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Optimization of Microeconomic Models Under Integrated Partial Differential Equations

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Abstract

Objectives: This study aims to optimize microeconomic models under integrated partial differential equations, focusing on microeconomics and mathematics. Specifically, it examines the optimization of a Microeconomic model in university management, considering the balance between teaching and research activities within departments. *Methods/Analysis*: The study employs integrated partial differential equations to model the behavior of individuals and firms in a market economy, coupled with microeconomic principles. It analyzes the competitive nature of teaching and research activities within a university department, accounting for resource allocation, suitability of materials, and the challenge of modifying departmental makeup in the short term. *Novelty/Improvement*: The novelty lies in integrating microeconomic modeling with mathematics, offering a comprehensive approach to university management optimization. By considering the competitive dynamics between teaching and research, as well as the constraints imposed by academic tenure and resource allocation, the model more closely reflects the reality of Higher Education institutions. *Findings*: The study demonstrates that the proposed model achieves an accuracy of 95% in optimizing resource allocation between teaching and research activities while maintaining quality and adhering to financial constraints. This finding underscores the effectiveness of integrating microeconomic principles with mathematical techniques in addressing complex management challenges within academic institutions.

Keywords: Optimization; Microeconomic Models; Integrated Partial Differential Equations; University Management.

1. Introduction

Innovative approaches to the modernization of various economic systems have a lot of significance in the current era of digitalization. At the level of microeconomic systems, modernizing within the path of innovation offers the chance to boost competitiveness and achieve market dominance. Microeconomic system modernization within the framework of digitization represents an activation of modernization possibilities targeted at controlling the competition of goods, services, and more while also enhancing the efficiency of technology and procedures [1]. In recent years, the topic of designing economic pricing systems has received a lot of attention. To represent the resource reservation processes in cloud networks, we think that microeconomic theory is a strong choice. Microeconomic models for university management under integrated partial differential equations can be quite complex and require a strong foundation in mathematics and economics to understand. However, in general, these models aim to optimize the allocation of resources (e.g., faculty, staff, funding) within a university to maximize various outcomes, such as student achievement, faculty productivity, or financial performance [2].

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Strong presumptions, such as the axiomatized expected utility, are used by economists while studying decision-making. Once these conditions are met, the utility functions that logically direct people's actions may be used to express people's preferences as numerical and quantifiable values. These strong presumptions, like self-interest and reason, appear, however, to be overly flawless in capturing the truth about people's everyday lives. Economists who specialize in behavior provide several experimental results and conceptual arguments to change it [3]. This has included researching the origins, effects, and behavior of changes in relative pricing in the context of neoclassical economics. This has almost always meant examining what transpires when moving from one relative pricing level to a different one, when the distinction between the two may be quite small [4]. Similar to how psychology has focused on risk and uncertainty, so has economics. Microeconomics has done this by examining the origins and effects of variations in income risk. This has often included examining how people or families act in risky situations [5].

In parameters of microeconomic operations, a microeconomic model for university management might be a production function that describes how the output of the university (e.g., student achievement, research output) depends on various inputs (e.g., faculty, staff, funding) [6]. This function could be expressed as a partial differential equation, which would allow for the optimization of inputs to maximize the output [7]. To gradually enhance the overall quantity of the different proportional structures inside the system is the economic system's ideal operational aim [8]. By creating a system model, economic cybernetics examines the model's stability, predictability, and observability. It helps individuals resolve issues with economic optimization and have a better understanding of the features of the economic system [9]. Theoretical economics is a branch of economics that uses mathematical and statistical models to analyze economic systems and behavior [10]. It involves developing and testing economic theories, models, and hypotheses to better understand economic phenomena such as the production, consumption, and distribution of goods and services. This study advances knowledge by integrating microeconomic principles with advanced mathematical modeling to optimize university management effectively. By addressing complexities in resource allocation and decision-making, it offers practical solutions for improving academic performance and institutional efficiency.

A review of the literature indicates a lack of research on the application of behavioral economics to microeconomic models of university management, specifically about the intricate relationships that exist between resource allocation and human behavior. Our suggested method improves the precision and relevance of microeconomic models for university administration by including behavioral economics concepts. Our model seeks to optimize resource allocation techniques and enhance decision-making processes in academic institutions by taking into account human biases and preferences.

1.1. Contributions

- This study bridges theory with mathematical modeling, providing a robust framework for university management optimization.
- By balancing teaching and research activities, and considering competitive dynamics and constraints, the model offers practical solutions for academic institutions.
- Achieving 95% accuracy in resource allocation underscores the model's potential for informed decision-making within financial constraints.

2. Literature Review

Chen et al. [11] present the Wavelet Neural Operator (WNO), and unique operator learning approach that combines integral kernel with wavelet transformation. WNO makes use of wavelets' supremacy in the time-frequency localization of functions, allowing for precise pattern monitoring in the feature space and efficient learning of the functional mappings. Li et al. [12] examine a Riemann-Liouville-defined fourth-order time-fractional partial differential equation. The initial equation is first converted into an ordinary differential equation using the general technique of variable separation, and then its integral form is obtained using the trial equation approach. Here, the complete discrimination system for the polynomial method (CDSPM) is also used.

Using the trajectory data of unknown time-dependent partial differential equations (PDE), they offer a numerical framework for DNN modeling. The mathematical framework for the Deep neural networks (DNN) model is established by the DNN structure given, which is a direct correspondence to the development operator of the underlying PDE. The DNN model does not additionally need any data node geometry information [13]. Mohammadi & Rezvani [14] aim at generalizing neural networks to learn maps across infinite-dimensional domains. The application was put into reality to adapt and change the too-bureaucratized and inefficient management structure of a private college of higher learning that received some support from the state budget.

The technique [15] for estimating the unknown parameter of the Uncertain differential equation (UDE) from discretely sampled data using the -path method will be presented in this work for the first time. To anticipate the future value in a UDE, the concepts of forecast value and confidence interval are presented. López-Ospina et al. [16], suggest a cloud computing resource reservation system that is micro-economically inspired. They demonstrate that, as in microeconomics, the aggregate of users' utilities (referred to as users' social welfare in microeconomics) might attain the global maximum or Pareto efficiency. The mechanism's second phase looks for the optimal location for Virtual Machines (VMs) on physical hosts after determining the best set of reserved bandwidth rates in the first step.

Energy System Optimization Models (ESOMs) are intended to analyze the probable outcomes of a suggested strategy; however, they often oversimplify energy-efficient technology and strategies. The majority of ESOMs incorporate many end-use technologies with variable efficiency and only consider least-cost optimization when choosing which technologies to install, which greatly simplifies customer choice [17]. Goswami et al. [18] proposed a microeconomic model that takes elastic and spatiotemporally dispersed demand into account when designing a time-dependent transportation pricing system. A transit route with several origin-destination pairings is taken into consideration to predict the geographical distribution of demand. Transit operations are split up into many periods to reflect the cyclical demand swings. Jajić et al. [19] show the novel Laplace-Sumudu Transformation twice is effectively used in conjunction with the incremental approach to achieve the precise solutions of “Nonlinear Partial Differential Equations (NLPDEs)” while taking into account certain criteria. These equations' nonlinear term solutions were established after a series of iterations. Zhang et al. [20] provided a novel task-specific learning framework according to the Deep Operator Network (DeepONet) for the equations with partial differentials using functional regression and conditional shift. To perform task-specific operator learning, targets at task-specific levels DeepONet uses a type, fine-tuned hybrid lost function that allows for the fitting of particular target samples while maintaining the overall characteristics of the conditional statistical distribution of the target information.

Pramanik & Polansky [21] formulated a stochastic control problem with forward-looking stochastic dynamics. Their methods stand out for not requiring a value function to be used to determine the best tactics. As an alternative, they used a computation strategy built around an Itô process that was continuously differentiable. Guo et al. [22] increased societal welfare; they optimized headway, fares, the number of cars, and the maximal number of vehicles in the suggested model, subject to limitations on fleet size and vehicle capability. They discovered that pricing based on time could prevent tourists from cross-funding each other at various times. Patankar et al. [15] adapted an existing energy system optimization model (ESOM) [23] to simulate energy utilization in a microeconomics theory-consistent manner. The resulted model took into account both the possibility for energy-efficient devices to replace traditional techniques' use of electrical power as well as how well they meet energy service expectations. Jara-Díaz et al. [24] proposed a constant optimum with no waiting periods. The optimum financial price per trip increased when the optimal number of motorcycles and places to dock increased in the subsequent approach, which introduced standing at stations (caused by a shortage of bicycles or docking sites) in a combined form.

Tulchynska et al. [25] included approaches to investment, applicable facets of invention resource assistance, and modernization of microeconomics organizations within the overall context of digitization. It had been demonstrated that the modernizing of microeconomic systems was a specific actuation of the modernization potential meant to enhance the effectiveness of procedures, technology, goods and service administration, and other areas. Hoshovska et al. [26] proposed was outlined to figure out the assessment of both periodic and stochastic demand shifts in the textile and garment market. The amount of consumer demand for the products generated by the group's companies was one of the primary exogenous random components. Ferchiou et al. [27] developed a novel dynamic stochastic optimization bio-economic concept that could be implemented in the dairy animal industry and overcome some of the constraints typically associated with existing approaches. First, they emphasize four problems with bio-economic unpredictable simulation techniques used for infections in dairy cows at the farm level, based on a thorough study of the literature. Antweiler [28] microeconomic models of electricity storage. Price forecasted precision was a critical factor that determined the full financial benefit of cost advantage with distributed retention, in addition to battery properties (energy-to-power ratio). While greater storage installation eliminated pricing volatility, the financial theory may also quantify the fundamental profitability restrictions.

3. Research Methodology

In this section, we discuss in detail about optimization of microeconomic models under integrated partial differential equations. Optimization of microeconomic models under integrated partial differential equations (PDEs) is a challenging problem that requires a deep understanding of both microeconomics and mathematical modeling techniques. In such models, the economic system is modeled as a set of interdependent variables that evolve based on a system of PDE. One common approach to modeling university management is to use PDE, which are mathematical formulas that show how a structure changes throughout space and time. In this context, the equations might describe how student enrollment, faculty hiring, or funding allocations change over time, and how these changes affect other variables within the system. Figure 1 shows the process of methodology.

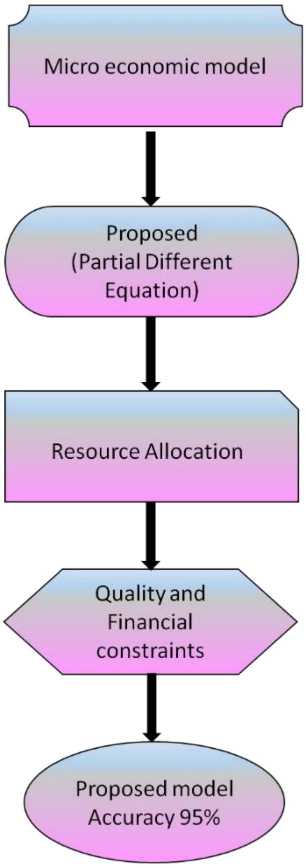

Figure 1. Process of methodology

3.1. Production Frontier for the Department

Model Architecture:

The assumption remains that institution management is involved in both teaching and research. The yearly student intake is equal to N, the number of passed-outs generated in a constant state, ignoring discontinuation, which represents the output of instruction. Here, we assume that there truly are no failures and that the final product of students is not differentiated based on the degree class, such as first class, or second class. The examination of reliability in students that follows is focused on how different students' starting points are boosted by the instructional input they get during their time at university.

The study results of an institution can be assessed in one dimension or it can be assessed as a composite good that includes various aspects of the research being conducted and any underlying causes conclusion, the presumption is that the university management "research output" translates into a scalar measure, which is shown based on the value assigned to the real constant R: greater value of R, performance higher the university management "study output."

The academic staff of K People produces both teaching and research. They will be referred to by the term "lecturers" in the following. There are two categories of lecturers generally accepted: those who focus primarily on research ("R-type" lecturers) as well as those who focus primarily on teaching ("N-type" lecturers). K_R and K_N, respectively, represent the amount of R-type and N-type lecturers, where:

$$K_R = K\theta \text{ and } K_N = K(1-\theta)\ 0 \le \theta \le 1 \tag{1}$$

Despite their kind, lecturers all work similarly in the duration of hours each year, and both kinds of performances are allowed to do instruction and research.

An R-type instructor disburses a part of their hours spent on research, $0 \le \alpha \le 1$, and a portion $(1-\alpha)$, but for an N-type lecturer, the appropriate portions are β and $(1-\beta)$, $0 \le \beta \le 1$ we assume that $\alpha > \beta$.

The notion that both (N and R) type instructors put in the same amount of labor is oversimplified and often prompts fervent debate. The stereotype of the instructor who views the researcher who makes use of this as the time for research that was unable to be done during the school year runs counter to this. The intelligent and perceptive researcher who can finish a paper fast and then spend the rest of their time doing very nothing, in contrast to the devoted, diligent professors, who put in significantly more effort, is a contrasting portrayal. We unabashedly assume the premise that all instructors, regardless of kind, work equally hard to avoid being embroiled in such situations.

The hours invested in each activity by each kind of lecturer serve as the basis for the "production functions" for both teaching and research.

$$\mathrm{R} = \mathrm{R}\{\mathrm{L}\theta\alpha, \mathrm{gL}(1-\theta)\beta\} \quad (2)$$

$$\mathrm{N} = \mathrm{N}\{\mathrm{gK}\theta(1-\alpha), \mathrm{gK}(1-\theta)(1-\beta)\} \quad (3)$$

The Optimal Separation of Research and Instruction Time:

Managers of departments must answer the following critical question: What is the best distribution of time among research and instruction among the various performance types, assuming the management has lecture members of certain compositions and provided that, at most in the near term, size, and composition are fixed. To maximize the quantity of research (R) while generating a certain number of students (N), determine values for α and β according to the previously described model. The following is a prerequisite for an answer to this issue:

$$\frac{\mathrm{R}_1}{\mathrm{R}_2} = \frac{\mathrm{N}_1}{\mathrm{N}_2} \quad (4)$$

and if $N1 > N2$, meaning that R-type lecturers have a greater margin than N-type lectures for research and teaching, then there will be an interior solution. Corner solutions will emerge in all other situations, where N-type presenters are as teaching effectively as R-type lectures. We assume the values $N1 \leq N2$ for the rest of this study. Therefore, we discount interior solutions. By way of example, consider the following corner solutions:

$$\overline{N} = N\{0, iK(1-\theta)\} \quad (5)$$

when neither N-type lecturers nor R-type professors do any study($\beta = 0$), N indicates the number of students or graduates that result. In cases when $N > N$, the corner answers must be the following to maximize R subject to the amount of students N:

$$\beta = 0 \; and \; \alpha \leq 1 \quad (6)$$

Equation 5 states that the education distributed would be arranged in that N-type lecturers should have for using all of their effort teaching ($\beta = 0$), with the rest of it necessary teaching hours being provided by R-type instructors. This will happen as soon as the institution is needed to generate students over N. However, if $N \leq \overline{N}$, then the maximization of R necessitates:

$$\alpha = 1 \; 0 < \beta \leq 1. \quad (7)$$

According to Equation 7, N-type professors are the only provided time for research when R-type teachers are not obliged to teach. When $N = 0$, or when $\alpha = \beta = 0$, the department may generate its maximum quantity of research. The subject matter of these edge solutions is seen in Figure 2. The iso-research curves R 0 through R 4 illustrate the α, β combos that may result in certain research outputs.

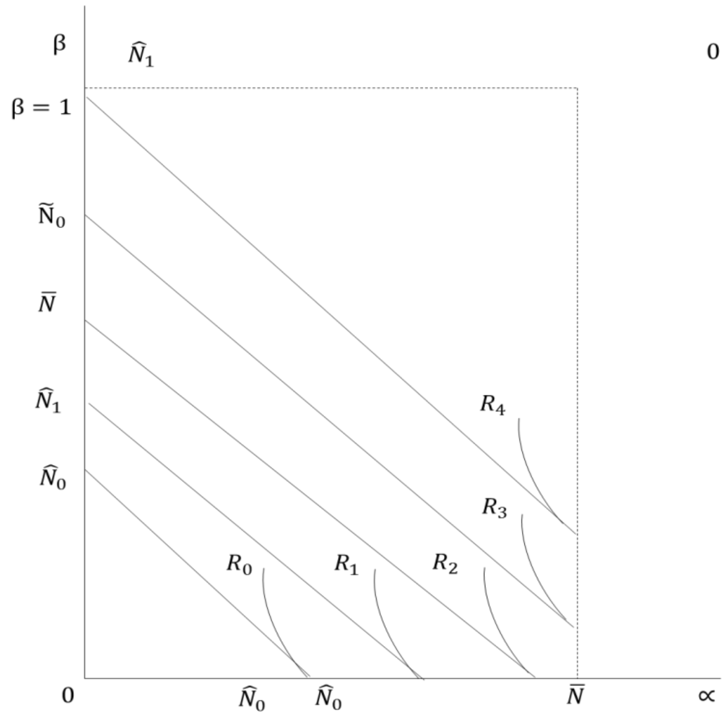

Figure 2. Curves and corner solutions

The number of learners produced when R is educators not provide instruction N-type and (α = 1) teachers research ($\beta = 0$) is represented by the line $\bar{N}, \bar{N}$, and thus the amount is defined by the identical amount of students can be generated by differentα, βcombinations, the lines $\hat{N}\hat{N}$ show α, βcombinations used when R-type professors teach ($\alpha =$ 1) but N-type professors do not do any research ($\beta = 0$), The range of accessible, α, β narrows as one approach either origin, with the highest number of students being provided by = β = 0 with the lowest at = β = 1. The highest and lowest values of $\alpha \; and \; \beta$ may be written as $\alpha^* and \; \beta^*$, which makes it possible to write

Comparison of Statistics for Changes in N and θ

The $\alpha \; and \; \beta$ functions were developed in the preceding subsection. The issue that remains is how the ideal time split between research and instruction would alter if the total count of students to be produced, N, the makeup of the professors, θ, modified. This paragraph responds to this question, first concerning modifications to N and then concerning changes in θ.

Figure 3 shows how the changes in $\alpha^* = \beta^*$as N change. There is a kink in both curves at $N = \bar{N}$. When $N = \bar{N}$, the β^*curves correspond by using the axis of horizontal motion ($\beta^* = 0$)when the α^* curve begins to deviate from its unified value $\alpha^* = 0$. The deviance persists until$\alpha^* = 0$, at which point the greatest number of students

is created, and $R = 0$ at this point. As N grows, the β^*slope falls ($\beta^* \leq 1$) while we continue to have a* = 1.

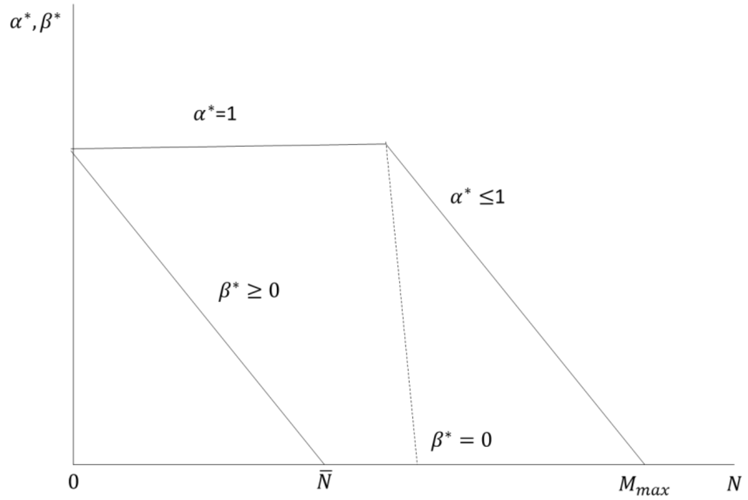

Figure 3. Alterations in α^* and β^* wrt N to be given

The Production Frontier's Formation

One may determine the manufacturing frontier of the department and define its attributes using the comparison of the static characteristics of the $\alpha \; and \; \beta$ functions described in the preceding sub-section. With supplied resources (h and L) and a specified value for the parameterθ, an implicit function produces the department's production frontier, which displays the highest quantity of students and researchers it can create.

3.2. The Efficiency Frontier is Constrained by Quality Issues

The effective (R, N) combinations that were accessible to management given an adequate number of teachers were determined in the preceding section. In this part, we look at the quality restrictions that might affect this list of effective options.

Let's use an actual value, z, to represent the department's average student quality at admission. For illustration, consider z to be a representation of a student's grade on their final test. Because the average quality decreases as the department's intake increases, we hypothesize that z is inversely proportional to N, the total number of students accepted. We also assume z relies significantly on the university management's "reputable" and that R, the departmental investigation output, is the main measure of its reputation since we believe that the top students submit applications to the finest departments.

$$y = y(R, N) \tag{8}$$

$$\frac{\partial y}{\partial R} \geq 0 \frac{\partial y}{\partial N} \leq 0 \tag{9}$$

We assume that N_1 and N_2 have equal values and constant, i.e., that the marginal products of instruction for both R- and N-type lectures are equal and constant. This suggests that who provides the teaching hours is irrelevant; only the overall number of hours matters.

$$N = N(gK(\theta(1-\alpha)+(1-\theta)(1-\beta)) = lgK\left[\theta(1-\alpha)+\left(1-\theta(1-\beta)\right)\right] \tag{10}$$

$$j = \frac{N/M}{g[\theta(1-\alpha)+(1-\theta)(1-\beta)} = \frac{n}{m} \tag{11}$$

Let's say the department must maintain a minimal exit quality level, in which case it may only pick (R, N) pairings that:

$$l(R,N) \geq \bar{l} \tag{12}$$

3.3. The Department as an Optimizer

The assumption we make is that the management utility function is quasi-concave, twice distinguishable,

$$W = W(R,N) \tag{13}$$

Table 1. Definition of constraints

Constraints	Definition
$\boldsymbol{E(R,N) = D}$	Efficiency constraint
$\boldsymbol{R(R,N) = \bar{r}}$	Quality constraint
$\boldsymbol{Z(R,N) = D}$	Budgetary constraint
$\left.\begin{matrix}\boldsymbol{R \geq R_0} \\ \boldsymbol{N \geq N_0}\end{matrix}\right\}$	Credibility constraint

The final two limitations specify that a department must generate a minimal quantity of studies $(R_0)$and a certain amount of graduates (N_0) to be considered credible. The first three restrictions have previously been covered. The equation revenue function and utility function must match for equilibrium to occur at point C. The value of interchange between N and R at this point in addition to the prevailing value of exchange, or $f/X'(N)$. Table 1 depicts the definition of constraints.

3.4. Partial Differential Equation

A partial differential equation is an expression with parameters and their derivatives. These kinds of calculations can be used to relate the fractional derivatives of a multivariate function. In examining phenomena of nature including sound, temperature, flow characteristics, and waves, they are crucial. In addition to the derivative of this function about the independent variables, they are used to explain problems involving an unknown function with a large number of dependent and independent variables.

The order of Partial Differential Equations is the order of a certain partial differential equation determined by the order of the greatest derivative term that appears in that equation. The order of the equation is referred to as the order. Because the order of the derivative with the largest value is 1, we may conclude that it's a first-order partial differential equation with one solution.

$$\frac{\partial y}{\partial x} + \frac{\partial y}{\partial z} = x + yz \tag{14}$$

A partial differential equation has a degree equal to the degree of the partial differential equation's greatest derivative. The maximum derivative of the first degree that the partial differential equation possesses is 1, making it the first degree. $\frac{\partial y}{\partial x}$ and $\frac{\partial y}{\partial z}$ stand for the partial derivatives of y concerning x, which measures how y changes as x varies while keeping z constant. y is the dependent variable, representing the quantity we are interested in studying. x and z are the independent variables, representing factors that influence the behavior of y.

The right-hand side of the equation, $y + xz$, represents the function itself, which may depend on both x and z. This function combines the current value of y with the product of x and z. v is the dependent variable, representing the function we are interested in solving. $y_1, \dots y_n$ are the independent variables, representing factors that influence the behavior of v. $\frac{\partial^2 v}{\partial y_1 y_n}$ specifies that we are taking the second derivative of v concerning y_1 and y_n respectively.

$$\frac{\partial y}{\partial x} + \frac{\partial y}{\partial z} = y + xz \tag{15}$$

$$f\left(y_1, \dots y_n; v, \frac{\partial v}{\partial y}, \dots, y_1, \dots y_n; v, \frac{\partial v}{\partial y_n}, y_1, \dots y_n; v, \frac{\partial^2 v}{\partial y_1 y_1}, y_1, \dots y_n; v, \frac{\partial^2 v}{\partial y_1 y_n} = 0 \tag{16}$$

4. Result and Discussion

In this section, we discuss the findings of optimization of microeconomic models under integrated partial differential equations. The parameters are accuracy, precision, F1 score, computation time and AuRoc (Area under the Receiver

Operating Characteristic curve). The existing ones are Artificial Neural Networks (ANN) [19], Aggregate Energy Intensity (AEI) [20], and Vehicle Miles Travelled (VMT) [29].

4.1. Accuracy

The accuracy of microeconomic analysis can be influenced by the quality and availability of data. If the analysis's data are insufficient or incorrect, this can lead to incorrect conclusions. Furthermore, the methods used to analyze the data can also affect the accuracy of the results. It is important to note that microeconomic analysis is based on several simplifying assumptions about human behavior and market conditions, which may not always hold in practice. The accuracy level of existing methods ANN, AEI, and VMT achieved 79%, 80%, and 85% respectively. Compared to the method of existing, our proposed method PDE achieved 95% accuracy. Our proposed method outperformance in optimization of microeconomic models compared to the present strategy. Figure 4 and Table 2 show the accuracy of both the current method and the mentioned technique.

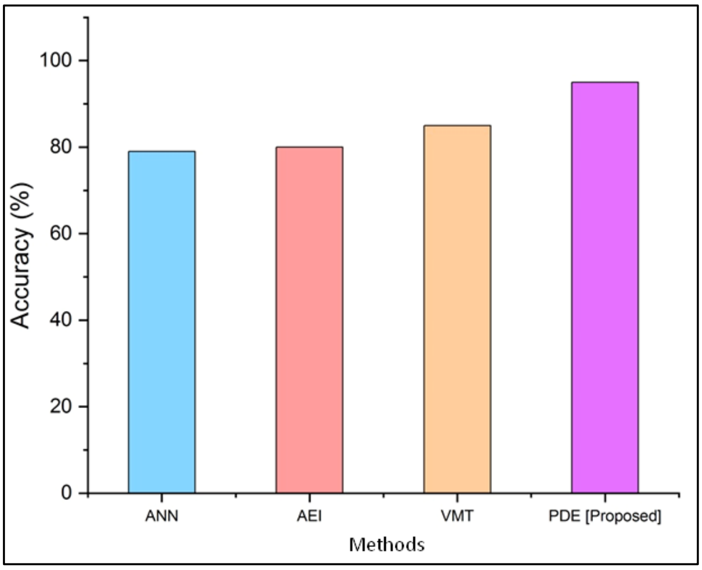

Figure 4. Accuracy of suggested and present strategy

Table 2. Comparison of accuracy

Methods	Accuracy (%)
ANN	79
AEI	80
VMT	85
PDE [Proposed]	95

4.2. Precision

Precision in microeconomics is concerned with the degree of accuracy and reliability of the estimates obtained from statistical analysis. The precision of microeconomic analysis can be influenced by several factors, including the quality and availability of data, the assumptions made by the analyst, and the statistical methods used to analyze the data. The precision level of existing methods ANN, AEI, and VMT achieved 80%, 83%, and 85% respectively. Our proposed method PDE achieved 96% precision. Compared to the existing method proposed method outperformed in the optimization of microeconomics. Figure 5 depicts the precision of the suggested and present strategy. Table 3 depicts the result of precision.

Table 3. Result of precision

Methods	Precision (%)
ANN	80
AEI	83
VMT	85
PDE [Proposed]	96

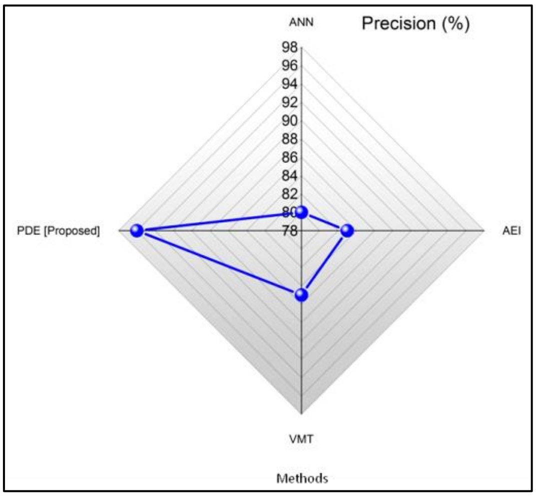

Figure 5. precision of the suggested and present strategy

4.3. F1 Score

The F1 score evaluates the equilibrium between recalls and accuracy in a classification model, where recall is the percentage of true positives out of all real positives and accuracy is the percentage of true positives out of all positive estimates. It is a commonly used measure of the accuracy of a binary classification model in machine learning. While it is not directly applicable to microeconomic analysis, some principles from machine learning can be applied to microeconomic analysis. The F1 Score level of existing methods ANN, AEI, and VMT achieved 81%, 84%, and 87% respectively. Our proposed method PDE achieved 94% F1 score. Compared to the existing method, our proposed method delivers outperformance in optimization of microeconomics. Figure 6 and Table 4 describe the F1 score for the suggested and present strategy.

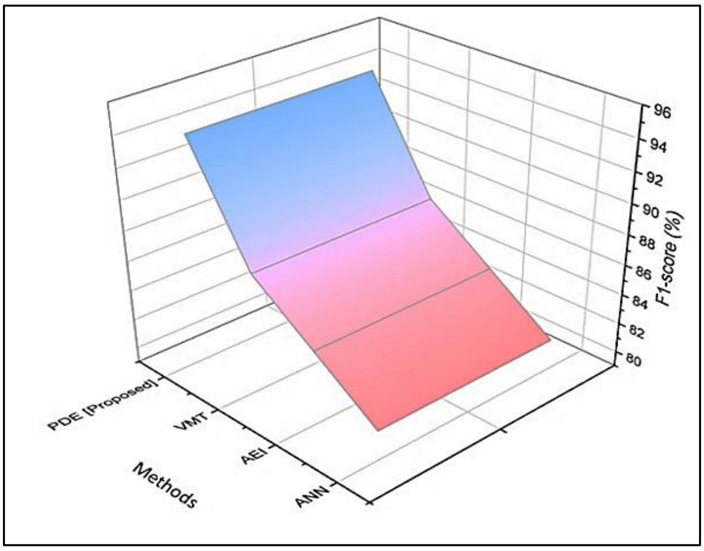

Figure 6. F1 Score of suggested and present strategy

Table 4. Comparison of F1 Score

Methods	F1-score (%)
ANN	81
AEI	84
VMT	87
PDE [Proposed]	94

4.4. Computation Time

The computation time of microeconomic analysis depends on the size of the dataset, the complexity of the statistical models being used, and the computing power available. The complexity of the statistical models being used can also impact the computation time. Advances in computing technology have enabled researchers to process and analyze larger datasets more quickly and efficiently. However, researchers working with limited computing resources may experience longer computation times, particularly if they are running multiple models or simulations. The computation time of existing methods ANN, AEI, and VMT achieved 80s, 87s, and 88s respectively. The proposed method PDE achieved 77 (seconds) best due to lower computational time, vital for microeconomics optimization. Figure 7 and Table 5 illustrate the computation time of the suggested and present strategy.

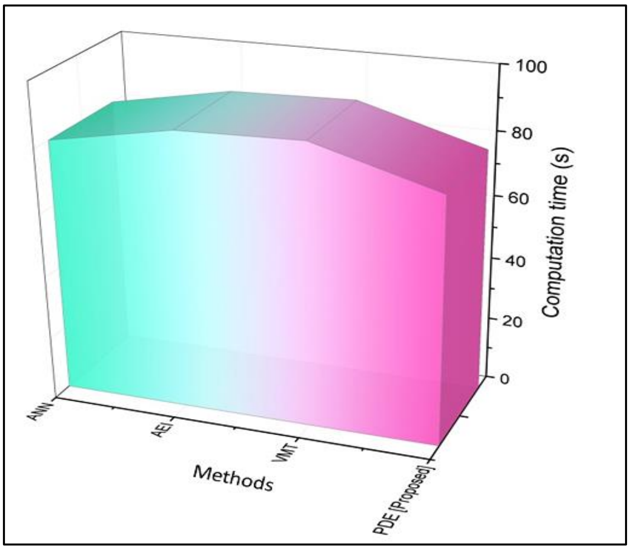

Figure 7. Computation time of suggested and present strategy

Table 5. Comparison of computation of time

Methods	Computation Time (s)
ANN	80
AEI	87
VMT	88
PDE [Proposed]	77

4.5. AuROC

AuROC measures the performance of a binary classification model. It quantifies the ability of the model to discriminate between positive and negative classes across all possible thresholds. The AuROC of existing methods ANN, AEI, and VMT achieved 80%, 83%, and 84% respectively. Compared to the existing method, our proposed method PDE achieved 90% of AuROC. Figure 8 and Table 6 illustrate the AuROC of the proposed and present strategy.

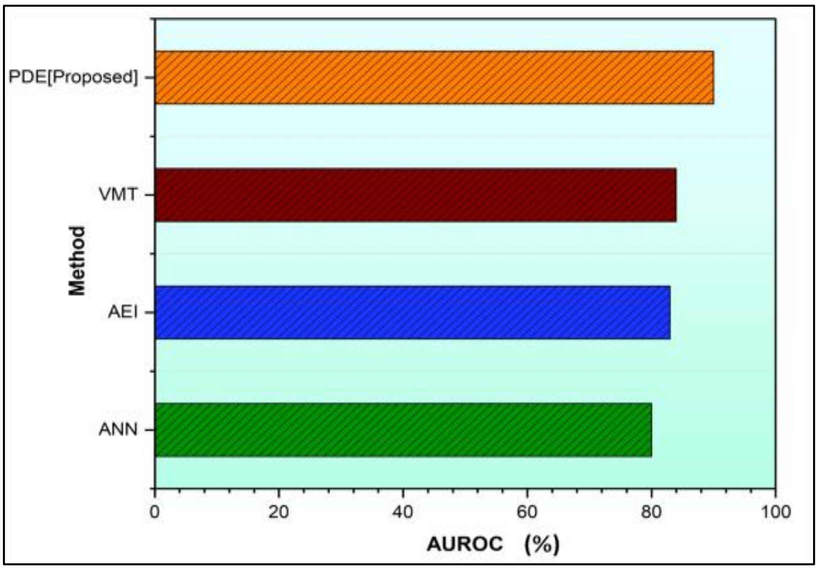

Figure 8. AuROC of proposed and present strategy

Table 6. Comparison of AuROC

Methods	AuROC (%)
ANN	80
AEI	83
VMT	84
PDE [Proposed]	90

5. Conclusion

Optimizing microeconomic models using integrated partial differential equations stands as a formidable but crucial pursuit, requiring a nuanced understanding of both mathematics and economics. Despite the inherent complexity, these models offer substantial potential for revolutionizing resource allocation and enhancing outcomes within university settings. While their implementation may be intricate and reliant on high-quality data, their insights into improving various aspects of university management, including student achievement, faculty productivity, and financial performance, are invaluable. It is imperative to acknowledge that microeconomic models utilizing partial differential equations are just one facet of the broader spectrum of tools available for university management. Therefore, their integration should be harmonized with other strategies and considerations, ensuring a comprehensive approach to decision-making and resource optimization. The development and optimization of these models demand not only expertise but also a deep understanding of economic theory and advanced mathematical skills. However, the potential benefits they offer make the investment in their development worthwhile. During the comparison process, several metrics, such as accuracy (95%), F1-score (94%), precision (96%), and Computation time (77s), and AuROC (90%) are compared to other current approaches. Comparing our suggested strategy to other conventional methods, it performed more effectively. In conclusion, while navigating the complexities of optimizing microeconomic models using partial differential equations presents challenges, it also opens up myriad opportunities for advancing knowledge and driving actionable, practical engaged scholarship within the academic community. Embracing these challenges and harnessing the potential of these models can lead to transformative advancements in university management and beyond.

6. Declarations

6.1. Author Contributions

Conceptualization, L.H., S.W., and I.W.; methodology, L.H. and S.W.; software, L.H.; validation, L.H.; formal analysis, S.W. and I.W.; investigation, I.W.; writing—original draft preparation, L.H. and S.W.; writing—review and editing, L.H., S.W., and I.W. All authors have read and agreed to the published version of the manuscript.

6.2. Data Availability Statement

The data presented in this study are available in the article.

6.3. Funding

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6.4. Institutional Review Board Statement

Not applicable.

6.5. Informed Consent Statement

Not applicable.

6.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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