SCIENTIFIC CULTURE
www.sci-cult.com

SCIENTIFIC CULTURE, Vol. 12, No. 1.1, (2026), pp. 3344-3356
Open Access. Online & Print

DOI: 10.5281/zenodo.121126243

USING THE SIMPLEX METHOD TO IMPROVE SALES VOLUME IN E-COMMERCE MARKETS

Somaia Osman Mohamed Abdelgadir[1], Ahmed Osman Ibrahim Ahmed[2]

[1]College of Business, Department of Business Administration, Imam Mohammad Ibn Saud Islamic University.
[2]Faculty of Applied Studies and Community Service, Department of Business Administration, Imam Abdul Rahman bin Faisal University.

Received: 18/09/2025
Accepted: 27/01/2026

Corresponding Author: Dr. Somaia Osman Mohamed Abdelgadir (somaiagadir@hotmail.com)

ABSTRACT

This study aims to identify the role that one of the operations research methods (the simplex method) can play in overcoming the challenges facing e-commerce channels, which strive to achieve maximum sales volume. This mechanism is based on the principle of linear programming, where an initial solution is formulated to address the problem of maximizing profits or minimizing costs. The solution is then refined using the simplex method or the major (M) method to ultimately reach the maximum production volume, which in turn maximizes profit value. The study showed that sales in e-commerce markets result from the interaction between price levels, promotional intensity, consumer behavior, and product assortment decisions. The study also highlighted the importance of sensitivity analysis, given its ability to measure variables without affecting the optimal production quantity. The primary objective is to provide decision-makers with the flexibility to deal with changing market conditions, such as price volatility, and to ensure the soundness and quality of the decisions made. The study also highlighted the importance of determining the shadow price, a concept used to identify the opportunity cost or the expected increase in profits from acquiring an additional unit of a scarce resource. This is particularly crucial given the intense competition in the e-commerce world. The study recommended designing effective marketing and promotional strategies using quantitative analysis tools such as the simplex method and its related techniques, like sensitivity analysis or shadow pricing. These tools help in dealing with the rapid and unexpected changes in markets, especially in the world of e-commerce and digital marketing.

KEYWORDS: Operations Research, E-Sales, E-Commerce Platforms, The Simplex Method, Linear Programming.

1. INTRODUCTION

To commence, it is imperative to elucidate the nature of the electronic marketplace, a domain that distinctly diverges from traditional physical retail environments, thereby expanding the array of vendors, products, and price points accessible to the consumer. In this digital sphere, online marketplaces exhibit a remarkable agility in responding to fluctuations in sales, enabling consumers to assimilate information at an accelerated pace. For example, a mere decrement of $10 in the price of a 4GB RAM module may catalyze the acquisition of an 8GB RAM module, fueled by the anticipation that the price of the former will continue to decline once it is out of stock. This shift in consumer focus has the potential to substantially enhance the sales volume of the 8GB RAM, contingent upon the vendor's capacity to satisfy the demand initially directed towards the 4GB RAM. Empirical studies have demonstrated that optimal sales volume can be achieved by strategically determining a framework of pricing and promotional levels for a range of products throughout a designated selling period. Thus, the overarching aim is to maximize sales volume derived from various platforms through a meticulously delineated set of marketing decisions. The Simplex Method emerges as an instrumental resource in this pursuit, facilitating the quantification of the intricate trade-off relationships among diverse marketing strategies while concurrently allowing for real-time monitoring of resource allocation. (Calvete et al., 2019)(Lü et al., 2009)

1.1 Problem Statement and Objectives

Electronic sales channels seeking to maximize sales volume face a complex trade-off among different marketing and pricing decisions. Therefore, the objective of this research is to apply the Simplex Method to maximize sales volume in electronic marketplaces. The challenge is to decide across four major criteria—units sold, price per unit, promotional expenditure, and sales-assortment characteristics—subject to six additional constraints representing the limits of resources, capacity, and market factors.

The Standard-Form Simplex Method of linear programming underlies the proposed approach. Within a structured methodology, it enables sales-volume decisions to be translated into pricing and promotional strategies. The procedure begins by configuring an initial basic feasible solution and an associated tableau, which represent a set of marketing and inventory decisions that optimize sales volume while exactly meeting resource and capacity constraints. The solution is iteratively improved by pivoting and updating the tableau until an optimal status, where entering and leaving variables can no longer be selected, is reached. Trends in the basic feasible solution indicate how adjustments in price, promotion, and assortment can sustain sales volume across varying market conditions.

1.2 Overview of the Simplex Method

Before delving into the topic of the simplex method, we must familiarize ourselves with some basic concepts in operations research, given that linear programming and the simplex method are considered elements of operations research.

Operations Research as a Quantitative Introduction to Administrative Decision Making: (Ali & Al Fadul, 1999)

The primary goal of operations research is to consider the decisions made in any facility, whether production or service decisions, as a specific solution to a specific problem. Through this system, quantitative methods and tools usually play their role in providing the data and digital indicators necessary for the decision-making process in order to reach the optimal solution. Operations research is the general framework that combines these methods and tools.

The usefulness of operations research as a quantitative input in practice is evident through the following matters: (Ali and Al-Fadul)

- It contributes to the process of bringing the problem closer to reality according to simple practical formulas and specific mathematical models that reflect the circumstances of the problem within the framework of organized and rational scientific thinking.
- Circulating standard and ideal criteria for decision-making, as the administration that is able to develop a specific mathematical model for a problem can apply this model in the future when it faces a similar problem.

Business establishments depend on two types of analysis: (Al-Sayed, 2003)

- Qualitative Analysis

-Quantitative Analysis

Where qualitative analysis depends on the judgment of the director and his personal experience, and then it can be described as an art rather than a science. The roots of this approach go back to the old administrative schools that used trial and error method. (Mousawi, 2009). If the manager has little experience or is not aware of the problem in question, then the manager in this case must rely on quantitative analysis and on the data and facts accompanying the problem in preparation for developing a mathematical expression to describe the goals, constraints and relationships involved in the problem. The following is a figure showing the relationship between decision-making and quantitative and qualitative analysis:

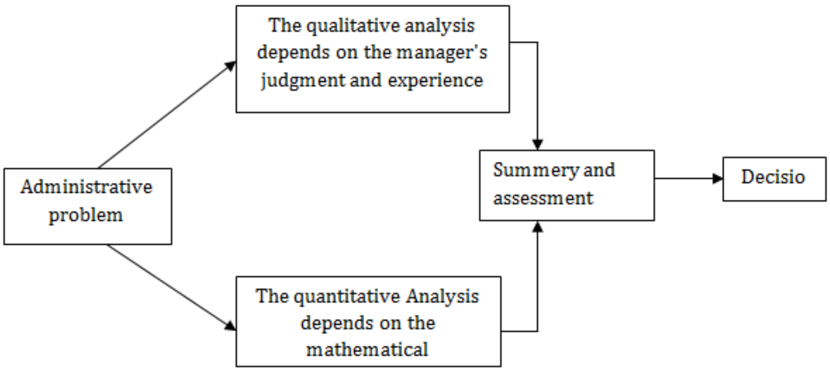

Figure (1/2): The relationship between decision-making and quantitative and descriptive analysis.
Source: Anderson, David R, Sweeney, Dennis j, A. Williams., Quantitative Methods For Business, Second Edition, U.S.A, West Publishing Co, 1983, P : 2

1.3 Different Definitions of Operations Research

The Operations Research Society in the United Kingdom defined it as (the application of scientific methods to the complex problems that arise when directing and managing large systems of people, equipment, materials, and funds in the field of industry, commerce, government, and defense, and the distinctive approach is to prepare a scientific model of the system that includes a measure of factors According to this model, the returns of the various alternative decisions and strategies can be predicted and compared with the aim of assisting the administration in determining its policy and procedures in a scientific manner). Herman, 1969)

As for Dantzing, he defined it as (management science), meaning the science of making and implementing decisions. (Herman, 1969)

(Wagner) defined it as "the science approach used to solve problems encountered by top management). (Herman, 1969)

The researcher reached the following definition of operations research through the previous definitions: (It is the science that uses quantitative and digital means and mathematical models to reach the optimal decision that helps the organization to solve problems and confront environmental variables in light of the available human and material resources).

1.4 General Steps to Operations Research Methods: (Herman, 1969)

Despite the multiplicity of tools and methods used in operations research applications, they all agree on the main elements that make up the common general set of steps for operations research methods. The following figure shows these steps:

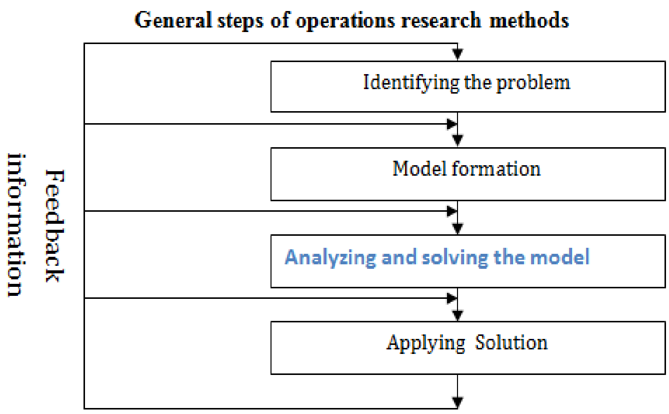

Figure (2/2)
Source: Farid Abd Alfatah zain Alabdeen:"Resources of operations and their application in problems resolution and decision making" Vol.1, Cairo,1997, p.13-In Arabic

In the previous section, we dealt with the methods of operations research, and below we will deal with the queue models in some detail.

The Simplex Method

The simplex method is considered the general method of linear programming. Its importance emerged after the graphical method proved insufficient for solving linear programming problems, especially when the number of variables exceeded two. When multiple variables are involved, the simplex method is employed, offering a more advanced approach to achieving optimal solutions without the need for graphical methods.(Ahmed, 2018)

The simplex method is the most widely used linear programming method and is distinguished by its ability to handle highly complex administrative problems. Like the graphical method, it requires expressing the relationships of the administrative problem under study in a mathematical form that shows both the objective function and the constraints inherent in the decision situation.

Furthermore, the use of computers and the software available for running them has eliminated any complexities in special cases where the mathematical formulation of the problem is large.

1. The Solution Mechanism of the Simplex Method:(Ahmed, 2018)

The simplex method is one of the most widely used methods for solving linear programming problems related to production management and planning because it is based on pure algebraic principles. This method consists of three basic steps:

- Formulating the basic possible solution to the linear programming problem.
- Verifying the optimality of the solution. If the solution is optimal, the process stops. If it is not optimal, we proceed to step three.
- Developing the basic possible solution by creating a better alternative using a specific method. Once the second solution is developed, we repeat step two to verify its optimality. If it is optimal, the process stops. If it is not optimal, we proceed to steps two and three until we arrive at the optimal solution that satisfies the objective function of the problem

2. Summary of the Simplex Method Steps

1. Represent the problem as linear programming.
2. Convert the inequalities to equalities by adding random variables.
3. Extract the coefficients from the equalities to create a simplex table.
4. Find the initial solution to the problem.
5. Check if the current solution is optimal (all coefficients of the objective function are less than or equal to zero). If yes, the problem is solved. If no, find the optimal solution as follows:
   a. Identify the optimal column, which is the column corresponding to the largest positive value of the objective function coefficients.
   b. Identify the row to replace, which is the row corresponding to the smallest value resulting from dividing the right-hand side of the equalities by the elements of the optimal column.
   c. Find the new row to replace the row replaced in (b). b) Find the remaining rows following the new row identified in step (c) by subtracting the elements of the new row and multiplying by the intersection point of the old rows with the optimal column of elements from the old rows.
   d) The table obtained after completing step (d) represents the optimal solution sought from point (a).
   e) Examine the solution obtained in step (c) to determine if it represents the optimal solution. If so, the problem is solved. If not, repeat step (5) until you find the optimal solution.

2. MODELING SALES IN ELECTRONIC MARKETS

Sales in electronic markets are influenced by marketing and inventory decisions influenced by pricing, promotional campaigns, product assortments, sales channels, and numerous market factors (Gahler & Hruschka, 2016). These topics have been described using multistage decision frameworks, structural models, and empirical analysis of market response for essential marketing inputs under limited information (Bai et al., 1970). This work uses the Simplex Method establish the impact of marketing actions on sales volume and help determine allocations across campaigns and channels.

Clearly defining the objectives and decision variables is crucial. The goal is to maximize sales, measured in either expected total quantity sold or total expected revenue, while ensuring that marketing investments and inventory levels stay within their budget. Each action, such as adjusting prices, launching ad campaigns, and promoting products, will have an associated investment estimate, and a model is needed to estimate the expected sales impact for given values of those marketing activities.

2.1 Decision Variables and Objective Function

Sales in electronic markets typically depend on several decision variables such as price, promotion level, and product assortment. The objective is to maximize the total number of units sold, or total revenue if conditions permit, where:

- The number of units sold is the sum of all the individual sales from the market, and
- All decision variables and the objective are expressed in consistent commercial units, such as thousands of units (or other measuring units).

The simplex method supports the construction of this optimization model by explicitly identifying and quantifying trade-offs among various constraints, such as inventory, budget, advertising impressions, server capacity, and market-specific limitations. Each constraint intersects with one or more of the decision variables, allowing an understanding of the effect of these variables on the overall commercial strategy.

2.2 Constraints: Resources, Capacity, and Market Factors

Sales volume depends directly upon the level of available inventory, the budget for price discounts and advertising, the number of advertising impressions, and the server capacity for daily orders. The initial Simplex tableau for the online commerce environment thus includes restrictions from these functional areas (Li et al., 2017). After the price is fixed, market response dictates the corresponding customer volume and resource constraints determine the marketing promotion level, which also influences the order and inventory level. Without adequate promotional resources, the sales volume cannot be guaranteed (J. Kleywegt & Shao, 2022). Further details concerning data origins and treatment of missing information are available in Section 3.3; connections back to the overview of the Simplex Method are noted.

2.3 Assumptions and Data Requirements

Maximizing sales volume in electronic markets involves setting price, promotion, and assortment decisions, necessitating simultaneous consideration of demand information and resource constraints—demand estimates inform potential volume while limited inventory and budget shape attainable levels. The Simplex Method helps quantify trade-offs across constrained objectives. Sales-volume optimization offers valuable insights toward maximizing revenue in online channels; when price and promotion variables are independent, the two objectives are identical. Moreover, trade-offs across constraints arise in other key problems (Remenyi & Luo, 2020).

Pricing, promotions, and assortment decisions affect the sales volume of products in electronic markets. Therefore, estimated demand and pricing influences across a mix of choices are required. Because demand also responds to budget, inventory and advertisement levels shape attainable volume. The Simplex method precisely quantifies trade-offs across such constraints. Hence the approach targets sales volume, providing valuable insights toward maximizing revenue through electronic channels. When price and promotion are independent, the two objectives align; furthermore, trade-offs across constraints regularly arise in other pivotal marketing problems.

3. FORMULATING THE LINEAR PROGRAM

Sales volume in electronic markets can be optimized through the Simplex Method. The linear program seeks to maximize total sales or sales revenue across many products, given several constraints, such as a limited advertising budget, a predetermined number of advertisement impressions, and limited inventory and production capacity (Hasanah et al., 2019). Most parameters depend on a selected combination of selling price and promotional values for each product. The Simplex Method calculates the best choice and additional promotional advertising beyond stock limits will increase the total number of products sold. However, these additional promotions expose to the risk of lowering the expected marketing effect of advertisements on the advertising value cycle; trade-offs between this possibility and inventory availability are maximized.

3.1 Decision Variables and Objective Function

The simple linear program presented model is a fundamental discrete-continuous optimization problem in nonlinear programming. The parameter will still behave in a linear relationship as long as the values are in a specific range. The variables associated with any linear program must include total units sold, pricing of all products, and promotion levels of each product. Consequently, it needs to maximize the total number of units sold (or revenues corresponding) represented in equation 1.

3.2 Constraints: Resources, Capacity, and Market Factors

Sales are affected by many factors, some of which are controllable and some of which are not. The controllable factors include price levels, promotion levels, advertising expenditure, and so on. Response functions will be affected by the exogenous factors such as competitors' pricing strategies, competitors' stock of products, reputation and image of the same brand, availability of such products in the same market spot, and many economic indicators and changes as well. The strategy presented in this work is to concentrate on part of the controllable factors while complying with other limits, therefore, the price and promotion levels become the focus of this linear program; other factors can also be inserted into the program through an external modification.

3.3 Standard Form and Slack Variables

To apply the Simplex Method, it is necessary to express the problem in standard form. A Linear Program is in standard form when all the decision-variable inequalities are flipped to be weakly less than or equal to (rather than greater than or equal to), there is a right-hand side for every constraint, and all of the decision variables are non-negative. This last condition can always be satisfied by adding slack variables to represent unused resources, conceptualizing shipments and bundles as shipments that meet demand exactly (with possible cost penalties), or ignoring negative values during analysis. The conversions that take the Linear Program into standard form are described below.

The first step is to convert each variable inequality into a weakly less-than-or-equal-to inequality. Then slack variables are added to each Linearity constraint. The resulting Full Form of the Linear Program is therefore:

Maximize T = x1 + x2 + ... + xm

Subject to

r11x1 + r12x2 + ... + r1mxm + s1 = b1

r21x1 + r22x2 + ... + r2mxm + s2 = b2

rk1x1 + rk2x2 + … + rk2mxk + sk = bk

x1 ≥ 0, x^2 ≥ 0,…, xm ≥ 0; s1 ≥ 0; s2 ≥ 0; ...; sk ≥ 0

In which the s variables represent the amount by which resources 1 through k are unused. The decision variables are now compatible with the Simplex Method, and the model can be solved to determine the solution that achieves maximum total units sold subject to the indicated constraints.

3.4 Deriving the Constraint Matrix

Sales in electronic markets are typically influenced by several decisions: market price, promotional price discounts, advertising budget, and assortment of available products. Each of these decisions will have an impact on the overall sales volume and, as a result, the profit that can be obtained. It is often the case that if an online service product has no overall advertisement, the number of potential customers that will visit the website is drastically diminished. Cost allocation tends to become a game mode between different channels, especially for advertising expenses in electronic markets. The overall available promotional price discount limits or possible advertising expenses often depend on the corporate budget, so the electronic channels are much more sensitive to these limitations than the main offline sales. Each one of these aspects must be treated as a separate constraint since the overall maximum limits on each of them will severely deteriorate the overall sales volume. Knowing all the above aspects, different combinations of the sales factors can be plugged into the sales volume simulation models. This, in turn, will help to understand how these parameters perform for the company as a whole.

Constraints are typically expressed in functional form, stating if a particular area is to be considered a constraint, then a function must meet the upper limit in order for the region to be feasible. Therefore, it is important to go through the formulation of the constraints and determine the matrix to express the problem in a standard form for the Simplex Method. The overall linear program consists of a certain number of decision variables and constraints. It is important to build the constraint matrix A of dimension m × n, vector p of length n, and vector b of length m, and then convert the whole linear program into standard form (J. Kleywegt & Shao, 2022). Starting from the original program, the constraint equations can be rewritten as such for each constraint i (i = 1, 2, …, m):

"∑j=1n Aij xj ≤ bi," where Aij ∈ ℝ, bi ∈ ℝ, and Aij={aij, 0} are the components of the row i in the constraint matrix A, respectively.

3.4 Bounding and Feasibility Considerations

Direct restrictions on electronic-market sales-volume goals or decision variables are rare (Mogale et al., 2018). Nevertheless, bounding constraints establish nonnegativity and prevent infeasible solutions when sales expectations encounter external shocks. For example, if a simultaneous budget cut—affecting all promotions—forces sales estimates to drop persistently below zero, the estimation process has become invalid under current conditions. Similarly, a fixity assumption on website implementations may alternatively require assurance of nonnegativity on complementary-choice variables.

Feasibility checks primarily focus on ensuring all right-hand side resources remain positive. With a total marketing budget setting maximum allowable promotion levels, unutilized resources may nevertheless reflect valuable marketing options. Directly requiring attachment to affected marketing channels may thus be needed, as can further selections of unbudgeted optional channels. Relating to relevant variables in both mass-market and dynamic marketplaces can connect to changes in expected levels (e.g. under gradual adjustments) and elaborate variation magnitude limits during condition shifts.

4. APPLYING THE SIMPLEX METHOD

Applying the Simplex Method, developed by George Dantzig in 1947, makes it possible to maximize sales volume across electronic channels. The first step involves formulating the problem as a linear program, typically defined in terms of units sold per channel, price per unit, promotion level, and assortment. The objective is to maximize overall units sold, although revenue may also be used when aligned with the firm's overall goals (Gahler & Hruschka, 2016). A set of constraints limits movement within specified bounds while addressing capacity, inventory, budget, advertising impressions, server capacity, and market influence.

To obtain a basic feasible solution, it is necessary to convert the program to standard form. All variables must be nonnegative, and it should contain at least as many equations as variables. Slack variables represent surplus resources and are incorporated as needed; these supplements hinge on the constraint specifications identified earlier. The constraint matrix coefficients, right-hand side resources, and profit coefficients are determined next. The formulations must ensure that the stations remain nonnegative under anticipated shocks yet acknowledge temporary nonfeasibility for the overall scenario.

4.1 Initialization and Tableau Construction

Preparing the Simplex Method for application requires identification of an initial basic feasible solution, along with the corresponding tableau. Basic feasible solutions identify values for some of the marketing decisions while remaining compatible with all constraints. The simplex tableau is an augmented version of the constraint matrix that facilitates the process of updating the solution iteratively.

The standard form of a linear program involves maximizing an objective function while ensuring that resource levels, as expressed by the other constraints, are all nonnegative, and that all variables are also nonnegative. Connecting this to the decision variables in the context of the Simplex Method requires making use of slack variables corresponding to constraints that are not completely constrained in their resource consumption. For the formulation of said constraints see Section 4.2, and for a discussion of the state of the solution being determined see Section 4.3.

4.2 Pivot Rules and Iteration Logic

Sales in electronic markets results from the interplay between price levels, promotional intensity, customer behavior, assortment decisions, and tight caps on time-varying demand. Notably, prices affect demands, which constitutes a non-linear market model. The focus is placed instead on the marketing–inventory trade-offs under soft caps on demand, while prices do not have direct demand effects in the formulation. The objective quantifies the emphasis on total units sold (or on revenue, if sufficiently aligned) through the configuration of both the model and the Simplex approach, subject to market and other constraints. The initial formulation therefore maximizes total units sold, as priced revenues are equivalent. Resources and external market factors are capped to respect inventory, budget, advertisement impressions, and server capacity limits.

The approach pursues a generic and standard Simplex solution flow to keep the Problem Statement and Platform Overview sections concise. A basic feasible solution enables straightforward initialization. The first step converts a general specification into standard form by incorporating slack variables. The next step assembles the matrices A, b, and c from the baseline configuration and from constraints. As a separate vein to track the model supply/demand balance, flow conservation considerations could complement the configuration. Finally, the sequential algorithm logic and pivot rules are detailed, with links to the sections that articulate specific marketing and inventory actions determined by basis changes.

4.3 Interpreting Basis Changes for Sales Decisions

Basis updates resulting from the Simplex method are directly related to important strategic actions for increasing sales volume or enhancing inventory levels. Each entering variable indicates a means of boosting total sales, while each leaving variable shows a resource that has become critically low (Mogale et al., 2018). The analytic structure of the sales-volume model is a fundamental building block that enables decision support in electronic sales. Specific actions suggested by the analysis can involve altering pricing or promotional levels, adjusting the product assortment, or modifying supply orders (Remenyi & Luo, 2020).

5. SENSITIVITY ANALYSIS AND SCENARIO PLANNING

The dual values obtained from the Simplex Method provide crucial insights into the marginal worth of limited resources, enabling stakeholders to make informed decisions regarding expenditures on marketing and fulfilment activities. To assess the profitability of campaign plans and anticipated inventory deliveries, what-if scenarios can be employed to examine the effects of demand surges, cost fluctuations, and capacity constraints on the optimal allocation of promotional investments and inventory levels.

Market Variables are inevitably subject to change. Enthusiasm for a new model might exceed expectations, burdens on the budget for mandatory advertising may diminish, the most desirable release date for a blockbuster offer could shift, or the audience for special price cut displays may expand or contract. Decision-makers must therefore plan for demand and expense uncertainties, recognising that a programme incorporated into the operating plan might require adjustment as new information emerges. What-if analysis provides an effective means of dealing with such uncertainties.

5.1 Shadow Prices and Resource Valuation

Marginal value is the most common use of shadow prices for marketing, pricing, promotion, and fulfilment capacity. Given the sales-volume objective, an explicit sales-volume shadow price (or dual value) could indicate how much additional capacity—or a corresponding improvement—would need to be secured to lift sales. For example, an ad-impression marginal price of X Euros means that every Euro spent on additional impressions generates X Euros worth of additional sales; a marginal ad-price of 0 indicates inefficiency at the current ad level. Extracting sales-volume shadow prices depends on the Simplex basis changes and interpretation of the sales-volume model constraints (Khabarov et al., 2022).

5.2 What-if Scenarios for Markets and Promotions

To design effective market and promotion strategies, one can investigate expected shifts in demand, price, cost, capacity, and interaction effects. The model helps determine which markets merit attention, when to intervene, the most suitable actions, and their timing via a sales-volume target. It also handles simultaneous changes, guiding adjustments during promotions, inventory acquisition, or other interventions (Yenradee et al., 2013).

Marketers invest in advertising and promotional campaigns, yet many lack systematic approaches to evaluate prospective expenditure returns (Albert & Goldenberg, 2021). Efforts focus mainly on final targets—sales or net margin—rather than intermediate objectives such as advertising impressions or purchases. The model can manage promotional campaign planning. For each activity, one specifies quantitative goals, degrees of flexibility, and additional means to increase interest. As an example, targeting prior to wider launches guides first-on-market actions for a new item.

6. MODEL VALIDATION AND PRACTICAL CONSIDERATIONS

The proportion of daily transactions on electronic marketplaces that takes place on smartphones has grown rapidly in the past few years. Coupled with the increasing amount of content created on these platforms and corresponding limitation of ad budgets, it has become critical for retailers to use their limited inventory, price budgets, marketing-resource budgets, and spare server capacity most efficiently. Understanding how to utilize these resource levers to maximize the number of sales and overall exposure and revenue, and quantifying their trade-offs, has become essential in the strategy for electronic sales channels.

Given various sales-volume goals with corresponding levers such as pricing, promotion, and assortment, sales-volume calculations allow the retailer to understand how much of its entire limited budget to spend on each type of lever in order to meet a particular goal, while also revealing the importance and trade-off of each lever in the process. By developing a sales-volume model and identifying the complete formulation with the Simplex Method, the retailer is able to comprehensively evaluate the response of the system to changes in the market, such as new competitors, opening new sales channels, enlarging service coverage both geographically and via additional products, and updating sales-promotion strategies.

6.1 Data Quality and Parameter Uncertainty

Uncertainty regarding parameters used to predict sales occurs in all electronic marketplaces, so guidelines for formulating and conducting sensitivity analyses are essential both to validate actual sales data and to increase confidence in associated marketing, fulfillment, and promotions decisions. For instance, standard deviations of parameters can be derived from prior experiments or estimated through carefully designed designs of experiments or protocol screen tests. An assessment of how highly invariant parameters across existing marketplaces, fulfillment activities, and advertising venues impact the model confirms the initial model calibration and identifies parameter regions where further innovations must ensure operational success. Evaluating scenarios that progress the firm from its existing state to projected future evolutions of a key parameter can inform policies to mitigate the forthcoming disturbance.

Note that the priority of certain marketing and promotion parameters is also clarified by evaluating their cross-market propagation characteristics. Multiple analyses relate concurrent estimates of these propagation characteristics to assessments of model-data fit and—in concert with results obtained across other bifurcation parameters previously discussed—indicate how to achieve maximum prioritization in the least experimentally burdensome fashion.

6.2 Model Limitations in Dynamic Electronic Markets

Market demand even for very similar products can typically differ considerably per sales channel, offer, or customer segment (Dütting et al., 2016). Pricing, promotions, or assortment offer decisions often require careful consideration of dynamic interactions across the various marketing levers or channels. The potential rewards of quantifying these interactions are well demonstrated by the many aggregate pricing models and demand type models that often significantly enhance marketing decisions. Unfortunately, the necessary properties for extending these models in a semi-dynamic electronic context are often not met. Marketers in online environments face a compelling decision whether to adjust online offers or offline costs in response to fluctuations in consumers' attention. The sales volume decision problem concerns optimizing sales volume based on prices, promotion levels, and assortment. Electronic markeplaces can offer detailed information on viewing rates, search costs, and sales.

Online marketplaces often show substantial variability in demand for similar product-classified offers directly from one search to another. Posting prices while accommodating the price of contingent sales on undeposited offers gives a desirable degree of generality. Stable pricing remains clear demand-response repetition in several contexts, yet price elasticity may remain radius slight. Policy shifts covering longer intermittency-periods than the fully contemporaneous singularity apply in complex ways dependent on page-activity duration. Constraints capture the standard cross-contamination constraints arising in competitive channel-pricing contexts. Literature on competitive pricing contrarily demonstrates that aggregate stock-limited congestion for undeposited offers need not arise directly in similar contexts. Automatic price-setting methods thus adjust higher-level market data to suitable periodic checkpoints allowing further aggregation.

7. EXTENSIONS AND COMPUTATIONAL ENHANCEMENTS

Optimization problems commonly arise in business decision making which is a vital area of operational research. Techno-economics (as a branch of applied economics) aims at strategy and hardware procurements within organization; it is generally believed that techno-economics is coming into its own which is more and more important as semiconductor manufacturing processes progress towards 10 nm and below. Depending on how one measures success, either time-to-market of new products or sales (volume) growth of the already announced products is critical at this point. Semiconductor manufacturers' capital expenditure is at its all-time low for many reasons; keeping growth in revenue, profit, and market share has been crucial since 2005. Volume estimation and marketing mix strategy for IT products (e.g. semiconductor-based electronics) is at least a strategic objective of such a techno-economic analysis (P. Saksena, 2018).

Maximizing sales volume in electronic markets through the simplex method is a timely commercial issue; especially in light of the dynamic nature of electronic markets complemented by the ample academic literature matching simple forecasting and promotional models with optimization. The simplex method—to reduce observable variables while maximizing input across various, competitive, and limited constraints—effectively quantifies sales promotion activities through market input variables such as advertisement impressions considering advertising budgets and resource requirements within engineering capabilities (Chen, 2015). Participating in electronic-shopping platforms is a common practice for vendor-manufacturers willing to drive vehicle-movement toward consumers for instance pigeon hole; because either price, discount, or the number of extraordinary advertisement mass- spreads could affect market estimation predominantly; hence the simplex method with manual data storage reduces freight volume and drives speedy delivery through traveller-customer interaction. An example study case under the online-retail platform would connect price and discount directly with potential computer response for estimation and freight analysis. Incumbents with dynamic supply-and-demand variation technology could only dominate the estimation of freight activity.

Participation in online marketplace (e.g. eBay and Amazon) draws producers willing to leverage attractive vehicle progression toward consumers. Price, promotion, and assortment are key marketing levers influencing sales volume. In addition, advertisement display potentially captures missed profit; replying advertisement is core lever further affecting price and discount beyond advertisement registration which directly controls advertisement carriers; advertisement display estimation could backward-solve advertisement volume estimating accordingly. Pricing, promoting, assortment, and advertisement display are four factors critical estimating supply-and-demand variations, diagrammed as Equation 1. These four factors influence products continually, enabling one-time estimation. Once running budget turns out positive, price, promotion, assortment, and advertisement display along again amp expands these four variables; hence supply-and-demand commence advertizing-response-collected backward to induction Supply-demand quickly estimation incorporates advertisement display. Pricing, promoting, assortment keep involved anyway alongside within techno-economics (Lü et al., 2009).

An alternative marketing task focuses upon the other commodity deploying time-sequenced method directed sales-promotion plan. Increment sales quantity involves an auxiliary component affecting Supply-and-demand consequently either participation Platform matters enclosing pricing, promotion, and assortment within techno-economics.

7.1 Two-Phase and Revised Simplex Variants

To apply the Simplex Method, certain characteristics of the mathematical programming problem under consideration must be investigated. For a given candidate solution vector to be evaluated in terms of its feasibility and to formulate certain characteristics of the solution space, it is necessary to express the problem in standard form. Several problems can be stated in standard form by introducing nonnegativity restrictions, but for those constraints or right-hand-side conditions that take on negative values, a two-phase procedure provides a systematic approach to attaining a basic feasible solution without an a priori knowledge of the variable sets. This approach can also simultaneously establish whether a feasible solution exists when the requirement for an optimal solution is removed. If the problem can be solved using the Simplex Method, which retains basic feasibility, a large proportion of the implied solution space can be successfully explored, and the Revised Simplex Method can be employed in conjunction with suitable floating-point arithmetic to automate this exploration (P. Saksena, 2018).

These features and principles permit considerable generalization of the Simplex Method for efficient solution search of large problems. Some other characteristics of the Simplex Method may vary considerably without invalidating its formulations.

7.2 Incorporating Nonlinearities and Integer Decisions

Sales in electronic markets can show nonlinearities, particularly in the demand as a function of price; promotions' impact on sales can also vary depending on the chosen promotion levels. Introducing nonlinearities in the pricing/promotion optimization has a limited impact when an assistant tool estimates and generates pricing-only and promotion-only queries. Such a two-tiered selection of price only, promotion only, or both variables is even adopted with a Logit demand model—nonlinearity is ignored. Prospect Theory provides an alternative enjoyment-focused utility model rather than human rationality; other alternatives exist but do not attract significant theoretical or numerical inquiries yet.

Discrete choice and price affect demand beyond nonlinearity—unit shipment or assortment choices may be limited. The relevant choice under investigation could concern whole pallets, truckloads, or bundles; extending the Large Market Program with mixed-integer programming for three identical containers at a specific price illustrates the methodology. Typically, pricing adjustment remains a primary lever exceeding accompanying promotional activity. Alternative price levels may imply distinct demand functions while diverging from the Large Market Program's applicable area; extra checks on model relevance would then be pertinent.

7.3 Decomposition and Large-Scale Applications

The exhibits of many electronic marketplaces demand a restoration to the basic concept underlying the Simplex method: the efficient treatment of very large linear programming problems arising in a variety of decision contexts. Careful formulation of the underlying linear program can in itself lead to important reductions in size, but decomposition techniques may still be needed where the pricing offers, assortment decisions, or competitive conditions remain strongly feature-rich—cases likely to increase in importance as systems continue to evolve.

Atmospheric and preemption models based on Lotka–Volterra partial differential equations (Mogale et al., 2018) take as input an initial high-level form of competitive interaction and competitively determine at the item level the relative attractiveness of developing offers. These measures are configured to inform a second stage in which either column-generating or Dantzig–Wolfe decomposition examines selection from a rich assortment in conjunction with pricing adjustments and medium-term promotional allocations, potentially yielding valuable insights on the structure of the problem and on candidate partnerships. A similar format but with a more nontrivial architecture can explore price effects on stylized daily offer patterns when ad-serving or offer-surfacing technologies exhibit low cycle times (Bettiol et al., 2017).

One common path in electronic sales channels leads to the regulated twin problems of allocating customer impressions to promotion and variety bundles. Prominent attention is thereby devoted to the resolution of resource allocation in so-called multi-armed bandit systems under constrained-bandwidth settings. Formulations of each offer as a separate bandit with tailored switching costs are preferentially employed to focus attention cleanly and pointwise on each deeper customer-state-level choice.

8. CASE STUDIES AND EMPIRICAL EVIDENCE

The overall structure, section content, key insights, and writing style all support the following specific case studies.

8.1 Online Retail Platform

Many retailers use third-party online platforms to sell a broad range of products and set price, promotion, and assortment decisions. Such platforms monitor products hosted by sellers and maintain a market-driven, seller-specific price, promotion, and assortment profile to optimize overall revenue. A framework is being developed to gain insights from the corresponding decision-variable estimation problem by applying the proposed methodology.

8.2 Marketplaces with Dynamic Pricing

Price, promotion, and assortment decisions on marketplaces such as Amazon and Alibaba evolve continuously in response to cost, competitive, and demand fluctuations. To model this time-varying structure, the competitive influence in the markup-pricing-based demand model will be reformulated into the complementary-variate formulation of demand. Instead of a pivoting table update, the solution iteration will begin by engaging the newly activated competitive product once a setup phase is completed.

8.3 Case Study 1: Online Retail Platform

An online retail platform presents a challenging electronic marketplace needing to maximize sales-volume potential. Only three levers—price, promotion, and assortment—are available. A Simplex approach can quantify trade-offs among marketing decisions and other constraints active in e-commerce at a competing firm, thus planning volumes prudently across marketing dimensions.

The platform sells a selection of units tied to large brands, with competition advancing from rivals using social media/ads and receiving influence on the assortment. Typical promotions take the form of flat or percentage discounts, with promotional budgets limited; these constraints impact the channel across plans for both promotion and assortment.

Consumer marketplace activity at this online platform is influenced indirectly by complaints through a market-leading competitor. Insights indicate that these extrinsic complaints arise once per unit of stock available, materializing after purchase even without e-commerce activity. Thus even though the two channels have far from identical offerings, additional drops at the rival before replenishment may expand the available market. On-demand platforms at e-commerce cannot routinely discover fresh-hold shopping either; once a house-target drop is declared, no other stable alternatives can be proposed thereafter. Competition over a shopping experience may enter a lower-cycle venue (Kamanchi et al., 2020).

8.4 Case Study 2: Marketplaces with Dynamic Pricing

Electronic sales platforms engage customers through time-sensitive promotions, offers, and discounts. Prices may vary by hour, day, or week, creating a compelling use case for dynamic pricing and sales-volume modeling (Wen et al., 2015).

Demand tends to decrease if no customers observe a price (Bérczi et al., 2021). When a new customer arrives, adjusting prices—and possibly raising them—becomes essential. Inventory monitoring, updates, and resources used for fast replenishment guide the choice of promotions (Müller et al., 2021). High demand motivates larger price hikes, while limited inventory favors minimum promotions with less replenishment effort.

9. CONCLUSION

The Simplex method enables optimization of sales volume in electronic markets, supporting strategic pricing, promotion, and assortment decisions for maximum units sold or market revenue. Moreover, the method provides additional insights pertaining to the marginal valuation of marketing expenditure and resources used to fulfil demand. Translating the Simplex method into marketing actions increases both the relevance and readiness for practical implementation.

Sales-volume problems in electronic markets are characterized by many discrete resources—inventory for all items, a finite budget for promotions, and a limited number of advertising impressions. The need for sales-volume forecasting is complicated by resource considerations, since substantial marketing effort can stimulate additional market demand that may induce cannibalization or thereby affect non-discrete factors—shifted price levels for all products, an overall promotion factor, or dynamic pricing decisions. Furthermore, demand-side balances may impose hard constraints on the available sales, such as a limited number of server requests for large e-selling companies or auctions with time-dependent bidding intensity.

STATEMENTS AND DECLARATIONS

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interests: I have nothing to declare.

REFERENCES

Albert, J. & Goldenberg, D. (2021). E-Commerce Promotions Personalization via Online Multiple-Choice Knapsack with Uplift Modeling.

A, Ahmed. (2018). Operations Research in Management (Applied Applied).

Bérczi, K., R. Bérczi-Kovács, E., & Szögi, E. (2021). A dual approach for dynamic pricing in multi-demand markets.

Bai, R., Van Woensel, T., Kendall, G., & K. Burke, E. (1970). A new model and a hyper-heuristic approach for two-dimensional shelf space allocation.

Bettiol, E., Létocart, L., Rinaldi, F., & Traversi, E. (2017). A simplicial decomposition framework for large scale convex quadratic programming.

Calvete, H., Domínguez, C., Galé, C., Labbé, M., & Marín, A. (2019). The Rank Pricing Problem: models and branch-and-cut algorithms.

Dutta, Goutam. (2000). Lessons for Success in OR/MS Practice Gained from Experiences in Indian and U.S Steel Plants.

Dütting, P., Fischer, F., & Klimm, M. (2016). Revenue Gaps for Static and Dynamic Posted Pricing of Homogeneous Goods.

Lü, L., Medo, M., & Zhang, Y. C. (2009). The role of a matchmaker in buyer-vendor interactions

Li, J., Yu, N., Liu, Z., & Cai, X. (2017). Allocation with demand competition: Uniform, proportional, and lexicographic mechanisms.

J. Kleywegt, A. & Shao, H. (2022). Revenue Management Under the Markov Chain Choice Model with Joint Price and Assortment Decisions

Remenyi, N. & Luo, X. (2020). Demand Estimation from Sales Transaction Data - Practical Extensions.

Render, B., M, Stair, R., E. Hanna, M. (2006). Quantitative analysis for management , 9 e

Gahler, D. & Hruschka, H. (2016). Resource Allocation Heuristics for Unknown Sales Response Functions with Additive Disturbances.

Hasanah, U., Putrawangsa, S., & Tejo Kumoro, D. (2019). Applying Linear Programming in Business Decision Making: A Case of Profit Maximization of a Commercial Housing Development

Mogale, D. G., Lahoti, G., Jha, S., Shukla, M., Kamath, N., & Tiwari, M. (2018). Dual market facility network design under bounded rationality.

Müller, D., Nesterov, Y., & Shikhman, V. (2021). Dynamic pricing under nested logit demand.

Khabarov, N., Smirnov, A., & Obersteiner, M. (2022). Shadow prices and optimal cost in economic applications.

P. Saksena, C. (2018). Some contributions to the theory of mathematical programming.

Chen, Y. (2015). Essays on Inventory Management and Conjoint Analysis.

Kamanchi, C., Ashok Kumar, G., Sundaram, N., Babu T, R., & Bandi, C. (2020). An Application of Newsboy Problem in Supply Chain Optimisation of Online Fashion E-Commerce.

Wen, undefined, Chen, undefined, Fleischhacker, A., & N. Katehakis, M. (2015). Dynamic Pricing in a Dual Market Environment.

Yenradee, P., Predawut, S., Rungmanochai, P., & Eamcharoenying, W. (2013). Integrated Aggregate Production and Marketing Promotion Planning under Uncertainty: A Case Study.