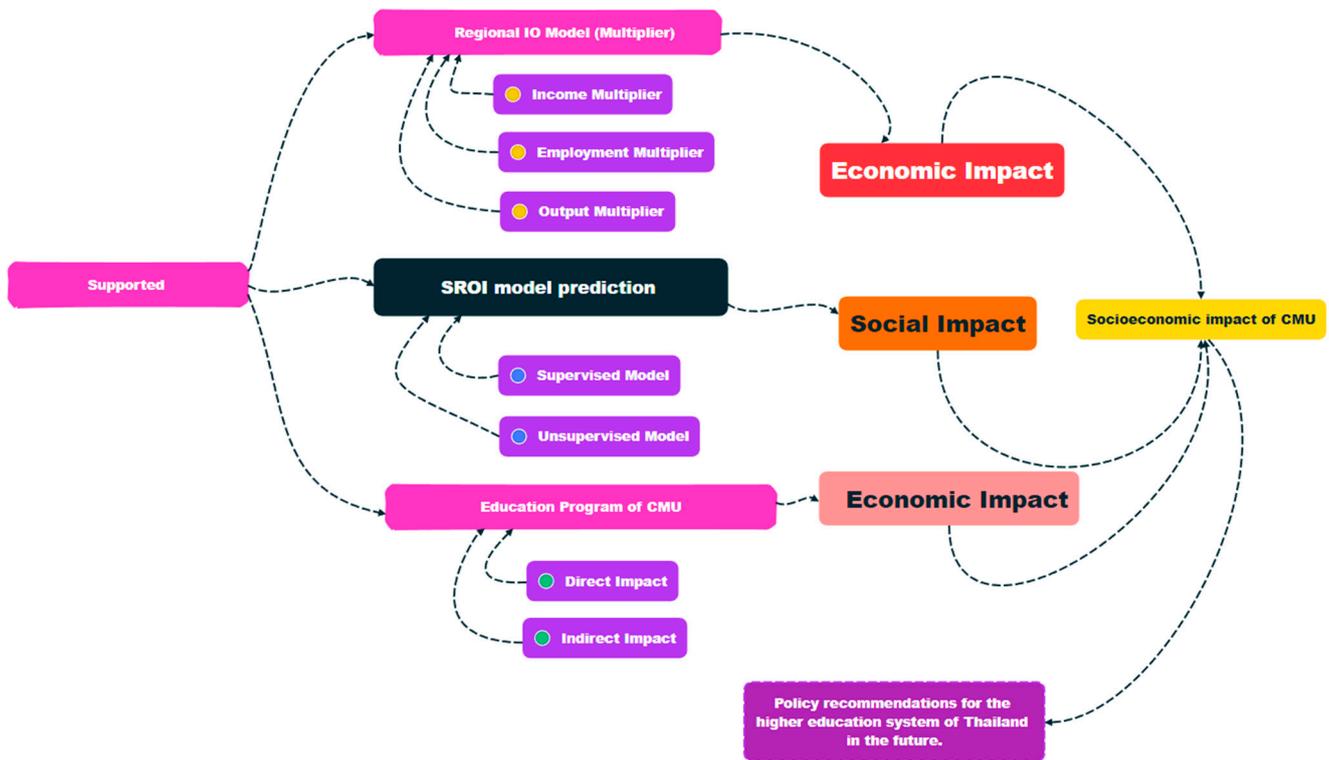


Figure 4. The conceptual framework and some brief methodological concepts of research.

The conceptual framework and some brief methodological research concepts of this study to quantify the socioeconomic impact of Chiang Mai University are defined by three methods. The first method quantified the economic impact using the regional IO models, and the second method was based on the SROI model prediction to quantify the social impact. The third method involved utilizing the econometric model to evaluate the education program of Chiang Mai University and its impact on the economy, both direct and indirect. The final step of this research study presents the results of the socioeconomic impact of Chiang Mai University during the study period. Also, both the output and outcome of this research study display policy recommendations for higher education in Thailand regarding the efficient allocation of budget impacts on the country, related to the socioeconomic impact, to support and promote SDG 4 of the United Nations.

In addition, this research study ultimately aims to contribute by integrating quantitative analysis within social and economic contexts, employing a variety of methods, including economic models, econometric models, and machine learning algorithms, alongside the three main methodologies: regional IO models for economic impact, the SROI model for social impact, and an econometric evaluation of Chiang Mai University’s education program. This study culminates in the presentation of socioeconomic impact results and policy recommendations for higher education in Thailand, with a focus on optimizing budget allocation and supporting SDG 4 of the United Nations.

3.2. Methodology of Research Study

3.2.1. Regional IO Model

The IO model was explained by Miller and Blair (1985, 2009, 2022). They explain that this model allows economists to grasp how shifts in demand influence the economy and to evaluate the movement of goods and services. The model proves to be highly beneficial for assessing the economic impact through the multiplier effect, which is essential for economic planning and policy evaluation.

The regional Input–Output (IO) model is a powerful tool for quantifying the economic impact of Chiang Mai University through the multiplier effect, particularly in Northern Thailand. Numerous studies, including those by Ambargis et al. (2014), Gašperová et al. (2017), and Jeffrey (2021)⁸, have demonstrated the effectiveness of using this model to measure the economic contributions of universities to specific regions, highlighting the significant role of university spending in driving regional economic growth. The principle of the regional input coefficient, which shows the proportion of the value of input factors in a region to the output in that region, can be calculated from the national input coefficient, or, in other words, by converting the matrix A or the matrix of national input coefficients into the matrix A^R or the regional input coefficient matrix (Arunee Punyasavatsut 2018)

$$P_i^R = \frac{(x_i^R - e_i^R)}{(x_i^R - e_i^R + m_i^R)} \tag{1}$$

where

x_i^R is the total output of sector i (Agriculture sector, Industry sector, and Service sector) in region R (North of Thailand),

e_i^R is the export of sector i (Agriculture sector, Industry sector, and Service sector) in region R (North of Thailand), and

m_i^R is the import of sector i (Agriculture sector, Industry sector, and Service sector) in region R (North of Thailand).

Considering $(x_i^R - e_i^R)$ is the value of sector i output produced in region R remaining in region R (after deducting the portion exported outside the region), $(x_i^R - e_i^R + m_i^R)$ is the value of the total sector i output in region R , including both its own output in the region and its imports from outside the region. Thus, P_i^R represents the proportion of sector output produced in the region to the total sector i output available in region R . $P_i^R \times 100$ is the percentage of output produced in the region (regional supply percentage).

Let P be a column vector of P_i^R where i (Agriculture sector, Industry sector, and Service sector) is in region R (North of Thailand), and \hat{P} or $\langle P \rangle$ is a square matrix with the same diagonal elements as the Agriculture sector, Industry sector, and Service sector. The zero represents the off-diagonal elements.

$$P = \begin{bmatrix} P_1^R \\ P_2^R \\ \vdots \\ P_n^R \end{bmatrix}$$

$$\hat{P} = \langle P \rangle = \begin{bmatrix} P_1^R & 0 & \dots & 0 \\ 0 & P_2^R & \dots & 0 \\ \vdots & \vdots & \dots & \vdots \\ 0 & 0 & \dots & P_n^R \end{bmatrix} \tag{2}$$

Therefore, the product of the member of row i of the factor coefficient matrix (matrix A) with P_i^R gives the proportion of the i factor of output produced domestically in the region that is used in the output of the different goods, or

$$A^R = \hat{P}A \tag{3}$$

And the impact of changes in final demand in a region on the different output sectors in that region can be found from

$$X^R = (I - A^R)^{-1}Y^R \tag{4}$$

The regional Input–Output (IO) model used to evaluate the economic impact of Chiang Mai University can be categorized into three distinct types: the first is an IO model based on the output multiplier, the second is an IO model based on the income multiplier, and the third is an IO model based on the employment multiplier.

Output Multiplier for Regional IO Model

The output multiplier calculates the total increase in production (both direct and indirect) throughout the economy in response to a one-unit increase in demand for a specific industry’s output (Leontief 1936), as only direct and indirect effects are considered from Equation (5).

$$\frac{dY^R}{dX^R} = (I - A^R)^{-1} \tag{5}$$

We already found the inverse matrix of the output technology coefficient, which is

$$\frac{dY^R}{dX^R} = (I - A^R)^{-1} = \begin{bmatrix} 1.50 & 1.23 & 1.09 \\ 1.83 & 2.70 & 0.70 \\ 0.11 & 0.22 & 1.26 \end{bmatrix}$$

Make a vertical sum to obtain the output multipliers for each output sector as follows:

$$\frac{dY^R}{dX^R} = (I - A^R)^{-1} = \begin{bmatrix} 1.50 & 1.23 & 1.09 \\ 1.83 & 2.70 & 0.70 \\ 0.11 & 0.22 & 1.26 \end{bmatrix}$$

A	I	S
3.44	4.15	3.05

Output multiplier

From the example above, it shows that the output multipliers of the agricultural, industrial, and service sectors for the regional IO model are equal to 3.44, 4.15, and 3.05, respectively. In the case of the multipliers’ explanation, it can be implied that the multiplier of the industrial sector of the economy has the highest impact compared to other sectors. The lowest impact on the economy is the multiplier of the service sector.

In terms of impact on the economy by the multiplier effect, which means that, when investing money, especially when the Thai government allocated a budget of THB 1 million in the higher education system, if it transfers to the industrial sector, then the degree of impact from this sector to contribute to other sectors, both the direct effect and the indirect effect, as well as the induced effect, is equal to 4.15 times the money invested for the regional area.

Employment Multiplier for Regional IO Model

The employment multiplier for the Regional IO model measures how much an increase in final demand affects the consumption of a sector’s output, considering only direct and indirect effects (Atems 2019). The matrix multiplier can be used to calculate the employment multiplier described above in a convenient and quick way as follows (see Equation (6)):

$$E^R = e^{T(R)} \cdot (I - A^R)^{-1} \tag{6}$$

where

E^R = Total direct and indirect impact on employment growth in the economy.
For the regional Input–Output (IO) model.

$e^{T(R)}$ = Transpose of employment to output vector for the regional Input–Output (IO) model.

$(I - A^R)^{-1}$ = Inverse matrix of technology coefficients for the regional Input–Output (IO) model.

Therefore, from the above equation example, the employment multiplier of each branch can be calculated by the following method:

$$E^R = [73 \quad 4 \quad 12] \cdot \begin{bmatrix} 1.50 & 1.23 & 1.09 \\ 1.83 & 2.70 & 0.70 \\ 0.11 & 0.22 & 1.26 \end{bmatrix} = \begin{matrix} \boxed{\text{A}} & \boxed{\text{M}} & \boxed{\text{S}} \\ [118.14 & 103.23 & 97.49] \end{matrix}$$

According to the example of the employment multiplier for the regional IO model, it can be calculated using the matrix form mentioned above. The employment multipliers of the agriculture sector, industrial sector, and service sector are equal to 1.62 (118.14/73), 25.81 (103.23/4), and 8.12 (97.49/12), respectively. For example, when the Thai government allocated a budget of THB 1 million to the higher education system, if it transfers to the industrial sector (M), then it can create at least 25.81 jobs in the industrial sector (M) for the regional economy of Thailand.

Income Multiplier for Regional IO Model

By taking into account solely direct and indirect impacts, the income multiplier for the regional IO model (Thirlwall 2011) calculates the amount that a rise in final demand will alter for every household in the economy (Keynes 1936). The income multiplier as previously mentioned may be quickly and easily calculated using the matrix multiplier system for the regional IO model as follows (see Equation (7)) (Blanchard and Perotti 2002):

$$R^R = r^{T(R)} \cdot (I - A^R)^{-1} \tag{7}$$

where

R^R = The overall income impact of regional areas on Thailand’s economy including both direct and indirect effects.

$r^{T(R)}$ = Transpose of the income-to-output vector of regional areas on Thailand’s economy.

$(I - A^R)^{-1}$ = Inverse matrix of output technology coefficients for the income-to-output vector of regional areas on Thailand’s economy.

Therefore, from the above equation example, the income multiplier of each branch can be calculated by the following method:

$$E^R = [0.16 \quad 0.07 \quad 0.22] \cdot \begin{bmatrix} 1.50 & 1.23 & 1.09 \\ 1.83 & 2.70 & 0.70 \\ 0.11 & 0.22 & 1.26 \end{bmatrix} = \begin{matrix} \boxed{\text{A}} & \boxed{\text{M}} & \boxed{\text{S}} \\ [0.39 & 0.43 & 0.50] \end{matrix}$$

For example, suppose that, whenever the Thai government allocates a budget of THB 1 million to the higher education system, the impact on the Thai economy, both in terms of direct and indirect effects, depends on the size of the multipliers. Adding to this example based on Equation (7), the income multipliers of the industrial sector (M) are the highest for generating income for Thailand’s economy. For example, when the Thai government allocates a budget of THB 1 million to the higher education system, it will be transferred to the industrial sector, which is able to generate income for the economy, both directly and indirectly, of approximately THB 6.2 million. This finding is because the income multiplier of the industrial sector (M) is equal to 6.20 (0.43/0.07). From this example, it can be demonstrated that the income multiplier of the agricultural sector (A) is equal to 2.45 (0.39/0.16) and that the income multiplier of the service sector (S) is equal to 2.28 (0.50/0.22), respectively.

3.2.2. Econometric Model for Economic Impact

For the assessment of indirect economic impact, we proceeded with this process by mainly using econometric models to explore and understand the economic impact of the education program that was taught at Chiang Mai University in terms of indirect effects. To assess the return to education, this research study relied on an Ordinary Least Squares (OLS) estimation to regress the current salary on the dummy variable indicating the curriculum from which the samples graduated (Atkinson 2005; Blackwell et al. 2002; Williams et al. 2021). The estimated model is shown in Equation (8), which is the multiple regression model based on the literature that was already mentioned previously to estimate CMU's student salary. For an accurate and nuanced understanding of the specific factors that impact salary outcomes in this study, the dependent variable is defined as the salary of students who graduated from Chiang Mai University, and the independent variables are those of interest, such as Male, Age, and GPAX. In addition, the control variables used to estimate the salary of CMU's students are Curriculum, Hometown, and ParentOcc. Furthermore, multiple regression is very useful for handling confounding variables, which might provide a more reliable estimate of the salaries of students who graduated from Chiang Mai University.

$$\text{Salary}_i = \beta_0 + \beta_1 \text{Male}_i + \beta_2 \text{Age}_i + \beta_3 \text{GPAX}_i + \beta_4 \text{Curriculum}_i + \beta_5 \text{Hometown}_i + \beta_6 \text{ParentOcc}_i + \epsilon_i \quad (8)$$

where Salary_i is the salary of individual (i), and Male_i is a dummy variable equal to 1 if individual (i) is male and equal to 0 otherwise. Age_i is the age of individual (i). GPAX_i is the cumulative grade point average of individual (i). The Curriculum_i , Hometown_i , and ParentOcc_i are the fixed effects of curriculum, hometown, and the occupation of the parents of individual (i), respectively. The dataset utilized in this research study, aimed at evaluating the indirect economic impact of Chiang Mai University with a focus on curriculum-based teaching, was originally sourced from Chiang Mai University. This dataset serves as the foundation for estimating the indirect impact of the institution's educational activities.

For the assessment of direct economic impact, this research study relied on Siegfried et al. (2007) to classify the university spending in each curriculum according to economic activity with different regional multipliers. The direct cost is categorized into three types: salary, materials, and investment. The indirect cost came from two sources: outside the faculty and within the faculty. Since the production of academic institutions is regarded as an educational service, this research study employed the regional multiplier in service production to estimate the economic impact of teaching and learning activities (Vaiciukevičiūtė et al. 2019). Specifically, this research study employed the regional multiplier in income, which is equal to 1.006 (Equation (7)), to the cost in the salary of university employees and the multiplier in production, which is equal to 1.0104 (Equation (5)), to materials, investment, and indirect costs.

3.2.3. SROI Model Prediction

This research study attempted to develop an SROI model prediction to predict the social impact, economic impact, and environmental impact based on machine learning algorithms. Most of these algorithms belong to the supervised algorithm family, such as Naïve Bayes, the Generalized Linear Model, Logistic Regression, the Fast Large Margin, Deep Learning, Decision Trees, Random Forests, Gradient Boosted Trees, and Support Vector Machines. These algorithms were used to predict the SROI based on the historical database of the Social Return on Investment (SROI), which was collected by Chiang Mai University during the period of 2019, comprising approximately 7150 projects. Because the SROI aligns with SDG 4 (Quality Education), if it can predict or forecast the value of the SROI before the university grants funding to those projects, then it might benefit policymakers at the university to understand the broader impacts of educational development program

initiatives, which includes not only financial returns but also how educational development programs contribute to enhancing social, economic, and environmental well-being.

The method proposes leveraging machine learning algorithms to enhance the Social Return on Investment (SROI) classification process. By automating the classification of outcomes and impacts using supervised learning techniques, the approach aims to improve the accuracy, consistency, and efficiency of SROI evaluations. Utilizing data from historical SROI reports, including qualitative and quantitative aspects, the method employed the Fast Large Margin to identify the most accurate classifiers. This approach standardized the SROI analysis, making it more accessible and reliable for the research project. Therefore, this section provides the scope of the SROI and the estimation of the Fast Large Margin. For the first method, the scope of the SROI as outlined by Social Value U.K. provided a structured six-stage framework for evaluating the social and environmental impact of investments. This process includes establishing the scope and identifying stakeholders, mapping outcomes, evidencing outcomes and availability, establishing impact, calculating the SROI, and reporting and embedding the results. By following these stages, investors can gain a comprehensive understanding of the financial, social, and environmental returns on their investments, enabling them to make informed decisions that prioritize positive societal and ecological outcomes.

The methodology not only aids in demonstrating a commitment to social value but also facilitates continuous improvement in investment practices, ensuring sustained positive change (Social Value U.K. 2021).

The Fast Large Margin was used to identify the most accurate classifiers (see Equation (9)). The fundamental resource for training a Statistical Machine Translation (SMT) system is a training set denoted as $D = \{(s_i, r_i)\}_{1 \leq i \leq N}$, which consists of N source sentences s_i , each paired with a reference translation r_i . The set of possible translations for a sentence s_i is represented as $\mathcal{H}_{s_i} = \{h_{i,j}\}_{1 \leq j \leq n_i}$. The search space of the decoder is often approximated by an explicit list of the n -best hypotheses or by a lattice, which efficiently encodes a larger set of potential translations (Chiang et al. 2008).

$$\mathbf{h}_i^* = f(s_i; \mathbf{w}) = \left(\arg \max_{\mathbf{h} \in \mathcal{H}_{s_i}} \langle \mathbf{h} | \mathbf{w} \rangle \right) \quad (9)$$

where \mathbf{h}_i^* represents the predicted translation, and $\langle \cdot | \cdot \rangle$ denotes the dot product in \mathbb{R}^d . The objective of training a Statistical Machine Translation (SMT) system is to identify a weight vector \mathbf{w} (see Equation (9)) that maximizes the quality of the predicted translations. Formally, the training process involves solving the following optimization problem to ensure that the predictions are as accurate as possible (see Equation (10)).

$$\mathbf{w}^* = \left(\arg \max_{\mathbf{w}} G(D; \mathbf{w}) \right) \quad (10)$$

The gain function G , such as the BLEU score, measures the quality of the hypotheses $H = \{\mathbf{h}_i^*, s_i \in D\}$ generated for a given weight vector \mathbf{w} (Sokolov et al. 2012). Let us consider an extended version of the Hinge loss as the following (see Equation (11)):

$$l_i(\mathbf{w}) = \max_{2 \leq j} (\ell^{smt}(\mathbf{h}_{i,j}, \mathbf{h}_{i,1}) - (\mathbf{w} | \mathbf{h}_{i,1} - \mathbf{h}_{i,j})) \quad (11)$$

This loss function is convex, as it is defined as the maximum over a set of linear functions, though it is not differentiable at all points. It also clearly served as an upper bound for $\ell^{smt}(\mathbf{h}_{i,j}, \mathbf{h}_{i,1})$. The approach from a reformulation of the general large-margin classification problem, where the objective is to learn a function that scores the correct

output $\mathbf{h}_{i,j}$ was higher than any other possible output of both $\mathbf{h}_{i,j}$ and $\mathbf{h}_{i,j}$ by a specified margin (see Equation (12)) (Taskar et al. 2004).

$$\langle \mathbf{h}_{i,1} | \mathbf{w} \rangle + \xi_i \geq \max_{2 \leq j} (\langle \mathbf{h}_{i,1} | \mathbf{w} \rangle + \ell^{smt}(\mathbf{h}_{i,j}, \mathbf{h}_{i,1})) \quad (12)$$

When transforming the constraints of all examples into the objective function of the large-margin problem, it is important to note that, while both margin rescaling and slack rescaling provide general methods to derive a convex upper bound for any loss function ℓ , the effectiveness of this bound highly depends on the task and the loss function considered (Wisniewski and Yvon 2013). All the Equations (8)–(11) were applied to select the best algorithms, which consist of Naïve Bayes, the Generalized Linear Model, Logistic Regression, the Fast Large Margin, Deep Learning, Decision Trees, Random Forests, Gradient Boosted Trees, and Support Vector Machines for the prediction of SROI values in this research study.

4. Results

4.1. The Results of the IO Model for Socio-Economic Impact Based on University Spending

According to Chiang Mai University, it is the largest university in the north of Thailand. This university was allocated a budget supported by the government, ranked number two in the country, amounting to THB 5788 million in 2023. Therefore, this university must play a significant and responsible role in the utilization of the budget, impacting the socioeconomic status of Thailand. From the calculation of output multipliers, it can be summarized and grouped into three sectors. The first sector is the agriculture sector, with an average output multiplier of 1.0080. The second sector is the industrial sector, with an average output multiplier of 1.0131. The last sector is the service sector, with an average output multiplier of 1.0130 (see Table 1 and Figure 5).

Table 1. The output multipliers for the economic structure of the northern region of Thailand's economy.

Service	Output Multipliers
Agriculture	1.0080
Industry	1.0131
Service	1.0130

Source: Author's computation.

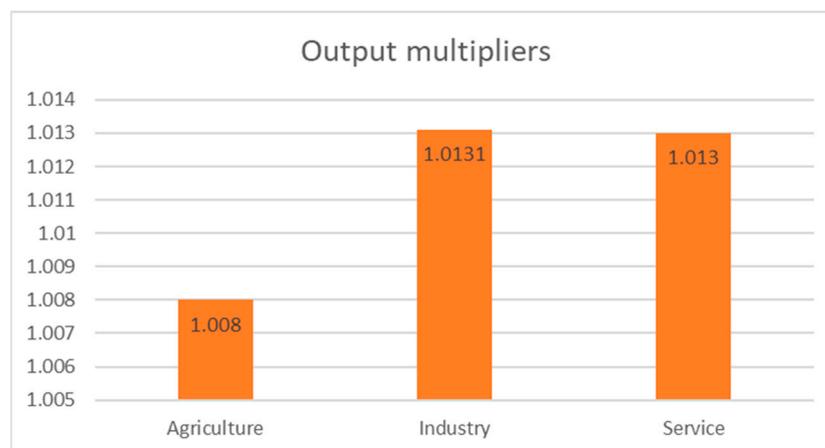


Figure 5. The output multipliers for the economic structure of the northern region of Thailand's economy.

From the economic impact results, the economic impact of Chiang Mai University in terms of output effect on the northern economy from 2024 to 2025 can be summarized in the following Table 2 and Figure 6.

Table 2. The economic impact of Chiang Mai University in terms of output effect on the northern economy from 2024 to 2025.

Years	Budget	Output Impact (THB)		
		Agriculture	Industry	Service
2024	1,178,561,700	1,187,990,194	1,194,000,858	1,193,883,002
2025	1,087,283,700	1,095,981,970	1,101,527,116	1,101,418,388

Source: Author’s computation.

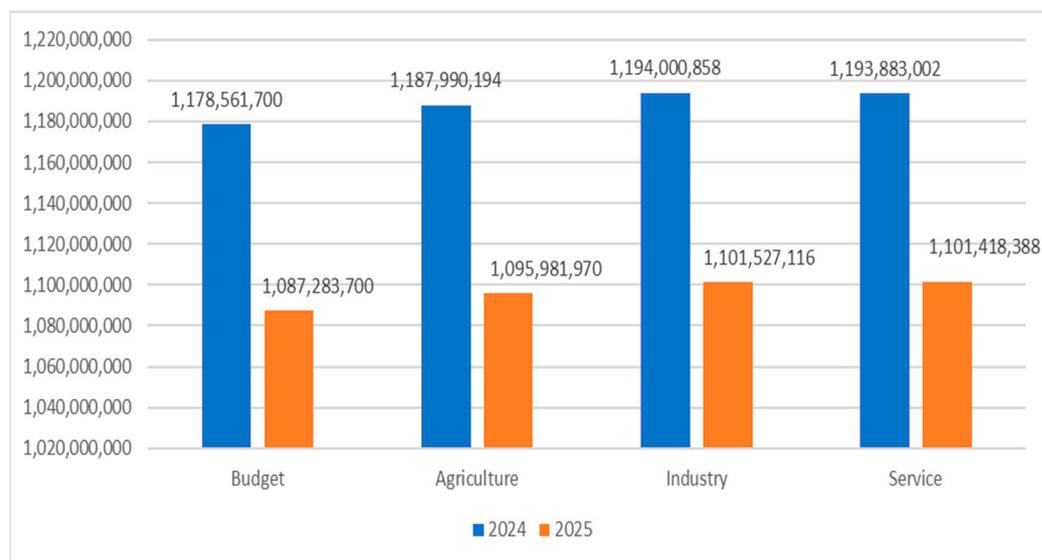


Figure 6. The economic impact of Chiang Mai University in terms of output effect on the northern economy from 2024 to 2025.

The following are the findings determined from the economic impact of Chiang Mai University in terms of output effect on the northern economy from 2024 to 2025: In 2024, there was an impact on agriculture of THB 1,187,990,194; in the industrial sector of THB 1,194,000,858; and, in the service sector, of THB 1,193,883,002. In 2025, there was an impact on the agriculture sector of THB 1,095,981,970; in the industrial sector of THB 1,101,527,116; and, in the service sector, of THB 1,101,418,388, respectively.

The calculation of income multipliers can be summarized and grouped into three averages. The first aspect is the agriculture sector, with an average income multiplier equal to 1.0055; the second aspect is the industrial sector, with an average income multiplier equal to 1.0191; and the last aspect is the service sector, with an average income multiplier equal to 1.0184, as can be seen in Table 3 and Figure 7.

Table 3. The income multipliers for the economic structure of the northern region of Thailand’s economy.

Service	Income Multipliers
Agriculture	1.0055
Industry	1.0191
Service	1.0184

Source: Author’s computation.



Figure 7. The income multipliers for the economic structure of the northern region of Thailand’s economy.

From the economic impact results, the economic impact of Chiang Mai University in terms of income effect on the northern economy from 2024 to 2025 can be summarized in the following Table 4 and Figure 8.

Table 4. The economic impact of Chiang Mai University in terms of income effect on the northern economy from 2024 to 2025.

Years	Budget	Income Impact (THB)		
		Agriculture	Industry	Service
2024	1,178,561,700	1,185,043,789	1,201,072,228	1,200,247,235
2025	1,087,283,700	1,093,263,760	1,108,050,819	1,107,289,720

Source: Author’s computation.

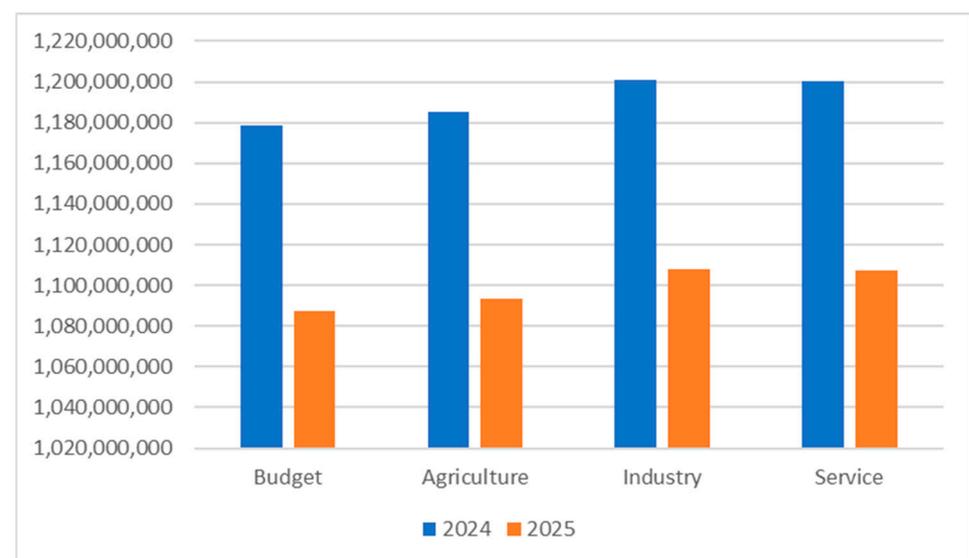


Figure 8. The economic impact of Chiang Mai University in terms of income effect on the northern economy from 2024 to 2025.

The following are the findings determined from the economic impact of Chiang Mai University in terms of income effect on the northern economy from 2024 to 2025. In 2024, there was an impact on the agriculture sector of THB 1,185,043,789; in the industrial sector of THB 1,201,072,228; and, in the service sector, of THB 1,200,247,235. In 2025, there was an impact on the agriculture sector of THB 1,093,263,760; in the industrial sector of THB 1,108,050,819; and, in the service sector, of THB 1,107,289,720, respectively.

The calculation of employment multipliers can be summarized and grouped into three averages. The first aspect is the agriculture sector, with an average employment multiplier of 1.0021; the second aspect is the industry sector, with an average employment multiplier of 1.1762; and the last aspect is the service sector, with an average employment multiplier of 1.1089, as can be seen in Table 5 and Figure 9.

Table 5. The employment multipliers for the economic structure of the northern region of Thailand's economy.

Service	Employment Multipliers
Agriculture	1.0021
Industry	1.1762
Service	1.1089

Source: Author's computation.

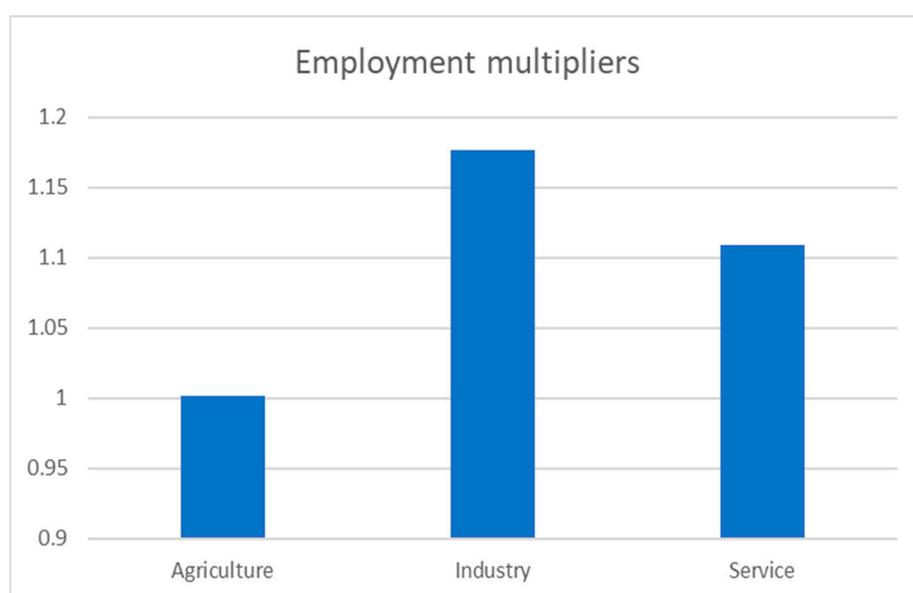


Figure 9. The employment multipliers for the economic structure of the northern region of Thailand's economy.

Chiang Mai University's socioeconomic impact can be assessed through its contribution to employment generation, driven by the institution's expenditures and activities, utilizing the employment multiplier effect. This effect captures the total employment impact resulting from university operations.

For example, suppose that, when Chiang Mai University's expenditure and activities are approximately THB 1,000,000 the effect of socioeconomic impact equals 1,002,100 ($1,000,000 \times 1.0021 = 1,002,100$). Because this spending and these activities transfer to the agriculture sector, this money is able to create jobs or employment for more than 704 workers (1 Baht = 0.0007 workers). In the same way, when Chiang Mai University's expenditure and activities are approximately THB 1,000,000, and it transfers to the industry sector, it would create jobs for more than 133 workers ($1,000,000 \times 1.1762 = 1,176,200$; 1 Baht = 0.0001 workers). For the service sector, when Chiang Mai University's expenditure and activities are approximately THB 1,000,000, and it transfers to the service sector, it would create jobs for 267 workers ($1,000,000 \times 1.1089 = 1,108,900$; 1 Baht = 0.0002 workers), respectively.

4.2. The Results of Socio-Economic Impact Based on Teaching and Learning Activities

For the result of the economic impact of Chiang Mai University's expenditure and activities, the direct impact of teaching and learning activities is shown in Table 6. It is the economic impact based on the educational group, which is classified by the International Standard Classification of Education (ISCED) into ten groups (UNESCO 2015). The estimated direct economic impact of Chiang Mai University in producing 6972 graduates in 2023 is equal to THB 2,071,874,186.31. The highest average cost per graduate, THB 1,011,296.00, is in the Health and Welfare group, while the lowest average cost per graduate, THB 330,565.90, is in the Business Administration and Law group. The curriculum in the Health and Welfare group includes Medicine, Dentistry, Nursing, Pharmacy, and Medical Sciences, which, on average, takes longer to complete than other groups of education. This longer completion time could be another reason that the cost per graduate in these groups of curricula is notably higher than in other groups, rather than just the fixed and material costs.

Table 6. Direct economic impact of teaching and learning activities (Baht) in 2023.

Educational Group	Average Cost Per Graduate	Total Economic Impact
Agriculture, forestry, fisheries, and veterinary	681,908.80	230,769,496.00
Arts and humanities	433,247.40	253,906,372.00
Business administration and law	330,565.90	340,752,275.44
Education	552,666.80	85,920,409.50
Engineering, manufacturing, and construction	493,144.70	229,877,438.00
Health and welfare	1,011,296.00	680,014,469.38
Information and Communication Technologies (ICTs)	551,547.60	9,376,310.00
Natural sciences, mathematics, and statistics	534,864.90	97,484,242.00
Services	482,004.40	68,419,878.00
Social sciences, journalism, and information	368,629.30	75,353,296.00
Total		2,071,874,186.31

Source: Author's computation.

The indirect impact, which is estimated from the return on education, is shown in Table 7. From all models, demonstrates that salary positively correlates with male sex, GPAX, and age. Under control variables are curriculum, hometown, and parental occupation. Under fixed effects in model 3, a one-point increase in GPAX leads to about a THB 2667 increase in salary, which is statistically significant at the 0.01 level. In addition, the male variable also has a positive influence correlated with the salary of CMU's students. It can be implied that male students can potentially receive a salary higher than that of other sexes by approximately THB 2471, which is statistically significant at the 0.01 level. The last independent variable is age; this factor also positively influences the salary of CMU's students, which is statistically significant at the 0.01 level. This finding means that the higher age of a student has the potential to receive a salary approximately increased by THB 1189. In terms of control variables, the curriculum, hometown, and parental occupation are appropriate to control for and explain the salary of CMU's students because the R^2 of this model estimation is the highest (see Table 7).

Next, this research study utilizes the estimated coefficients in model 3 to predict individual salaries based on their personal characteristics (highest R^2). The predicted salary is then multiplied by the number of graduates in each curriculum and the regional multiplier in income, 1.006. Therefore, the result portrays the total indirect economic impact categorized by the educational group in Table 8.

Table 7. The result of estimation for the econometric model to estimate the return on education.

Variable	Model-1	Model-2	Model-3
Male	3558.538 *** (843.570)	2160.624 *** (826.997)	2470.498 *** (739.555)
GPAX	2388.564 *** (904.361)	1441.438 (1017.823)	2666.995 *** (920.517)
Age	1259.228 *** (89.913)	1301.617 *** (156.937)	1188.865 *** (139.946)
Constant	−16,290.739 *** (2918.106)	16,596.652 *** (5954.932)	12,280.409 ** (5538.550)
Curriculum	No	Yes	Yes
Hometown	No	No	Yes
Parental occupation	No	No	Yes
Observations	2920	2920	2918
R ²	0.095	0.360	0.522

Notes: (1) Standard errors in parentheses (2) *** $p < 0.01$, ** $p < 0.05$ (3) The estimated coefficients are in Baht. (4) Parental occupation is categorized into 10 types: business, agriculture, government employee, government officer, retiree, private employee, state enterprise employee, student, unemployed, and other.

Table 8. Indirect economic impact of teaching and learning activities (Baht) in 2023.

Educational Group	Average Return on Education	Total Indirect Economic Impact
Agriculture, forestry, fisheries, and veterinary	24,352.41	12,745,156.64
Arts and humanities	24,363.07	18,067,949.82
Business administration and law	32,822.99	28,174,243.95
Education	20,436.10	6,709,061.13
Engineering, manufacturing, and construction	33,187.95	23,161,931.12
Health and welfare	37,297.22	39,409,458.59
Information and Communication Technologies (ICTs)	42,040.89	1,238,799.74
Natural sciences, mathematics, and statistics	31,493.03	14,192,467.18
Services	24,731.02	4,099,242.08
Social sciences, journalism, and information	26,531.74	16,224,970.74
Total		164,023,280.99

Source: Author's computation.

The group that generates the highest economic return is the Information and Communication Technology (ICT) group, which, on average, generates THB 42,040.89 of monthly income. To estimate economic impact, this research study excludes the samples who work abroad. It turns out that the Health and Welfare group generates the highest total indirect economic impact at THB 39,409,458.59. This finding is also influenced by the largest portion of the graduates in the Health and Welfare group compared to others. Among the 6972 graduates, the graduates who are categorized in the Health and Welfare group equal 1331 individuals or about 19 percent of the total graduates. In total, in 2023, the indirect economic impact of teaching and learning activities of Chiang Mai University is estimated to be THB 164,023,280.99.

4.3. The Result of SROI Model Prediction

This research study attempts to look for the best machine learning algorithms to predict the value of the SROI of Chiang Mai University for each academic project before the university grants funding to those projects. In terms of the results for feature selection, it can display the correlation among them (see Table 9).

Table 9. The correlation among three features (department, time, and budget).

Attribute	Features	Correlation
1	Department	7.76
2	Time	3.74
3	Budget	49.52

Source: Author's computation.

In machine learning, the selection of appropriate input features is critical for the model's accuracy and effectiveness. By analyzing the correlation between features and the target variable (SROI), this research study aims to identify the most influential features. The correlation between each feature and the target variable was assessed, resulting in the following values (see Table 9). The data indicate that the Budget attribute, with a correlation value of 0.4952, is the most significant predictor of the SROI, while the Time attribute, with a correlation of 0.0374, is the least significant. According to data stability, the stability of each feature was evaluated to ensure that the features contain a diverse range of values, which is essential for effective classification in machine learning tasks. Features with less variation contribute less to the model's predictive power (see Table 10).

Table 10. The results of data stability were utilized in training the model for machine learning algorithms to predict the value of SROI.

Attribute	Feature	Stability (%)
1	Department	8.41
2	Time	17.76
3	Budget	5.61

Source: Author's computation.

From Table 10, the results show that the Time feature exhibits the highest stability at 17.76%, suggesting that it may offer less utility in distinguishing between different SROI outcomes. By employing these methods, we aim to optimize the model's performance by focusing on the most relevant and variable features, thereby enhancing the accuracy of SROI predictions.

According to the model training and testing results, it is crucial to select an appropriate machine learning algorithm for SROI predictions. The dataset contains input features and output targets (SROIs), making it suitable for a supervised learning approach. Possible algorithms include Naïve Bayes, Generalized Linear Models, Logistic Regression, the Fast Large Margin, Deep Learning, Decision Trees, Random Forests, Gradient Boosted Trees, and Support Vector Machines. This project treats SROI predictions as a classification task, necessitating the grading of the SROI historical dataset (see Table 11). The choice of grading levels can significantly impact model accuracy, as more grades may increase the risk of incorrect predictions. Table 11 shows the criteria for various grading levels.

Table 11. Presents the classification of grades for the SROI data.

0–2	2–4	4–6
0	1	2

After evaluating the models using Altair AI Studio (see Figure 10 and Table 12), the Fast Large Margin model was found to have the highest accuracy among the options. Along with this model, the Decision Tree and Naïve Bayes were also selected for their notable performance in predicting the SROI (see Table 12).

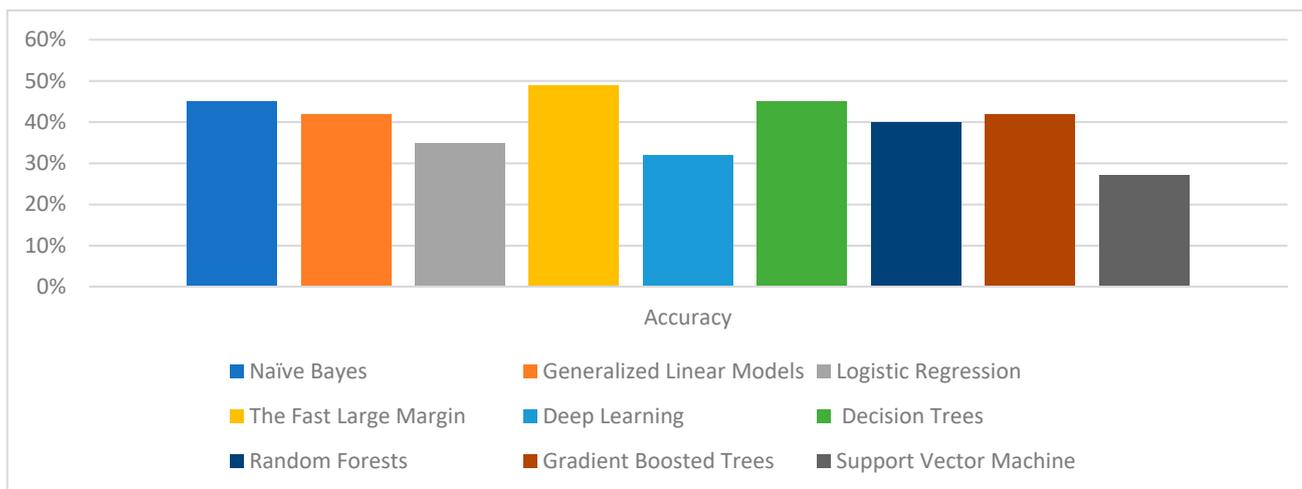


Figure 10. The results of the accuracy of the classification models for the SROI value prediction based on the training model and testing model.

Table 12. Accuracy comparison of models from AI Altair Studio and Python implementation based on training and testing models.

Model	AI Altair Studio	Model from Python
Fast large margin	49%	45%
Decision tree	45%	50%
Naïve Bayes	45%	45%

However, the Fast Large Margin model, initially selected for its high accuracy, showed a slight decrease from 49% in Altair Studio to 45% in Python (see Table 12). Despite this decrease, it remains a key model for forecasting SROI grades due to its overall performance. The Decision Tree model improved in accuracy when implemented in Python, while the Naïve Bayes model maintained consistent accuracy across both platforms (see Table 12).

5. Conclusions and Policy Recommendation

The conclusion and policy recommendation are aligned with the objectives of this research study. The first main objective of this research study is to analyze the socio-economic impacts of Northern Thailand, both from the annual expenditures of Chiang Mai University and to evaluate the economic impact of the university’s educational programs and training initiatives in achieving their intended outcomes. The second main objective of this study is to develop a model for predicting the social impact (SROI) by selecting the best enhanced machine learning algorithms to make Chiang Mai University’s planning more effective in social impact.

For the first main objective of this research study, this research study aims to conclude that the annual expenditures of Chiang Mai University between 2024 and 2025 have a greater economic impact on Northern Thailand’s economy, specifically in both the industry and service sectors, than in the agriculture sector. This result is examined only by the size of the multiplier effect from the output multiplier effect and the income multiplier effect. This finding implies that the annual expenditures of Chiang Mai University between 2024 and 2025 played an important role in driving Northern Thailand’s economy, particularly in these two sectors (Garrido-Yserte and Gallo-Rivera 2010; Fongwa et al. 2023). However, in terms of socioeconomic impact, it can be concluded that Chiang Mai University can be assessed through its contribution to employment generation. Based on this analysis, it can be concluded that Chiang Mai University significantly contributes to employment generation in Northern Thailand, particularly within the agriculture sector. With the region’s economy

still primarily employing workers in agriculture, the university's expenditure of THB 1,000,000 can generate employment for over 703 workers in agriculture, compared to only 113 workers in the industrial sector and 241 workers in the service sector, reflecting the labor-intensive nature of agriculture in this northern Thai economy (Siegfried et al. 2007; Carrascal Incera et al. 2021).

For the conclusion of the economic impact achievement effect based on Chiang Mai University's teaching and learning activities, it was found that the direct impact is higher than the indirect impact on Northern Thailand's economy substantially. The direct impact on Northern Thailand's economy is around THB 2.0 billion in 2023, and the indirect impact on this region is around THB 164 million. The total economic impact from Chiang Mai University's teaching and learning activities is equal to THB 2.1 billion. It is implied that Chiang Mai University not only plays an important role in providing advanced education and training to students but also in driving the Northern Thailand economy substantially (de Jong and Balaban 2022). However, this research conclusion does not include the economic impact of CMU students' spending while studying at Chiang Mai University; also, the spending of CMU staff is not included in this study. Therefore, future research may concentrate on the spending of CMU students and staff, as this spending may still be a significant factor influencing the economic impact on the economies of Chiang Mai City and Northern Thailand (Acevedo-Duque et al. 2020).

However, the IO model has a limitation in analysis when the prices of goods and services are not stable or when substitution effects play an important role in the economy. Additionally, the dynamic economic impact analysis has more bias when using the IO model to analyze the economic impact as well (Dixon and Jorgenson 2013). Therefore, this conclusion might be limited regarding the university's spending impact on the economy, which might have errors occurring in the measurement of this economic impact study.

The last conclusion of this research result is quite technical because the main second object of this study attempts to look for the best model to predict the SROI (Social Return on Investment) for the effective assessment of university academic projects. The Forecast-type SROI is very helpful in providing valuable insights for long-term planning and helps evaluate investments by showing the potential future impact of these projects, especially the academic projects of universities, before investing money (Pathak and Dattani 2014; Zulkefly et al. 2022).

The best model for the SROI prediction for Chiang Mai University is the Decision Tree model. If the model can be applied to other universities, then it might benefit not only Chiang Mai University but also other universities or organizations that would use this algorithm to predict the SROI and project the size of social impact before investing money substantially.

Finally, based on the findings of this research, the formulated policy recommendations highlight three key proposals. The first policy recommendation based on SDG 4 must confirm that financing the education efficiency allocation for the higher education system is the first priority for universities to be concerned with, especially regarding the size of the socioeconomic impact. The second policy suggests that universities must recognize the need to create teaching programs and learning activities that prioritize sustainability based on socioeconomic impact. All teaching programs and learning activities must reflect the university's attempts to enhance the community's living standards and develop society sustainably. The last of the policy recommendations emphasizes that both the public and private sectors must adopt a strong perspective on budget allocation to universities, taking into account that the initial reflection of their socioeconomic impact is the top priority.

Author Contributions: Conceptualization, C.C.; methodology, C.C., C.I., J.S., M.W. and P.E.; software, C.C., J.S., M.W. and W.C.; validation, C.C., W.C. and C.I.; formal analysis, C.C.; investigation, W.C.; resources, B.T. and P.E.; data curation, P.E.; writing—original draft preparation, C.C., J.S. and M.W.; writing—review and editing, C.C. and W.C.; visualization, C.C.; supervision, C.C.; project administration, W.C., C.I., J.S. and M.W.; funding acquisition, W.C. and C.C.; All authors have read and agreed to the published version of the manuscript.

Funding: This research was partially supported by Chiang Mai University [R66IN00331] and Planning Division of Office of the University CMU.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflict of interest.

Notes

- 1 https://universityofcalifornia.edu/sites/default/files/economic-impact-report-2021.pdf?_gl=1*18ia4qo*_ga*NzEwNTE3NzU2LjE3MzA1MzY2MzI.*_ga_FL92T52KS0*MTczMDUzNjYzMS4xLjEuMTczMDUzNzUzNC4wLjAuMA (accessed on 8 October 2024).
- 2 <https://www.nxpo.or.th/th/13522/> (accessed on 8 October 2024).
- 3 <https://so02.tci-thaijo.org/index.php/sahasart/article/view/252989> (accessed on 8 October 2024).
- 4 <https://www.nyu.edu/content/dam/nyu/govCommunAffairs/documents/Government/EconomicImpact/2015-01-14-NYU%20Economic%20Impact%20Report%20Final.pdf> (accessed on 8 October 2024).
- 5 <https://www.ucalgary.ca/sites/default/files/2021-01/University%20of%20Calgary%20-%20Economic%20Impact%20Analysis%20-%20December%202020.pdf> (accessed on 8 October 2024).
- 6 *UW–Madison’s 30 Billion Dollar Impact on the Wisconsin Economy.*
- 7 <https://www.bea.gov/system/files/papers/WP2000-1.pdf> (accessed on 8 October 2024).
- 8 https://provost.gsu.edu/document/usg-fy-2020-gsu-economic-impact/?ind=1627675188021&filename=USG_Impact_2020.pdf&wpdmdl=9403&refresh=66c9d7e02de301724504032. (accessed on 8 October 2024).

References

- Acevedo-Duque, Ángel, Alejandro Vega-Muñoz, and Guido Salazar-Sepúlveda. 2020. Analysis of Hospitality, Leisure, and Tourism Studies in Chile. *Sustainability* 12: 7238. [CrossRef]
- Ambargis, Zoë O., Charles Ian Mead, and Stanislaw J. Rzeznik. 2014. University contribution studies using input-output analysis. In *BEA Working Papers 0105*; Washington, DC: Bureau of Economic Analysis.
- Arunee Punyasavatsut. 2018. Input-Output Analysis. Department of Economics, Faculty of Economics, Kasetsart University (In Thai). Available online: https://kukr.lib.ku.ac.th/kukr_es/BKN_ECO/search_detail/result/409031 (accessed on 8 October 2024).
- Atems, Bebonchu. 2019. The Effects of Government Spending Shocks: Evidence from U.S. States. *Regional Science and Urban Economics* 74: 65–80. [CrossRef]
- Atkinson, Anthony Barnes. 2005. *The Atkinson Review: Final Report: Measurement of Government Output and Productivity for the National Accounts*. New York: Palgrave Macmillan.
- Banke-Thomas, Aduragbemi Oluwabusayo, Barbara Madaj, Ameh Charles, and N. van den Broek. 2015. Social Return on Investment (SROI) methodology to account for value for money of public health interventions: A systematic review. *BMC Public Health* 15: 582. [CrossRef] [PubMed]
- Beck, Thorsten, Asli Demirgüç-Kunt, and Ross Levine. 1995. Finance and Growth: Theory and Evidence. *Handbook of Economic Growth* 1: 865–934. [CrossRef]
- Blackwell, Michael, Steven Cobb, and David Weinberg. 2002. The economic impact of educational institutions: Issues and methodology. *Economic Development Quarterly* 16: 88–95. [CrossRef]
- Blanchard, Olivier, and Roberto Perotti. 2002. An empirical characterization of the dynamic effects of changes in government spending and taxes on output. *The Quarterly Journal of Economics* 117: 1329–68. [CrossRef]
- Caffrey, John, and Herbert H. Isaacs. 1971. *Estimating the Impact of a College or University on the Local Economy*. Washington, DC: American Council on Education.
- Carrascal Incera, Andre, Anastasios Kitsos, and Diana Gutierrez Posada. 2021. Universities, students and regional economies: A symbiotic relationship? *Regional Studies* 56: 892–908. [CrossRef]
- Chan, Ya-Lan, Sue-Ming Hsu, Neo Koe Hsin, and Mei-Hua Liao. 2021. The Social Performance of University Social Responsibility Elderly Project: The Perspective of Social Return on Investment. In *Innovative Mobile and Internet Services in Ubiquitous Computing. IMIS 2020*. Edited by L. Barolli, A. Poniszewska-Maranda and H. Park. Advances in Intelligent Systems and Computing. Cham: Springer, vol. 1195. [CrossRef]
- Charoenkul, Nantarat. 2015. Performance-based budget management in higher education: International perspectives and their effects on Thailand. *Journal of Education, Burapha University* 26: 210–22.
- Chiang, David, Yuval Marton, and Ps Resnik. 2008. Online large-margin training of syntactic and structural translation features. Paper presented at the 2008 Conference on Empirical Methods in Natural Language Processing (EMNLP’08), Honolulu, HI, USA, October 25–27; Stroudsburg: Association for Computational Linguistics.
- Császár, Zsuzsa M., Károly Teperics, Tamás Wusching, Ferenc Györi, Levente Alpek, Klára Czimre, Anna Sályi, and Arnold Koltai. 2019. The impact of the spending habits of international students on the economy of university cities—Case study: Hungary. In *Interdisciplinary Management Research. Interdisciplinary Management Research XV (IMR) Conference*. Opatija: pp. 562–85.

- de Jong, Stefan P. L., and Corina Balaban. 2022. How universities influence societal impact practices: Academics' sense-making of organizational impact strategies. *Science and Public Policy* 49: 609–20. [CrossRef]
- Dixon, Peter, and Dale Jorgenson. 2013. *Handbook of Computable General Equilibrium Modeling*. Amsterdam: North-Holland.
- Elliott, Donald S., Stanford L. Levin, and John B. Meisel. 1988. College impact on the local economy: A bill-of-goods approach. *Growth and Change* 19: 46–58. [CrossRef]
- Fongwa, Samuel, Stewart Ngandu, and Bongwiwe Mncwango. 2023. University engagement as local economic development: Estimating the economic impact of a South African university using a Keynesian multiplier approach. *African Journal of Higher Education Community Engagement* 1: 97–123. [CrossRef]
- Garrido-Yserte, Rubén, and María Gallo-Rivera. 2010. The impact of the university upon local economy: Three methods to estimate demand-side effects. *The Annals of Regional Science* 44: 39–67. [CrossRef]
- Gašperová, Lucia, Lucia Možuchová, and Maria Rostasova. 2017. Economic impact and multiplier effect of university on economic development of the host region. *ICERI2017 Proceedings*. IATED. pp. 8487–93. Available online: <https://library.iated.org/view/GASPEROVA2017ECO> (accessed on 8 October 2024).
- Hazelkorn, Ellen. 2011. *Rankings and the Reshaping of Higher Education*. New York: Palgrave Macmillan. [CrossRef]
- Isard, Walter. 1960. *Methods of Regional Analysis: An Introduction to Regional Science*. Cambridge: The MIT Press.
- Jeffrey, M. Humphreys. 2021. *The Economic Impact of University System of Georgia Institutions on Their Regional Economies in FY 2020*. Atlanta: University System of Georgia. Available online: https://provost.gsu.edu/document/usg-fy-2020-gsu-economic-impact/?ind=1627675188021&filename=USG_Impact_2020.pdf&wpdmdl=9403&refresh=66c9d7e02de301724504032 (accessed on 10 October 2024).
- Keynes, John Maynard. 1936. *The General Theory of Employment, Interest, and Money*. New York: Macmillan.
- Leontief, Wassily W. 1936. Quantitative Input and Output Relations in the Economic Systems of the United States. *The Review of Economics and Statistics* 18: 105. [CrossRef]
- Mangrum, Meghan. 2023. Does Money Matter? How Education Spending Affects Student Outcomes. Education Writers Association. Available online: <https://ewa.org/news-explainers/does-money-matter-how-education-spending-affects-student-outcomes> (accessed on 8 October 2024).
- Miller, Ronald E., and Peter D. Blair. 1985. *Input-Output Analysis: Foundations and Extensions*. Englewood Cliffs: Prentice-Hall.
- Miller, Ronald E., and Peter D. Blair. 2009. *Input-Output Analysis: Foundations and Extensions*, 2nd ed. Cambridge: Cambridge University Press.
- Miller, Ronald E., and Peter D. Blair. 2022. *Input-Output Analysis: Foundations and Extensions*, 3rd ed. Cambridge: Cambridge University Press.
- Pathak, Pathik, and Pratik Dattani. 2014. Social return on investment: Three technical challenges. *Social Enterprise Journal* 10: 91–104. [CrossRef]
- Puttanapong, Nattapong, and Kanit Sangsubhan. 2024. Impact Analysis of the Economic Eastern Corridor on the Thai Economy: An Application of Multi-Regional Input-Output Model and Dynamic Computable General Equilibrium Model. In *The Indonesian Economy and the Surrounding Regions in the 21st Century: Essays in Honor of Iwan Jaya Azis*. Singapore: Springer Nature, pp. 219–60. [CrossRef]
- Rotheroe, Neil, and Adam Richards. 2007. Social return on investment and social enterprise: Transparent accountability for sustainable development. *Social Enterprise Journal* 3: 31–48. [CrossRef]
- Siegfried, John J., Allen R. Sanderson, and Peter McHenry. 2007. The economic impact of colleges and universities. *Economics of Education Review* 26: 546–58. [CrossRef]
- Social Value U.K. 2021. A Guide to Social Return on Investment. Available online: <https://www.socialvalueuk.org/resource/a-guide-to-social-return-on-investment-2012/> (accessed on 8 October 2024).
- Sokolov, Artem, Guillaume Wisniewski, and François Yvon. 2012. Computing lattice BLEU oracle scores for machine translation. Paper presented at the 13th Conference of the European Chapter of the Association for Computational Linguistics (EACL), Avignon, France, April 23–27; pp. 120–29.
- Taskar, Ben, Carlos Guestrin, and Daphne Koller. 2004. Max-margin Markov networks. In *Advances in Neural Information Processing Systems 16 (NIPS 16)*. Cambridge: MIT Press.
- Thirlwall, Anthony Philip. 2011. *Economics of Development: Theory and Evidence*. New York: Palgrave Macmillan.
- UNESCO. 2015. *International Standard Classification of Education: Fields of Education and Training 2013 (ISCED-F 2013) Detailed Field Descriptions*. Montreal: UNESCO Institute for Statistics. [CrossRef]
- Vaiciukevičiūtė, Agnė, Jelena Stankevičienė, and Nomedra Bratčikovienė. 2019. Higher education institutions' impact on the economy. *Journal of Business Economics and Management* 20: 507–25. [CrossRef]
- Vinhais, Henrique, and Joaquim Guilhoto. 2012. Economic Impact of the Expansion of Federal Universities in Brazil. Paper presented at the 59th Annual North American Meetings of the Regional Science Association International, Ottawa, ON, Canada, November 7–12.
- Williams, Rhys, Andrew Pritchard, Maike Halterbeck, and Gavan Conlon. 2021. *The Economic Impact of the University of Glasgow*. Glasgow: University of Glasgow. Available online: https://www.gla.ac.uk/media/Media_816633_smx.pdf (accessed on 8 October 2024).

- Wisniewski, Guillaume, and François Yvon. 2013. Fast large-margin learning for statistical machine translation. *International Journal of Computational Linguistics & Applications* 4: 45–62.
- Yates, Brian T., and Mita Marra. 2017. Introduction: Social Return On Investment (SROI). *Evaluation and Program Planning* 64: 95–97. [\[CrossRef\]](#) [\[PubMed\]](#)
- Zulkefly, Nur Azreen, Norjihhan Abdul Ghani, Christie Pei-Yee Chin, Suraya Hamid, and Nor Aniza Abdullah. 2022. The future of social entrepreneurship: Modelling and predicting social impact. *Internet Research* 32: 640–53. [\[CrossRef\]](#)

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.